

Mrs Ernest W. Heller

EARLY MAN IN OREGON

ARCHAEOLOGICAL STUDIES
IN THE NORTHERN
GREAT BASIN



L. S. CRESSMAN
HOWEL WILLIAMS
ALEX D. KRIEGER

UNIVERSITY OF OREGON
EUGENE

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PREFACE

A GENERAL monograph on the archaeological work being carried on by the University of Oregon in southcentral Oregon is now in preparation. The papers in this volume are advance reports of the general nature and scope of the work and of some discoveries of particular interest and importance.

Research on the culture history of the Northern Great Basin was begun at the University under my direction in 1932, with a survey of Oregon petroglyphs. This study was followed by an archaeological survey of the Guano Valley region in 1934, and by a preliminary excavation in Catlow Cave No. 1 in 1935. Lack of funds prevented field work in 1936, but in the summers of 1937 and 1938 a party of ten spent six weeks in the field, excavating caves and carrying out extended reconnaissance.

The first paper, in a modified form, was read as a progress report before the Pacific Division of the American Association for the Advancement of Science in San Diego in 1937; it has been revised in the light of subsequent findings. Its conclusions are in no way final, but should be regarded as hypotheses to serve as starting points for further investigation.

The second paper, of which I share authorship with Mr. A. D. Krieger, formerly a member of the faculty of the Department of Anthropology of the University, presents a fairly exhaustive description of atlatls discovered in Oregon. Since this artifact is new to this area, and since the peculiar characteristics of the Oregon atlatls set them off from the types of other regions, an early report seemed desirable. Most of the detailed work on the atlatls was done by Krieger. The paper as a whole, however, is the product of cooperative field and laboratory work.

The third paper, of which I share authorship with Dr. Howel Williams of the Department of Geological Sciences of the University of California, presents the results of excavations and study of stratigraphic sites. Since geological stratification in caves in the New World is rare, the discovery of stratification in connection with cultural remains in Oregon caves is of extreme importance for North American archaeology.

In two caves, artifacts were found under a layer of pumice. If the time when this pumice fell can be established, then a framework of reference in time will be established for the archaeologist. Dr. Williams' minimum time limits for the Mt. Mazama cataclysm, which he is

convinced is the source of the Paisley Cave pumice, are from 4,000 to 10,000 years. If we accept 4,000 years as the minimum date—and this is the most conservative estimate made by any of the scholars working on the geological problems of Crater Lake—we have a geological time sequence which conflicts with the traditional cultural time sequence used to explain the relations of the Northern Great Basin peoples to those of the Southwest.

This presents a problem for archaeologists. The pumice is there in the caves; the stratigraphic sequence is unbroken; occupation appears both under and on top of the pumice; there is no sign of any sterile layer above the pumice to indicate a long period of abandonment of the caves between the time of the deposition of the pumice and the re-establishment of occupation; the sources of the pumice are identified. These facts cannot be ignored, and must be given adequate weight in any explanation of the cultural relations of the area. It appears that these discoveries may require radical revision of our traditional hypotheses.

I wish to express my appreciation to the Carnegie Institution of Washington and to the General Research Council of the Oregon State System of Higher Education for generous grants which have made the work possible. I am particularly grateful for the sympathetic support and encouragement from Dr. John C. Merriam, president emeritus of the Carnegie Institution. Funds have also been received from the Social Science Research Council for the preparation of maps, drawings, and photographs, from the Penrose Fund of the American Philosophical Society, and from the Condon Grant for Archaeological Investigations of Early Man in Oregon. Many individuals in different parts of the state of Oregon have assisted in a variety of ways. The administrative authorities of the University of Oregon and the Oregon State System of Higher Education have been generous in their support and encouragement. We are deeply grateful to all these individuals. Acknowledgment is also due to the United States Department of the Interior and Department of Agriculture for permission to carry on explorations and excavations on the public domain.

All the drawings of artifacts are by Miss Clarice Ashworth, except Fig. 21, which was prepared by Mrs. Marian Field. Mr. Carl Huffaker, a senior student in anthropology at the University, made all the diagrams, except Map 3, which was provided by Dr. Williams, and Map 1, reprinted from *Archaeological Survey of the Guano Valley Region in Southeastern Oregon* (U. of O. Monographs, Studies in Anthropology No. 1).

PREFACE

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This volume, we hope, will open up many questions and provide a series of working hypotheses for future investigations. If it does this, it will have achieved its purpose; with that hope, we submit it to our colleagues.

L. S. CRESSMAN.

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EARLY MAN AND CULTURE IN THE NORTHERN GREAT
BASIN REGION IN SOUTHCENTRAL OREGON.
PRELIMINARY REPORT

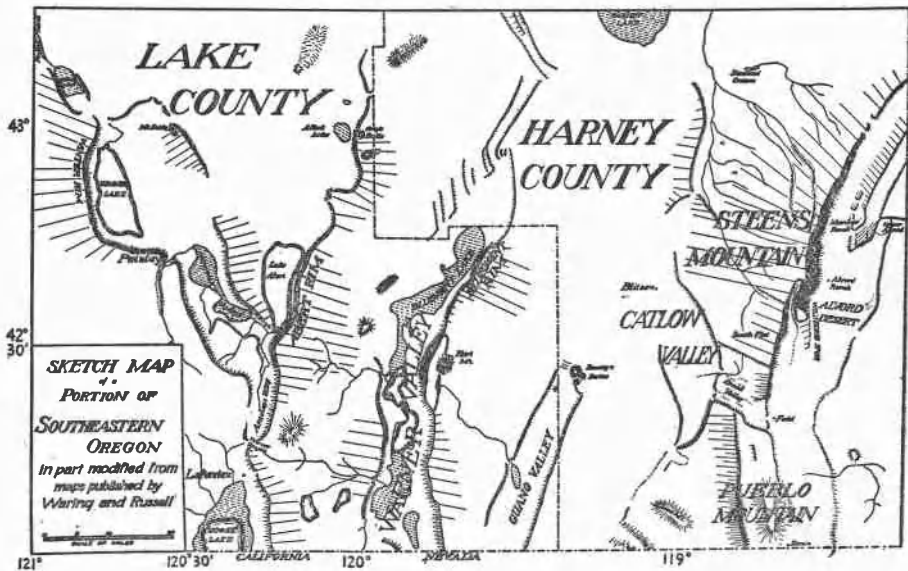
L. S. CRESSMAN

THIS paper is a preliminary report on the work carried on by the University of Oregon in the Northern Great Basin region of Oregon before the 1938 field season. Work was begun by a reconnaissance in 1934 in the Guano Valley region. In 1935 we worked for three weeks in a cave or huge shelter, designated as Catlow Cave No. 1, after one week of excavation just out of the basin region to the west on the Deschutes River. Lack of funds prevented work in 1936; but a grant from the Carnegie Institution of Washington enabled us to put a party of ten in the field for six weeks in 1937. This period was spent in intensive excavation in Catlow Cave No. 1, with exploratory work in adjacent areas on related aspects of our problem. On the final day tests were made in Roaring Springs Cave, 30 miles to the north of Catlow Cave No. 1 (excavated in 1938).

Catlow Valley is the sixth of seven grabens in southern Oregon starting with the Klamath basin in the west. It lies in Harney County, with the central portion about 100 miles south of Burns. The valley is roughly an isocles triangle with the apex pointing toward the west and the base (the longest leg) lying along the western side of Steens Mountain. The valley is roughly 50 miles long in its greatest length and 30 to 40 miles in maximum breadth. The western side of the valley is closed in by the high tableland formed by the great lava flows of the Tertiary period. The elevation of the floor of the valley is approximately 4,300 feet, while the tableland varies between 6,000 and 7,000 feet. Steens Mountain has a maximum elevation of approximately 10,000 feet with a very gradual slope on the west side, but drops on the east side precipitously 4,000 to 5,000 feet in some places. The only water in the valley is provided by a number of small streams: Roaring Springs, which breaks from the slope just under the rim; Home Creek and Three Mile Creek, which rise from springs and snow fields on the high Steens; and a number of intermittent streams which usually dry up after early summer. All of these quickly sink into the dry soil of the valley floor except during the heavy spring runoff, when all except Roaring Springs may discharge a sufficient flow to reach a depression, some 5 miles out in the valley, known as Garrison Lakes. Here water, if the runoff is sufficient, may and often does last all summer. In recent years, how-

ever, even these "lakes" have been quite dry. Most of the precipitation is furnished by snowfall and summer thunder showers.

Dr. W. D. Smith, head of the Department of Geology, and Mr. Lloyd Ruff, formerly instructor in geology at the University of Oregon, have studied the problem of exterior drainage. The evidence shows no outlet. There is a bare possibility that in times of storm there might have been a slopping over at the north end. This problem was re-examined by Dr. Ernst Antevs, whom the Carnegie Institution sent at my request to study the site in September in cooperation with Dr. Smith and myself. The re-examination made it clear that there could have been no outlet of any sort even at the north end.



MAP 1. Portion of Southeastern Oregon.

Along the east side of the valley there is visible a series of wave-cut terraces. The highest of these is slightly over 200 feet above the present floor. A beautifully shaped beach along the top terrace approximately 10 miles from the north end of the valley proves definitely that wave action, not structural forces, is the cause of the terraces. There are four main terraces, with sometimes a fifth just above the present valley floor showing a late level of the lake. In some few instances the terraces are obliterated by subsequent erosion, but for the most part they are remarkably clear. Home Creek and Three Mile Creek have cut through the terraces.

It is Dr. Antev's opinion that the water of the top terrace of the lake which filled Catlow Valley and the top terrace of Lake Lahontan were contemporaneous. According to Antevs, Russell, and others, this would make Catlow a Pleistocene lake with the water at the high terrace associated with the climax of the Wisconsin. Jones, however, would attribute a much later date to Lahontan. We are inclined to accept the theory of greater age. If, however, Jones should some day be proved correct, then all chronologies based on the theories of older formation of the lakes would have to be revised downward.

Along the eastern shore line are wave-cut caves in the basalt and andesite cliffs. The caves were cut into the cliffs where gas bubbles, structural weakness, or mud flows facilitated erosion. The presence of agglomerate and other materials less hard and hence capable of more rapid erosion than basalt complicates the problem of both geological and cultural sequences in this cave.

Catlow Cave No. 1 was laid out for excavation in a rectangular grid with a base line established outside the cave. The two ends of the line were marked by spikes set in solid rock and all measurements were made with reference to this line. A bench mark was established on the rear wall of the cave and all vertical measurements were made from this. True elevations were run from a U. S. C. G. S. bench mark G 119, 1934 on the road about three miles to the north. Lieutenant H. S. Oliver of the U. S. C. G. S. generously made available his field notes.

In 1935 a trench was cut across the north end of the cave at what appeared a most likely place to dig. This was taken down below the occupation level. In 1937 the entire north end of the cave was excavated and a trench run from north to south along the rear of the cave. A second trench, L-shaped, was opened in the south end. The south end proved to be much drier than the north; sandal fragments were found clear to the fine dust covering the water-smoothed boulders on the cave floor. The central part of the main trench had to be narrowed because of the huge rocks upon which occupation rested. The aboriginal inhabitants made use of these rocks by filling in the intervening spaces with small stones for a windbreak.¹

¹ Stratification in the north end of Catlow Cave No. 1 involves both geological and cultural features. The surface material is mostly windblown; in the sheltered corners some range-cattle manure and trappers' debris were found. Stratum I, the subsurface level, continued at shallow and varying depths through the remains of straw and sagebrush bark used for floor covering. The greatest number of artifacts was found in stratum II. Under stratum II was a damp bed labeled stratum III. No basketry was found here. Stone and bone artifacts were found only in the top. Rocks in this stratum were mostly fallen roof material.

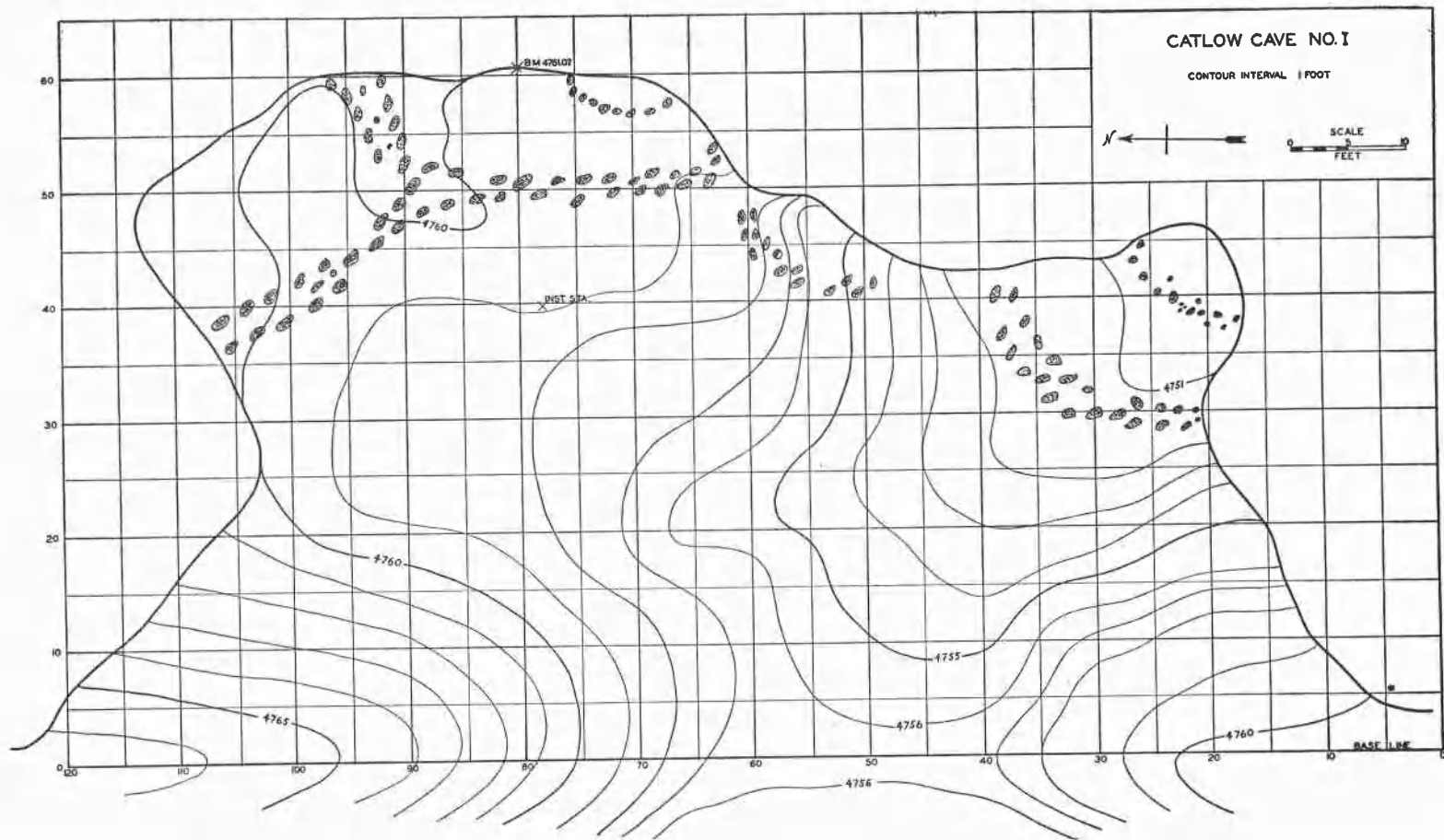


FIG. 1. Catlow Cave No. 1.

The trench running from west to east at the north end was taken to a depth of approximately 9 feet for the 10-foot square area enclosed within the coordinates 95/45-95/55 and 105/45-105/55.² In September 1937, under Dr. Antevs' supervision, this pit was carried down into the heavy beach gravel or rubble another 30 to 36 inches. The balance of the north-end trench varied in depth from 30 inches at one point where heavy rocks stopped excavation to about 4 feet at the extreme south end of the trench. The maximum depth of the trench in the south end was about 6 feet and sloped upward sharply to the rear wall of the cave over large water-smoothed boulders. The rear wall of the cave along its entire length curved out and downwards under the occupational and roof debris after the characteristic fashion of lava caves. At the north end beach gravels were encountered at about 6 feet at coordinate 104/48.

Continuous occupation in the north part of the cave appears to have begun later than in the south end. This opinion is based on (1) the shallower depth of occupational debris, and (2) the large amount of roof debris, including rocks weighing hundreds of pounds, which must have endangered the lives of inhabitants during the period when they fell. The main occupation level in the north end is on top of this roof material. This condition suggests a constant weathering of the roof in this area for a long period of time; only after weathering ceased was continuous occupation really safe, although there may have been sporadic occupation earlier. Of course, there is always the possibility that the roof debris might have been shaken down in masses by an earthquake. If this were the case, it must have taken place before any significant occupation had occurred, since practically no camp debris was found beneath roof materials. Some bone artifacts were found together with obsidian chips under the roof debris. It may be that the perishable materials had all decomposed because of the dampness under and around the rocks. The presence of a few scattered imperishable artifacts here and there in the roof materials and under them suggests the slow weathering of roof materials and occasional habitation by the more adventurous.

"Bedding" is a more accurate word than "stratification" to describe the geological series in this cave. In the south end of the cave the deposit was dry and lacked roof debris; the roof retains water-smoothed stones. Below the surface or substratum in the south trench it was not possible to correlate sequences with those in the north end. Sequences in the south trench have been worked out entirely on the basis of occurrence of artifacts.

² The first measurement is always along the axis parallel to the front of the cave (X) and the second is along the one at a right angle to this (Y) running toward the rear of the cave. All measurements are in feet. All start from station 0.00 at the right end of the X axis facing toward the rear of the cave. Station 0.00 is at the intersection of o(X) and o(Y).

This hypothesis is given support by the discovery of a storage pit dug down from the dry layer above into this roof material. The pit had been lined with a tule mat and had contained at least one basket. A large rock had fallen into the pit on top of the basket. Because of the dampness of the pit, in sharp contrast to the dryness of the debris above it, the tule mat and the basket were so rotten that they could be removed only in small fragments.

