Idaho State University
POCATELLO, IDAHO
83201

Museum

Friday 4 p.m.

Dear Don + Evelyn,

My apologies for the lousy copy, but I just couldn't afford Xerox at 5¢ a page! Dr. Swanson has tentatively O.K.'d it as is but now wants to reread the whole thing. Also, I haven't written conclusions yet - but you know what they are anyway.

Bill is going home for 2 weeks next week, + my parents are coming here for 10 days. We'll have to arrange a time good for all of us to get together. Hope you're both fine.

Chris

Chapter I: INTRODUCTION AND STATEMENT OF PROBLEM

Except for the work of W. H. Holmes around the turn of the century, studies in lithic technology have been largely untouched or ignored by the archaeologist. Lithic studies are now undergoing an increasing relevance, and archaeologists are becoming aware of their credibility and application to current research. This thesis is intended to arouse interest among fellow archaeologists the incredibly large body of knowledge there is to be gleaned from the study of lithic debitage, particularly at a quarry workshop site. For too long, members of the profession have concerned themselves only with describing and/or classifying finished artifacts of stone. There is far more to be learned if one is able to retrace the entire process of manufacture through careful examination of the debris from all stages, not merely the final one.

In studying the morphology of a stone tool, one is seeing only the final result of an involved series of processes, thus subtractive technology (Deetz 1967:48) speaks only of the last of these processes. It is my desire to attempt to reconstruct the stages of manufacture, based on the debris found at the Crabtree Site.

I am not concerned with establishing a datable chronology, nor do I wist to include complete ethnographic details about the aboriginals who used this quarry. It is my contention that the Crabtree Quarry was used merely as a source of fine obsidian toolstone and that users of this quarry intended only to remove raw materials from it after having worked these raw materials into an easily transportable or tradable size and shape.

The data support my assertion that this site was at no time a long term habitation area, and further that no pressure flaking or other fine finishing of tools was carried on here.

The Crabtree site is one of two North American obsidian quarries to investigated in depth. The other is the Riley Site, Oregon, by John Atherton in 1966. Certain affinities to other types of quarries will be examined. Effort will be made to determine what manufacturing techniques are shared, and what variables influence what is found at a quarry.

Another aspect of this thesis will be the method of collection employed at a quarry site. I will show that a person who is familiar with stoneworking methods and has had some practical experience is able to selectively collect a statistically representative sample of debitage.

II

NATURAL SETTING

The Crabtree Site is located about 70 miles west of Burns in the high lava desert of central Oregon. This desert is the youngest and least eroded region of Oregon. Its general form and elevation are due largely to nearly horizontal beds of Basalt. Buttes and cinder cones are common. General elevation a.s.l. is 4000 feet. Some of the buttes rise to 6,000 The surface of this region is composed of accumulations of ash, cinder, pumice and obsidian, recent lava flows and other extrusive igneous rocks. (Dicken 1965, Fenneman 1931)

The dominant structural feature of Glass Buttes is an anticline which has been greatly modified by normal faulting. Three separate extrusions of lava are represented. Some of the lava is so recent it is bare and unaltered. Considerable quantities of obsidian occur in the Glass Buttes range. It is of two types: jet black and almost transparent in thin sections, and variegated, which contains inclusions of black obsidian in a brownish red base. Some obsidian shows alternating banding of red and black. Such variables as the temperatures and pressures which caused the igneous activity, the conditions of its cooling, and the composition of the original molten mass determine what type of igneous rock is formed. Obsidian results from the rapid cooling of highly silicious magma. ~~xxxxx~~ Its other constituents include iron, aluminum, magnesium, calcium, sodium, and potassium (Waters 1927, Hunt 1967)

The High Lava Desert is a land of interior drainage with few well defined stream courses. The permeability of underlying rock contributes to the aridity of the region along with scant rainfall, averaging less than 10 inches a year

The climate, landforms, and soils are reflected in the vegetation cover. The High Desert is dominated by sagebrush (Artemisia tridentata), tall perennial grasses of the bunch habit, and halophytes such as Atriplex spp., Sarcobatus vermiculatus, Eurotia lanata and Grayia spinosa. There is sufficient moisture at approximately 5000 feet for juniper trees to grow, and these are found on some of the buttes. They are widely spaced to make most efficient use of water. (Fenneman 1931; Daubenmire 1943; Hunt 1967; Dicken 1965)

Ethnographic Information

Inhabitants of the Harney Valley region of Oregon were identified by Beatrice Blythe as the Wada Tika (seedeater) band of the Northern Paiute. She reported that there was no ownership of food resources. It follows then that materials sources such as Glass Buttes were also subject to use by many bands.

> " There was no feeling of band ownership of the hunting and gathering grounds. Any group of people might utilize the produce of the terrain without trespassing. There was a tendancy however, for the Wada eaters to frequent the same places from year to year. During the summer wandering, they would often encounter people of different groups.
>
> The Wada eaters knew and had frequent intercourse with seven surrounding bands. . . In mapping these regions, there is land which they did not assign to any definite group. Such territory was undoubtedly utilized by all adjacent bands, like all hunting and gathering grounds (1938:403).

Concerning use of California stone quarries, Heizer and Treganza report the following:

> The Indians probably had no particular "mining Gods" as such although one principle of Indian philosophy which ran through everything was applied to the use of mines and quarries; this principle is the conservation of natural resources. . .
>
> In the eastern United States, certain quarry sites were recognized by all natives as neutral ground where tribes which were bitter enemies could meet but not fight. The concept and practice of neutral ground also obtained in California at the Stonyford salt seepage and the obsidian quarries of Clear Lake where any hostile group could meet another but trouble was forbidden (1944:300-301).

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The Setting (Site)

The Crabtree Quarry area covers an extended ridge top which runs in a nearly north south line. Obsidian is exposed over the entire surface of the ground. On a sunny day it is visible for some distance. Nodules and broken pieces are everywhere, though the heaviest concentration of evidently worked material occurs in a number of well defined chipping pits directly on the ridge top. There are at least eight of these chipping pits, two of which were excavated for this study (See fig. __) The concentration of debris covers an area approximately 40 by 100 meters. Hereafter this area will be designated GBI

The steep slope to the west of the quarry ridge reveals layers or shelf like deposits of obsidian. It appears to have been laid down in a blanket, and perhaps later covered by additional deposits of obsidian. At one point some 100 yards from G.B.I on the west slope an outcrop of this obsidian shelf was observed. A solid deposit at least thirty inches thick was uncovered. A vertical crack in the material was filled with extremely hard packed fine grained matter of a clay like appearance. Two men weilding an iron crowbar dug thirty minutes without reaching the base of the deposit. How much deeper it continued into the earth is unknown. A factor in the cooling process accounts for the vertical cracks. As hot volcanic magma loses heat, under certain conditions it may fracture somewhat in the manner of columnar basalt. This phenomenen also occurs within smaller masses or around the perimeters of obsidian flows, causing very symmetrical or rod like shapes to be produced (Hunt 1967:23-4). These "starch fractures" (Crabtree:pc) vary from toothpick size up to twelve inches or more in length.

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Approximately 20 yards east of the concentration of debitage pits is located a small cliff, some 20 feet high in places, running north south for about 1/2 mile. Juniper trees of varying sizes grow both at the top and bottom of the cliff. It is the only spot currently affording any shade at all for a considerable distance from G.B.I. Large deposits of flakes and nodules occur at the base. The face of the cliff is not strictly vertical and is in places easily surmountable. This area is designated G.B.II

Eastward from the base of the cliff extends a steep hillside littered with large pieces of cliff fall. This is G.B.III

Two miles south of G.B.I lies a ridge hwere so called "rain bow" obsidian is found. This is G.B.IV. An Indian legend makes the following account of of its origin:

> After the mount.in had burned for several days there came up a shower having a beautiful rainbow. The rainbow shone all day on one spot on the south side of the mountain and at evening seemed to enter the ground at this particular spot. After the fire they found that some of the mountain had melted and had made heaps of glass for their arrows and spear points, but the rainbow had settled into one heap and left the beautiful colors there (Forbes 1935:307).

Three miles north of G.B I along a ridge top is another quarry location. This area, G.B.V, consists predominantly of black rather than variegated or red obsidian.

For the precise locations of G.B. I - V please see ~~the~~ Fig. —)

[redacted]

REVIEW AND ANALYSIS OF SELECTED LITERATURE

In order to gain some insight into the study of quarry sites, a short review of other North American quarries is called fof. In this chapter I will focus mainly on the works of W.H. Holmes, Floyd Sharrock, Kirk Bryan, Douglas Bucy, Alan Bryan and Donald Tuohy, John Atherton, and Malcolm Farmer.

William H. Holmes (various) has probably contributed more to the study of lithic technology than any other individual. His reports on aboriginal knapping and quarrying activities from all over North America and Meso America are voluminous. Why they have gone so long unnotifed is not clear. However, today there appears to be an increasing appreciation of Holmes' work. He was one of the earliest people to practice stone working techniques himself, trying to replicate aboriginal specimens. In doing so, he recognized that a continuum of manufacture necessarily exists, and that to arrive at the end product, each step in the continuum must be effected. His words, written 75 years ago, are applicable today to the sequence of events represented at the Crabtree quarry:

> I have found that in reaching one final form I have left many failures by the way, and that these failures duplicate, and in proper proportions, all the forms found on the quarry sites. . .
>
> I further find by these experiments--and the conclusion is a most important one--that every implement resembling the final form here described,

> and every blade shaped projectile point made from a bowlder or similar bit of rock not already approximate in shape, must pass through the same or nearly the same stages of development, leaving the same wasters, whether shaped today, yesterday, or a million years ago; whether in the hands of the civilized, the barbarous, or the savage man (Holmes 1897:61).

Holmes' basic conclusions about the nature of quarry workshops were that 1) they were used by aboriginals as a source of toolstone which was worked into roughly formed objects of a convenient size and shape for export and 2) that final shaping of functional tools was carried on elsewhere. This is well summarized in the following:

> Now, although the blades produced in the quarry shops may without modification have been used for cutting, scraping, perforating and other purposes, I am decidedly of the opinion that as a rule they were intended for further elaboration; this is rendered almost certain, first by the fact that the most fully shaped broken pieces found on the quarry shop sites are but rudely trimmed on points and edges, specimens of like grade being fitted for use in cutting and scraping; and, second, that all the tens of thousands of specialized forms--spearheads, arrowpoints, and

perforators--are necessarily specialized from such blades, as shown in subsequent section. The quarry workshop was naturally not a place for finishing tools, but one for roughing out the material and selecting that fitted to be carried away for final shaping. A laborer engaged in such work in a pit in the forest would not be likely to throw aside the rough hammer used in fracturing cobblestones to take up and operate an entirely different kind of machinery, involving a distinct and delicate process. Being a reasoning and practical dreature, he would carry away the roughed out tools, the long thin blades, to be disposed of or to be finished at his leisure and by whatsoever method experience placed at his Disposal.

The quarries, being extensive, were worked somewhat systematically and the product was naturally of great importance to the people concerned. The baades made during a prolonged season's work were numerous and were carried to village sites far and near for use, specialization or trade. There would be in their history a period of transportation attended by storage, and this would explain the cache, an interesting feature of stone implement phenomena, and one which involves just such blades as were produced in the quarry shops (Holmes 1897:62).

The only exception I take to the above quate is that all specialized forms such as spearheadsm arrowpoints and perforators are not necessarily derived from blades or blanks. Holmes also rectified this error in a later publication (Holmes 1919).

Hoämes, in his work at Spanish Diggings, Wyoming + Oklahoma, reports that the "beds of chert are of unknown area and of great thickness". This statement also describes the nature of obsidian at the Crabtree site. Holmes noted that beside the gënerally round pits of debitage where flaking operations took place were found piles of raw material, brought to within reach of the workmen. As in previous quarry studies by Holmes, the Spanish Diggings site produced almost exclusively blamks intended for further shaping later. Hoämes found scant evidence of other tool manufacture, and attributes this to the fact that the quarry was not subject to long term habitation. He says:

> As in other cases where dwelling was not associated with the factory site, no specialized implements were found (1919:207).

He includes an excellent photograph of blank "rejects" (1919:205) which excepting the material they were made from, are very similar morphologically to those I recovered from the Crabtree site (Fig.__). Holmes does list among other items found "a few large thick blades. . .

notched in opposite margins as if to be hafted as picks, and several fluted cores or nuclei from which thin flakes had been detached. . .(Holmes 1919:207). These large thick blades are perhaps tools used in quarrying, or possibly the remnants of the most temporary campsites.