The faunal remains show a distinct change from the lower levels toward the top. No large mammal bones occur in stratum III but were found in large numbers in strata II and I. The bones from the earlier period are mostly those of waterfowl and small rodents; these become proportionately scarcer and are displaced by bison and mountain-sheep bones in the later periods. Bones of small rodents are fairly continuous. The bird bones have been identified by the Smithsonian Institution and the mammalian materials by the Museum of Vertebrate Zoology at the University of California.³

The flora seems to have remained unchanged through the occupational period, if we can judge from the artifacts. Sandals, basketry, twine, rope, and possibly clothing were made from sagebrush and tule (and probably *Apocynum*). Cane (*Phragmites communis*), which today is not found near the site, was used for arrow and probably atlatl shafts. Nocks and foreshafts were made from local woods, among them greasewood (*Sarcobatus vermiculatus*). The larger pieces of wood have been identified as sagebrush by Dr. J. Elton Lodewick of the Forest Products Division of the Pacific Northwest Forest Experiment Station in Portland, Oregon.

In 1935 a human tooth and some fragments of ribs and vertebrae were found in a small dry pocket about 6 inches across, between two large boulders and a heavy overlying rock. The impression is inescapable that there had occurred here an accidental death caused by a large rock falling upon one of the cave's occupants, crushing everything except those parts which were pressed down into the space between the lower rocks. A partially mineralized right radius was found just above the gravel at the extreme north end of the trench.

In 1937 a discovery was made that may possibly have marked importance in the history of Early Man in North America. Human skeletal material was discovered in the gravels at the north end of the cave, almost against the rear wall. A tibia was pressed against the wall and the skull lay about 6 inches from the rear. The skull

³ Complete lists and their stratigraphic positions will be given in the monograph in preparation.

lay at 102.9/49.4 and at the elevation 4753.67 feet, at a depth of about 7 feet. Beach gravel appeared at this point at 4754.12 feet or just short of 6 inches above the skull. The skull lay on its right side facing roughly toward the outside of the cave. A half inch of sand separated the skull from a water-smoothed rock underneath. This rock was 9 to 10 inches long and roughly 6 inches in width. The skull was, of course, crushed by the weight of materials upon it but the rough approximation of the parts was kept by the outward pressure of sand which had sifted into the cranium. Careful excavation and wrapping as exposure took place preserved the skull for study.

Many small fragments of bones were found; the following may be listed, in addition to the skull, as the more important: left tibia, right femur, head of femur, pelvic fragments. In addition to these a part of the sphenoid bone belonging to another individual was found. The bones were scattered over an area more than 5 feet square and 1 foot deep; all measurements were taken from the top of the bone exposed. The bones lay in no orderly arrangement or sequence, as would naturally be expected in case of a burial.

The skeletal material was first sent to Dr. Ales Hrdlicka for examination. He reported that the material represented an aged edentulous female with a cranial index of 70.2. "The skull and bones fall well within the range of variation of the oblong headed West Coast Indian," Dr. Hrdlicka wrote in his letter of October 22. Since the types of the West Coast vary so markedly, I again wrote Dr. Hrdlicka, under date of November 8, requesting further and more specific information. Dr. Hrdlicka replied as follows on November 15:

Among the known Indians of the West Coast—taking that term as broadly as those of the 'Southwest,' 'Gulf States,' etc.—there are found both short and oblong headed strains. Among the oblong headed are principally the Shoshonean and related tribes, and most of the Coast people right down to the tip of Lower California. Here and there, locally the oblong headedness is especially marked while the rest of the important characteristics remain much the same.

In order to secure other independent opinion on the type of the skull, it was submitted to Dr. E. A. Hooton. Dr. Hooton replied under date of January 12 as follows:

In general type the skull corresponds closely to that of the early American stratum of long heads such as represented in the Basketmaker of the Southwest and in many skulls from other areas. There is nothing particularly archaic or primitive about it. Dr. George Woodbury concurs with me in this.

Complete records of the correspondence and details of location of the bones will be published in the final report on this work.

In September Dr. Antevs accompanied the writer and Dr. W. D. Smith into the field for examination of the site with special reference to the stratigraphic problems involved and the possibility of correlation of the terraces with those of Lake Lahontan. We examined the site to determine whether (1) the bones were in gravel and (2), if so, was there indisputable evidence of their deposition by natural means and not by a burial.

To check this problem the writer under observation of Antevs and Smith carried out further excavation at the site; more bone fragments were found. It was generally agreed that there was sufficient evidence to show that they were in gravel.

The second point could not be answered conclusively either positively or negatively. The shallow cover of gravel, about 6 inches, which had originally covered the skull made the problem difficult from the start. The greatest difficulty lay, however, in the lack of real stratification in the cave. There was bedding without stratification. A zone of transition could be readily seen where the bed of occupation debris ran into that of roof material and where the roof material merged into the gravels, but the clearly defined line of cleavage characteristic of stratified series was lacking. Dry material from the roof and wind-blown debris had sifted down and mixed with the fine gravels on top of the gravel bed, so that there was some confusion marking the boundaries. It is the opinion of the writer, who uncovered and removed the skull and most of the skeletal remains, that there was no disturbance of the material lying over the skull and that it was in undisturbed coarse sand and gravel; but the proof of this is lacking.

The possibilities concerning the skeletal material may be stated as follows:

(1) That it was a burial which had later been disturbed by animals. But, if the skeleton had been dug up by animals, there would have been marks of their teeth upon the bones; however, Hrdlicka, Hooton, and Woodbury all agree that there are no signs of gnawing of animals on the bones.⁴

(2) That it was a secondary burial. The scattered character of the bones counts against this. A secondary burial results in confusion of the bones but not in scattering them.

⁴The suggestion has been made that the coyote, after digging up all the bones and finding no flesh on any of them, did not chew them. This suggests Coyote the Trickster rather than Coyote the Carnivore.

(3) That it was a natural deposition of a body—either the individual crawled in and died or the body was washed in by the waves during a storm when the water level was already in the process of being lowered by the changing postglacial conditions. The position of the body was coincident with the latter hypothesis. Between the skull and the wall of the cave was a pocket of typical drift material—bird bones, the canine of a dog or coyote, a dark organic stain about an inch in diameter—all held together by the pressure of the surrounding sand. The skeleton lay under the part of the roof which was most weathered and from which much debris, from fine granular material up to enormous blocks of rock, had fallen. If the body with some of the flesh still adhering was washed into this position and became snagged on the slope of gravel, the wave action could have easily dismembered it. After storm action it could have been covered with sand and weathered roof debris. The covering of flesh would account for the lack of evidence of scars from the gravel. If the body were covered as it was dismembered, the gradual decomposition of the flesh would have protected the bone surface from scratches, and we would have a satisfactory explanation of the absence of signs of scratching or of gnawing by animals. A cave which might be filled with water at any time would not provide a den for wild animals. By the time it became available for habitation by man or beast, the skeleton would have sufficient covering to protect it. The presence of a portion of a sphenoid from another individual may also be explained by the wave-action theory.

That man occupied the cave soon after recession of the water is clearly indicated by the condition of the south end, where occupation goes practically to the water-smoothed rocks. A layer of fine damp dust, less than half an inch thick, powdered by weathering and perhaps by tramping feet, separates the deepest artifacts from the water-smoothed boulders in the bottom. These boulders were too large to move with any of the tools we had available. The fragility of parts of the skull and the unbroken condition of certain of those parts is difficult to understand where so much pressure must have been exerted upon them. However, even more fragile bones, the skulls of two ducks, were found in a remarkable state of preservation at the same depth as the human remains.

In the gravel and sand just below the skull and just toward the entrance of the cave was found a crude bone awl or gouge, about $1\frac{1}{2}$ inches long and $\frac{1}{2}$ inch wide, shaped to a point at each end. It was a long bone of some animal either split lengthwise or worked down

from one side. One end appears to have been cut across diagonally while the other has the shape of an inverted V. This bone shows little mineralization.

About 5 feet from the skull and slightly toward the south end of the trench in the same material as the skull, two fragments of what may be a femur of some large mammal were found. Although these lay at least a foot apart, they fit together into an object measuring 2 by $1\frac{1}{4}$ inches. This had been crudely cut into a gouge or drill and shows chipping at both ends. The bone is heavily mineralized. The slightly curved stroke of the chipping shows that the working was done while the bone was soft or before it was mineralized. These artifacts are mentioned here because they show evidence that man was living in the vicinity of the cave at a date early enough to allow his crude artifacts to be deposited in the gravels at the same level as the skull.

In 1938, in an excavation intended to determine the southerly limits of the gravel under the north-south trench of 1939, two fragments of bones were found near the top of the gravel about 5 feet from the south edge of the skeletal deposits worked in 1937. Dr. Chester Stock kindly examined these bones. He identified one as belonging to *Equus* but could not give the species. The other was unidentifiable. We thus have the Pleistocene horse in the gravel bed at the same level as the human skeletal materials. In 1939 a test pit in a cave in the Summer Lake region showed the presence of bones of Pleistocene horse and camel, bison, mountain sheep, bear, wolf, red fox, and other mammals associated with human occupation.

Our hypothesis of natural deposition may not be the correct answer to the question; but it has more in its favor and less against it than any other explanation. It fits better into the whole pattern of evidence than any other single hypothesis.

At the present time we are unwilling to do more than state that, if the theory just set forth is correct, we are dealing with late Pleistocene or early Recent materials. Glacial and precipitation conditions are the result of both cosmic and local factors. A deep lake of small expanse with a large hydrographic basin and glacial sources would last longer than a shallow mere layer lake with a smaller drainage area and without glacial sources. Furthermore the variation in level of the former type of lake would be more marked than in the second. Even today slight variations in precipitation in time show marked effects upon the water in these dry lake beds, and differential variation between lake beds is also obvious where the drainage areas and lake

basins vary. When glaciologists and palaeontologists can agree on a chronology, then the archaeologist who must rely on them can give dates if they must be had. For the present we offer late Pleistocene or early Recent as the period represented by the skeletal remains of Catlow Cave No. 1, if our hypothesis of natural deposition is correct.

The artifacts show a rather striking uniformity throughout. We are not yet in a position to give a complete report on this aspect of the work. But our study of the artifacts does not indicate any significant change in types or in combinations in which specimens occur from top to bottom or in the different parts of the cave.⁵

Basketry with few exceptions is fine twining on a two-ply twisted warp. Over 100 pieces of twined basketry were taken from Catlow Cave No. 1. Nine pieces of coiled ware were found. Three were disturbed surface finds. The other six were not found *in situ*. One specimen came from the top of stratum III; but its location with reference to some rat holes and the lack of characteristic brown moist soil on it strongly suggests that it came to its position by the rat hole or that the rats had covered it with refuse which preserved its "clean" appearance in contrast with the usual "dirtiness" of stratum III finds. Both split and interlocking stitches occur. There are three single-rod, one two-rod vertical, and five three-rod triangular specimens. All pieces are small; only one or two are well preserved.

The twined specimens from the south end show a ratio of about three decorated pieces to one undecorated, while in the north trench the ratio is about half and half. The decoration is applied by two different degrees of overlay and overlay in colors contrasting with the weft and false embroidery; the pattern is formed by contrast of a light-colored overlay strand against a darker background or vice versa. The patterns are: checkerboard, diagonal, alternating horizontal or vertical rows in a series, rectangle, and triangle; sometimes a number of horizontal rows will separate two or more bright rows of overlay. A number of pieces from Catlow Cave No. 1 have the design applied by the use of black overlay.

The basketry from Roaring Springs Cave is more impressive both in size and in artistry of manufacture. The use of black in the overlay to produce the design is strikingly developed here. A particu-

⁵ In Catlow Cave No. 1 there appears to be a bottom stratum lacking basketry. In Roaring Springs Cave basketry is clearly lacking in the bottom stratum. Atlatls occurred in the early period but the bow and arrow gradually came in and probably displaced the atlatl, as is shown in the second paper of this series.

larly impressive piece shows a series of triangles running diagonally to the right; the base of the triangles is a continuous diagonal line. This basket is heavy and is made on a four-ply twisted double two-ply twisted warp. The twist on every specimen of basketry is down to the right. Twilling and open work on a diagonal warp occur; the latter type also is found with a solid overlay. The basketry, with the exception of the coiled ware, closely approximates the Klamath-Modoc type of recent times. Klamath-Modoc ware has warp strands continuous from one rim down across the bottom to the other rim. Our basketry lacks this; in the basket bottoms which we have for study, the warps radiate from the center. Archaeological specimens from the Klamath-Modoc region are not available for comparison.

Loud and Harrington report finding in Lovelock Cave, in the lower levels of Pit 15 (1924 excavations), basketry of the "Klamath-Modoc-Pit River type."⁶ They do not specify the characteristic two-ply twisted warp. Loud in 1912 found two fragments: "Two fragments of tule basketry had warp of two twisted strands."⁷ This report lacks adequate stratigraphic evidence. Professor E. W. Gifford of the Museum of Anthropology of the University of California sent us for study specimens from this collection and from Pit 15. The former do not appear to be the typical Klamath-Modoc type; the 1912 specimens are like ours.

Mr. A. D. Krieger, who with Mr. R. F. Heizer is writing a report for the University of California on the artifacts from Humboldt Cave close to Lovelock Cave in Nevada, has informed me that they found in the upper half of the unstratified deposit roughly 15 specimens *in situ* which, when the basket bottom was available, showed the typical Klamath-Modoc warp arrangement. One fragment found at the bottom of the upper half of the deposit was similar to the Catlow Cave specimens, with the warps radiating out from the center. Strong *et al.* report finding one small specimen of two-ply twisted warp in the Dalles-Deschutes region.⁸ A reconnaissance party from the University of Oregon Museum of Natural History in June 1938 found basketry identical with the Klamath-Modoc type in caves in the north-central part of Oregon on the John Day and Crooked rivers.

The two-ply twisted warp of string occurs in the Basket Maker bags, in the soft bags and soft baskets of the Columbia and Plateau areas,

⁶ "Lovelock Cave," *U. C. P. A. A. E.*, vol. XXV (1929) pp. 18-38 *passim*.

⁷ *Ibid.*, p. 69.

⁸ W. Duncan Strong, W. Egbery Schenck, and H. Julian Steward, "Archaeology of the Dalles-Deschutes Region," *U. C. P. A. A. E.*, vol. XXIX (1930), p. 118.

and whenever, to our present knowledge, the soft bag or basket occurs in the Northwest. The device was perhaps developed to give body to a very flexible bag and was extended to semiflexible baskets. In our area and in the Klamath-Modoc region the device evidently became so established that it was used on all basketry. One fragment from our material is an openwork type made from willow or similar twigs; even this type has the customary two-ply twisted warp. The traits in our area may be listed as: two-ply twisted warp (which seems definitive), downward twist to the right, overlay, wrapping, and geometric design elements. It is possible that the Klamath-Modoc method of warp arrangement from rim to rim across the bottom may be a later development in technique, an improvement over the radiating warp structure. Since apparently the only structural difference between the Catlow and Klamath-Modoc basketry is in the arrangement of the warps at the bottom, one would certainly seem justified in looking for a relationship. The twined basketry suggests a northern orientation, both because of its technique and because of the decorative design.

Thirty-four sandals or sandal fragments were found in Catlow Cave No. 1. These appear to have been most numerous in the lower half of the deposit. With two exceptions, these are made from shredded sagebrush bark twisted into ropes and then twined into the sandal. Two are made from bundles of grass. These types are duplicated by sandals from the Fort Rock Cave. Tule sandals are found in Roaring Spring Cave and in the Paisley caves.

Except in Roaring Springs Cave, no piece that could be definitely identified as a bow was found, although two small flat pieces of wood from Catlow Cave No. 1 may be fragments of bows. Sixty-one pieces of arrow shafts were found. Twenty-four of the pieces are of cane (*Phragmites communis*). Some of our points are atlatl-dart points, and a number of the shafts belong to that type of weapon. Atlatls were found in Roaring Springs Cave but not in Catlow Cave No. 1.

Projectile points are discussed in detail in the second paper of this series and so are not taken up here.

Metates for grinding food and paint and one pestle were found, but no mortars.

I will not attempt to give here a complete list of all the artifacts recovered. One more type should, however, be referred to. A number of small shreds of an undecorated black pottery were found. These came from the upper levels near the top at the north end of the cave. Dr. James Griffin has examined these and reports that they lack distinguishing characteristics. The closest resemblance he finds

in Strong's Dismal River type, but he does not mean to indicate any relationship.

The artifacts found in this area indicate a culture sharing many traits with the Great Basin. Some traits, especially the atlatl, are also to be found in the Southwest. The question naturally arises: Are we dealing with an area peripheral to the Southwest or one in the main autochthonous? The answer to this question has a vital bearing on New World prehistory, its order of development, and its spatial distribution. It is difficult to answer this question because of the lack of adequate archaeological evidence between our area and the Southwest. Efforts to find an answer based upon the time-area concept run into difficulties because of conflict with the geological time elements involved. Geological evidence as presented by Dr. Williams in the third paper of this series shows conclusively the lapse of 4,000 and perhaps 10,000 years as a minimum, in the case of the Paisley Five Mile Point Cave, and possibly several thousand years in the case of Fort Rock Cave. The Southwest origin and diffusion theory of the source of this culture with which we are dealing cannot be fitted into this geological framework; it is the writer's opinion that the geological evidence strongly points in the main toward an autochthonous origin for this Northern Great Basin culture.

SUMMARY AND CONCLUSION

The points stated in this summary are, it must be kept in mind, only working hypotheses. Only part of the evidence on which they are based has been presented in the preliminary report.

(1) Early man was evidently in the Northern Great Basin at the end of the Pleistocene or Early Recent period. This man, as represented by the skull, belongs to the ancient dolichocephalic Basket Maker type.

(2) The early culture of the Northern Great Basin was adapted to a lacustrine or a marshy environment, as is shown by the great reliance on waterfowl for food and tule for basketry materials.

(3) The changes in food habits which occurred may have been due to change in environment with a new fauna, change in fauna without climatic change, change in hunting methods, or change in food preference.

(4) The technology of the region was based upon the utilization of sagebrush bark, probably *Apocynum*, tule, wood, and bone, but not leather.