Spanish diggings and Hell Gap are closely associated. [illegible] [illegible]

Basically in accord with Holmes' work is Floyd Sharrock's study of several Bridger Basin, Wyoming quarry sites (1966). Raw materials here were quartzite cobbles or quarried blocks of quartzite and tiger chert. The following statement by Sharrock closely parallels an earlier quote from Holmes (loc. cit. p. __):

> Because all the sites included in this study are always either directly or closely associated with a water source, with the Lyman Surface (quartzite cobbles), and with a tiger chert outcropping or a Uinta quartzite foothill, there seems to be no doubt that transients were moving to potential quarry locales specifically to camp, quarry and manufacture artifacts or to reduce the size of large pieces of stone blanks to manageable proportion for transport (~~op. cit.~~ 1966: p. 39).

Sharrock found that blanks in quartzite workshop sites clustered at five stages along the manufacturing trajectory. He defines these stages according primarily to the estimated average thickness to width ratio, edge morph, gross shape, I observed no such clearly defined stages of reduction in bifaces from the Crabtree site. However, judging from Sharrock's descriptions and illustrations (1966:43-46), there are many blanks from the Crabtree site which are markedly similar to his Stages 1, 2½, and 3. Sharrock's Stages 4 and 5 include smaller and thinner artifacts than were present at the Crabtree site. Sharrock concludes that:

> A blank of any stage. . . can easily be confused with a finished artifact. Stage 1 and 2 blanks are identical statistically to the ubiquitous chopper or chopping tool associated with most archaeological sites everywhere. . .Stage 4 forms, morphologically could be knives and many probably were. . .Stage 5, in all respects could be knives or unstemmed projectile points and many undoubtedly were (1966:41-42).

A large inventory of other finished chip stone artifacts was recovered in the Pine Springs area by Sharrock. Their presence is explained in the following quote:

> It should be borne in mind that the extensive quarrying activity throughout the surveyed area is a product of the availability in the area of stone suitable for knapping.. . The area is quite suitable for camping and game apparently was plentiful. As a consequence of these two factors, people apparently took advantage of the quarries while camping, hunting or gathering, or perhaps came specifically to take advantage of the quarries--camping, hunting and gathering while there (1966:145).

Kirk Bryan has a very divergent opinion of quarrying in general, and also of the Spanish Diggings site. He contends basically that many finished tools were manufactured qt quarries, and rather than transporting these tools to be used elsewhere, the raw materials of wood or bone were hauled to the quarry and worked there. Much of his argument is based on what he claims to be evidence of use wear or retouch on a number of flakes. However, never in his paper does he discuss the criteria for deciding something has been man altered rather than the result of accident or nature. In Bryan's words:

> It is the purpose of this paper to outline in considerable detail several more or less interwoven theories regarding quarries. Two main theses are presented:
>
> 1) that many of the so-called "blanks" and "rejects" are usable tools, mainly axes, and that they were actually used;
>
> 2) that many flint quarries were not only sources of flint for export, but also industrial sites or factories to which materials such as wood and bone were brought to be worked in the presence of abundant tools. These main theses are supported and inspired by the very greatly expanded knowledge of typology developed in the past thirty years; by the recognition in the debris of quarries of numerous flakes, and of shaped and utilized pieces of irregular shape; and by

our present saner attitude toward the antiquity of man in America (Bryan 1950:3).

Bryan further advocated that many rejects or fragments of broken bifacially worked flaked oval "blades" are the result of accidents of use or misuse, rather than errors of manufacture. He claims that these heavy bifaces were actually used as hafted axes to work wood imported to the quarry workshop:

> . . . many of the heavy bifaces are broken at right angles to the long axis. . . such breaks cannot easily be attributed to manufacture but can be explained plausibly as due to use (Bryan 1950:22).

Bucy (1971) takes exception to this opinion as follows:

> The transverse breaks across the long axis of Bryan's rough shaped hoes and axes can result from manufacture from a number of causes--each of which created certain distinctive types of fracture surfaces. Such breaks can occur because the material contains unsuspected flaws such as natural cleavage planes, crystal pockets or vugs, and changes of texture or homogeneity of the material. . (1971:40).

Another plausible explanation of the transverse breaks often observed in bifacially worked objects is offered by Tuohy and Bryan (1960). They demonstrated through experiment that a biface dropped upon a hard surface may break across its long axis leaving little evidence of abulb of force, and oftem terminating in a hinge on the face opposite that which received the blow (1960:506).

In sum, Kirk Bryan's theory that heavy bifaces are actually the remains of hafted axes used for woodworking is unconvinc ng to me for two reasons:

1) He claims to have observed use wear on these items, but he offers no criteria for the determination of use; and

2) He dismissed the possibility that some of these implements may have been used in quarrying operations labeling them "unsuitable in shape and size" (1950:13).

Byran's work is not however, totally without merit. He offers the following cogent remark concerning quarry studies:

> We should, therefore, expect that more detailed archaeological work in the debris of flint quarries would yield data adequate for the recapitulation of the technical sequences of flintworking. Each major implement was presumably begun in a way leading to economy of labor either in reduction of strokes of in the value of by-products and of the imperfect transitional stages. We should expect the sequences to merge into each other and to bifurcate, so that there may not necessarily be a single way to begin nor a single way to finish from one beginning. This type of analysis still awaits the patient and fortunate typologist (1950:33).

Site 10-WN-10, part of the Midvale complex, is located in western Idaho near the confluence of the Weiser and Snake Rivers.(Warren, Wilkinson and Pavesic 1971). The complex contains ten sites. One of these is thought to be a major habitation site, representing a wide range of activities: tool manufacturing, hunting and collecting. The remaining sites appear to be satellite areas, where specialized activities took place. 10-WN-10, 11 and 12 are limited to quarrying . They are source areas for basalt which occurs in nodular form on the surface. Concerning the debitage from 10-WN-10, Bucy reports the following:

> The high percentages of flaking detritus at the earliest stages of manufacture, particularly cortex flakes, and the low percentages of detritus representing the final working stages indicate that this site served as a materials source. The site represents an area where high quality material was sought and reduced to transportable form, the greatest percentage of waste being removed and left at the source. The transportable forms, roughouts or quarry blanks were carried away from the quarry to other sites in the general locality for further shaping and finishing work. . .anvils, a variety of hammerstones and a number of simple scraper forms are present at quarry sources. These

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implements were used in obtaining and reducing the raw material to preliminary blanks and roughouts. . .(Bucy 1971:92).

A small number of finished tools was found at 10*WN-10, indicating that perhaps some very limited subsistence activity took place. He says:

> Specialized flakes and implements excluding fla king tools constitute 9.75% of the total collection, indicating that relatively little finishing work was carried out at the quarry. The finished implements found at this site probably represent those used by the workmen in acquiring raw material while in the locality (Bucy 1971:91).

Although Bucy identified more functional tool types than I beleive to be present at the Crabtree site, his biface blanks appear morphologically very similar to those I recovered except for the material they are made of (See Bucy 1971: Figs. 15 a-m). The transverse breaks shown in Figs. 15 g, h, j, and l (1971) closely resemble many broken biface fragments from the Crabtree site which exhibit patterns of hinge fracture (Fig.__).

Bucy also reports the use of "self" hammers at the Midvale quarry. This helps to explain the small number of hammerstones recovered. However, the use of obsidian self hammers at the Crabtree quarry is unlikely. The brittle, glassy qualities of the stone would make this technique very hazardous, as pieces of the percussor are easily detached and may become potentially dangerous missiles. I have experienced this in my own flintworking, and have observed the same by other flintworkers.

A difference between the Crabtree and Midvale quarries is the presence of possible cores at the Midvale quarry, although Bucy (1971) theorizes that these were not cores for the manufacture of flake tools, but rather were samples of material being tested by the aboriginal by the removal of a fresh flake.

Comparitively then, the Midvale and Crabtree quarries share a number of traits: the presence of broken biface fragments, some similarity in transverse breaks of some bifaces, very few hammerstones, and the lack of a major core and blade industry. The greatest differences between the two quarries are the presence of retouched flakes and some finished tools at Midvale, the presence of an intensively occupied habitation area one and a half miles from 10-WN-10, and the indication that self hammers were used on the tougher, more resistant basalt at Midvale.

The Stockhoff quarry, reported by Bryan and Tuohy (1960) is a basalt quarry in northeastern Oregon. It differs from the Crabtree site in that it contains a habitation area where projectile points of stone exotic tothe region were found. All other material from the site was indigenous finegrained basalt. It is also markedly different from the Crabtree site in that it contained 165 artifacts Many of which were finished tools designated as scrapers, choppers, cutting or piercing tools, points, knives and spokeshaves. Bryan and Tuohy also found 13 blades and blade blanks. Their criteria for distinction between the two was degree of finish--blades exhibited finer retouch and controlled flaking, though this distinction was admittedly subjective. The wide range of alleged finished tool types found at the Stockhoff quarry caused them to concur with a basic tenet of KirkBryan's--that biface blades or blanks are not the only products of most quarryshops. Although Bryan and Tuohy present more credible evidence for their classification of finished tools (1960:491-502) than Kirk Bryan, I beleive their conclusion to be too simplistic and general. It may apply to the Stockhoff quarry, but can certainly not be said of "most" quarries. One must consider that this quarry also included an adjacent habitation area, as previously seen in the Midvale complex. If this area were occupied for any length of time concurrent with quarrying activities, as indicated at Midvale, one might reasonably expect some finished tools to be present.

The Crabtree site provided no evidence to indicate that there had been any habitation. It follows then, that none of the finished tools associated with long term subsistence activities are present. As previously quoted by Holmes:

> As in other cases where dwelling was not associated with the factory site, no specialized implements were found (Holmes 1919:207).

I believe that a distinction must be made concerning quarry sites which contain no habitation evidence and those which do. The presence of a living site may show itself to be a major factor in determining what artifacts are found at the quarry.

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The Riley quarry, investigated by John Atherton (1966) is an obsidian quarry some twenty five miles east of the Glass Buttes. Materialhere was collected entirely from the surface. Nodules of raw material were the source of toolstone, as seen also at the Midvale quarry. Atherton reports that no actual quarrying of rock from its matrix was carried on here--only the flaking of nodules into mostly biface blanks and occasionally other simple tools:

> The Riley site. . .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 habing 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 tra ces (1966:69).

Atherton reports that the absence of hammerstones is probably due to the fact that aboriginals who used this quarry brought with them adequate hammers and carried them off when their task was completed. No use of obsidian self hammers was indicated.

Atherton does report finding "a few blades and three or four blade cores", but concludes that this small sample does not indicate a significant blade and core industry. The Crabtree quarry also yielded a small inventory of blades, and no cores at all. However, what is important here is that the knowledge of a blade and cove technology existed at all, not that it is represented by only a few specimens.

Concerning some of the flakes found at the Riley quarry, Atherton says:

> Some of these flakes. . .show definite signs of having been utilized. . . What these flakes were used for is not certain, but it is possible that they were used to work other tools of wood, bone, antler, or some similar material (1956:71).

This cursory dismissal of utilized flakes is hardly satisfactory. No definition of utilization is offered by the author, so I must remain at most skeptical.

Aside from Atherton's classification of utilized flakes, my information from the Crabtree site concurs quite well with the Riley site material. The lack of habitation, the absence or very small number of hammerstones, the technology of blade making but scant evidence that blades were a major product at either quarry, and the presence of whole or fragmented blank rejects are some characteristics common to both the Riley and Crabtree sites. The major difference is that the Riley site contains no original deposits of obsidian or flows of it, only nodules on the surface.

In ashort article, Malcolm Farmer reports on an obsidian quarry near Coso Hot Springs, California (Farmer 1937). His basic observations agree with those of Holmes and also my own. The site contains three slides of obsidian, fragments of a gray to black translucent to opaque quality. Some of these fragments show evidence of having been percussion flaked into "rude leaf shaped blanks." Farmer reports that:

> No obsidian artifacts what could be classed as finished implements were found near the quarry. All the chips indicated that they were removed from larger fragments by percussion during the process of manufacture of the leaf shaped blanks from which finished implements were later made. The absence of completed implements is additional proof that blanks were chipped out at the quarry and transported to more permanent dwelling places to be converted into implements of utility and war (Farmer 1937). 8)

Summary

In review, I have compared the findings at the Crabtree site to anumber of other quarry sites in north America. Affinities and differences have been cited. In the case of the Crabtree site, my findings agree generally with Holmes, Bucy, Sharrock, Farmer and Atherton. Certain attributes of other quarries are not represented at the Crabtree site, e.g. finished tools and evidence of nearby habitation. Of course, many variables are likely to hav e had some bearing on what activities occurred at a prehistoric stone quarry. Factors such as the number of groups of aboriginals using the quarry, the amount of raw material available and whether it was in deposited or nodular form, the mechanical means required to form useful artifacts, and the methods known to the aboriginal knapper are necessarily a few of the determinants of what refuse is left for the archaeologixt. These as well as social factors must be considered in future archaeological investigations of quarries.

II

FIELD PROCEDURES

DISCUSSION OF ~~SAMPLING TECHNI~~QUES

The samples from the Crabtree site were not gathered on a random basis. That is, each item present there did not have an equal chance of being selected. Instead, I attempted to recover a representative sample of the debitage. Specifically I was interested in those flakes which in my opinion demonstrated some characteristim of intentional alteration by man. My choice was based primarily on my personal experience in flintworking and the observations of other flintworkers.

I have little interest in sophisticated statistical inventories of different flake types and sizes. This would be of no use in the study I did. Instead, I have made some simple mathematical comparisons of the data.

For purposes of control, two adjacent Test Pits on GBI were collected in the following manner: A one meter square was established directly over two of the apparent chipping stations. (more detail Fig. —) The first such Pit, A, was collected in ten centimeter increments to a depth of 70 centimeters. Every lithic object regardless of size was saved. In the second of these one meter squares, Test Pit B, I examined material from each of the ten centimeter levels and saved only those items I judged to be diagnostic of certain man made operations. This involved discarding by far the majority of the material from each level, including countless specimens which for a variety of reasons were not helpful in the determination of knapping techniques. In Pit A the lithic flakes had all but disappeared by level 70 cm. In Pit B the flakes stopped at about 64 cm. Because the sidewalls in the upper levels were composed almost entirely of stones, it became increasingly difficult to maintain accurate control horizontally. By the time excavations had reached the lower levels, both Test Pits were nearly conical in shape. A continuous rain of debris from the upper sidewalls made deeper excavation prohibitive.

Both in June and again in August, extensive collecting was conducted over the entire surface of the quarry area and at GBII. Provenience of the articals collected was not recorced, as much of this was not done by me, and further it is not critical to the project. In addition, the area had for so long been subjected to amateur rock pickers and weekend archaeologists that not a great deal of emphasis should be put upon the precise location of any surface item.

Three exploratory Test Pits were sunk abutting the cliff at G.B. II. (See map #11) My reason for digging these pits was to search for some evidence of habitation. Downslope to the east GBIII two more test pits were dug in search of habitation signs.

The conclusions I will draw later are based on lithic specimens collected from four situations:

1) Test Pit A--collected entirely
2) Test Pit B--collected selectively
3) The collection of artifacts from the usrface area at large
4) The debitage from Glass Buttes II and III--Test Pits 1 -5.

None was found

III The Data

DATA CLASSIFICATION + TABULATION

I have established the following categories for the articles collected: Unaltered nodules; starch fractures; non-obsidian articles; small rubble; varia; primary decortication flakes; thinning flakes; blade like flakes; and biface fragments. These are defined as follows:

Unaltered ~~Nodules~~ natural lumps or pieces.

Lithic objects which exhibit no evidence of working by man. This includes many specimens completely covered by the original cortex from which no flakes have been removed. Also included are those which I judge to be "naturefacts"--that is, rocks showing exposed flaked surfaces attributable to natural agency. (Fyrxell and Bense___ _____)

Starch Fractures

These items occur in profusion nearly everywhere in the site. They are geometric pieces of obsidian which resemble old fashioned nails, often elongated and pointed. Atherton (1966) reports their use as awls or needles. Elsewhere they are "prismatic obsidian splinters known as tinklers" (Heizer and Whipple 1965:160). For tabulation processes, I have called starch fractures those which are most regular in appearance. There may be some overlapping between this category and unaltered ~~nodules~~. PIECES

Non-obsidian articles

Very few lithic specimens of material other than obsidian were retrieved. These may or may not have been ~~xxxxxxx~~ hammerstones or fragments of hammerstones. I refer to these as artifactual because they are of all rock exotic to the area, and therefore must have been transported in, most likely by man.

Small Rubble

This material consists of thousands of minute fragments of obsidian too samll to be of any diagnostic value at this time. Included are great numbers of very small starch fractrues. Most of this debris was gravel like in size and appearance. To count the individual pieces would be a monumental task. Therefore the volume of this material has been recorded in the following manner: I selected at random 100 pieces of small rubble, observing the area they occupied. Then, I arranged the remained of the material in similar sized clusters, and multiplied the number of clusters by 100.

Varia

Many specimens appear to be the work of man, but they lack the necessary attributes to be so classified. For example, many large flakes are missing their proximal portions, hence platforms and bulbs of percussion. I have put this type of object into the Varia category to denote that it is quite possibly the work of man but because of insufficient evidence I cannot be certain. Again, a certain degree of arbitrariness, tempered by a knowledge of flintworking, was involved.

Primary Decortication Flakes

These are man made flakes showing all or some of the original cortex on the dorsal side, and often showing cortex-covered platforms. Many of these follow natural ridges. The intent was to remove as much of the undesired cortex without reducing the outline of the object (Muto 1971).

Thinning Flakes

This includes man made flakes which bear the scars of previous flake removal. Since they represent a later stage in the manufacturing continuum, they are usually thinner than primary decortication flakes. Some of these thinning flakes may show evidence of platform preparation (See. Fig___) or beveling from the opposite side of the intended flake, but this is not mandatory.

Blade Like Flakes

This class is labeled blade like rather than blade since the existence of a blade and core industry at the Crabtree Site is QUESTIONABLE at this time. My definition of blade like is a flake twice as long as it is wide, having roughly parallel sides, showing a bulb of percussion and eraillure scar, but not necessarily showing pervious blade removal scars. Although I found no blade cores at the site, finds of blades and blade cores from elsewhere in Oregon have been reported at Five Mile Rapids, Burns, and near the S.E.Oregon / Nevada border.(Dumond 1962)

Biface Fragments

Contained here are the partial remains of artifacts which show flaking on both surfaces. No whole specimens were recovered, but a total of 36 fragments were collected. Most of these exhibit breaks perpendicular to their long axis. They are not uniform in size or degree of finish. Presumably they were broken at different stages of their manufacture--some in the earlier stages when the object remained relatively thick; others much later when the item has been considerably thinned (See Fig. __)

The above categories were established according to the material observed on the surface. Once defined, I have applied them consistently to the materáál from all levles.

Tabulation of the Data

All the material from Test Pits A and B was washed and sorted into the previousáy described categories. Since the material collected from Pit B consisted only of artifacts, for purposes of comparison I used only the same four classes of artifacts from Pit A. That is, all items in the remaining four classes from Pit A were excluded, since none were recovered from Pit B. This left a total of 639 artifacts in the four categories of Pit A, and 107 artifacts in the same four categories of Pit B. Therefore, Pit B represented a sample approximately ~~#~~ 17% per pit [redacted]e of Pit A.

I compared the percentage of artifacts in each of the four categories of Pit B with the same four categories in Pit A. The results, shown in Table 3, bear out my original contention that a statistically representative sample of artifacts may be selected by a person who has had some training and experience in flintworking himself. The practical experience I gained in the ~~National Science~~ ISU Museum (NSF awarded grant #) F[redacted]n Flintworking Session during summer 1971 has proven itself invaluable in such a situation. This further suggests that for a trained individual, it is not necessary to collect every rock from a quarry to be able to determine the knapping procedures which once took place there. I obtained very nearly the same percentages working with only a 17% sample. Referring to the Totals in Tables I and 2, this would mean a difference in the number of articles collected of over 7,000. In terms of time alone, this is very significant.

The figures in Table 4 represent the numerical inventory of four types of artifacts collected at large from the surface area: Primary decortication flakes, thinning flakes, blade like flakes, and Biface fragments. The very high percentage of biface fragments (40% of the total) demonstrates even the archaeologists's bias towards more finished looking artifacts.

	Surface	0-10	10-20	20-30	30-40	40-50	50-60	60-70	Total
Unaltered Nodules	203	427	200	11	10	14	8	5	878
Starch Fractures	42	63	30	0	0	0	0	0	135
Non-Obsidian Articles	1	2	0	0	0	0	0	0	3
Small Rubble	1050	2700	2400	17	37	60	35	33	6332
Varia	59	140	105	12	14	28	13	10	381
Biface Fragments	2	2	0	1	0	0	0	0	5
Primary Decortication Flakes	20	64	19	3	3	2	2	4	117
Thinning Flakes	118	143	111	30	17	31	26	11	487
Blade-like Flakes	8	12	6	2	0	1	1	0	30
TOTALS	1403	3553	2871	76	81	136	85	63	8168

Table I.
TEST PIT A--TOTAL INVENTORY

	Surface	0-10	10-20	20-30	30-40	40-50	50-60	Total
Primary Decortication flakes	6	3	7	1	4	2	1	24
Thinning Flakes	7	6	19	11	11	12	9	75
Biface Fragments	1	0	1	0	0	0	0	2
Blade Like Flakes	0	1	3	2	0	0	0	6
Totals	14	10	30	14	15	14	10	107

TABLE 2

Test Pit B Artifact Inventory

Test Pit A Perdentages of Artifacts in Each Category	
Primary Decortication Flakes	18.3%
Thinning Flakes	76.2%
Blade like Flakes	4.7%
Biface Fragments	0.8%
	100.00%

Test Pit B Percentafes of Artifacts in each Category	
Primary Decortication Flakes	22.4%
Thinning Flakes	70.1%
Blade like Flakes	55.6%
Biface Fragments	1.9%
	100.00%

TABLE 3 Comparison of Test Pits A and B artifact inventories

SURFACE COLLECTIONS FROM ENTIRE QUARRY AREA

Primary Decortication Flakes	16
Thinning Flakes	28
Blade-like flakes	26
Biface Fragments	41
	88
	111

TABLE 4 Tabulation of surface collections at large

ANAYLSIS OF THE DATA

This thesis intends to show that the various processes involved in the production of bifaces are represented by the debitage of these operations. Each process leaves as its by product a distinctinve kind of flake, and through the careful scrutiny of these flakes the lithic technologist is able to reconstruct this continuum.

Choice of materials is the first critical step in the manufacture of stone tools. The Crabtree Site contains an abundant supply of obsidian nodules at the surface, as well as in situ deposits of shelves of obsidian presumably from the original flow, for example the exposed shelf of it down slope to the west of Glass Buttes I. The difficulty of removing large flakes of workable obsidian from its matrix is discussed by Crabtree.

> I have done much quarrying for lithic in situ material and have used sledges, mining bars, wedges, jacks, and abandoned aboriginal tools for the work. After several hours of strenuous labor, I succeeded only in removing one or two usable pieces of stone. This has convinced me of the tremendous amount of force and ingenuity necessary to detach large flakes or pieces of usable material for the making of artifacts. When mining, the worker must either strike toward himself, or sideways, so that he is often hit by flying flakes. Some of the large flakes quarried during prehistoric times were 12 to 14 inches long, 6 to 10 inches across and an inch and a half thick (1967:60)

Two aboriginal flakes I recovered from the Crabtree Site measure 12 inches by 5 x 2, and 10 x 3.5 x 1.5, respectively. (Fig.__).

Whether or not nodules were excavated at G.B.I., the quarry are aproper, is not certain. The distribution of material in the chipping pits suggests that some shallow excava ting for material may have taken place, and that later the depression left by such excavation was filled in with chipping detritus as the abogiginal knapper worked at the edge of the pit.

The supply of highly suitable obsidian today at the Crabtree Site would indicate an even greater supply in times past. Crabtree states that:

> Ideal lithic materials are kinds of stone with the necessary properties of texture, elasticity, and flexibility. They must be of an even texture, and relatively free of flaws, cracks and inclusions, cleavage planes and grains in order to withstand the proper amount of shock andforce necessary to detach a flake of predetermined dimension. . . (1967:63)

Selection of raw material is followed by the reduction of the nodules into desired core tools, flakes or blades. Crabtree says:

> By using a hammerstone, these blocks, nodules or masses of material are then formed into blanks, later to be made into preforms and ultimately finished artifacts. The hammerstone is usedto pare all of the undesirable material

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such as cortex, inclusions, vugs (crystal pockets) and improper texture from the blank (1967:63).