(5) The projectile points are mostly made from obsidian. The types described for the Puebloan sites, especially Pecos, are found. This means nothing, however, until it can be shown that arrow points have a greater diagnostic value than they now are known to have.

(6) The culture, as illustrated by the basketry of the region, would appear to be the center of diffusion archaeologically for the Northern Great Basin region extending to Lovelock on the south, to the Deschutes and John Day rivers on the north, and westward to the western limits of the Klamath basin, where similar basketry occurs in historic times. We do not know about the Klamath region archaeologically nor do we know the distribution to the east. Furthermore, this type of basketry is associated with Lovelock and Humboldt caves; if our theory of diffusion is correct, its appearance at Catlow Cave would be expected to antedate its appearance at this marginal locality.

(7) We may have here the origin of the Klamath-Modoc material culture, or at least a good museum exhibit of what the ancient lacustrine or marsh material culture, of which the Klamath-Modoc may be simply a residuum, was like.

(8) We shall eventually, by systematic extension of this work north and south and east and west, discover whether there was a province of culture west of the Rockies extending from far toward the Southwest well toward the Plateau region of the north, and, if there was such a province, what the cultural substratum was from which the later localized types of culture developed. Steward⁹ in 1937 formulated the following hypothesis ". . . that west of the Rocky Mountains there developed a series of types of as yet undetermined sequence whose general pattern differed markedly during its early phases from the *Folsom and related* forms east of the Rocky Mountains." This writer had independently formulated in his own mind the same hypothesis as a result of study and field work over a period of five years in this area. Systematic investigation is the only method of verification of this hypothesis.

⁹Julian H. Steward, *Ancient Caves of the Great Salt Lake Region*, Bureau of American Ethnology Bulletin no. 116 (1937), p. 123. Italics mine.

ATLATLS AND ASSOCIATED ARTIFACTS FROM SOUTHCENTRAL OREGON

L. S. CRESSMAN AND ALEX D. KRIEGER

TWO complete atlatls¹ and parts of two others were discovered by a University of Oregon archaeological expedition in the summer of 1938 in Roaring Springs Cave, Catlow Valley. This fortunate discovery not only helps to fill the great gap in distribution between southeastern Alaska and the Basket Maker caves of Utah, but also introduces a new type of implement, presenting a number of features in a combination not found heretofore in either the Old or the New World, so far as the authors are able to determine. A few days after this discovery a detail of the expedition found half of another atlatl of notably different type, more like those of the Southwest, in the refuse piles of a looted cave in Warner Valley, some 50 miles west of the first find.

GEOLOGICAL CONSIDERATIONS

Roaring Springs Cave² is located in the lava rimrock on the northeast side of Catlow Valley, where the westerly slope of Steens Mountain drops into the valley about 20 miles west of the summit. This area is roughly in central Harney County, southcentral Oregon, about 75 miles south of Burns, the county seat. Actually there are two caves at the site, their mouths practically adjoining. Both are slightly above the highest recognizable beach terrace of a now-extinct lake which formerly filled Catlow Valley to a depth of 175 feet or more. The lake basin itself is to be associated with the general complex of unstable playa lakes which at some period of greater rainfall than occurs today covered a large portion of the Great Basin. Like other Great Basin lakes, Catlow had no outlet. While the Steens Mountain area and Catlow Valley mark the approximate southern limits of the Columbia lava plateau geological province, caves in this area have been formed in much the same way as those elsewhere in the Great Basin, namely, through wave action at the time of greatest accumulation of water in the various lake basins. There are reasons for believing that the alternate filling and dessication of the main Great Basin lakes (Bonneville, Lahontan, Warner, and Catlow) must have

¹ "Atlatl" is a less committal term than "spear thrower," "spear sling," "throwing board," or "dart thrower," and seems to be gaining favor in the literature. A Mexican type of implement is not implied in use of the term.

² The full report of excavations in this cave is in preparation.

occurred more or less contemporaneously over the whole basin in conjunction with the same general periods of increased rainfall. How long ago the waters lay at the level of modern caves is still an open question. Each lake basin shows a series of terraces which indicates that not one but several more or less important "pluvial" periods have visited the Great Basin since glacial times. Antevs³ favors the "post-glacial pluvial" as the last period of rainfall sufficient to bring the lake waters up to the highest beach terraces, which is the level of most wave-eroded caves. Jones,⁴ on the other hand, estimates that only about 1,000 years have passed since the last maximum filling of Lake Lahontan. This problem can be laid aside here with the remark that, whatever the date of the formation of Roaring Springs and Catlow caves, they were occupied by human beings soon after the last subsidence of the lake from their level. The lake did not rise again to the cave level, though of course it may have risen as far as one of the four lower beach terraces still visible here. We know that playa lakes in the arid basin can fluctuate considerably in a short period of time—witness the growth of Abert Lake in Lake County, Oregon from a mere puddle in 1937 to a lake 15 miles long by 5 miles wide in 1938.

The more northerly of the two Roaring Springs caves is about 11 meters wide at the mouth and 12 meters deep. It contains a deposit having a maximum thickness of 1.2 meters (47 inches) in front and central portions, shallowing away toward the walls and back in conjunction with the rising floor. The southern cave is suitable for occupation only in the front, where a thin deposit of ash had accumulated. It is of no further concern in this report.

NATURE AND CONTENTS OF THE STRATA

Excavations were carried out systematically in the northern cave so that both longitudinal and lateral profiles were obtained of the whole deposit. A clean-cut stratification occurred throughout, dividing the entire deposit into two main beds. This division is well supported by distinct differences in artifact content in the two beds. The lower one, which we termed the "dirt bed," represents the earliest occupation of the cave, for it rests upon broken and granulated sterile roof material that more or less covered the floor before any human

³ Ernest Antevs, "On the Pleistocene History of the Great Basin," in *Quaternary Climates*, Publication 352 of the Carnegie Institution of Washington (1925).

⁴ J. C. Jones, "Geologic History of Lake Lahontan," *op. cit.*

beings lived in the cave. This "dirt bed" varied in thickness from a thin film near the walls to a half meter in the central parts. It contained some scattered ash beds, much additional fallen roof material somewhat decomposed and granulated, and probably a fair proportion of un laminated aeolian dust from the exterior. Artifacts ran almost entirely to large flaked points and/or knives, drills, and scrapers, mainly of obsidian, but including also some cherts. Scrapers are con-

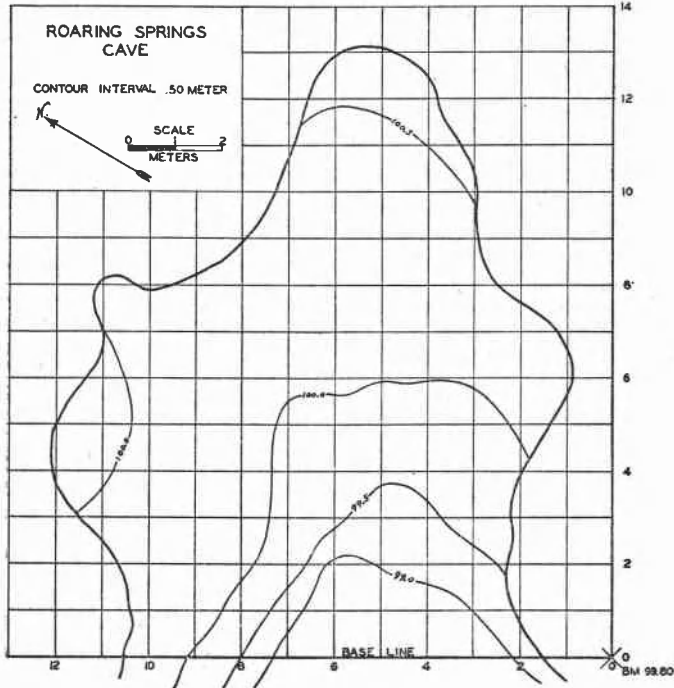


FIG. 2. Roaring Springs Cave.

cave "spoke shaves," plano-convex "snub-nose," and simple retouched spalls. A large triangular obsidian object frequently met with may be a convex-edge form of end scraper. The basal edge in this type of scraper shows every transition from straight to a pronounced convex arc. Some specimens have more or less convex sides, so that the "triangular" type grades into ovoid and even round forms.

In all probability arrow points are entirely absent from the lower bed. While one or two rather small points, which conceivably would serve for the arrow, came from here, they may instead represent a

small projectile used with a small variety of atlatl. This will appear as a valid possibility when we compare, below, the relative size of the two complete atlatls found in the upper or "straw" bed. All other pointed specimens from the lower bed are definitely large in comparison with the several "small" types found in the upper bed; with our present knowledge such a subjective reckoning of point sizes with inferential usages has a more than fair probability of being correct.⁵

Another important difference between the two beds is in the occurrence of artifacts made from vegetable materials. With the exception of a few nondescript fragments of rush matting, such artifacts are entirely absent in the lower bed. This lack is not the result of adverse preserving conditions; for, in addition to the scraps of matting, bits of bark and grass in good condition were frequently seen.

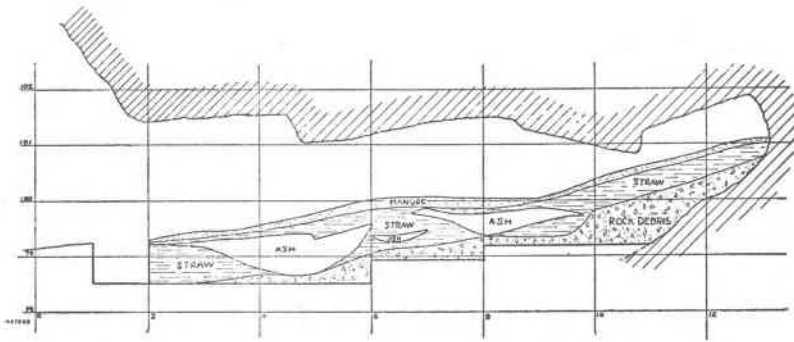


FIG. 3. Roaring Springs Cave. Longitudinal profile at 6-meter line.

The term "straw bed," applied to the upper half of the deposit, is a graphic one. It was composed almost wholly of large quantities of grass, rushes, sedges, bark and fiber, nondescript sticks, partially burned sagebrush firewood, etc., with only a very insignificant admixture of dust. Such a bed, other things being equal, would require for its accumulation but a fraction of the time represented by the lower bed of inorganic materials. Here and there the upper bed was broken by solid lenticular bodies of thoroughly burned white ash. This is significant, for such ash lenses indicate that human occupation of the cave was in later times quite extended. Most historic Great Basin bands, if they occupied caves at any time of the year, did so only for a few days, usually during the most severe winter weather.⁶ This

⁵ The complete statistical analysis of types, sizes, and frequencies will appear in the full report on this cave.

⁶ Unpublished field notes of Omer C. Stewart, Department of Anthropology, University of California, summer of 1936.

is supported by the junior writer's observations in other Great Basin caves, namely, that deep, solid, white-ash beds implying long periods of continuous burning are a rarity, while thin, partially burned ash lenses are common. This is not to be taken as evidence, however, that Roaring Springs Cave was continuously occupied through its upper half, for appreciable quantities of rat and bat guano were loosely mixed with the straw throughout its extent.

The cave was filled from wall to wall with this "straw bed" to a thickness ranging from .4 to .7 meter, exclusive of loose and disturbed trash on its surface. From bottom to top this bed yielded numerous fragments and circular sections of basketry in close twine with overlay and false embroidery, quite similar in both structure and materials to historic Klamath-Modoc ware.⁷ We have found this ware to be distributed over a wide area from the middle Columbia River on the north to the Pit River of California on the south,⁸ and from the Cascade Mountains on the west at least to Steens Mountain on the east.

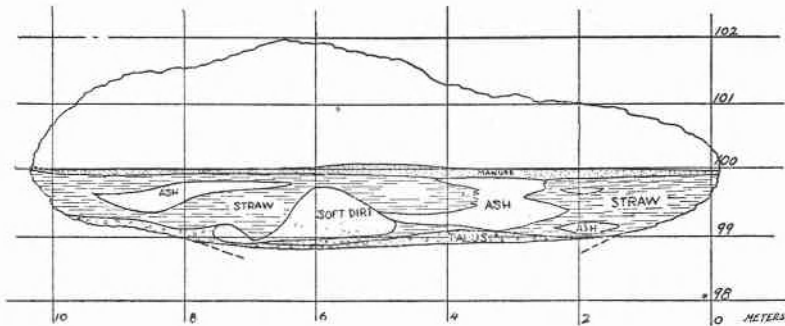


FIG. 4. Roaring Springs Cave. Cross profile at 4-meter line.

There were, in conjunction with this basketry, a great many flaked obsidian knives, points, and scrapers, spall scrapers, matting of rush and grass, sack-like bags in matting technique, sagebrush sandals, fire drills, bone awls, digging sticks, and other objects, similar on the whole to the general run of material culture in the Northern Great Basin. Significantly, however, those points which may safely be adjudged as projectile are of two general classes. One class is large,

⁷ If there is any weighty difference between this ware and Klamath-Modoc, it is in the method of starting the basket core; see above, page 12 (to be discussed in full report).

⁸ The mechanical principles of this basketry, applied to different materials, seem to belong to even a greater distribution area—from the Thompson of British Columbia to San Francisco Bay, where a number of charred fragments without overlay come from a cremation (late trait there).

similar to those of the "dirt bed"; the other consists of distinctly smaller points which may with reservations be considered as intended for arrows. A variety of arrow-shaft fragments and two bows from this bed expel any doubt as to the occurrence of the bow here in the later period. Throughout the upper bed, too, were a number of projectile-shaft fragments with small conical sockets in their butt ends. They are considerably larger in diameter than those which are definitely arrow, *i.e.*, have the arrow nock. There seems no room for doubt that these are "dart" fragments. Most of them are painted spirally in green, red, or black. The distinct dual classification of diameters for "arrows" and "darts" is clearly seen in Fig. 6. Here, then, we have definite proof of the contemporaneity of bow and atlatl throughout most, if not all, the period of time represented by our upper bed. Whether the atlatl disappeared in early or late times is unknown. All we can say is that no Paiute informant in the Northern Great Basin has ever seen or heard of the atlatl.⁹ If not older than the Paiute themselves in this region, it is at least older than their present traditions.

Mention should be made of the discovery of a cache pit at the back of the cave which contained two bison-hide¹⁰ moccasins and half a sinew-backed bow in three pieces. This bow is very well made—broad, flat, thin, and nicely finished. Nearly all the sinew is either torn off or eaten away by rodents. This bow contrasts strongly with the crude affairs made by historic Paiute. This cache pit may have been dug by a relatively temporary camping party. It was apparently dug from the surface at last occupation. Horse manure was mixed with the straw and other debris among which the moccasins lay at the top of the cache, and adhered to the wicker basketry specimen.

There are, therefore, at least four culture traits which enter this cave near the end of its aboriginal history: the sinew-backed bow, bison-hide moccasins, coiled basketry, and wicker basketry.

The two atlatls were found with the hook sides facing each other, but separated horizontally by a space about 6 cm. wide. They lay about midway vertically in the "straw bed," at a point underneath a rock lip which hangs down from the roof just back of the mouth of the cave. The deposit had eventually accumulated almost up to this lip. Not only the atlatls but much basketry had been cached away under the protection of this rock. Though the surface above was somewhat disturbed, probably by rodents, the implements themselves were *in situ* 20 cm. below the lowest disturbance. Close to the atlatls

⁹ Stewart's 1936 element list (see note 6) is entirely negative for frontier basin bands between the Snake River and Lake Tahoe, Burns and Walker Lake.

¹⁰ One is complete only for the front half and may be heavy deer hide.

at the same level was a small cache lined with a piece of basketry lying on a grass lining. This contained a dart point and an atlatl shaft butt.

In this part of the cave the straw reached its greatest thickness; hence the atlatls were deposited here about midway in the time period represented by the straw. There were no Caucasian objects anywhere in the cave (except for the surface covering of stock manure), so even an approximate date would be a pure guess. As stated above, the straw would have accumulated very rapidly in relation to the underlying "dirt bed." Whatever date may be put on the atlatls, they are significant only in relation to the association of the culture complex of this cave with other sites in the Great Basin, a task reserved for the full report.

DESCRIPTION OF THE ATLATLS

Atlatls may be described according to three main criteria: (1) the general shape and proportions of the body or shaft, (2) the mechanism for engaging the projectile, and (3) the provision for gripping. Perhaps the most striking thing about this implement from the world viewpoint is the great variety of means employed to satisfy these three requirements. Whether all types found in the world are to be traced to a single origin is more an academic than a practical question. Certainly structural principles are variable enough between the

TABLE I. Comparative Measurements—Roaring Springs Atlatls 1 and 2 and Plush Cave Atlatl

	<i>Measurements in cm.</i>		
	<i>R.S. 1</i>	<i>R.S. 2</i>	<i>Plush</i>
Length of body	50.5	41.5	.....
Length of finger-hold section.....	9.0	4.5	6.5
Length of grip taper	11.0	6.7	11.2
Length over all	70.5	52.7	.....
Maximum width	7.2	5.0	2.3
Distance of this point from heel	18.5	14.0	.....
Width across shoulders at hook	6.5	4.6	.....
Width next to finger-hold section	4.3	4.2	2.2
Width of finger-hold section	5.5	4.3	2.2
Depth of finger notches	1.7	0.7	0.5
Thickness at heel end	1.0	1.6*	.....
Thickness at handle end	0.7	0.9	1.2
Height of keel	0.5	0.5	none
Length of keel from heel down body	24.0	23.0	.....
Length of hook	5.4	3.2	.....
Height of hook above concave facing	2.0	0.9	.....
Width of hook at base	1.5	1.0	.....
Maximum depth of basin in top side	0.7	0.4	.....
Distance of keel perforation from heel end	3.2	14.0	.....

* Including keel protusion.

Esquimo, say, and the Melanesian forms of the implement to make multiple origins conceivable.

Of the two small fragments, both of which came from disturbed surface refuse, one is a hook and the other the "shoulder" next to the hook. In all probability they are from different specimens—making four implements in all from this cave, all of the same type.

There is a striking difference in the size of the two complete atlatls. In general, they are similar in shape and body proportions, identical in provision for engagement, and employ the same principle for grasping—indentations in the sides for the first and second fingers. There are, however, differences in the lateral cross section, and in the manner of carving out the finger-hold section. The larger of the two is hereafter called R.S. 1 (Roaring Springs 1) and the smaller R.S. 2 (Plate VII). Table I compares their main dimensions. Column 3 gives the obtainable measurements of the fragment from Plush Cave, Warner Valley, Lake County (Plate VII).

Roaring Springs 1

This atlatl is carved from a thick section of mountain mahogany (*Cercocarpus ledifolius*), a common treelike shrub in the arid division of the Transition Life Zone which includes the whole of the south-central and the southeastern parts of Oregon, exclusive of the higher reaches of Steens and Hart mountains. This wood is rather reddish in its natural condition, but the atlatl has been painted evenly with red ochre over its entire surface, giving it a rich, reddish-chocolate hue. It will be noted that the heel or hook end is stained a speckled brown color. Whether this was done intentionally or is the result of some exudence from a small rock lying next to the implement after caching is not determinable. The body is carved in a very graceful curve. A shallow basin begins at the hook end and extends about half way to the finger-hold section. At this half-way point the basin shallows out into a flat upper surface, and at the same point the body begins to narrow laterally, the width decreasing until the finger-hold section is reached. The under surface is convex in a more or less constant degree throughout. This is accentuated by the "keel," a protuberance blending with the hook (Plate VIII) and running 24 cm. down the underside. It is itself accentuated by a deep groove on each side. The implement as a whole is like a "board," broadest at the distal end, but gradually narrowing from the mid point to the tapered grip. The keel could be a practical means of abutting the hook, for in the act of throwing the

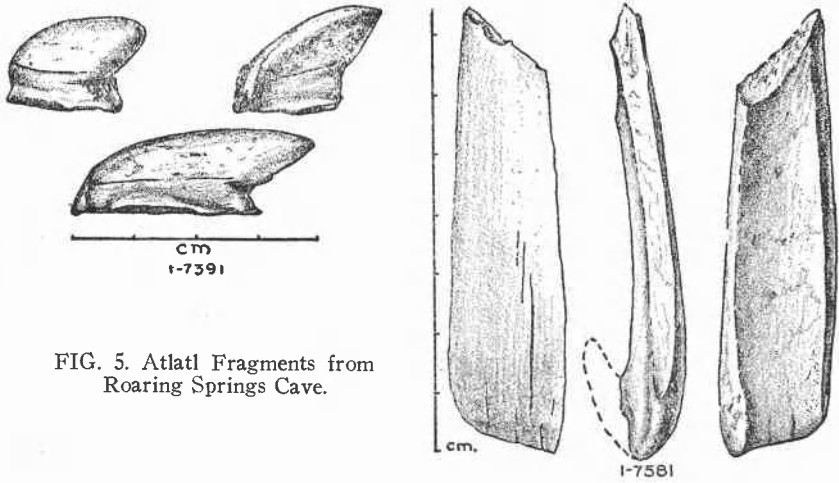


FIG. 5. Atlatl Fragments from Roaring Springs Cave.

“dart” there is a strong force tending to pry the hook away from the body. Indeed, the present specimen is split along the base of the hook, and no doubt had reached the end of its usefulness. One of the fragmentary specimens is a hook probably pried off in use (Fig. 5). On the other hand, the heel could have served for suspending feather ornaments, or perhaps a weight of unknown nature to increase its equilibrial force. However, the hole made through the keel of this specimen, 3 cm. from distal end, seems unsuited for anchoring a weight. The finger holds are formed by two notches cut into the sides of a widened section. This is narrowed to form the grip proper, which is wrapped in a deer or antelope skin. The wrapping was also painted red after it was attached.

Roaring Springs 2

This specimen is made, like R.S. 1, of mountain mahogany, afterwards painted over all with red ochre. R.S. 2, however, has been further decorated with three rows of white dots running unevenly along the upper face. The white dots on a red background look startlingly like Australian designs. As will be seen from the figures given in Table I, this, the smaller of the two specimens, is narrower, tapers less, and is thicker than the other. In lateral cross section it is more angular, more V-shaped, and has a shallower basin in which to lay the “dart.” The keel forms a slight protuberance at the base of the V and does not have the grooves on either side. The shoulders next to the hook are nearly flat, the basin beginning farther down the body.

On the whole, it is cruder than the first. The finger holds are simply cut into the body, not into an expanded section. There are two more notches below these, which may have served once to hold some wrapping for the grip, as in the larger specimen.

Perhaps the most significant points of difference between the two specimens are, first, their general relative size and, second, the size of their hooks. The hook of the smaller one could be engaged with a very small shaft, or even with an arrow nock. Its tip hardly protrudes beyond its base and is small and delicate, in contrast to the hook of the larger implement.

This confuses the possibility of working out a definite use classification for the several hundred projectile points found in the two deposit layers. It is conceivable that two different sizes of projectiles, one not necessarily much larger than an arrow, could be thrown with these two atlatls. We cannot clarify this point for lack of whole projectiles from this cave and from Catlow Cave. Lastly, it should be mentioned that several of the "dart" sections from these caves are of wood from 5/16 to 7/16 inches in diameter, and therefore heavy in comparison with "arrow" shafts.

Plush Atlatl

The provenience of the specimen within Plush Cave in Warner Valley has been lost, for it was found in looters' back dirt. It is an entirely different type from those just described, falling in rather readily with the common "Basket Maker" types from Utah to Mexico. It cannot be determined whether this had a groove instead of a basin in which to lay the projectile, or whether the hook was a separate piece laid in the back of the groove, if any. These points would, of course, strengthen the analogies with "Basket Maker" types. As it is, we have only the handle and the cross section of the body from which to judge. This portion is of uniform width and thickness throughout, broken only by the long, graceful indentations for the fingers, and the encircling grooves next to them (see Plate VII). These grooves were almost certainly intended to hold cord or thong finger loops, a common feature on atlatls from the Southwest and Mexico. In cross section this specimen is slightly more than a semicircle. The top side is not flat, having a slightly raised ridge along the center line throughout. Thus the diameter of the semicircle is bent up into a very shallow inverted "V". The handle shows a certain amount of smoothing from use. The piece is of soft wood, either willow or aspen, and has never been painted.

WORLD DISTRIBUTION AREAS OF THE ATLATL¹¹

Krause,¹² following von Luschan's suggestion,¹³ classified "throwing sticks" as "male," and "female," and "mixed" (zwitterhaften). This system is based on fundamentally distinct mechanical principles used in the engagement of projectile and throwing implement. On the basis of this terminology the major atlatl areas of the world may be distinguished and conveniently summarized. While the "sex" of the implement is not of course completely diagnostic in itself, other features such as the shape of the shaft and the grip can be correlated with the first concept. Without pursuing excessive detail, an outline of the world distribution, based on the "sex" of the implement, is here presented first. We then attempt to orient the Roaring Springs specimens in the world scheme, a task which is complicated by their lack of agreement with other New World specimens.

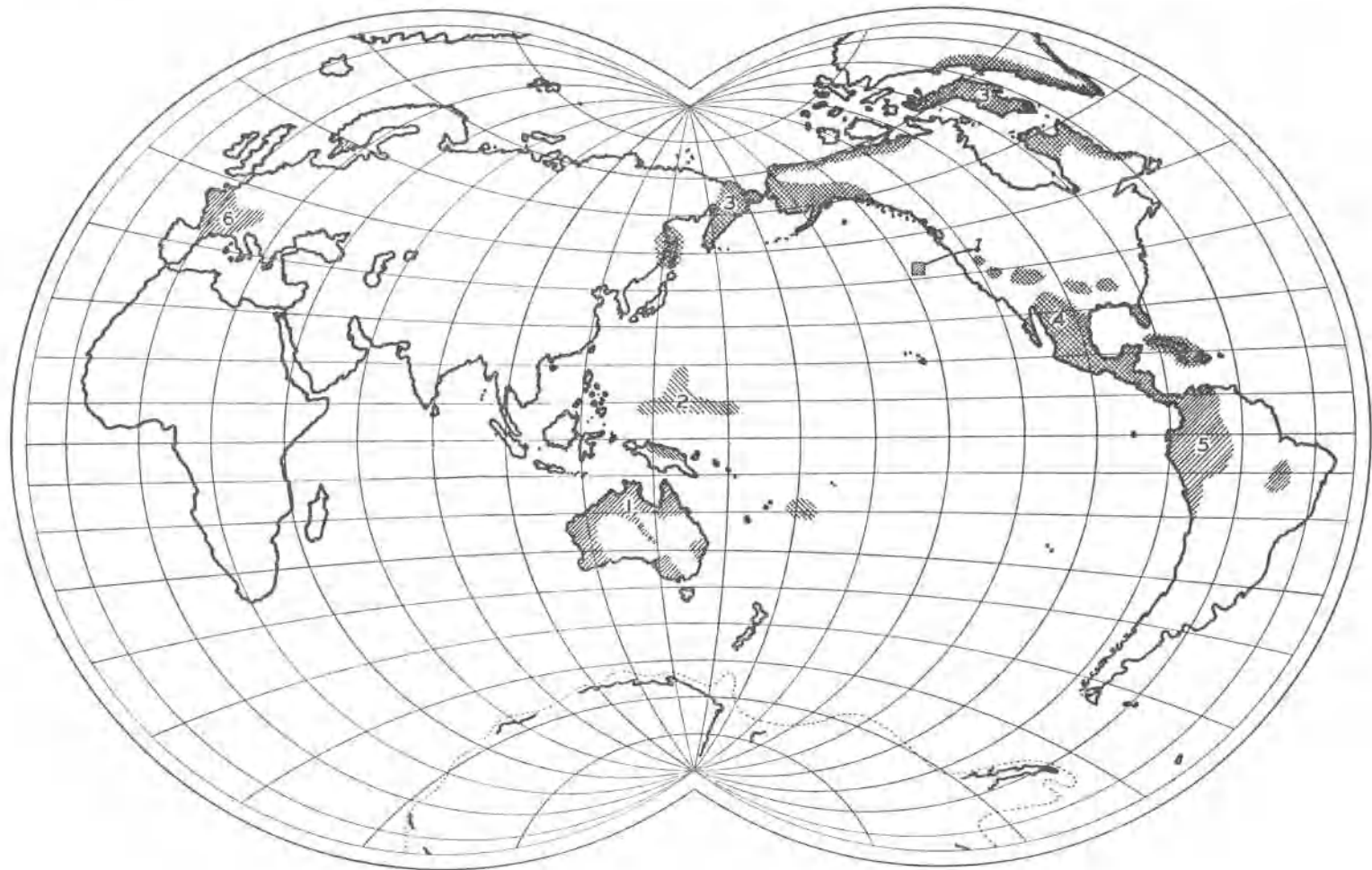
"Male" atlatls are those with a convex, flat, or perhaps slightly concave upper surface, and a hook that stands up from the distal end to engage the butt of the projectile. The hook may or may not be carved from the shaft. Various forms of this class occur widely in Australia even to the present day; indeed, Australian atlatls are exclusively of "male" design. They are also known over a large portion of South America, where we may recognize two groups, one in prehistoric Peru and Ecuador, extending into southern Colombia, the other in western Brazil and most of Colombia, with an outlying related region about the middle Xingu River. Interestingly enough, the Roaring Spring specimens are "male" and are apparently the only specimens of this class outside of Australia, South American, and perhaps paleolithic France.

"Female" atlatls are grooved on the upper surface; the projectile may be laid in the groove when "cocked" for throwing. As will be seen, the spear is not always laid in the groove, so a stronger diagnostic feature is the lack of a hook on which to engage the projectile. Thus, in Melanesian and Micronesian weapons, the spear itself is equipped

¹¹ The following section on distribution is to be credited to Krieger. Krieger hopes that, following this initial survey, he will find the opportunity to present a more elaborate study of this weapon, giving consideration, among other problems, to the mechanical principles involved and the efficiency by which the different types meet the demands of the instrument. As a result of new discoveries constantly being made, previous studies need to be revised and consideration given anew to the problems involved in both time and space distributions. L. S. C.

¹² F. Krause, "Schleudervorrichtungen für Wurfaffen," *Internationales Archiv für Ethnographie*, Bd. XV (1902), Hft. 4, S. 121-151; translated and condensed in annual report for 1904 of Smithsonian Institution. The original is recommended for its more pragmatic outlining of classifications.

¹³ F. von Luschan, "Das Wurfholz in Neu-Holland und in Oceanien," *Festschrift zum 70. Geburtstag von Adolf Bastian* (1896).




 Male


 Female


 Mixed

MAP 2. World Distribution of Atlatl Types.

with a hook which engages the hollow at the back of the groove in the thrower. On the other hand, some Greenland specimens show a hollow cup at the back of the groove into which the spear butt fits. "Female" forms occur exclusively in Melanesia and Micronesia, while in Greenland they occur with other forms in the "mixed" class. This appears to exhaust their distribution.

"Mixed" atlatls combine features of the other two classes. They employ both groove and hook, the hook being set in the rear of the groove, extending forwards horizontally or at a slight upward angle to facilitate disengagement at some point in the throwing arc. The hook, usually bone, seems always to be a separate piece inserted in the back of the groove. This class has the widest dispersion, being found among northeastern Asiatics, among Alaskan and Canadian Esquimos, and among Greenland Esquimos in conjunction with female forms; in the southwestern United States, Mexico, Central America, Florida, the West Indies, the Greater Antilles and the Bahamas, and perhaps in northernmost South America near the Isthmus of Panama. This great distribution in the New World must be subdivided because of distinctive features into northern or "Arctic," and southern or "Mexican."

Thus there are six major atlatl areas in the world which may serve as a frame of reference for a distribution study:

- (1) Australia, "males" only.
- (2) Melanesia-Micronesia, "females" only.
- (3) Arctic, from northeastern Asia to Greenland, "mixed" only, except for addition of "females" in Greenland (called here 3a).
- (4) Mexican, bounded by Oregon, Panama, and Florida, "mixed" only.
- (5) South American, bounded by Panama, southern Peru or northern Chile, and the Xingu River, "males" only, but in two main groups, eastern and western.
- (6) Palaeolithic France, where it seems probable that a "male" form existed.

According to this world distribution (Map 2, p. 27), we have to place the Roaring Springs specimens in a separate or seventh area. They do not agree with either the Arctic forms to the north or the Southwest and Mexican forms to the south. Combining the hook with body shape and grip, we find still less agreement among these two major North American areas. It is true that our specimens in some ways

show greater affiliations with Australian forms than with any others, but this we regard as pure coincidence.

In body shape and grip these world areas vary greatly, which further indicates their separateness. This is not to be construed as a postulation of seven separate origins for the implement. It seems impossible to be more conclusive at present.

(1) *Australia*. Body shapes vary from long, thin sticks to broad, flat ovate "boards." A curious mechanical inefficiency is seen in these broad forms, for they increase wind resistance through the throwing arc. In the northern parts the natives of North Queensland and the Cape York Peninsula apparently sensed this disadvantage and turned the "board" edgewise, tying the hook to the edge instead of the upper face. However, through conservatism or for some other reason, the great lateral dimension was retained.¹⁴ From Port Darwin to Melville Island, we find admirable economy in a combined atlatl and boomerang, the shaft being curved in the desired degree instead of straight as in ordinary forms. Hooks were carved from the same piece as the shaft in the vicinity of Melbourne; elsewhere on the continent a separate hook of bone, kangaroo tooth, or hard wax was fastened to the distal end with wax, gum, reed splints, or thread. Grips vary from carved wooden knobs or indented finger holds to balls of cord, stones, shells, or sticks attached to the proximal end to provide a hand hold. In some cases the handle was simply tapered down and roughened to increase friction. Australians sometimes made very large atlatls, as long as 5 feet, with which they could hurl a 15-foot spear a distance of 276 feet.¹⁵

(2) *Melanesia-Micronesia*. Krause believes there was an early general distribution through this area, but actual specimens are known only from New Guinea, Viti Island (Fiji), the Carolines, Pelew, and the Marianas. Today they survive only on the northern coast of New Guinea, as a weapon of war (though some accounts hint at occasional use in the chase as well). The "female" class was used exclusively; and this also may be divided into two groups, namely those with an attached block on which to support the projectile for aiming, and those without this piece. The former occurs only on the north coast of New Guinea and would seem to be a rather late innovation not yet widely diffused. The shaft of both types is a round piece of bamboo cut so that the distal end is closed by a joint which serves as a hard seat for engagement with the spear. The spear, however, is at some

¹⁴ Krause, *op. cit.*, plate IX, 1-9.

¹⁵ Klemm, "Werkzeuge und Waffen," *Allgemeine Kulturwissenschaft*, Bd. I (1854), S. 31 f.

point along its shaft equipped with a hook, which, directed backward, fits into a socket in the hard joint at the back of the thrower. Thus, the projectile does not rest in the groove in front of this socket. The groove is functional, however, for it seems to allow the hook on the spear to disengage without danger of fouling on the upper surface of the atlatl.

The grip on these implements is simple. It can hardly be tapered because of the hollow nature of the material, but it may be roughened and wound with cord. It will be seen that this combination of features is quite distinct from the other "female" area, Greenland.

Three aspects of the Melanesian-Micronesian implements are especially significant for the present problem. First, the shaft is grooved and bears no hook, but the projectile does not lie in the groove, being supported instead by an additional piece fastened above the grip. Where this piece is lacking the front end of the projectile must be held and aimed by the left hand. Second, it is the projectile which bears the hook, and this is directed backward to engage the socket in the atlatl. Third, this hook is placed some distance from the butt of the projectile, and back of it is a brush of coconut fibers which causes the projectile to fall on its target from above.¹⁶

(3) *Arctic*. The atlatl survives today in certain northern regions as a weapon used in hunting from boats or kyaks. For this purpose it has advantages over the bow, for it may be used with one hand while the craft is steadied with the other. Furthermore, a spear or harpoon may be propelled with much greater force than either a hand-thrown projectile or an arrow, an important item in walrus hunting, for example.