Bifaces at the Crabtree Site could have been ~~reduced~~ manufactured from cobbles, flakes or starch fractures. A number of biface fragments (Fig.___) show portions of previous flake scars which exhibit extremely large fissures or hackles. Experimentally, the size of these hackles is directly related to the size of the flake on which they appear. That bifaces were also manufactured from starch fractures is ~~also~~ indicated by some fragments which show remnants of the original flat ~~x~~ surface of the starch fracture (Fig.___). Crabtree has produced a biface from a starch fracture, intentionally leaving portions of the flat cortex for purposes of comparison with aboriginal specimens. (Fig.___).

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At the Crabtree Site, ~~many~~ most of the primary decortication flakes exhibit cortex covered platforms, with no evidence of platform preparation at this stage. The type of percussor used is not certain, ~~since, some~~ altho the majority of these large flakes show attributes generally assigned to hard hammers (FIG—) such as

1) an acuminate bulb of force

2) a salient bulb of force

3) fissures, eraillures and ripple marks

4) a moderately crushed or collapsed platform

while ~~other~~ fewer of the primary decortication flakes (FIG—) show soft hammer struck characteristics of

1) a truncated bulb relative to the contact area

2) a diffuse bulb of force

3) a lip ~~of~~ slight overhang on the proximal end of the ventral surface

4) eraillures or fissures (Muto 1971:77-83)

I have observed the occurrence of these traits both in my own experimental work and the observation of fellow flintworkers. In spite of the criticism of such self proclaimed skeptics as Mewhinney (1957), I consider these characteristics to be a quite effective means of determining the relative hardness of a percussor. These are certainly not infallible, but when applied to a large population of flakes such as those found at quarry sites, flake attributes are indeed a valuable indicator for the lithic technologist.

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Percussion tools are of both hard and soft stone, depending on what work is to be done. Selection must include size and material to fit each purpose. Normally hammerstones are selected from waterworn cobbles or boulders. They are then used in their natural form or slightly altered to fit the specific problem of mining of the quarry or of fabricating the artifact, whichever the case may be. . . Percussion tools seen at quarries include ovate, discoidal, lenticular, cylincrical ,spherical, conical, and biconical shapes. These tools are found in many sizes. Various hammerstone types are designed to fit certain phases in making artifacts or to suit certain types of mining operations. Their shape was governed by the manner in which they were held and the specific type of work they were to do.(1967:60)

Description of possible hammerstones from the Crabtree Site

During the course of making surface collections from a number of localities in the area of the site, an extremely small number of non-obsidian stones were collected. Naturally this appeared to me unusual considering the activities postulated to occur in a quarry. A total of nine of these objects ~~were~~ was collected, excluding the pit areas proper. This represents the systematic reconnaissance of ~~an estimated several~~ about 600 hundred acres of territory.

Six of the items are basaltic, scoriacious or vesicular. (Fig. __). Some exhibit what I judge to be use wear. Primarily, this consists of ~~xxxxx~~ battering or a pecked appearance on one margin. Another of the specimens is of pumicious stone, what appears to be half of a rounded cobble showing use wear i.e. scrubbing at one end.

One of the specimens is a fragment of aquartzite cobble with definite indications of wear through use on one edge. This rounded end bears the scars or peck marks of repeated bruising through contact. The last of these items is a large, ovoid piece of quartzite, very well smoothed and discolored by age on its outside (Fig. __), At one end, three regular flakes have been removed, possibly to modify this for use in quarrying obsidian from its matrix. A large flake detached from the opposite end may have been an accident of use.

I have considered the possibility that these stones may not have been used as hammerstones. However, the quartzite cobbles especially are exotic to the area and must have been carried in with a purpose in mind.

Discussion of hammerstones

Following are some possible explanations for the small number of hammerstones collected:

1) Hammers of stone exotic to the area were so highly valued that few were left behind. The stoneworker who traveled to the quarry came and left with a suitable hammer.

2) Hammerstones were used seasonally over and over by the same groups of people coming to gather obsidian. They were cached in a place known only to their owners. However, no such cache has yet been found at the Crabtree Site.

3) Percussors of non-lithic materials were used in addition to the small number of stone hammers. These wood or antler tools have simply not been preserved.

4) Nodules of obsidian were employed as hammers.

5) Likely looking hammerstones have been removed by rock hounds and amateur collectors.

6) My sampling techniques may have been inaccurate.

According to Bucy, in his report of a basalt quarry in Southwestern Idaho:

> While the number of hammerstones found appears to be extremely few for the amount of work which was done, the rarity of hammerstones is quite common in many archaeological sites. At 10-WN010 four hammerstones were found and related to some 3014 other pieces recovered, really rather a high proportion. . . A single hammerstone may be used for long periods of time and many thousands of flakes may be struck with it. It is not uncommon to use a single hammerstone for several weeks or months. I have several favorite hammerstones which I have used for four years and during that time I have used them to remove probably several hundred thousand flakes. It would not be uncommon for Crabtree to use only a few hammerstones at certain obsidian sources in East Central Oregon over a period of a week and during that time he may remove close to a hundred thousand flakes (1971:99-100).

I have learned from the 1971 and 1972 sessions of the ISU MUSEUM Flintworking school that one becomes very accustomed to a certain hammer which is especially suited for a particular task. Hammerstonesfor the school are collected from a locality 75 miles distant, After the undesired cortex material has been removed from a cobble or nodule, the process of thinning the piece is undärtaken. At the Crabtree Site, the method of direct percussion was used. In this method the objective piece is held in one hand and struck with a hammerstone held in the * other hand. The direction and velocity of the blow, the hardness of the percussor, the size of the contact area, the size of the propsed flake, and prévious platform preparation are some variables which influence the nature of the proposed flake, detached from the underside of the piece. Crabtree (movie The Flintworker) has thinned bifaces usng an intermediate tool of antler, the indirect percussion method, but this leaves a zig zag or crimped looking edge not observed on any of the Glass Buttes material.

Platform Preparation

Platform preparation can be accomplished by different techniques such as grinding or beveling. Each serves to strengthen the proposed striking platform and to align this platform at the desired angle with the proposed flake. Platforms may be prepared singly before bifacial thinning, or the entire margin may be unifacially prepred and then unifacially thinned. Bordaz uses platform preparation as the basis for distinguishing between Abbevillian and Acheulian:

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The Acheulian knapper used two new techniques for production of his core tools. The first of these was a method of considerable importance because it was used extensively, in later times, by more advanced makers of stone tools. It consisted of flaking the edge itself, in order to build up preliminary striking platforms set at the correct angle (about perpendicular) to the face to be flaked. The flakes struck from these prepared platforms left scars carrying back across the face of the implement, resulting in a tool with the desired thinner, more tapered section. The preparation of a striking platform, preliminary to flaking, greatly increased the Knapper's degree of control over the shape of his bifaces. But most modern experimenters believe that the very shallow flake scars, often with long parallel sides, observed on the Acheulian hand axes, are possible to produce only by means of an additional trick of technique, probably invented in several different areas at the end of the Lower Pleistocene. This is the baton, or soft hammer method.

As the name of this second method implies, it involved the use of a hard wood, bone, horn, or antler baton, which, because it is of softer material than the stone, can be struck very close to the edge of the nodule without crushing it. In addition, it seems that the use of softer and more elastic hammer material slightly extends the time during which the force acts on the edge of the tool. The flakes resulting from such soft hammer blows---which may sometimes be merely a relatively soft stone---are longer and thinner, have a more diffuse bulb of percussion and flatter ripples than the flakes removed by hard hammer percussion (Bordaz 1970:24-25).

Evidence for some sort of platform preparation is present on only some of the thinning flakes and biface fragments from the Crabtree Site. Muto (1971) describes two kinds of platform preparation; beveling and strengthening:

> . . . The beveling of the edge may be accomplished by the use of the hammerstone. . . beveling may also be accomplished by the use of a fine or coarse grained abrading stone. . . The abrading stone is pushed transversely across the edge, in a direction away from the flake face. . . .
>
> The platform strengthening flakes are those flakes on the flake face which remove the spurs or overhang as well as strengthen and shape the platform (68-69).

At the Crabtree Site there is a higher incidence of platform preparation on the larger, thicker thinning flakes than on the smaller, thinner thinning flakes. This took the [illegible] form of unifacial beveling. No grinding is evidenced, and the platform preparation ~~xxx~~ where it did occur was not elaborate. This suggests a correlation between platform preparation and type of percussor used, and agrees with Bordaz' theory that Acheulian hand axes were first roughed out by hammerstone percussion, with or without preliminary platforms, and then finished with a baton (1970:27). In other words, flakes at the Crabtree Site struck with a hard hammer have a greater tendency to exhibit platform preparation than do those struck with a soft hammer. However, there is no apparent point in the thinning process at which the hard hammer was abandoned and the soft hammer flaking begun. That is, there is much overlap in the size of the hardhammer thinning flakes and the soft hammer thinning flakes. Also, distinguishing between flakes struck with a soft stone hammer and those struck with antler or other non-lithic percussors is as yet an unsolved dilemma.

Experimental replications of Glass Buttes obsidian bifaces made by Crabtree are indistinguishable in flake character from the aboriginal artifacts (Fig.__). In the past, Mr. Crabtree preferred to "rough out" the biface from a large flake or nodule with a fairly hard stone hammer. Then he would switch to an antler billet for the final thinning. Of late, Mr. Crabtree has abandoned the antler billet for bifacial thinning and carries out the entire process with stone hammers, using a soft stone hammer for the final thinning.

The material from the Crabtree site clearly indicates that the major products of the quarry were bifacially flaked oval forms. A total of forty one fragments of bifaces were recovered in this study. None was whole, though one remarkable find was both halves of a biface lying less than a foot apart on the surface (Fig. _). When fitted together, the blow which caused the piece to fracture is evident.

The fragments recovered represent a variety of degree of completion. The word completion is used here to denote finishing of the work to be don at a quarry, and is not intended to imply that further elaborqtion into refined tools did not occur elsewhere.

These oval forms or bifaces are blanks, defined by Wormington as follows:

> A blank is a roughly shaped stone artif ct, still in the process of manufacture, which has been blocked out to the approximate shape and thickness desired for a completed tool (1957:274).

Crabtree's definition concurs:

> A usable piece of lithic material of adequate size and form for making a lithic artifact---such as unmodified flakes of a size larger than the proposed artifact, bearing little or no waste material, and suitable for assorted lithic artifact styles. The shape or form of the final

> product is not disclosed in the blank.
> A series of objects in the early stages in the manufacturing process before the preform is reached (1972:42).

The concept of the preform has no clear definition, though it is recognized as a more "finished" blank or representing a later stage in the continuum towards the intended artifact (Muto 1971:109).

Crabtree further comments on the quarry-shop:

> There is little evidence that all the stages of artifact manufacture were completed at the quarry site, for rarely is the quarry a suitable place for the time consuming work of flintknapping. It appears that the aboriginal preferred to rough out blanks and preforms at the quarry and do his finishing under the more comfortable conditions of his campsite (1967:63).

These broken bifaces I recovered are the true rejects referred to by Holmes (1919). I contend that these were not finished tools such as aexs, broken by accidents of misuse, the view held by Kirk Bryan (1950). Of the forty one biface fragments. only three exhibited any edge dulling at all which may or may not indicate use. ~~These were photographed~~ photo-micrographed (Fig.__). If indeed these were used, I suggest that it was merely incidental, possibly as quarrying picks or aids.

The predominantly transverse breaks across the long axes of the majority of the bifaces are attributable to errors in manufacture. End shock (Crabtree 1972:60) or insufficient support of the objective piece often result in these characteristic hinging fractures. This has been shown experimentally by Crabtree as well as inadvertently by most beginning students of flintworking.

One particular biface fragment from the surface collections exhibited a distinctly different type of thinning flake than was observed on any other specimen from Glass Buttes (Fig.__). The piece has been percussion thinned from its lateral margins, then a large flake was struck from one end, terminating in a hinge fracture at approximately the midsection of the biface. The large channel type flake intersects the previous thinning flakes, and closely parallels the Old World Levallois technique. Other instances of this technology have been reported in the Western United States (Green 1972; Leonhardy et al. 1971; Muto, personal communication).