The Arctic distribution area extends from northeastern Asia, notably among the Gilyak of the lower Amur River and northern Sakhalin Island, through the Aleutian Island chain, the entire coast of Alaska as far south as the Tlingit Indians and around to the Arctic

¹⁶ F. von Luschan has argued that Australian "male" and Melanesian-Micronesian "females" are divergent developments from a common ancestral form, having been subjected to a certain amount of geographical selectivity. All the implements in the latter area are made of bamboo. Because of its hollow nature, a longitudinal cut made on its side opens a cavity in which the butt of the projectile may become ensnared at some point in the throwing arc. Moreover, it is difficult to fasten a hook to the round surface of the bamboo. Therefore, experimentation led to a solution by placing the hook on the projectile so as to keep the bodies of the two objects somewhat farther apart. The groove remains functionally useful, however, to prevent the hook of the disengaged spear from fouling on the upper surface of the throwing implement. A further improvement, localized in northern New Guinea, is the addition of the supporting block to steady the projectile at two points. The two shafts thus lie parallel, but some distance apart, in the act of "cocking." While such an interpretation is plausible, it seems better to reserve judgment and treat areas (1) and (2) as separate, employing different principles.

coast, then as far east as Greenland and Labrador. Krause distinguishes three groups of these implements according to their provision for the forefinger in the grip. These groups agree closely with geographical and ethnographic subareas: (a) a hole for the forefinger is cut on the side of the shaft to the right of the groove; (b) the pocket or cavity for forefinger is placed on the center line of the under side, and, if it goes completely through the body, appears in the groove on the upper side; (c) a notch is cut for the forefinger on the right side of the grip, as in (a), but one or more pegs are inserted in the same side on which to hook the forefinger, or perhaps more than one finger. These complicated grips are in a sense geographically determined. The atlatl cannot be used with a gloved hand, so more efficient grips must be devised to prevent the implement slipping out of a bare hand stiffened and inflexible from extreme cold. Esquimos were in possession of a considerable amount of mechanical knowledge and ability, and could easily make the necessary fittings.

While it is not our purpose here to give detailed descriptions of the implements of the six areas, a few notes on Arctic types are in order. Arctic types are all equipped with grooves on the upper surface. In most cases the groove is rather long, extending down to the grip. It may be of uniform width, gradually deepening toward the distal end, into the back of which is inserted the bone point to engage the projectile, or it may be narrow and deep at the distal end but gradually shallowing and broadening toward the grip. These northern implements are quite generally broad and thin at the proximal end, narrowing to a width only sufficient to include a groove the size of the projectile butt at the distal end. This groove makes a snug fit with the projectile, so that a very small bone hook suffices to hold the two together in "cocking." This hook is inserted in the wood at the back of the groove, never tied on as in Australian atlatls. The lateral cross section of these Arctic specimens is often shaped like a triangle, with the bottom side presenting a sharp ridge, the top side flat but indented near the center where the groove lies. Their average length would be something like 40 cm., their width from 5 to 8 cm., perhaps more. Occasionally they are inlaid on the upper surface, even in the groove, with bits of ivory.

A Tlingit specimen more or less related to the Arctic forms is very intricately carved with typical Northwest Coast motifs.¹⁷

(4) "Mexican." This area, like the Arctic, shows a wide variety of "mixed" atlatls combining groove and hook. Shapes and grips dif-

¹⁷ Niblack, "The Coast-Indians of Southern Alaska and Northern British Columbia," *Smithsonian Institution, Annual Report for 1888*, pp. 231-386; and Mason, "Throwing-Sticks in the National Museum," *Annual Report of the United States National Museum for 1884*, plate XVII.

fer so very markedly, however, that we can be sure we are dealing with a distribution zone not very closely related to the northern zone. The "Mexican" area shows a very sporadic scattering of specimens, but it is reasonably clear that they are all traceable to a general basic pattern. Hooks are quite generally of bone, inserted in the back of the groove. Specimens are known, however, in which the hook is carved from the body of the shaft. The shaft is usually long and slim, and more round than flat in cross section. Some of these implements are quite delicate and seem incapable of withstanding much pressure in use. Ancient Mexicans and Mayans made great ceremonial use of the atlatl, and some of their implements were highly ornamented and decorated, but the ornamented atlatls were never intended for practical use. Practical uses, to judge from the records, were varied, ranging from warfare and the chase to the spearing of fish and waterfowl. The atlatl was used until recently for spearing fish and fowl at Lake Patzcuaro¹⁸ in the highland of Mexico and along the Tampico and Tabascan coast.¹⁹ There are reasons to believe that its use continued into protohistoric, or perhaps even into historic times, in much of the "Mexican" area here considered, outside of southern Mexico itself.²⁰ It has long been held that the atlatl was used by the Basket Makers of the Southwest before the entrance of Puebloan cultures and peoples, who brought with them the bow. There is no good reason to think that the transition there was abrupt; the atlatl may have survived in conjunction with the bow until fairly late in Pueblo history.²¹ Cultures of Basket Maker tenor may have survived in the Southwest contemporaneously with developed Pueblo cultures until a rather late time. In other words, we cannot safely regard the atlatl as chronologically limited to early periods anywhere in the "Mexican" area, though it may be so in some cases.

The only case of historic use of the atlatl in the western United States comes from the Santa Barbara Channel area in southern California. While this is interesting, Heizer has recently given an excellent argument for its Mexican origin, diffused to southern California by early Spanish navigators employing southern Mexican natives as seamen.²² The shape of the specimen in question is strikingly

¹⁸ Frederick Starr, "Some North American Spear-Throwers," *Internationales Archiv für Ethnographie*, Bd. XI (1898), S. 233 ff.

¹⁹ Krause, *op. cit.*, plate XV (map of Middle American distribution).

²⁰ See, for example, John R. Swanton, "A Historic Use of the Spear-Thrower in Southeastern North America," *American Antiquity*, vol. III (1938), pp. 356-358.

²¹ M. R. Harrington, in conversation with A. D. Krieger, January 1938.

²² R. F. Heizer, "An Inquiry into the Status of the Santa Barbara Spear-Thrower," *American Antiquity*, vol. IV (1938), pp. 137-141. He includes figures of the Santa Barbara specimen and Starr's Lake Patzcuaro (Mexico) specimen.

similar to the well-known type found in Michoacan, Mexico. Moreover, there is no direct evidence of its prehistoric use in the Santa Barbara area.

Perhaps the most revealing feature of "Mexican" type atlatls lies in the shape of the grip. It almost always includes two "eyes" for the insertion of the first and second fingers. These "eyes" may be bored through the body of the grip (as in the Lake Patzcuaro and Santa Barbara specimens), or they may be formed at the sides of the grip by attached cords, thongs, carved shell loops, etc. In the latter form, the sides of the grip will be carved into shallow finger holds, with the loops added to increase the efficiency of the grip around the fingers. The proximal end of the implement is then smoothed or tapered to a rounded tip. Krause illustrates a grip from Greenland which is practically identical to the common "Mexican" form, including cord loops at the sides.²³ Certainly this grip is atypical for Greenland atlatls, but its presence is not to be disregarded in the North American scheme. Neither can we disregard the considerable similarity between the Lake Patzcuaro specimen and the more common Esquimo forms. The shaft, groove, hook, and bored finger holds are similar. It would be incautious, however, to infer from these similarities any past historical connections, especially since the areas are so widely separated and the distribution gap remains unfilled. The Oregon specimens are of little help in this connection.

An unusual feature found in the "Mexican" area is the use of attached stones on one side or the other of the atlatl. These stones are not always functional. They may be nothing more than charms, attached just above the grip; if so, they are usually quite small. On the other hand, atlatls from the Southwest often bear rather large stone weights on the under side, bound to the shaft by thongs or sinew. These appear to be functional, giving a certain added centrifugal force through the throwing arc. This is important, for the characteristic Southwestern atlatl is very thin and light, and often rather flexible and fragile. The weight may be simple, that is, unbored but grooved to hold the binding. Some, however, have been bored through; this may be of some advantage in fastening them to the shaft. An interesting possibility arises in this connection with the occurrence of small, semicircular, perforated stones in collections from the middle Columbia River region.²⁴

²³ Krause, *op. cit.*, plate XI, fig. 33.

²⁴ Though no direct evidence of the atlatl has yet been found in the Columbia basin, these stones strongly suggest possible atlatl weights, grooved along the straight side for fitting against the shaft. If so, atlatls are associated with rather late cultures in this area, which include numerous arrow points and cremation, as well as elaborate stone carvings.

The atlatls found nearest to Roaring Springs Cave are those from Lovelock Cave in westcentral Nevada, and the previously mentioned fragment from Warner Valley. Both these finds are apparently related to Southwest types, or, in the larger distribution, to the "Mexican" area. That is, they are "mixed," combining groove and hook. In the Lovelock collection,²⁵ all specimens are grooved (all are fragmentary), but there seems to have been a notable difference in the length of the groove. One has only a short groove before the hook, while this hook is carved from the same piece as the shaft, an unusual combination. Another fragment has a long, deep groove with a bone hook set in its extreme distal end, resembling in no small degree both Esquimo and Lake Patzcuaro specimens. It is unfortunate that this specimen consists only of the distal end. The only nearly complete specimen from Lovelock Cave presents a most interesting combination of grip with finger notches, a spur just above the grip, a broad, convex "keel" running most of the length of the under side beyond the grip, and a straight, narrow groove running about half the length on the upper side. The distal tip is missing, but there are grooves near the end which suggest that the hook was tied on. If so, this would be another atypical feature for North America. This specimen is similar to the Roaring Springs atlatls as far as the grip goes, but the shaft, groove, and spur near the grip set it apart. The "keel" is also quite dissimilar from the sharp, narrow ridge on the under side of the Oregon specimens. Moreover, if the hook of the Lovelock atlatl was a separate piece, the "keel" would not be functionally useful in strengthening the hook against breakage. Unfortunately, we are not informed in the Lovelock paper as to the position of these atlatls; however, dart fragments are said to have come from the four lowest of the six layers recognized, and arrows from the two upper layers.

In the summer of 1938 Heizer found a complete atlatl dart in a rock shelter between the town of Lovelock and the cave, under conditions which point to relative recency in that area. It is hoped that further excavations in the Great Basin will help to date the use of the atlatl and the entrance of the bow into this area.²⁶

(5) *South America.* A rather large portion of the South American continent is included in the atlatl distribution area, though this

²⁵ Loud and Harrington, "Lovelock Cave," *U. C. P. A. A. E.*, vol. XXV (1929), pp. 110-111, figs. 16, 18.

²⁶ The evidence from Roaring Springs is that the bow and atlatl were used contemporaneously throughout the upper bed. A point analysis which is to appear in the final report (condensed in final section of present paper) shows a gradual swing in favor of the bow.

distribution is mainly northerly and westerly, that is, toward the Andean regions and the upper Amazon drainage. An isolated area appears in eastern Brazil in the region of the Xingu and Araguaya rivers which may be related typologically to western Brazil. Through much of Brazil the atlatl is still in use, principally for hunting and for spearing fish and turtles from canoes. The South American area shows a bewildering variety in forms of the implement. One feature is held in common, however, which sets this area off from the "Mexican" area north of Panama. This is the lack of a groove in which to lay the projectile. The hook may or may not be an extra piece, but it stands up from the distal end to engage the spear. If it is an extra piece it is generally a carved block of wood fitted on to the shaft. Using the nature of the hook as a criterion, two major subareas may be defined in South America.

The first is more or less Andean, including the Chibcha of Colombia, highland peoples of Ecuador and Peru as far as the Chilean border, and equatorial forest tribes of the Riobamba and Latacunga rivers. The atlatl is no longer known in this area. Descriptions come to us from early Spanish accounts and illustrations, from fascimiles in gold, from pottery panels, and from specimens in older collections. There are strong indications of its widespread use until a late date. All specimens and accounts appear to agree that the implements from this area consist of a round stick which broadens (is carved?) into a flat, disklike proximal end fitting conveniently into the hand. This handle may be an extra piece, fashioned from wood, stone, or shell, and lashed to the main shaft. Just above the handle is a small hook protruding at right angles to the shaft, over which the forefinger is crooked when the hand grasps the implement. This differs from the Esquimo "peg" in being above the grip, not part of it. The hook for engagement is commonly a carved piece, perhaps in the conventionalized shape of a bird, lashed to the distal end of the thrower. Type specimens come mainly from about Quito.

The second area is principally Brazilian, though it also covers most of Colombia, including its Pacific coastline, and the basins of the Cauca and Magdalena rivers. The atlatl appears to be still in use among the tribes of the Magdalena region in war, chase, and turtle spearing, and also by the Xingu and Araguaya River tribes.²⁷ Specimens present amazing variety of form and would justify a full report in themselves. They range from long, slim, beautifully shaped, almost wandlike forms from the Cauca Valley of Colombia²⁸ to broad, flat

²⁷ Karl von den Steinen, *Unter den Naturvölkern Zentral-Brasiliens* (1. Aufl., 1894), S. 231 ff.

²⁸ Krause, *op. cit.*, from information in manuscripts of Cieza and Piedratuta.

boards very gracefully shaped, from the Canamaris of the Jurua River in northwestern Brazil.²⁹ They seem, however, to have two principal structural features in common. The hook is a small pointed piece of bone attached to the distal tip, while the grip is equipped with either a single hole for the forefinger in the middle of the shaft or a pit for the forefinger in the under side.

(6) *Palaeolithic France*. There seems to be considerable uncertainty as to the exact forms used by Magdalenian peoples in western Europe. Krause mentions them under "mixed" types but gives no explanation.³⁰ From published illustrations, they would rather appear to be "male" forms, for they do not seem to make use of a groove for the projectile. They are carved from bone, ivory, or reindeer antler, often with startlingly beautiful conventionalized zoomorphic motifs. The hook is often, if not always, carved from the same piece as the shaft, standing up to engage the projectile as in other "male" forms.³¹ We need not concern ourselves further with this area, for its possible connections with the other five areas seem too remote both historically and morphologically to cast much light on the place of the Oregon specimens.

Summary. The foregoing discussion has ignored such important considerations as design elements, painting, and aesthetic elaborations of the atlatls wherever found. Nor has it included the methods of arranging the fingers when aiming the engaged projectile and thrower; such a study could be expected to yield important clues in the same way as arrow releases. It is clear, however, on the basis of the principles reviewed, that the six major areas are quite distinct and that hypotheses dealing with past historical relations between any two or more of these areas would be risky ventures unless accompanied by close similarities in other aspects of culture. For the present, we can agree with Krause in his conclusions:

Thus, in Central and South America are three restricted areas of the distribution of the spear sling. The Mexican type extends from Utah to Panama; the second is indigenous to Colombia, Ecuador, and Peru; the third has been and still is used, in part, in Colombia, eastern Peru, northern and eastern Brazil. Each

²⁹ P. Ehrenreich, *Beiträge zur Völkerkunde Brasiliens* (1891), Hft. 7, S. 51.

³⁰ Krause, *op. cit.*, S. 124.

³¹ See, for example, J. Dechelette, *Manuel d'archéologie préhistorique, celtique et gallo-romaine*, vol. I (1924), pp. 150-159, 219, and figs. 60, 61, and 86; W. J. Sollas, *Ancient Hunters and their Modern Representatives* (1915), pp. 448-450 and figs. 243-245; H. Breuil, "Les subdivisions du paleolithique supérieur et leur signification" *congrès international d'anthropologie et d'archéologie préhistorique* (1912), pp. 201 ff.

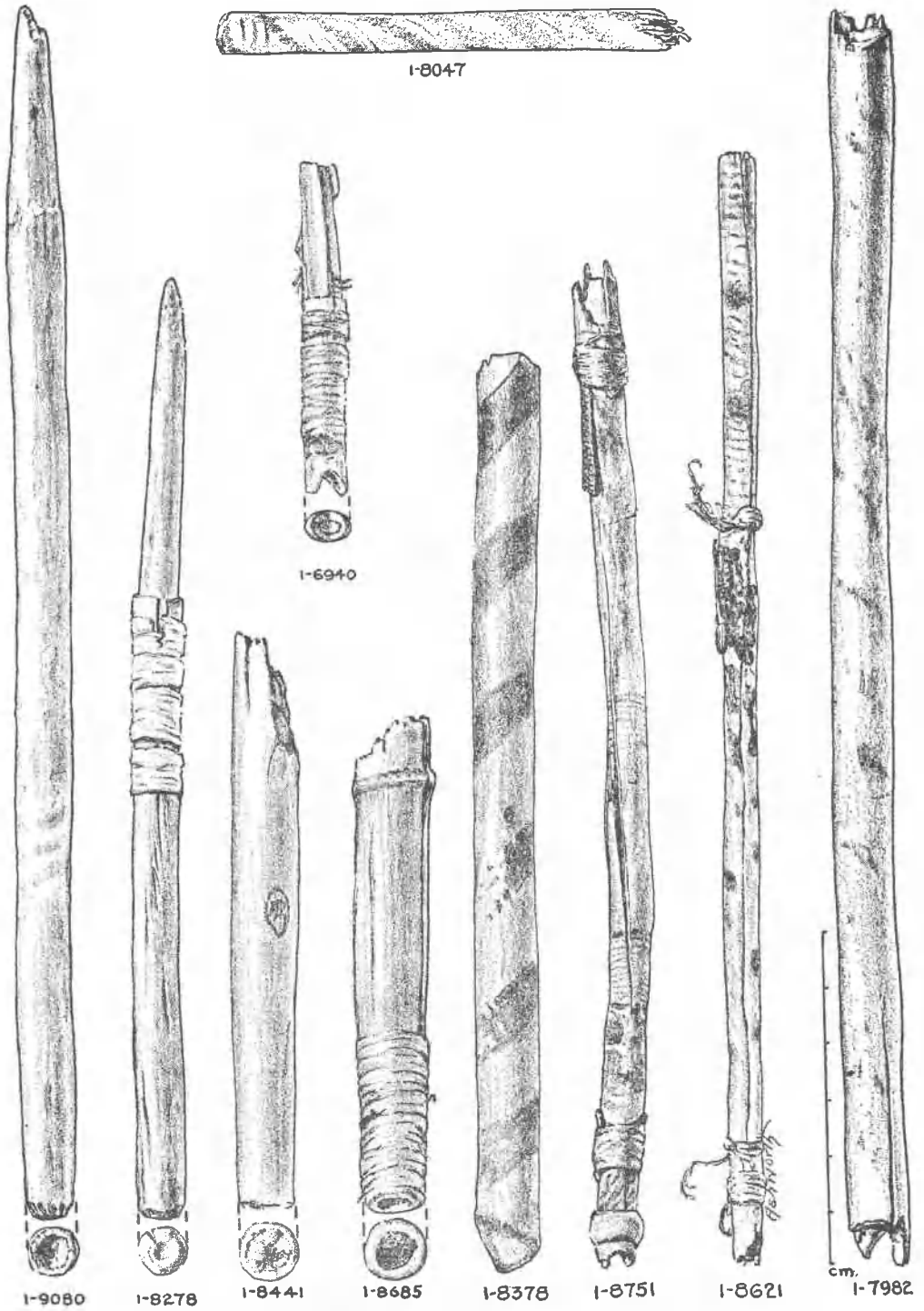


FIG. 6. Projectile Shaft Fragments from Roaring Springs Cave.

of the three types is in itself a complete unit, and the third in contradistinction to the other two. But between these three types themselves no relationship is discoverable; each is distinctly foreign to the other. A common prototype cannot here be thought of. But a relationship between the shafts of the Esquimo and those of the American type might be considered, as Mason suggests.³²

Both are of the mixed type, and in the grip here occurs one or two, there one, finger hole. But all connecting links between the most southerly Esquimo shafts (Sitka) and the most northerly Mexican types (Utah) fail!³³

The Roaring Springs specimens do not clarify the issue. They are slightly farther north than the Utah Basket Maker discoveries and the Lovelock Cave specimens, but all of these are "mixed" while the Roaring Springs specimens are wholly "male." For the present they must be considered as a new type and are entered on Map 2 as Area 7.

As will be seen in Plate VII, only the grip end of the Plush Cave atlatl was found, hence we cannot place it in the world scheme. No groove is visible, but then the groove of the Basket Maker atlatl (and one Lovelock Cave fragment) commonly begins rather far up on the shaft. In provision for cord or thong loops, in cross section, and in proportions, this specimen seems clearly related to the Southwest cultures. It is of some significance that it should be found so far north, some 20 miles north of the California-Oregon-Nevada boundary intersection, in territory occupied in historic times by Paiute bands and occasionally by Achomawi from around Goose Lake. This does not imply association of the implement with these tribes, for they do not seem to know its use.

THE ATLATL COMPLEX AT ROARING SPRINGS CAVE

Painting

As previously stated, the atlatls from this cave had been painted over all with red ochre. The two fragmentary specimens, as well as the two whole ones, show this feature. Specimens from the Mexican-Southwest area and Australia also show a tendency to paint these implements; often, apparently, the painting has some magical or ceremonial significance. A typical Basket Maker atlatl from western Texas³⁴ is

³² O. T. Mason, "Throwing Sticks in the National Museum," *Annual Report of the United States National Museum for 1884*, pp. 279-289.

³³ "Sling Contrivances for Projectile Weapons," *Annual Report of Smithsonian Institution for 1904*, p. 636.

³⁴ Photostatic copy kindly provided by Franklin Fenenga of Sacramento Junior College, California. Cf. also H. P. Mera, *Reconnaissance and Excavation in Southeastern New Mexico*, Memoir 51 of American Anthropological Association (1938), p. 29 and plate II, fig. 1.

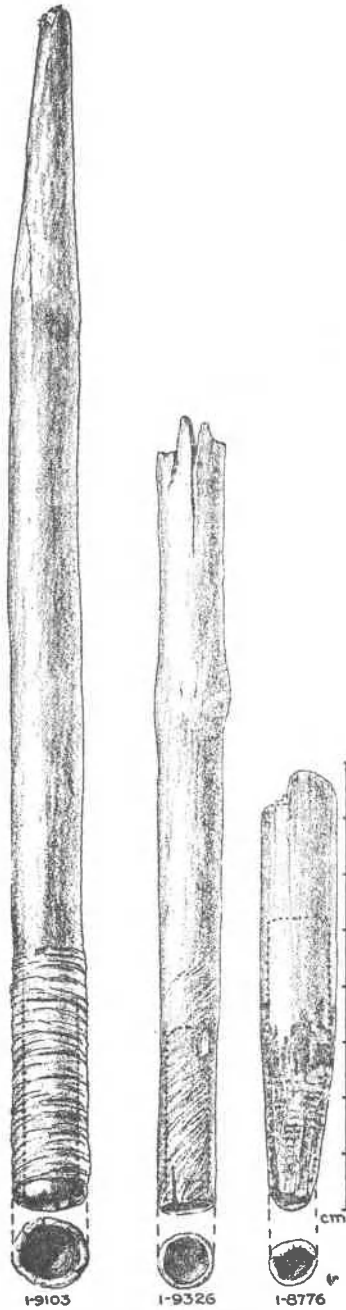


FIG. 7. Atlatl Dart Fragments from Roaring Springs Cave

incised on the upper surface with zigzag lines on both sides of the groove. While such incised work is not uncommon on specimens from the Mexican-Southwest area, it is not found on the Oregon atlatls, one of which, however, has rows of painted dots on the upper surface.

Some of the projectile-shaft fragments which we presume to be parts of atlatl "darts" are decorated in one way or another. Fig. 6 shows one fragment (distinguishable from definite arrow shafts by the notably greater diameter) which has a spiral decoration in black paint (1-8378), and another which has a spiral in green paint (1-7982). No. 1-8776 (Fig. 7), an atlatl shaft butt, is painted red at the proximal end. Fig. 6 also shows three arrow shafts, one of which has a spiral in green paint very similar to the presumed dart fragment (1-8047), while the other two are painted in bands of red, black, and green, especially about the feathered section (1-8751, 1-8621).

A complete atlatl dart from central Nevada³⁵ is elaborately painted in spiral along the cane butt section, illustrating further the strength of the painting idea in connection with the atlatl and with atlatl projectiles. As is well known, Gypsum Cave yielded a variety of beautifully painted dart shafts.³⁶

³⁵ R. F. Heiser, "A Complete Atlatl Dart from Pershing County, Nevada," *New Mexico Anthropologist*, vol. II (1938), pp. 70-71.

³⁶ M. R. Harrington, *Gypsum Cave, Nevada*, Southwest Museum Paper No. 8 (1933).

Bunt Points of Bone

Pepper³⁷ illustrates the use of a large bone, usually the distal end of an ungulate cannon bone, to form a large blunt surface on the striking end of the projectile. This presumably serves to stun game rather than to kill it. Apparently the trait is common in connection with the atlatl in Basket Maker (*i.e.*, pre-Puebloan) cultures.

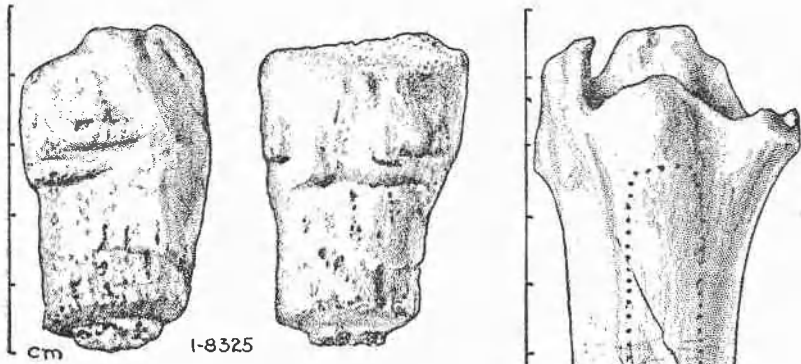


FIG. 8. (Above) Bone from Roaring Springs Cave. Probably unfinished bunt.

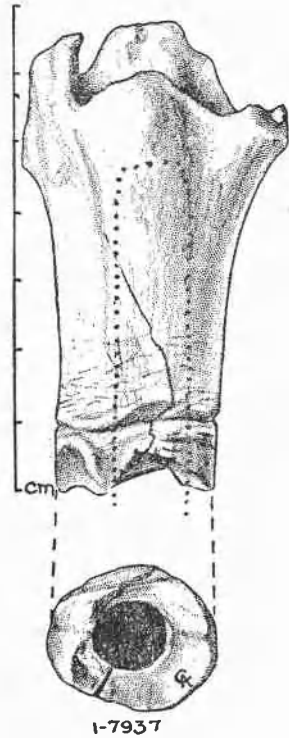


FIG. 9. (Right) Atlatl Bunt from Roaring Springs Cave.

Two bones which could have served the same purpose were found in the upper bed at Roaring Springs. One is, like the common Southwest type, the distal end of a cannon bone, probably deer or mountain sheep, painted red (Fig. 9). The other is difficult to identify because it has been worked down from a large bone, but it is definitely not cannon (Fig. 8).

³⁷ George Pepper, "The Throwing-Stick of a Prehistoric People of the Southwest," *International Congress of Americanists, 13th Annual Session* (1905), pp. 107-130. The distal-end cannon bones illustrated by Loud and Harrington ("Love-lock Cave," plate 49a) are almost certainly for atlatl-dart bunts; this makes it probable that the trait covered practically all of the Great Basin, in addition to the Southwest area.

Projectile Points

Approximately 650 points which may fairly be termed projectile were recovered from the cave. By far the larger portion comes from the upper bed. Of the total number, 580 have been classified into types. The remainder constitutes a scattering of forms. These may be extreme variations of established forms herein treated. They may include a few distinctive types not well represented numerically, or other special forms which will be treated in the full report.

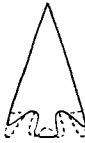








Table II represents a summary of the frequency and depth distribution of nine major point types found in the cave. A word of explanation is necessary to show how the table was derived.

Being dissatisfied with previous symbolic classificatory systems, the junior author decided to try a new classification based on sight alone. Points that *looked* as though they were made with the same principle in mind were grouped, then subgrouped according to minor distinctions such as length of barb, shape of stem base, flare of stem base, and position of notches (*i.e.*, whether in the corner or on the side). This gave a total of 28 different "types." The number of points in each type in each vertical layer cut in the cave was calculated. It was then apparent that "types" based on minor distinctions had essentially the same distribution in the cave as more outstanding forms. When it had been determined that much of the finer work had no significance toward the reconstruction problem, the points were regrouped into nine classes, each of which was distinctive in shape. These had a significant distribution. The matter of distribution was, of course, held secondary to grouping.

Each of the nine groups was then divided, subjectively, it must be admitted, into "small" and "large" points. In every group there was no particular difficulty in making a major distinction as to size, and especially as to weight. There is good reason to think that weight is more important functionally than dimensions. In a few cases (7 per cent of the total) the point was of such size and weight that it was in an overlap zone, and we did not attempt to call it either large or small. On the whole, however, there was not much difficulty in separating small, light points from large, heavier ones. This system, though of course somewhat indefinite, showed a significant division of occurrence in the final tabulation. In each column of Table II, the first figure denotes "small" (arrow?) points, the third figure "large" (dart?) points, the middle figure intermediate points, possibly belonging to either size class.

Weight is the most important distinction between our two main

TABLE II. Roaring Springs Projectile Point Distribution (condensed to 9 types)

Types :										Totals
	1	2	3	4	5	6	7	8	9	
Disturbed surface	30 1 0	1 0 0	16 0 8	7 1 12	12 1 0	7 0 9	3 5 19	0 0 3	0 0 0	76 8 51 (135)
Upper bed :										
surface to 99.79	16 2 0	-- -- --	5 0 2	1 0 4	-- -- --	3 0 4	0 4 11	0 0 3	-- -- --	25 6 24 (55)
99.79 to 99.59	34 0 0	4 0 0	8 0 2	1 0 5	3 0 0	10 0 9	2 6 27	0 0 4	-- -- --	62 6 47 (115)
99.59 to 99.37	17 0 0	-- -- --	2 0 3	1 1 4	4 0 0	6 0 2	0 2 21	0 0 3	0 0 3	30 3 36 (69)
99.37 to 99.17	15 0 1	1 0 0	7 0 1	6 0 3	3 0 0	2 0 3	0 5 25	0 0 5	0 0 2	34 5 40 (79)
99.17 to 98.78	20 3 1	2 0 0	2 0 4	0 4 6	1 0 0	7 0 6	1 3 17	0 0 3	0 0 4	33 10 41 (84)
Total, upper bed	102 5 2	7 0 0	24 0 12	9 5 22	11 0 0	28 0 24	3 20 101	0 0 18	0 0 9	184 30 188 (402)
Lower bed :										
99.37 to 98.98	3 0 0	-- -- --	0 1 0	0 0 4	-- -- --	0 0 2	0 1 9	0 0 1	0 0 2	3 2 18 (23)
98.98 to 98.58	3 0 1	-- -- --	0 0 1	0 1 2	-- -- --	2 1 1	0 2 4	0 0 1	0 0 1	5 4 11 (20)
Total, lower bed	6 0 1	-- -- --	0 1 1	0 1 6	-- -- --	2 1 3	0 3 13	0 0 2	0 0 3	8 6 29 (43)
Total, size-groups	138 6 3	8 0 0	40 1 21	16 7 40	23 1 0	37 1 36	6 28 183	0 0 23	0 0 12	268 44 268 (580)
Type totals	(147)	(8)	(62)	(63)	(24)	(74)	(167)	(23)	(12)	(580)

NOTE: The first figure in each column denotes "small" points, probably arrow; the third figure denotes "large" points, probably atlatl dart, or possibly spear; the middle figure denotes intermediate points, not determinable. See text for ranges, p. 43.

size-classes. "Small" points weigh from .4 to about 2.0 grams, "large" points from 2.0 to 6.2 grams. There is an overlap or "intermediate" range from about 1.8 to 2.2 grams.³⁸ "Small" points reach a maximum length of 40 mm., but only 2 or 3 of them are more than 36 mm. "Large" points grade downward from about 55 mm. to 23 mm. Thus, though some may be shorter than many supposed arrow points, they are bulkier, broader, and heavier. Again, "small" points may reach a maximum breadth of 23 mm., though most are less than 18 mm. "Large" points may be as little as 18 mm. in breadth but range up to 33 mm. There are thus overlap zones in all three criteria, and the dual classification of the collection as a whole is derived from a combination of all three measurements. Individual points may be long, narrow, and thin but quite light—or short, broad, thick, and heavier. In any event, weight would seem to be more helpful than dimensions.

There is always the possibility that our "large" points were not all made for darts, but may be spear points. A few of the stemmed points are very large and heavy, and are reserved for later treatment.

A complication arises from the difference in size of the two complete atlatls from the cave (see p. 22). If two distinct sizes of projectiles were thrown with these implements, the smaller one may have taken points not necessarily larger or heavier than some arrow points. In general, however, flaking seems to be much finer on the supposed arrow points.³⁹

We realize that the validity of our classification is open to question in several respects. An objective statistical treatment, which was used as a table of reference for our classification, is in preparation for the final report. But, on the basis of the material presented here, a few conclusions are in order.

In the earlier period there is a very strong preponderance on the side of large points. Type 7 includes nearly half the large points. This type, moreover, includes the vast majority of known atlatl points from the Southwest.⁴⁰ Kidder has suggested that the flaring protuberances of the stem have a functional purpose in preventing the dart or arrow

³⁸ Kidder, *The Artifacts of Pecos*, Papers of Southwestern Expedition, Phillips Academy (1932), p. 22, states: "As all these specimens are undoubtedly arrowheads, we are able to determine what was considered, by Pecos archers, the proper weight for such points. The longer examples, as fig. 4, *o*, *p*, weigh 25 to 32 grains troy (=1.62-2.07 grams); the smallest, as fig. 4, *a*, *b*, 8 to 10 grains (= .51-.64 grams); and the average, as fig. 4, *l*, 16 to 20 grains (=1.03-1.29 grams)."

³⁹ *Ibid.*; compare fig. 4 with figs. 7 and 8 for fineness of flaking.

⁴⁰ Pepper, *op. cit.*; Kidder, *op. cit.*; Kidder and Guernsey, *Archaeological Explorations in Northeastern Arizona*, Bureau of American Ethnology Bulletin no. 65 (1919).

shaft from being withdrawn from a wound, for these flares hold the binding from slipping off over the end of the shaft. If this is true, the same thing would hold for types 4, 5, 8, 9, and possibly 6. On the other hand, small-stemmed points such as type 1, and possibly 2, would permit the shaft being pulled from a wound; for the binding would slip easily over the small stem, with no spurs to hold it.

Seven of the nine types were found in the lower bed. Of the 43 points, 8 have been classed as small. Six of the 8 points are of type 1, which was vastly preferred for arrows in the later period. If they are actually arrow points, we cannot say that the bow and arrow were absolutely lacking in the earlier period. It may be that they became intrusive in the lower bed by activities in the cave after the later period began.

Types 2 and 5 were used in the later period only. Type 2 seems to be a special form, long and narrow with a curious flaring at the base, and quite small and very light. Conceivably, it could be a variation of type 1; yet all 8 points were easily picked out from all the others. Type 5 represents a variation of the common, widespread triangular point with concave base and side notches. The variation consists of a notch in the center of the concave base which catches against the bottom of the slot in an arrow shaft, thus preventing the point from wobbling laterally after attachment. All but one of the 24 points are definitely small, light, and delicate. By tracing column 4 up from the bottom, we find type 4 used for darts in the early period, then for both dart and arrow in the later period, the former still predominating (22 points to 9, plus 12 points to 7 on the disturbed surface). The basal notch of type 5 was possibly an outgrowth from type 4 for use on arrows only.

The simple triangular point, type 3, with no notches, is scantily represented in the early period. It is preferred 2:1 for the arrow over the dart in the later period and on the surface.

Types 8 and 9 were used exclusively for the dart through both periods. Type 8 is a peculiar "legged" form with an expanding stem and a very deep basal notch, though occasionally the sides of the stem become almost parallel. Type 9 employs a large bulbous stem. Both these types represent a carry-over for darts in the later period; apparently neither style was ever transferred to the arrow.