The remaining specimens I recovered show little evidence of crushing, a possible indicator of use. However, there is much current research being done on determining the criteria for use wear ([illegible]). The eventual results of such study should prove to be invaluable in the interpretation of quarry materials. Until such time arises, the determination of use is at best uncertain, although the context of the find is also a factor which must be considered.

Evidence for a blade industry at the Crabtree site

I stated earlier that the presence of a blade and core industry at the Crabtree site is questionable at this time. In the surface collections at large (Fig.__) I recovered 26 specimens I classified as "blade like flakes". Close examination of these, however, has revealed that at least 17 of these are true blades: Twice as long as wide, roughly to very parallel sides, cross sections plano-convex, triangulate or trapezoidal, bearing scars of previous blade removal. One of these blades has been made on a very geometric starch fracture (Fig.__), which terminated in an outrepasse (Crabtree 1972:80). In making a biface from a starch fracture, a primary objective is to remove angular ridges, often by alternate percussion flaking (Crabtree: personal communication). A blade of this type is hardly a step in the continuum of biface production. Another artifact indicating the presence of blade making is a crested blade, showing alternate flaking to produce a ridge for the blade to follow (Fig.__). Again, this is not a procedure ancillary to biface production. Other examples of what I judge to be true blades are illustrated in Fig.__.

The question then arises: If blades were manufactured at the Crabtree site, why were no cores found? Possibly the cores from which these blades were struck were not exhausted, but simply reduced to a form suitable for biface production. Recent experiments by Crabtree (personal communication) in blade making techniques have led him to this same conclusion.

This idea has also been proposed by Green (1972) concerning the Rock Creek site in southern Idaho.

Granted that blades were produced at the Crabtree site, this process still accounts for only a small fraction of the total amount of stoneworking which did occur there.

If, as I have proposed earlier, bifacially flaked blanks were the major product at the Crabtree quarry and were intended for trade and possibly later elaboration into refined tools, where are such blanks found? In tracing the occurrence of these items I am not limiting myself to obsidian. I simply want to show that blanks or rough outs of many materials are found, often in archaeological contexts which indicate they were intended for eventual manufacture into more finished tools.

In a surface collection from southeastern Oregon, Coyote Flats, Butler (1970) reported that seventeen "blanks, preforms and kinves" were found. He states

> This is a highly variable group consisting mostly of roughed out items that appear to represent a stage in manufacturing rather then completed implements, but which in many instances could also have served as cutting or scraping tools. . . (1970)38).

Conceivably then, these bifaces could have been destined for further fabrication into such articles as crescents and scrapers, one hundred and ten of which were recovered at Coyote Flats.

A survey in the Warner Valley-Hart Mountain region of southcentral Oregon yielded a cache containing 15 obsidian ovates, 1 quartzite ovate, 1 unretouched obsidian flake, 1 projectile point, 1 mineralized bone flaking tool, 1 lump of yellow ocher and 9 pieces of glassy pumice (Weide and Weide 1969). Nine of the obsidian ovates are bifacially flaked and appear to have been fabricated from flakes, while the other six are unifacially flaked. The authors believe that the ovates from this cache are differently shaped, smaller, and less crude than the contents of a workshop area at the nearest known obsidian source. Also, the inclusion of non-obsidian artifacts is viewed as unusual, since obsidian is by far the major raw material in the area. The authors hold that this is not an ordinary cache of blanks. However, the presence of the bone pressure flaker is nearly conclusive evidence that some sort of further retouch was intended for these ovates or blanks.

Cressman (1936) reports a large area of exposed black obsidian on the west slope of a butte near the Big Springs site in Guano valley, southcentral Oregon. Eight miles north of Big Springs he located a chipping site.

> Fragments of many beautifully chipped pieces of large knives were exposed there. Before being broken the knives must have been six, eight, or perhaps ten inches long, and from one and one half to two and one half or three inches in their maximum diameter. . . .few complete pieces of any kind were found (1936:33).

Some of the abovementioned specimens are illustrated Cressman (1936: Figs. 5, 6, 11). Judging from these illustrations these objects could easily be blanks or preforms, a preform used to denote a stage in the manufacturing process closer to the intended finished product, ~~(Muto 1971:109)~~. No discussion of use wear or dulling of the edges is offered by Cressman. Since a wide range of other finished tool types ~~were~~ was found in a campsite nearby, the possibility that these "knives" were actually quarry blanks or preforms seems a reasonable inference.

In Catlow Valley Cave, near Fort Rock Cave in south central Oregon, Cressman reports additional "knives" and "scrapers" (1942:81-82). These appear morphologically very similar to some of the mor finished bifaces from the Crabtree site (Fig.__).

The Simon site (Butler 1963; Butler and Fitzwater 1965) near Fairfield, Idaho providesan excellent example of the Blank-preform-product continuum (Muto 1971). Originally the material, which includes two Clovis points apparently in a cache, was identified according to standard morphological tool types, i.e., scrapers, knives and points. Segments of one large biface were labeled three separate tools. Later it was discovered that these three sections fitted together to form part of the original biface (Butler and Fitzwater 1965). According to Muto:

> The concern here is not with the mistake but with the underlying assumption; with the fragmentary biface reconstructed only one error was rectified. A progression of preforms, showing a manufacturing sequence toward the large Clovis points, was hidden by the typological assumption which called for only finished types; the preforms were identified as knives. . . The Simon site data illustrate a typological problem that is quite general. The use of the artifact class termed "knives" as a classificatory catch-all obscures the "blank-preform-product" continuum (1971:111-112).

A survey of Southwestern Idaho (Swanson, Powers and Bryan 19[illegible]) yielded in excess of two hundred bifacially flaked ovate forms (c.f. Figs. 8-12, 15). I examined these specimens in the Idaho State University Museum, and at least some of them are indeed blanks rather than completed tools. They are made from a variety of materials: obsidian, basalt, ignimbrite, chert, and quartzite.

Another cache of nine blanks of obsidian welded tuff was recovered near Sterling in southeastern Idaho (Pavesic 1966). The blanks were located in a pocket some 12 to 18 inches below the surface, and no other artifacts were found with the exception of one chip. Pavesic designated eight of these specimens projectile point blanks, and one as a knife blank.

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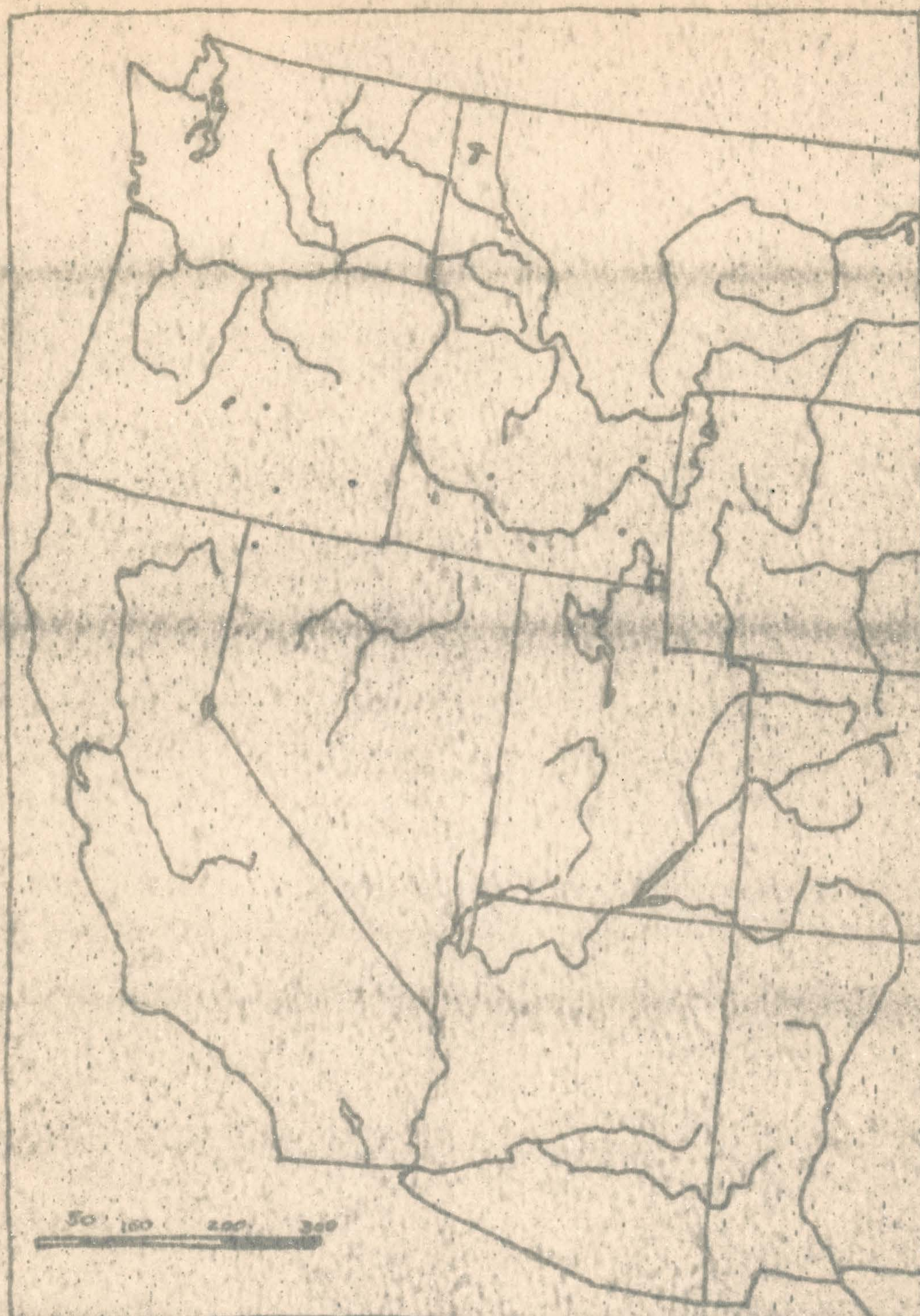
Three additional finds of large, thin bifaces have been reported in eastern Idaho (Butler 1969). The Higgins find consisted of three quartzite bifaces found imbedded in lumps of dirt which had fallen from an eroding cliff face at the American Falls Reservoir. They are believed by Butler to be part of a cache.

The Little Camas Creek find included two obsidian bifacially flaked ovates found in the creek near Kilgore, eastern Idaho. Abrasions on the artifact faces suggests transport by stream or slope wash. The third find came from the Portneuf River valley about a mile west of Lava Hot Springs. It is of white quartzite and exhibits well controlled percussion flaking. All six of these specimens bear some resemblance to the Simon site bifaces. Although Butler does not clearly label these as blanks or preforms it is implicit in his article.

Sonia Ragir and Jane Lancaster report finding 129 rough outs and blanks at High Rock Canyon, northwestern Nevada (1966). The group includes broken and unfinished specimens representing different manufacturing stages. Ninety nine of these artifacts were broken. The other 30 show signs of unsuccessful attempts to reshape or reduce their thickness, probably accounting for their abandonment.

Falcon Hill


50 100 200 300

Atherton, John 1964 The Riley Quarry. Unpublished M.A. Thesis. Univ. of Oregon, Eugene

Ascher, Robert and Marcia Ascher

1965 Recognizing the Emergence of Man. Science 147:246-252.

Ball, Sydney

1941 The Mining of Gems and Ornamental Stones by American Indians. Smithsonian Institution Bureau of American Ethnography Bulletin 128, Number 13. Government Printing Office, Washington, D.C.

Bryan, Alan L. and Donald Tuohy

1960 A Basalt Quarry in Northeastern Oregon. Proceedings of the American Philosophical Society 104(5):485-510. Philadelphia.

Bryan, Kirk

1950 Flint Quarries: The Sources of Tools and at the same time the Factories of the American Indian. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, 17(3).

Bordaz, Jacques

1970 Tools of the Old and New Stone Age. Natural History Press, Garden City, New York.

Bordes, Francois and Don Crabtree

1969 The Corbiac Blade Technique and Other Experiments. Tebiwa 12(2):1-21. Pocatello.

Bucy, Douglas R.

1971 A Technological Analysis of a Basalt Quarry in Western Idaho. Unpublished M.A. Thesis, Idaho State University, Pocatello.

Butler, B. Robert

1963 An Early Man Site at Big Camas Prairie, South-central Idaho. Tebiwa 6(1):22-23. Pocatello.

Butler, B. Robert and R. J. Fitzwater

1965 A Further Note on the Colvis Site at Big Camas Prairie, South-Central Idaho. Tebiwa 8(1):38-40.

Butler, B. Robert

1970 A Surface Collection from Coyote Flat, Southeastern Oregon. Tebiwa 13(1):34-57. Pocatello.

Clarke, Rainbird

1935 The Flintknapping Industry at Brandon. Antiquity 9:38-56.

Crabtree, Don E.

1966 A Stoneworker's Approach to Analyzing and Replicating the Lindenmeier Folsom. Tebiwa 9(1):3-39.

1967a Notes on Experiments in Flintknapping: 3. The Flintknapper's Raw Materials. Tebiwa 10(1):8-24.

1967 b Notes on Experiments in Flintknapping: 4/ Tools used for Making Flaked Stone Artifacts. Tebiwa 10(1):60-73.

1968 MesoAmerican Polyhedral Cores and Prismatic Blades. American Antiquity 33(4):446-478.

1970 Flaking Stone with Wooden Implements. Science, 196:146-153.

1972 An Introduction to Flintworking. Occasional Papers of the Idaho State University Museum, No. 28. Pocatello.

Crabtree, Don E. and B. Robert Butler

1964 Notes on Experiments in Flintknapping: 1. Heat Treatment of Silica Minerals. Tebiwa 7(1):1-6.

Crabtree. Don E. and Earl H. Swanson, Jr.

1968 Edge Ground Cobbles and Blade Making in the Northwest. Tebiwa 11(2):50-58.

Cressman, Luther S.

1936 Archaeological Survey of the Guano Valley Region in Southeastern Oregon. University of Oregon Monographs No. 1, Eugene.

1942 Archaeological Researches in the Northern Great Basin. Carnegie Institution of Washington, Publication 538. Washington, D.C.

Cressman, Luther S., and Howel Williams and Alex Kreiger

1940 Early Man in Oregon- Archaeological Studies in the Northern Great Basin. University of Oregon Monographs, No. 3. Eugene.

Daubenmire, R. F.

1943 Vegetational Zonation in the Rocky Mountains. The Botanical Review 9(6):325-393.

Deetz, James

1967 Invitation to Archaeology. American Museum Science Books, The Natural History Press, Garden City, New York.

Davis, James T.

1966 Trade Routes and Economic Exchange among the Indians of California IN Aboriginal California: Three Studies in Culture History, Robert Heizer editor. University of California, Berkeley.

CC,6,4,85,67

Dicken, Samuel N.

1965 Oregon Geography (Fourth edition). Edwards Brothers, Inc., Ann Arbor, Michigan.

Dixon J. E., J. R. Cann and Colin Renfrew

1968 Obsidian and the Orig n of Trade. Scientific American 218(3):38-44.

Dumond, Don E.

1962 Blades and Cores in Oregon. American Antiquity 27(3):419-424.

Ellis, H. Holmes

1965 Flintworking Techniques of the American Indians: An Experimental Study. Ohio Historical Society, Columbus.

Farmer, Malcolm F.

1937 An Obsidian Quarry near Coso Hot Springs. Southwest Museum Masterkey 11:7-9.

Fennemen, Nevin M.

1931 Physiography of Western United States. McGraw Hill Inc., London and New York.

Frison, George C.

1968 A functional Analysis of Certain Chipped Stone Tools. American Antiquity 33(2):149-155.

Green, James P.

1972 The Archaeology of the Rock Creek Site, Sawtooth National Forest, Cassia County, Idaho. Unpublished M.A. Thesis, Idaho State University, Pocatello.

Heiser, Robert and A. E. Treganza

1944 Mines and Quarries of the Indians of California. California Journal of Mines and Geology 40:291-351.

Holmes, William H.

1890 A Quarry Workshop of the Flaked-Stone Implement Makers in the District of Columbia. American Anthropologist 3:;-26.

1893 Distribution of Stone Implements in the Tidewater Country. American Anthropologist o.s. 6(1):1-14.

1897 Stone Implements of the Potomac Chesapeake Tidewater Province. Bureau of American Ethnology, 15th Annual Report. Washington, D.C.

1919 Handbook of Aboriginal American Antiquities. Part 1 Introductory the Lithic Industries. Smithsonian Institution Bureau of American Ethnology Bulletin 60. Government Printing Office, Washington.

Leakey, L. S. B.

1960 Adam's Ancestors: The Evolution of Man and His Culture. Fourth Edition. Harper Torchbooks. Happer and Brothers. New York.

Muto, Guy R.

1971a A Technological Analysis of the Early Stages in the Manufacture of Lithic Artifacts. Unpublished M. A. These, Idaho State University, Poc atello.

1971b A Stage Analysis of the M nufacture of Stone Tools. IN University of Oregon Anthropological Papers No. 1, C. Melvin Aikens, Editor. Eugene.

Mewhinney, Hubert.

1957 A Manual for Neanderthals. University of Texas Press, Austin, Texas.

Oakley, Kenneth P.

1957 Man the Toolmaker. Third edition. Phoenix Books. University of Chicago Press.

Pavesic, Max G.

1966 A Projectile point "blank" Cache from southeastern Idaho. Tebiwa 9(1):52-57.

Ragir, Sonia and Jane Lancaster

1966 An Analysis of a Surface Collection from High Rock Canyon Site 26-WA-177, Nevada. University of California Archaeological Survey No. 66. Berkeley.

Ray, Verne F. et al.

1938 Tribal Distribution in Eastern Oregon and Adjacent Regions. American Anthropologist n.s. 40(3):384-415.

Rust, Horatio N.

1905 The Obsidian Blades of California. American Anthropologist n.s. 7(4):688-695.

Semenov, S. A.

1964 Prehistoric Technology. Cory, Adams and Mackay, London.

Sharrock, Floyd

1966 Prehistoric Occupation Patterns in Southwest Wyoming and Cultural Relationships with the Great Basin and Plains Culture Areas. University of Utah Anthropological Papers No. 77. Salt Lake City.

Swanson, Earl H. Jr., Donald Tuohy and Alan Bryan

1959 Archaeological Explorations in Central and South Idaho--1958. Occasional Papers of the Idaho [illegible] University Museum No. 2.

Cc. 6, 4, 85, 70

7

Swanson, Earl H. Jr., Roger Powers and Alan Bryan

1964 The Material Culture of the 1959 Southwestern Idaho Survey. Tebiwa 7(2):1-27. Pocatello.

Warren, Claude N., Kent Wilkinson and Max Pavesic

1971 The Midvale Complex. Tebiwa 14(2):39-72.

Weide, Margaret L. and David Weide

1969 A Cache from Warner Valley, Oregon. Tebiwa 12(2):28-34.

Wilmsen, Edwin N.

1968 Lithic Analysis in Paleo-Anthropology. Science 147:246-252.

Wormington, H. Marie

1957 Ancient Man in North America. Fourth Edition, Revised. Denver Museum of Natural History Popular Series No. 4. Denver, Colorado.

ADDENDA

Leenhardy, Frank
1971

Forbes, P.L. Iridescent Obsidian
1935 Gemmologist 4(46):306-309

Hunt, Charles B.
1967 Physiography of the United States W.H. Freeman & Co. San Francisco + London.

Tentative table of contents

Don -
I've read this much to Dr. Swanson and he thinks it's o.k. I've given copies to the rest of the committee for their comments. Thanks.

Chris

I. INTRODUCTION AND STATEMENT OF THE PROBLEM

Except for the work of W. H. Holmes around the turn of the century, studies in lithic technology have been largely untouched or ignored by the archaeologist. Lithic studies are now undergoing an increasing relevance, and archaeologists are becoming aware of their credibility and application to current research. The intent of this thesis is to arouse in the minds of fellow archaeologists the incredibly large body of knowledge there is to be gleaned from the study of lithic debitage, particularly at a quarry workshop site. For too long, members of the profession have concerned themselves only with describing and/or classifying finished artifacts of stone. There is far more to be learned if one is able to retrace the entire process of manufacture through careful examination and painstaking scrutiny of the debris from all stages, not merely the final one.

In studying the morphology of a stone tool, one is seeing only the result of an involved series of processes. This subtractive technology (Deetz 1967:48) speakes only of the last of these processes. It is my desire to attempt to reconstruct the continuum of manufacture, based on the debris found at the Crabtree Site.

The site is located on the high lava desert of central Oregon, 70 miles west of Burns. The debitage at the quarry lie on a ridge which runs in a north-south orientation. Two pits were used as the basis for this study. Test Pit A was excavated and collected in ten centimeter increments. The total inventory was taken from this pit (8168 articles) and used for purposes of control. In adjacent Test Pit B, I selectively retained material from each ten centimeter level, using my judgement based upon my own flintworking experience and the observation of other flintworkers. I was interested in recovering flakes which indicated a mode of manufacture. Continued lithic experiments have demonstrated that flakes struck with a certain type of percussor will necessarily show certain attributes not present when another type of percussor is used. My comparison of the data demonstrate that a very reliable statistical representation of diagnostic flakes is possible without a 100% collection of the material. In other words, the percentages of a certain type of flake were very nearly the same in both Test Pits A and B, while Pit A included a total of 8168 items (639 artifactual), and Pit B consisted of only 107 artifacts.

I am not concerned with establishing a datable chronology, nor do I wish to include ethnographic details about the aboriginals who used this quarry. It is my contention that the Crabtree Quarry was used merely as a source of fine obsidian toolstone and that users of this quarry intended only to remove raw materials from it after having worked these raw materials into an easily transportable or tradable shape and size.

The data support my assertion that this site was at no time a long term habitation area, and further that no pressure flaking or other fine finishing of tools was carried on here.

The Crabtree Site is one of two North American obsidian quarries to be investigated in depth. Certain affinities to other quarries will be examined. Effort will be made to determine what manufacturing techniques are shared, and what variables influence what is found at a quarry.

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Introductory Investigations

Initial reconnaissance of the Crabtree Site was undertaken in June of 1971. The area, long favored by rockhounds for its tremendous array of fine obsidian, was to provide us with the raw materials for our summer flintworking session in July. The investigating party included the following people: Don and Evelyn Crabtree who first introduced me to the site, Dr. and Mrs. Earl Swanson and Earl Jr., Gene Titmus and his son David, Guy Muto and myself. After sufficient quantity of red and black obsidian had been collected, we spent several more days mapping and surveying the area.

During this initial visit the quarry workshop area and surrounding ridge top were painstakingly measured for contours. I later discovered that this section of Oregon has not yet been mapped by the United States Geological Survey, although I was able to obtain aerial photographs.

I returned to the Crabtree Site in August 1971. With the help of a crew of three, Vicki Clay, Margie French and Roy Warner, a significant amount of excavation was carried out on the ridge top and the base of the cliff. My intent was to collect a selective sample of debitage which I thought to be representative of the industry at the quarry. No attempt at random sampling techniques was made, since I was looking for a particular kind of artifact.

Also at this time, several test pits were sunk on the hillside east of the cliff in an attempt to find some possible stratigraphic differentiation or some signs of habitation. (See map __)

Geographic Setting

The Crabtree Site is located in the high desert of east central Oregon. The region is extremely sparsely populated and there is no water in the area with the exception of a few man made cowponds. The vegetation consists almost entirely of sagebrush and scrub grasses, with intermittent juniper trees in the higher elevations. Small islandsof aspen trees are rare. Livestock ranges over the countryside. Also observed were white tailed deer, pronghorn antelope, jackrabbits, mice and rattlesnakes; mountain bluebirds and magpies. For a detailed description of the region, see Dice (1943) and Daubenmire (1943)

Climate

"The climate of the Lava Plains is probably the driest in Oregon. The rainfall averages about ten inches, and in some places is less than eight inches." (Dicken 1965:108) For additional climatic information, see Dicken 1965 and Fennemen ____.