Type 6 is at times hard to differentiate from type 7, but can generally be determined by the angularity of its stem sides and barbs. The base may be straight, slightly convex or concave, the barbs long or short. It appears to have been used on both dart and arrow, with

about equal frequency all through the column. The two unexpected points in the lower bed may have been intrusive. They are abnormally small for the type.

The main interest centers about types 1 and 7. Classification of points found in the upper bed according to size reveals a heavy preponderance of small type 1 and of large type 7 points. The main feature other than size which distinguishes them is the width of the stem in relation to the width of the body.

Type 1 has a small stem which varies from straight to somewhat converging or somewhat expanding sides,⁴¹ but at any rate the *stem* is *small*. In some forms the notches were cut from the base, so that two long, square-tipped "barbs" protrude perhaps as far as the base. Other barbs are pointed and of varying lengths, or may be lacking. Another variation consists of a notch in the center of the stem base, which, as remarked for type 5, may serve to catch in the shaft slot and hold the point firmly. The variations under type 1 are of no significance in depth-frequency distribution; all the points have a general distribution in the upper bed. With 2 exceptions, the 140 of type 1 points in the upper bed and on the surface are of arrow size, though there may be some question about the 6 classed as intermediate.

Type 7 is probably the most characteristic point style associated with the atlatl dart in the whole western part of the United States. It is commonly found in Basket Maker specimens, often still mounted on the shafts. It is usually a broad point, rather thick and crudely flaked, with very deep notches in the corners. The stem is quite broad and commonly concave at the base, so that it flares out quite a distance on both sides of the stem neck. At times these flares reach as far as the lateral extremities of the point as a whole, thus grading into the "side-notched" type (see types 3 and 4) in which the base is as broad as the shoulders or broader. Weights of typical points range from 2.4 to 5.4 grams, with smaller ones ranging down to 1.4 grams, which is less than the largest arrow points (see Fig. 10). Type 7, as will be seen from the table, remained a dart point all through the upper bed, just as type 1 remained the typical arrow point all through the same period.

⁴¹ This illustrates one reason for our abandoning the well-known classification of Strong (*An Introduction to Nebraska Archaeology*) for the purpose of this report. It is easy to become overpragmatic and place in different categories points which barely shade into one another, *e.g.*, whether the stem sides expand slightly or not. In a collection of this size it is far easier to group stems as narrow for the total size and width of the point, or as broad and expanding, with definite barbs which will protrude through the binding around the hafted portion of the projectile point.

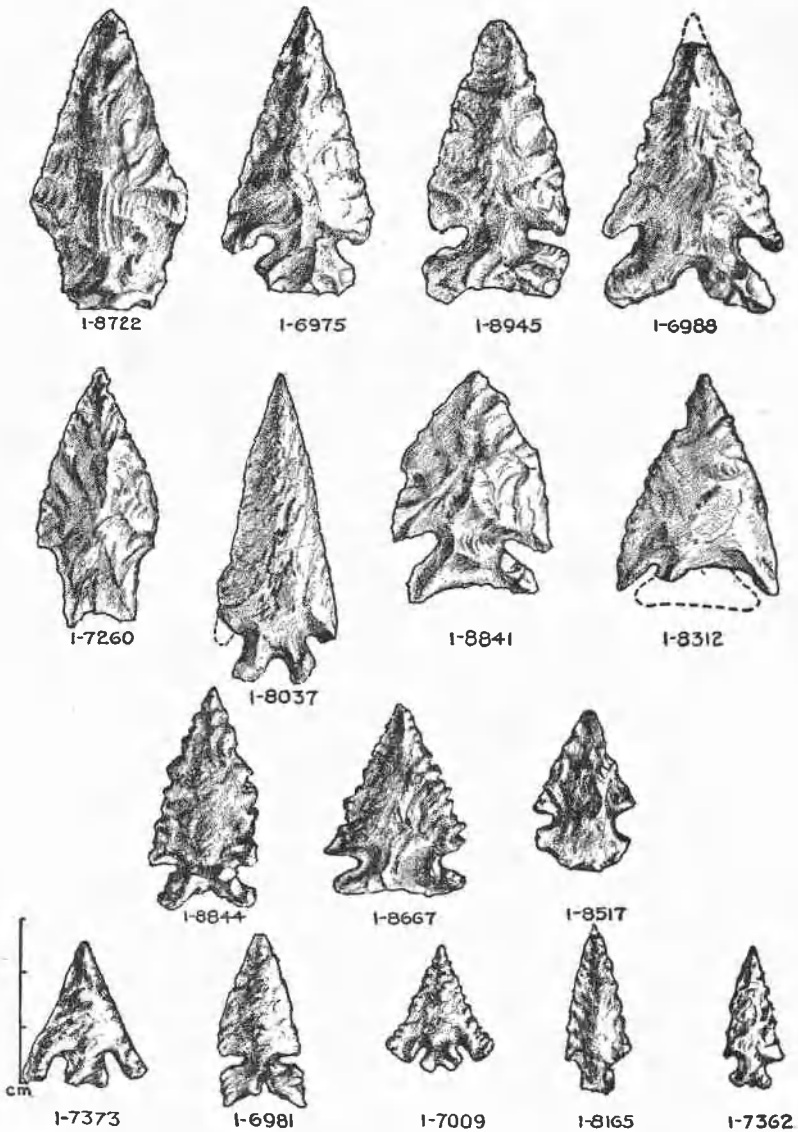


FIG. 10. Projectile Point Types from Roaring Springs Cave.

Thus it may be said that types 1 and 7 were favored over all others for their respective weapons, with types 2 and 5 used exclusively on the arrow in the later period, types 8 and 9 used exclusively on the dart through both periods, and types 3, 4, and 6 applied to the dart in the earlier period and to both arrow and dart

in the later period. Of the last three, type 3 is preferred for the arrow over the dart, type 4 is preferred for the dart over the arrow, and type 6 is used equally on both, as far as the later period is concerned.

The horizontal totals found in the last column are also interesting. Strangely enough, the totals revealed exactly the same number of points, 268, for "arrows" and "darts" from the cave as a whole, with 44 "intermediate," or not determined one way or the other.

In the earlier period we find 8 "arrows" against 29 "darts," with 6 in between. We suspect that the arrow actually was absent in the lower bed, and that the 8 points are intrusive through some factor missed during excavations. Field notes made daily reveal no instance of any such points found below the stratification line; and it may be that the points in question came out in screening operations from material from one of the numerous ash pockets which crossed the stratification line.

In the upper bed, the totals show from bottom to top a gradual but pronounced shift from "dart" to "arrow" points. The five cuts in vertical order show, successively, 41 to 33, 40 to 34, 36 to 30 in favor of "darts," then a shift to 62 to 47, 25 to 24, and 76 to 51 in favor of "arrows" in the upper two cuts and surface material. The essential fact of importance in all this is that, *if our premises have any value at all, we have definite contemporaneity of bow and atlatl throughout our whole later period, with only a shift in emphasis from one to the other as time passes.*⁴² The idea that the earlier atlatl was suddenly replaced by the bow is untenable; even if a new population is represented in the upper bed, it must have possessed both weapons.

A second significant conclusion is that, despite the fact that the throwing implements themselves were found about in the vertical midpoint of the upper bed, *the point types to be associated with the weapon continue up to the surface of the cave deposit*, where also were found parts of a sinew-backed bow, the only pieces of coiled basketry from the cave, a piece of diagonally twined winnowing tray, a small circular seed beater (?) of wickerware, and two hide moccasins. The approximate association of all these traits, together with evidence of bison hunting at the same time (in the form of burned and cracked bison bones), forms an interesting background for the temporal position of the atlatl in the Great Basin. It must, however, be kept in mind that the position of artifacts in the area surrounding the cache pit must be taken as "disturbed," since the pit was dug into an earlier occupational level.

⁴² Comparable gradual changes are now well established for the Texas region (see Fenenga, Patterson, and Pearce) and are strongly indicated at Lovelock Cave, where Harrington identified a "transition" period (*op. cit.*, pp. 24-25).

SUPPLEMENTARY TRAITS

Materials. So far as projectile points are concerned (though not necessarily other flaked objects), there appears to be a shift in the choice of materials between the lower and upper bed. In the lower, the points show a preference for obsidian; but a small proportion of gray and brown cherts appears also, especially for the largest points. In the upper bed, projectile points are exclusively of obsidian, insofar as flaked points are concerned, while wooden foreshafts without stone heads enter as a new form. The latter are from 10 to 25 cm. long, pointed at both ends, and were doubtlessly socketed into the projectile shafts. This trait has a wide distribution in the Great Basin, and is of interest here since it was probably absent in the lower bed.

"Yuma" Points. Two long points or knives usually referred to as "Yuma" on the Great Plains occurred in the upper bed and will be described in the full report.

Weights. The problem of weights attached to atlatls to increase the centrifugal force of the throwing arc promises to be interesting from the distribution standpoint. As stated above, stones more or less shaped for this function have been found on Southwest atlatls, and are known either as charms or as functional objects on Mexican specimens. Patterson has recently brought out a comprehensive work on various carved stones collectively referred to as "boat-shaped," some of which at least may well be atlatl weights.⁴³ It is very interesting that certain peculiar stones, more or less hemispherical with a groove or hollow on the flat side, were found by Gifford and Schenck in the southern San Joaquin Valley of California. These authors do not commit themselves concerning use; but there is strong resemblance of these objects to some of the boat-shaped stones of the central United States.⁴⁴ There are indications of the use of similar stones from Lovelock Cave⁴⁵ and on the middle Columbia River.⁴⁶ Accordingly, they might be expected to turn up elsewhere in the western part of the country. None have as yet been identified from southeastern Oregon. The Roaring Springs atlatls, as mentioned above, have holes bored through the keel, a practice which is possibly connected with the suspension of weights.⁴⁷

⁴³ Patterson, *Boat-Shaped Artifacts of the Gulf Southwest States*, University of Texas Bulletin No. 3732 (Aug. 22, 1937).

⁴⁴ Gifford and Schenck, "Archaeology of the Southern San Joaquin Valley, California," *U. C. P. A. A. E.*, vol. XXIII (1926), p. 69 and plate 19, a-1.

⁴⁵ Loud and Harrington, *op. cit.*, p. 113 and plate 57, d.

⁴⁶ See note 24.

⁴⁷ Patterson, *op. cit.*, pp. 50-52, 62-72, discusses the problems of fastening such weights.

CONCLUSION

(1) The atlatl was used through both periods at Roaring Springs Cave, while from the first of these the bow was absent. Point styles used for "darts" in the earlier period were these: 3, 4, 6, 7, 8, 9.

(2) Point styles continued in the later period for "darts" but not transferred to "arrows" when the bow came in were these: 7, 8, 9.

(3) Point styles used first for "darts" and later for "arrows" as well were these: 3, 4, 6.

(4) Intrusive point styles used for "arrows" but not on "darts" were these: 1, 1 (base notch), 2, 5.

(5) The transfer from atlatl to bow was gradual and had not been completed at the end of occupation of the cave, when both implements were associated with artifacts similar to relatively recent Great Basin materials.

(6) The form of the Roaring Springs implements is distinctive for North America and does not specifically connect them with more-southern forms, though some associated traits (point styles, wooden foreshaft points, painting of both projectile and thrower, bone bunts, possible weighting, etc.) are of more general distribution in southern North America.

(7) More specifically southwestern implements are represented by the Warner Valley fragment, indicating a diffusion northward at least as far as southern Oregon.

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EARLY MAN IN SOUTHCENTRAL OREGON: EVIDENCE FROM STRATIFIED SITES

L. S. CRESSMAN AND HOWEL WILLIAMS

AN archaeological field party of the Department of Anthropology of the University of Oregon excavated two stratified caves in southcentral Oregon, in the northern part of the Great Basin area, during the 1938 field season. The two caves are known as the Paisley Five Mile Point Cave and the Fort Rock Cave. In 1935 excavations were carried out at the Wikiup Damsite No. 1 on the Deschutes River in eastern Oregon.¹ At each of these sites occupational levels were covered by an unbroken stratum of pumice. The caves were examined in September 1937 by a University party, in company with Dr. Ernst Antevs. It seemed likely that the pumice will be definitive for dating of occupational zones. Dr. Howel Williams, at the end of the 1938 excavations, made a field examination of the profiles of the caves. Dr. W. D. Smith, professor of geology at the University of Oregon, had previously examined the Wikiup Damsite, and gave his opinion that the pumice there was from the Mt. Mazama explosion which helped to form Crater Lake. Microscopic analysis of the pumice from all three sites has been made by Dr. Williams.

PAISLEY FIVE MILE POINT CAVE

The Paisley Cave lies on a projecting section of the east rim of Summer Lake about 5 miles northwest of the village of Paisley.

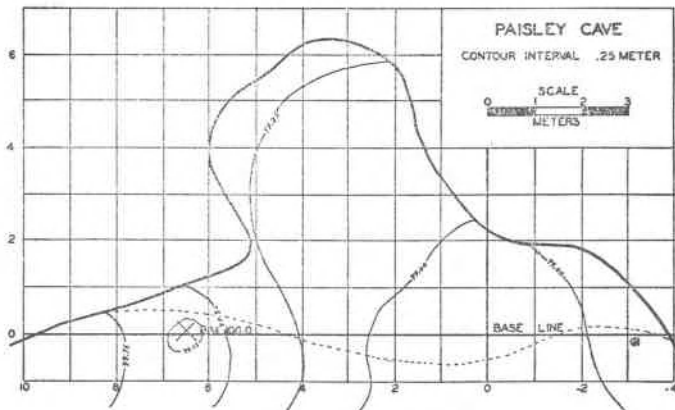


FIG. 11. Paisley Cave.

¹ L. S. Cressman, "The Wikiup Damsite No. 1 Knives," *American Antiquity*, vol 3 (July 1937), pp. 53-67.

The cave, cut by waves in scoriaceous basalt, is about 6 meters long and 4 to 5 meters wide. There is a projecting overhang in front much like a porch roof, which provided excellent shelter. The floor plan is shown in Fig. 11.

A second cave, called here Paisley Cave No. 2, cuts into the rock at right angles to Paisley Cave No. 1. Only a thin wall of rock separates the two caves. Cave No. 2 is small and dark.

Summer Lake is now almost dry, except for a small amount of water which remains from the winter's precipitation. There is also some water from the runoff from Ana Spring at the head of the lake. Most of the spring water, however, is spread over the meadows for irrigation. At one time the lake was probably more than 100 feet deep, as shown by the terraces on both sides of the valley. These terraces are to be seen in front of the Paisley Cave. The Summer Lake basin is continuous with the Chewaucan depression to the south and east and with Abert Lake some 25 miles farther to the east. At the

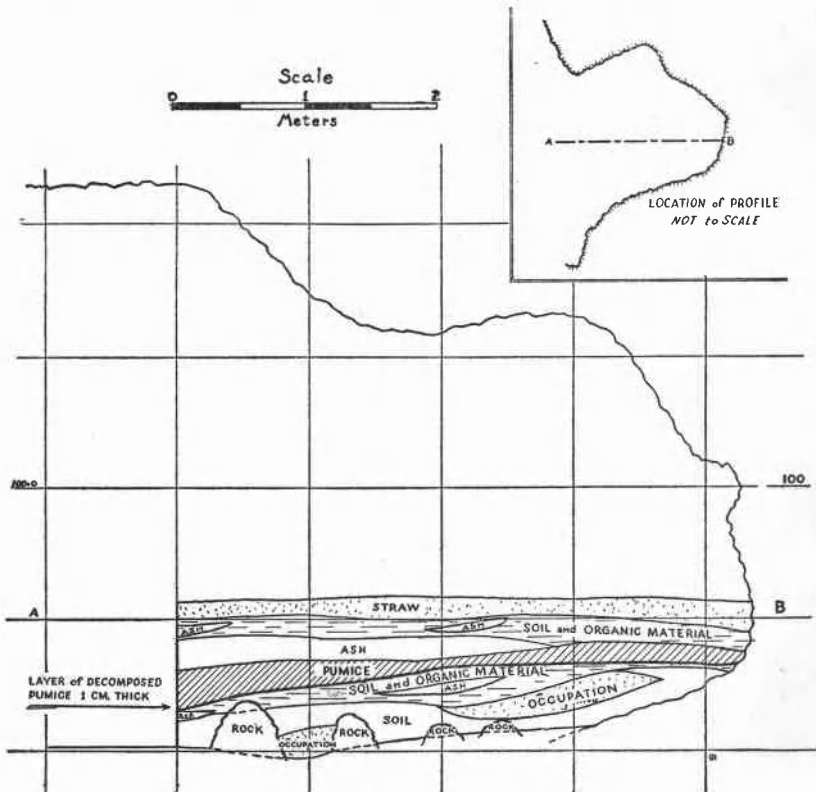


FIG. 12. Paisley Cave. Profile I on 3-meter line.

time of high water, this basin formed a large lake, roughly in the shape of a right triangle, with one leg represented by the Summer Lake-Che-waucan axis and the other by Abert Lake. Each leg is approximately 50 miles long. The lake basin is part of the great fault system of southcentral Oregon.²

The elevation of the floor of Summer Lake is approximately 4,100 feet. High-water elevation of Summer Lake is given as 4,178 feet on the quarter-inch map of Fremont National Forest, Oregon, Wil-lamette Meridian, 1927. The west side of Summer Lake is enclosed by Winter Rim (called on some maps, including the one referred to, Summer Ridge). Exact elevations on this rim are not available, but it rises approximately 2,000 feet.³ It is this rim that was made

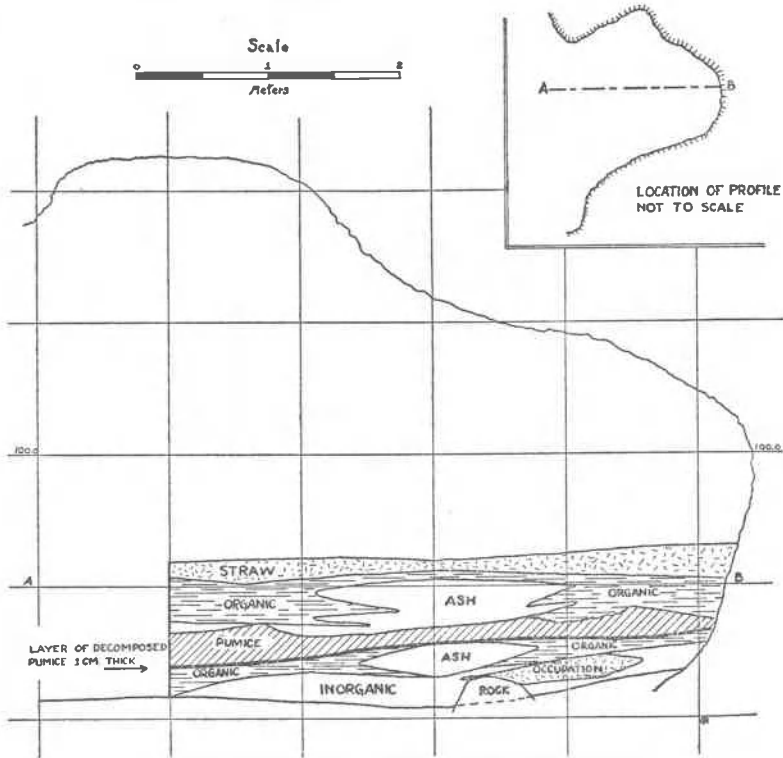


FIG. 13. Paisley Cave. Profile II on 4-meter line.