Geologic Information

"The Glass Buttes are a small mountain range rising out of the rather featureless sandy desert of northern Lake County Oregon. . .(They) have as their dominant structural feature an anticline. This anticline has been very greatly modified by a multitude of normal faluts. The lavas of the district represent three periodsof extrusion. The older flows of basalt were followed by a series of acidic lavas which were, in turn, partially covered by a later series of basalts. . 1 Although minor in size in comparison to the fault block ranges of southern Cregonand Nevada, this range has received a certain amount of attention owing to the occurrence of considerable quantities of black and variegated obsidian within its borders." (Waters 1927:441)

A Brief Discussion of the Glass Buttes Region

The general area of Glass Buttes is contained in the following area, as designated by the Bureau of Land Management: Oregon unit South East 6, Townships 23 and 24 South, and Ranges 22 and 23 East. The Glass Buttes region of former vulcanism contains more than one quarry workshop. However, this thesis concerns itself mostly with the Crabtree Quarry, designated as Glass Buttes I, and some surface collections from elsewhere. The enclosed aerial photograph (Fig.__) shows the location of other quarry debris, for example the predominantly black obsidian concentration some two miles north of the Crabtree Quarry and denoted as Glass Buttes II, and the hillside of so called 'Rainbow' obsidian to the south west--Glass Buttes III. An Indian legend makes the following account of the origin of rainbow obsidian:

"After the mountain had burned for several days, there came up a shower having a beautiful rainbow. The rainbow shone all day on one spot on the south side of the mountain and at evening seemed to enter the ground at this particular spot. After the fire they found that some of the mountain had melted and had made heaps of glass for their arrows and spear points, but the rainbow had settled into one heap and left the beautiful colors there." (Forbes 1935:307)

The excavations were conducted only at the Crabtree Quarry. For the precise location of the Test Pits, see Fig. __.

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II. GENERAL SITE DESCRIPTION

The Crabtree Quarry area covers an extended ridge top, running in a nearly north south line. Obsidian is exposed over the entire surface of the ground. On a sunny day it almost glitters. Nodules and broken pieces are everywhere, though the heaviest concentration of evidently worked material occurs in a number of well defined chipping pits directly on the ridge top. (See Fig.__)

The steep slope to the west of the quarry ridge reveals layers or shelf like deposits of obsidian. It appears to have been lain down in an extensive blanket. At one point perhaps 100 yards from the major pit area on the west slope, an outcrop of this obsidian shelf was observed. A solid deposit at least thirty inches thich was uncovered. A vertical crack in the material was filled with extremely hard packed fine grained matter of a clay like appearance. Two men weilding an iron crowbar dug thirty minutes without reaching the base of the deposit. How much deeper it continued into the earth is unknown. A factor in the cooling process accounts for the vertical cracks or fissures. As hot volcanic glass loses heat, under certain conditions it may fracture somewhat in the manner of columnar basalt. This phenomena also occurs within smaller masses or around the perimeters of obsidian flows, causing very symmetrical or rod like shapes to be produced.(__________) These "Starch fractures" (Crabtree: personal Comm.) vary in size from toothpick up to twelve inches or more.

Approximately twenty yards east of the concentration of debitage pits is located a small cliff, some twenty feet high in places, running north-south for about 1/2 mile. Juniper trees of varying sizes grow both at the top and bottom of the cliff. It is the only spot affording any shade at all for a considerable distance fromthe site. Large deposits of flakes and nodules occur at the base. Eastward from the base of the cliff extends a steep hillside, littered with large pieces of cliff fall. The face of the cliff itself is not strictly vertical, and in a number of spots it is easily surmountable. Directly abutting the cliff fase are masses of flakes. The arrangement of this debris first suggests that the aboriginal knapper took advantage of the shade and proximity of materials, flaking atop the cliff as his chippage fell below.

An amateur rock collector reported that he had found a hearth with remains of charcoal and possibly ochre, But I was unable to find out exactly where this was.

The one scarcely represented feature one would expect to find at a quarry site is a number of adequate hammerstones. I collected from the surface no more than nine non-obsidian stones which may have been used as percussors. However, these were not all of a good homogeneous quality and their use as hammersis not certain. This will be dealt with in greater depth later.

III. REVIEW OF THE LITERATURE ON OTHER QUARRIES

In order to gain some insight into the study of quarry sites, a short review of other North American quarries appears in order. Only one other obsidian quarry has been reported, but there is considerable material available on other kinds of aboriginal stone quarries. My review will focus mainly on the works of W. H. Holmes, Kirk Bryan, Doug Bucy, John Atherton, Alan Bryan and Donald Tuohy, and Malcolm Farmer.

William H. Holmes has probably contributed more to the study of lithic technology than any other individual. His reports on aboriginal knapping and quarrying activities from all over North America and part of South America are voluminous. Why they have gone so long unnoticed is not clear. However, today there appears to be an increasing appreciation of Holmes' work. He was probably the first person to practice stoneworking techniques himself, trying to replicate aboriginal specimens. In doing so, he recognized that a continuum of manufacture necessarily exists, and to arrive at the end product, each step in the continuum must be effected. In his words:

"I have found that in reaching one final form I have left many failures by the way, and that these failures duplicate, and in proper proportions, all the forms found on the quarry sites. . .

I further find by these experiments--and the conclusion is a most important one--that every implement resembling the final form here described, and every blade shaped projectile point made from a bowlder or similar bit of rock not already approximate in shape, must pass through the same or nearly the same stages of development, leaving the same wasters, whether shaped today, yesterday, or a million years ago; whether in the hands of the civilized, the barbarous, or the savage man." (Holmes 1897:61)

Holmes' basic conclusions about the nature of quarry workshops were that 1) they were used by aboriginals as a source of toolstone which was worked into roughly formed objects of a convenient size and shape for export and 2) that final shaping of functional tools was carried on elsewhere. This is well summarized in the following:

"Now, although the blades produced in the quarry shops may without modification have been used for cutting, scraping, perforating and other purposes, I am decidedly of the opinion that as a rule they were intended for further elaboration; this is rendered almost certain, first, by the fact that the most fully shaped broken pieces found on the quarry shop sites are but rudely trimmed on points and edges, specimens of like grade being fitted for use in cutting and scraping; and, second, that all the tens of thousands of specialized forms--spearheads, arrowpoints, and perforators--are necessarily specialized from such blades, as shown in subsequent section. The quarry workshop was naturally not a place for finishing tools, but one for roughing out the material and selecting that fitted to be carried away for final shaping. A laborer engaged in such work in a pit in the forest would not be likely to throw aside the rough hammer used in fracturing cobble stones to take up and operate an entirely different kind of machinery, involving a distinct and delicate process. Being a reasoning and practical creature, he would carry away the roughed-out tools, the long thin blades, to be disposed of or to be finished at his leisure and by whatsoever method experience placed at his disposal.

The quarries, being extensive, were worked somewhat systematically and the product was naturally of great importance to the people concerned. The blades made during a prolonged season's work were numerous and were carried to village sites far and near for use, specialization or trade. There would be in their history a period of transportation attended by storage, and this would explain the cache, an interesting feature of stone implement phenomena, and one which involves just such blades as were produced in the quarry shops." (Holmes 1897:62)

Examples of caches such as those described by Holmes 75 years ago appear in the literature today. Some of these are the Simon Site near Fairfield, Idaho, the Braden Burial Site near Weiser, Idaho, and the Spring Creek Cache near Fort Hall, Idaho, reported by Muto (1971a). If, as proposed by Holmes, bifaces intended for trade were the major product at many quarries, finds of such biface blanks should occur in archaeological sites such as these.

Originally the material from the Simon Site was examined and labeled according to functional tool types (Butler 1963). The hypothesis presented by Muto is that the different "tools" were actually different stages in the manufacture of a tool. The larger forms represented an earlier stage of production. This is well illustrated (Muto 1971a:Figs 1.-5.). Artifacts from the Spring Creek cache bear a marked similarity to the Crabtree Site bifaces (Fig. __) Muto says of the Spring Creek material:

. . . The possibility that such forms may be blanks roughed out to varying degrees of finish for trade or transportation to suggest otherwise, they might best be described as transport blanks or trade blanks, since we know that Danish flint blanks were roughed out for this very purpose and are concentrated along trade and travel routes throughout Europe (Bordaz 1970). Also in the Spring Creek cache was found a series of triangular artifacts which must similarly be identified as blanks (1971a:112)

Spanish Diggings

W. H. Holmes' work at Spanish Diggins, Oklahoma led him to draw similar conclusions about this chert quarry. He reports that the "beds of chert are of unknown area and of great thickness." This statement also described the nature of obsidian at the Crabtree site. Holmes nated that beside the generally round pits of debitage where flaking operations took place were found piles of raw material, brought to within reach of the workmen: As in previous quarry studies by Holmes, the Spanish Diggings site produced almost exclusively blades or blanks intended for further shaping later. Holmes found scant evidence of other tool manufacture, and attributes this to the fact that the quarry was not subject to long term habitation. He says: "As in other cases where dwelling was not associated with the factory site, no specialized implements were found." (Holmes 1919:207) He includes an excellent photograph of blank "rejects" (p. 205) which, excepting the material they were made from, are very similar to those I recovered from the Crabtree site. (Fig. __) Holmes does list among other items found" a few large thick blades...notched in opposite margins as if to be hafted as picks, and several fluted cores or nuclei from which thin flakes had been detached..." (Holmes 1919:207) These large thick blades are perhaps tools used in quarrying, or possibly the remnants of the most temporary campsites.

Kirk Bryan has a very divergent opinion of the material from Spanish Diggings, and also of quarrying in general. He contends basically that many finished tools were manufactured at quarries, and rather than transporting these tools to be used elsewhere, the raw materials of wood or bone were hauled to the quarry and worked there. Much of his argument is based on what he claims to be evidence of use wear or retouch on a number of flakes. However, never in his paper does he discuss the criteria for deciding something has been man altered rather than the result of accident or nature. In Bryan's words:

It is the purpose of this paper to outline in considerable detail several more or less interwoven theories regarding quarries. Two main theses are presented:

1) that many of the so-called "blanks" and "rejects" are usable tools, mainly axes, and that they were actually used;

2) that many flint quarries were not only sources of flint for export, but also industrial sites or factories to which materials such as wood and bone were brought to be worked in the presence of abundant tools. These main theses are supported and inspired by the very greatly expaned knowledge of typology developed in the past thirty years; by the recognition in the debris of quarries of numerous flakes, and of shaped and utilized pieces of irregular shape; and by our present saner attitude toward the antiquity of man in America." (Bryan 1950:3)

Bryan further advocated that may rejects or fragments of broken bifacially worked flaked oval "blades" are the result of accidents of use or misuse, rather than errors of manufacture. He claims that these heavy bifaces were actually used as hafted axes to work wood imported to the quarry workshop:

". . . many of the heavy bifaces are broken at right angles to the long axis. . . such breaks cannot easily be attributed to manufacture but can be explained plausibly as due to use." (Bryan 1950:22)

Bucy takes exception to this opinion as follows: "The transverse breaks across the long axis of Bryan's rough shaped hoes and axes can result from manufacture from a number of causes—each of which creates certain distinctive types of fracture surfaces. Such breaks can occur because the material contains unsuspected flaws such as natural cleavage planes, crystal pockets or vugs, and changes of texture or homogeneity of the material. . . "(Bucy 1971:40)

Another plausible explanation of the transverse breaks often observed in bifacially worked objects is offered by Tuohy and Bryan. They demonstrated through experiment that a biface dropped upon a hard surface may break across its long axis leaving little evidence of a bulb of force, and often terminating in a hinge on the face opposite that which received the blow." (Tuohy and Bryan 1960:506)

Kirk Bryan's theory that heavy bifaces are actually the remains of hafted axes used for woodworking is unconvincing to me for two reasons:

1) he claims to have observed use wear on these items, but he offered no criteria for the determination of use; and

2) he dismisses the possibility that some of these implements may have been used in quarrying operations labeling them "unsuitable in size and shape." (Bryan 1950:13)

Heizer and Treganza discuss the use of quarry implements in California and illustrate some of these (1944:325-6). Some may have been hafted. On at least three bifacially worked specimens from the Crabtree Site, I observed edge dulling indicative of use, most likely as quarrying tools (Crabtree: personal communication). One artifact in particular (Fig. __) appears to have been used as a chisel or wedge after it was broken across its long axis.

It may be expected that the use of a stone tool upon two very different materials would produce different patterns or types of wear. That is, extensive woodworking with asstone tool would produce different wear patterns than, say, quarrying with the same stone tool. Until thorough experimental study provides a clear definition of this, Bryan's hypothesis remains mere conjecture.

Kirk Bryan's classification of utilized flakes must also remian inconclusive. To describe a flake as ". . .rounded by retouch at one end and obviously utilized. . ." (1950:11) without a definition of utilized is hardly acceptable scientific evidence.

In all the thousands of flakes I examined and sorted from the Crabtree site, I saw very few whose edges exhibited flaking which could not be attributed to natural agency. My criteria for man made flaking and use are: 1) a very regular arrangement of flake scars--not random nibbles at irregular intervals along a flake margin, and 2) some crushing or dulling of an edge which has been used repeatedly. This is not to say that flakes could not have been used as cutting or scraping implements, upon occasion, or biface fragments used as quarrying aids. A freshly struck flake of obsidian, for example, provides an excellent sharp cutting edge with no modification whatever. However, any more than incidental use of unmodified flakes is not indicated at the Crabtree Site.

A brief comparative summary provides the following conclusions concerning Holmes' and Bryan's findings at Spanish Diggings.

Both recognized the major product manufactured at the quarry to be bifacially flaked ovoid forms. Holmes refers to these as blanks, while Bryan prefers to call them knives or axes. Holmes found scant evidence of any finished or finely worked tools, while Bryan claims to have observed large numbers of utilized flakes and scrapers. Since the definition of utilized is either missing or inadequate in Bryan's work, his classification of these items is unacceptable to me.

My findings at the Crabtree Site agree very well with Holmes'. Bifacially flaked forms were indeed the primary product of this quarry, and there is nothing to suggest that significant numbers of other finished tools were present; nor does my investigation support Bryan's theory that raw materials of wood and bone were imported to the quarry area and worked there.

The Stockhoff Quarry

The Stockhoff Quarry, reported by Bryan and Tuohy in 1960 is a basalt quarry in Northeastern Oregon. It deffers from the Crabtree Site in that it contains a habitation area where projectile points of stone exotic to the region were found. All other material from the site was indigenous fine grained basalt. It is also markedly different from the Crabtree Site in that it contained 165 specimens, many of which were finished tools designated as scrapers, choppers, cutting or piercing tools, points, knives and spokeshaves. Bryan and Tulhy also found "biface blade blanks". The wide range of alleged finished tool types found at the Stockhoff Quarry caused them to concur with a basic tenet of KirkBryan's--that biface blades or blanks do not comprise the majority of artifacts produced at most quarries. Although Bryan and Tuohy present more credible evidence for their classification of finished tools (Bryan and Tuohy 1960:491-502) than Kirk Bryan, I believe their conclusion to be too simplistic and general. It may apply to the Stockhoff Quarry, but can certainly not be said of "most" quarries. One must consider that the Stockhoff Quarry also included an adjacent habitation area. If this were occupied for any length of time concurrent with quarrying activities, it is not unusual to expect some finished tools to be present.

The Crabtree Site provided no evidence to indicate that there had been any habitation. It follow then, that none of the finished tools associated with long term subsistence activities are present. As previously quoted in Holmes: "As in other cases where dwelling was not associated with the factory site, no specalized implements were found." (Holmes 1919:207)

I believe that a distinction must be made concerning quarry sites which contain no habitation evidence and those which do. The presence of a living site may show itself to be a major factor in determining what artifacts are found.

The Riley Quarry

The Riley Quarry, first investigated by John Atherton in 1966 is an obisdian quarry some 25 miles east of the Glass Buttes. Material here was collected entirely from the surface. Nodules of raw material were the source of toolstone, and Atherton reports that actual quarrying (removing rock from its matrix) was not carried on here--only the flaking of nodules into mostly biface blanks and occasionally other simple tools:

"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 wasdone doe to the inadequate material 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 shape of the battered nodules found. . .

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 usersof the quarry knew the technique for making blades."(1966:69-71)

Atherton does not define his criteria for determining use either. He says:

"Some of these flakes. . . show definite signsof having been utilized.. What these flakes were used for is not certain, but it is possible that they were used to work other tools of wood, bone, antler, or some similar material."(1966:71) This explanation is more acceptable than the one proposed by Kirk Bryan, if indeed the flakes referred to by Atherton were utilized. However, until a clear definition of utilized is outlined by the author I remain skeptical.

Aside from Atherton's discussion of flake utilization mh information from the Crabtree Site concurs quite well with the Riley Site material. . . the lack of habitation, the absence or very small number of hammerstones, the technology of blade and core manufacture, but scant evidence that these were a product at either quarry, and the presence of whole or fragmented "blank" rejects. The major difference is that the Riley quarry is not located at a deposited source of obsidian as is the Crabtree quarry. Therefore, implements used in the quarrying of obsidian such as picks or digging tools may be expected at the Crabtree site, yet not at the Riley quarryshop.

<u>The Midvale Site</u>

Site 10-WN-10, the Midvale quarry, is located in western Idaho near the confluence of the Weiser and Snake Rivers. It was first investigated as a highway salvage archaeology project in 1962. The quarry was used aboriginally as a source of fine grained basalt toolstone. Like the Crabtree site, the Midvale quarry was not subject to major habitation. Rather, it was used as a source of materials which were reduced to transportable shape and size. In Bucy's words:

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"The high percentages of flaking detritus at the earliest stages of manufacture, particularly cortex flakes, and the low percentages of detritus representing the final working stages indicate that this site served as a materials source. The site represents an area where high quality material was sought and reduced to transportable form, the greatest percentage of waste being removed and left at the source. The transportable forms, roughouts or quarry blanks were carried away from the quarry to other sites in the general locality for further shaping and finishing work. . . anvils, a variety of hammerstones and a number of simple scraper forms are present at quarry sources. These implements were used in obtaining and reducing the raw material to preliminary blanks and roughouts. . .(Bucy 1971:92)

Bucy does report finding a small number of finished tools:

"Specialized flakes and implements excluding flaking tools constitute 9.75% of the total collection, indicating that relatively little finishing work was carried out at the quarry. The finished implements found at this site probably represent those used by the workmen in acquiring raw material and to maintain themselves and their equipment while in the locality (1971:91)

Although Bucy identified more functional tool types that I believe to be present at the Crabtree Site, his biface blanks appear morphologically very similar to those I recovered except for the material they are made from (See Bucy Figs.15 a-m). The transverse breaks shown in Fig. 15 g, h, j, and l closely resemble many broken biface fragments from the Crabtree Site, which exhibit a definite hinging termination.

Bucy also reports the use of self hammers at the Midvale quarry. This helps to explain the small number of hammerstones redovered. However, use of obsidian self hammers at the Crabtree quarry is unlikely. The glassy qualities of the stone would make this technique very hazardous, as pieces of the percussor or the objective piece are easily detached and may become potentially dangerous missiles.

A difference between the quarries is the presence of cores at the Midvale site. These were small and had had only a few blades struck off. Bucy theorizes that these were not blade cores for the manufacture of fine tools, but rather were samples of rock being tested by the aboriginal by the removal of a fresh flake.

Comparatively then, the Midvale and Crabtree quarries sh are a number of traits: the presence of whole and broken biface fragments, some similarity in transverse breaks of some bofaces, very few hammerstones, the lack of a major core and blade industry, the absence of habitation sites. The greatest differences between the two quarries are the presence of re-touched flakes and some finished tools at Midvale, and the indication that self hammers were used on the tougher, more resistant basalt at Midvale.

<u>The Coso Hot Springs Quarry</u>

In a very short article, Malcolm Farmer reports on an obsidian quarry near Coso Hot Springs, California. His basic observations agree with those of Holmes and also my own:

"From the ledge, extending down the slope of the crater, there are extensive slides of obsidian fragments. Some of these show evidence of having been roughly chipped by the percussion method into rude leaf-shape blanks. Others are chips from the above-mentioned process and cores from which chips have been struck. There are also many fragments that have broken naturally from the exposed face of the ledge. Some of the obsidian is translucent, but most of it is cloudy to opaque, and ranges in color from gray to black.

To the eastward and northward of the base of the crater there are Indian campsites. On these areas are found many chips, nodules, and rejects, but no finished implements. There were only a few metates. No obsidian artifacts that could be classed as finished implements were found near the quarry. All the chips indicated that they were removed from larger fragments by percussion during the process of manufacture of the leaf shape blanks from which finished implements were later made. The absence of completed implements is additional proof that blanks were chipped out at the quarry and transported to more permanent dwelling places to be converted into implements of utility and war." (Farmer 1937:8)

Conclusions

This short review of selected literature on quarry sites was not intended to be all inclusive. Instead, this was designed to acquaint the reader with little previous knowledge of quarries, with some of the major works on the subject. Conclusions drawn in other quarry studies may be applied to current research as a means of testing their validity. In the case of the Crabtree Site, my findings agree generally with the research of W. H. Holmes. Certain attributes of other quarries are not represented at the Crabtree Site. Of course, many variables are likely to have had some bearing on what activities occurred at a prehistoric stone quarry. Factors such as the geography of the area, its proximity to water and food resources, how many groups of aboriginals used the quarry, the amount of raw material available, the mechanical means required to form useful articals, and the methods known by the aboriginal knapper are necessarily a few of the determinants of what refuse is left for the archaeologist.

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THE CRABTREE SITE:
AN ABORIGINAL OBSIDIAN QUARRY
NEAR GLASS BUTTES, OREGON

With few exceptions, most notably the work of W.H. Holmes around the turn of the century, the science of lithic technology has largely been untouched or ignored until recently. It is now undergoing an increasing relevance, and archaeologists are becoming aware of its credibility and application to current research. It is the intent of this thesis to arouse in the minds of fellow archaeologists the incredibly large body of knowledge there is to be gleaned from the study of lithic debitage, particularly at a quarry workshop site. For too long, members of the profession have concerned themselves only with describing and/or classifying finished artifacts of stone. There is so much more to be learned if one is able to retrace the entire process of manufacture through careful examination and painstaking scrutiny of the debris from all stages, not merely the final one.

In studying the morphology of a stone tool, one is seeing only the result of an involved series of processes. This subtractive technology (Deetz;1967:48) speaks only of the last of these processes. It is my desire to attempt to reconstruct the continuum of manufacture, based on the debris found at the Crabtree site. ¶ The site is located on the high lava desert of central Oregon, 70 miles west of Burns. The debitage pits at the quarry lie on a ridge which runs in a north south orientation. Two pits were used as the basis for this study. Test Pit A was excavated and collected in ten centimeter increments. The total sample was taken from this pit--8168 articles, and used for purposes of control. In adjacent Test Pit B, I selectively retained material from each ten centimeter level, using my judgement based upon my own flintworking experience and the observation of other flintworkers. I was interested in recovering flakes which indicated a mode of manufacture. Continued lithic experiments have demonstrated that flakes struck with a certain type of percussor will necessarily show certain attributes not present when another type of percussor is used. My comparison of the data demonstrate that a very reliable statistical representation of diagnostic flakes is possible, without a 100% sample of the material. In other words, the percentages of a certain type of flake were very nearly the same in both Test Pits A and B, while Pit A included a total of 8168 (639 artifactual) items, and Pit B consisted of only 107 artifacts.

I am not concerned with establishing a datable chronology, nor do I wish to determine which aboriginals were using this quarry. It is my contention that the quarry under study was used merely as a source of fine obsidian toolstone, and that users of this quarry intended only to remove raw materials from it after having worked these raw materials into an easily transportable or tradable shape and size.

The data support my assertion that this site was at no time a long term habitation area, and further that no pressure flaking or other fine finishing of tools was carried on here.

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PRELIMINARY BIBLIOGRAPHY

Bryan, Kirk

1950 Flint Quarries--the Source of Tools, and at the same time, the Factories of the American Indian. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University 17:3. Cambridge, Massachusetts

Crabtree, Don E.

1967a Notes on Experiments in Flintknapping: 3 The Flintknappers Raw Materials. Tebiwa 10:1: 8-25. Pocatello, Idaho

1967b Notes on Experiments in Flintknapping: 4 Tools used for Making Flaked Stone Artifacts. Tebiwa 10:1:60-73. Pocatello, Idaho

Deetz, James

1967 Invitation to Archaeology. American Museum Science Books. The Natural History Press. Garden City, New York

Ellis, H. Holmes

1965 Flintworking Techniques of the American Indians; an Experimental Study. Columbus: Ohio State Museum Lithic Laboratory. Revised printing, Ohio Historical Society

Holmes, Wm. H.

1919 Handbook of Aboriginal American Antiquities. Smithsonian Institution Bureau of American Ethnology, Bulletin 60. U. S. Government Printing Office, Washington, D.C.

Muto, Guy R.

1971 A Technological Analysis of the Early Stages in the Manufacture of Lithic Artifacts. Unpublished M.A. Thesis, Idaho State University, Pocatello

Semenov, Sergai A.

1964 Prehistoric Technology. London; Cory, Adams and Mackay.

Bucy, Douglas R.

1971 A Technological Analysis of a Basalt Quarry in Western Idaho. Unpublished M.A. Thesis Idaho State University, Pocatello

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