² "In the central part of the county, Summer Lake, Chewaucan Marsh, and Abert Lake are in a valley that was once occupied by a single great water body; hence these three now rather distinct basins are topographically one. Structurally, however, they are separate. . . ." Gerald A. Waring, *Geology and Water Resources of a Portion of South-Central Oregon*, U. S. Geological Survey Water-Supply Paper 220 (1908), p. 51.

³ Waring, *op. cit.*, plate VI.

famous by General Fremont in his efforts to descend to Summer Lake without leaving behind his precious cannon.

The high tableland to the west from Winter Rim is forested with ponderosa pine. The area to the east, which starts with the rim enclosing that side of the valley, has no cover but sage brush. The breadth of the valley from rim to rim averages about 12 miles. It is hardly likely that there was at any time a connection between Silver Lake Valley and Summer Lake, although what appears to be gravel is to be found high up near the pass. It may be that these smooth stones are due to surface erosion from the steep slopes on each side of the road. If there had been a connection, there must have been a sufficient uplift at the point of the pass to raise the elevation well above that of the highest lake levels as shown by terraces, and to obliterate the surface evidence.

FORT ROCK CAVE

Fort Rock Cave lies in S.W. $\frac{1}{4}$ of the N.W. $\frac{1}{4}$, Sec. 25, T. 25 S., R. 13 E. Willamette Meridian. Fort Rock Valley takes its name from the remains of an ancient volcano, 1 $\frac{1}{2}$ miles due east of the cave. The walls of the volcano rise 200 feet or more from the valley floor, forming an almost semicircular structure. Wave action and other natural forces have cut out the southeast portion of the structure and the softer interior parts have all disappeared. Notches, approximately 15 feet high in the front, sloping back and down from the top to form an acute angle at the bottom in the rear (/), indicate long-continued wave action against the wall. These appear at both sides of the broken wall. A somewhat smaller one appears in the rock projecting beyond the mouth of the cave.

Masses of molten material were erupted from the vent; the uneroded remains are to be seen in mounds or hillocks reaching 100 feet or more above the sands of the ancient lake. In one of these the Fort Rock Cave is located.

The general shape of the cave is roughly conical. Instead of being quite round, it is flattened somewhat from the upper and lower sides. The roof drops sharply to the rear and the floor rises equally sharply from the front. The bottom slopes up on both sides to the side walls. The bottom of the cave contains a stratum of gravel giving in many places the appearance of a shingle beach. This is probably due to the thin layers of the bed rock which broke along horizontal joints. The constant wave action upon it produced a flat type of gravel. The gravel rises sharply and is mixed with the manure of

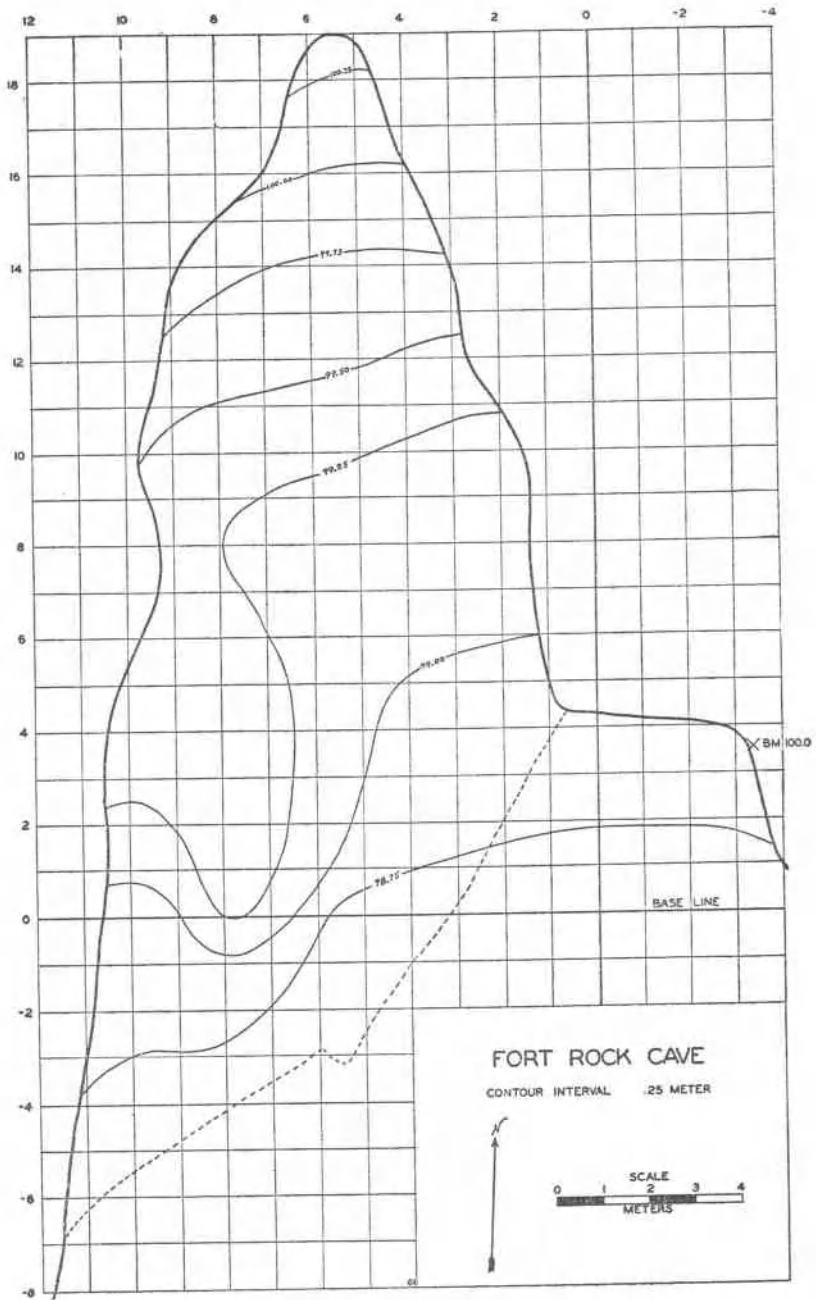


FIG. 14. Fort Rock Cave.

recent animals in the inner third of the cave. Human occupation did not extend that far to the rear. Very little manure, however, covered the gravel in the rear because the roof was too low to permit fully grown stock to get that far back.

This cave, which faces the south, is approximately 20 meters long and 10 meters wide in the front. The floor plan is shown in Fig. 14. Since the cave faces the south and because of a projecting overhang and the extension of the west wall running out some 25 to 30 yards, the cave is an admirable shelter.

Directly opposite, on the north side of the hill, there is a small cave in which the only sign of human occupation is a few bits of charcoal in the upper part. Under the immediate surface, there is a bed of clean pumice approximately 4 feet thick containing pieces as large as a clenched fist. Apparently there is no gravel in the bottom of this cave; it lies in the lee of the hill and would have been protected from wave action. The north cave is not to be compared with the south cave as a place for habitation since the sun cannot warm it, nor is it protected from the cold north winds. Even stock avoid it as a place of shelter in a storm, though they take shelter in the south cave. It is important to keep in mind the difference in the depth of the pumice and the size of the particles in the two caves.

The Fort Rock basin should really be spoken of as the Fort Rock-Silver Lake basin. The north-south extent is roughly some 40 miles. The southern extremity is marked by the ridge dividing it from the Summer Lake depression. The maximum breadth cannot be given exactly, since adequate survey maps do not exist for the area; but it is likely that the breadth is not less than 20 or 30 miles. The water level in this whole basin has been subjected to marked fluctuations even in recent times. The ancient terraces show approximately a 100-foot elevation.⁴

In 1917 the little village of Fort Rock had two creameries supported by the dairy herds of the valley. The Cabin Lake Ranger Sta-

⁴"On account of the shallowness of the water bodies of Lake County the water level of the lakes can fall but little without destroying them. Such occasional dryings up have no doubt occurred within recent time. The best known instance is that of Silver Lake. In 1879 Cope found Thorn Lake dry and Silver Lake low, but Russell states that during the following three years the surface of Silver Lake rose 6 feet and in 1882 was confluent with that of Thorn Lake. As has been stated, in 1888-89 Silver Lake completely dried up, which required a change in level during these six or seven years of at least 10 feet, for Russell stated that in June, 1882, when confluent with Thorn Lake, it was only 10 feet deep. In 1890 it again began to fill, and during the fall of 1906 the gauge board established by the Reclamation Service indicated about 13 feet, but it was not learned whether this was supposed to be the depth of the lake. . . ." Waring, *op. cit.*, pp. 37-38.

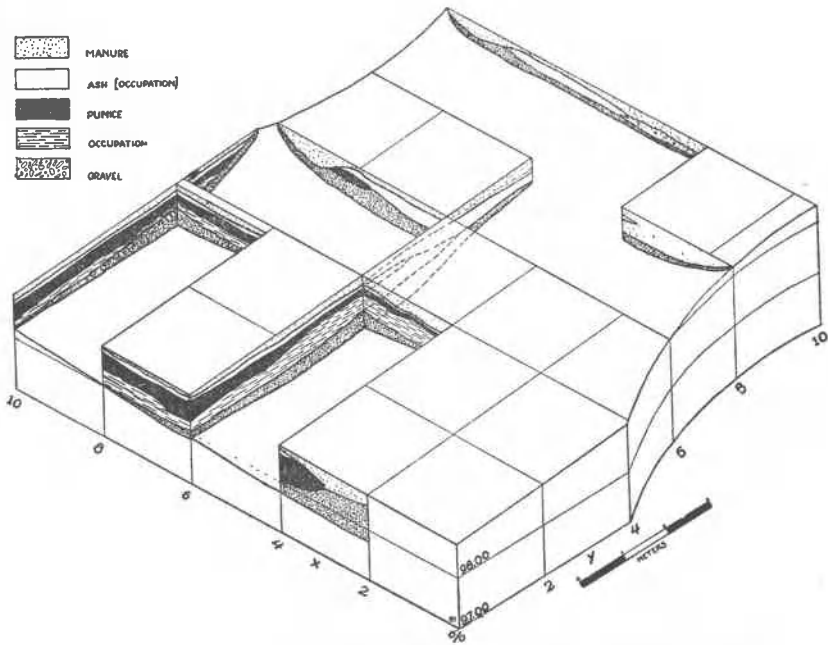


FIG. 15. Fort Rock Cave. Block diagram showing excavated areas.

tion which administers this district of the Deschutes National Forest from this point to more than 20 miles to the north, including the popular recreation area of the East Lake and Paulina Lake district, was established about 1916. Most of the work of the Forest Service in this part of the forest was the adjustment of relations with the homesteaders of the Fort Rock Valley. This function scarcely exists today, since the valley is now one of the great dry basins of the eastern part of the state. The creameries have disappeared, the village of Fort Rock is dilapidated and dust covered, and there is only an occasional ranch in the valley.

ARTIFACTS

The artifacts from the two caves differ strikingly. The stone tools found in the Fort Rock Cave show a marked difference from those of the Paisley Cave. The Fort Rock Cave has large numbers of shredded sagebrush bark sandals, while the Paisley Cave in the upper level has tule sandals. Basketry is almost totally absent from both caves; one piece was found in the Fort Rock Cave and three fragments were found in the Paisley Cave.

The artifacts will be treated as those from above and those from under the pumice. The pumice is sterile except for the immediate surface, into which a few artifacts have dropped or have been tramped down from the upper level of occupation.

Paisley Cave—Above Pumice

Sandals. One fairly complete sandal and the front halves of a pair, together with scattered fragments, came from the upper stratum. These are made of tule. The warps are made from a number of pieces of tule bunched together. At the toe, warps are untwisted and the component parts are turned up and back to form a protective toe flap in openwork twining. The loops of twisted tule, five on each side, are formed by a running cord. There is a well-developed upper as a support for the heel. A two-strand tule cord is worked into the upper, perhaps to bind the parts together or simply to give added strength.

Basketry. Three very small fragments of twined basketry on a two-ply twisted warp were found (1-8994, 1-9003, 1-9023, shown on Plate X). These do not appear to have been wrapped. The material is tule. Fragments of prepared warp, similar to those from other caves in the basin region, were found. A few pieces of prepared shredded sagebrush bark, *Apocynum*, and a piece of twined mat (1-9034) were found. The bark may have been prepared for basketry. It is possible that the large amount of ash in the upper layer may explain the lack of basketry, since there is some evidence of its having been there.

Wooden Objects. Two wooden artifacts were found. One (1-9036) was possibly a dart foreshaft of greasewood, the other (1-9026) a fire-drill foreshaft. The fire-drill foreshaft is slightly flattened on the sides toward the proximal end, making it rectangular rather than round. These are shown on Plate XIII.

Stone Pieces. Stone pieces were few in number. Small ovoid scrapers, triangle-shaped scrapers, and small crudely retouched scrapers were found. One large point with the base fractured (1-9013) might have been a dart point. No. 1-9011 is also probably a dart point. Seven arrowheads were found. Two of these are very long slender pieces with fine flaking and showing corner notches. The others, with the exception of 1-8984, are corner notched. No. 1-8984 is side notched. All specimens are obsidian.

Manos. One paint mano and a metate with red pigment on it were found.

Paisley Cave—Below Pumice

Stone Artifacts. Stone artifacts found include a butt end of an atlatl point (1-9015), a fragment of a small crescent-shaped scraper (1-8977) made from chalcedony, 8 reworked pieces of obsidian, a chalcedony reject, and 2 retouched flake scrapers (1-8986, 1-8988). A half-pebble scraper (1-8989) was found *in situ* near bedrock. The type is described in the section dealing with Fort Rock artifacts, since several specimens which presumably define the type were found in that cave.

A point (1-9043) probably comes from this stratum, although we cannot be sure because of incomplete notes on it. It is 50 mm. long, 27 mm. across the tips of the barbs, weighs 6 grams, and is probably an atlatl point.

Trench profiles (Figs. 12-13) show fire lenses and occupation debris below the pumice stratum to the floor rock. The occupation under the pumice is not continuous to the bedrock, but is broken by sterile sections, which seem to be made up of basaltic dust and organic material.

Other Artifacts. The artifacts from below pumice in Paisley Cave are few. There is one small piece of shredded sagebrush bark mat (1-8974), a small knotted piece of two-ply shredded sagebrush bark rope (1-8985) which might have been a part of a sandal, and a two-ply twisted basketry warp (1-9039). They are shown on Plates IX, XI. One small piece of whang (1-8973) was found. There were no wooden objects.

Paisley Cave No. 2

Paisley Cave No. 2, which was partially excavated in 1938, showed unstratified material, pumice being mixed with the occupation debris. Some stone pieces, tule sandals, a bone awl, and a fine atlatl shaft butt came from the small excavated section. The mixture of pumice with the occupation materials seemed to indicate that there had been a thin layer of pumice which was trampled and kicked about with the camp debris. The artifacts were similar to those found in Cave No. 1. The two caves should be contemporaneous. Proof of this appeared difficult, however, because of the disturbed state of the pumice in Cave No. 2. In 1939 we completely excavated Cave No. 2, and found that a long passage had, at the time of the pumice shower, led back toward the wall of Cave No. 1. The outer wall had later collapsed. The passage was at a 90° angle from the direction of the pumice shower. The pumice consequently entered the cave in an eddy, and did not reach the rear of the cave. However, at the entrance, the west wall of which had collapsed during the later period of occupation, we found perfect strati-

fication, with a top stratum of occupation, a middle stratum of pumice, and a bottom stratum of occupation.

Fort Rock Cave—Above Pumice

Wooden Pieces. The wooden pieces consist of a sharpened needle-like specimen (1-9280); a foreshaft of a fire drill (1-9282) trimmed to a hexagonal pattern (Plate XIV); the trigger for a trap (1-9460); a broken piece of greasewood (1-9281) pointed at one end, probably a fragment of a foreshaft; and possibly a small fragment of an atlatl shaft (1-9365), 12 mm. in diameter, split lengthwise (Plate XIV).

Projectile Points. The projectile points probably include both atlatl and arrow points, if size is any criterion. There are both crudely and very finely worked specimens.

Stemless or leaf-shaped points include specimens ranging from 84 mm. (1-9167) to 38 mm. in length. One (1-9288), broken on both ends, is 68 mm. long. Its length before breaking must have been close to 10 cm. Of 81 specimens collected, 23 are sufficiently complete for study.

Stemmed points varied from 71 mm. (1-9287) to 18 mm. (1-9320). There are in this group 7 side-notched and 11 corner-notched specimens. One specimen (1-9318) (Fig. 16) is particularly worth noting because of its similarity to the Silver Lake point figured by Amsden.⁵ This point has a maximum breadth at the shoulder of 33 mm. From the shoulder to the point it measures 30 mm. The length

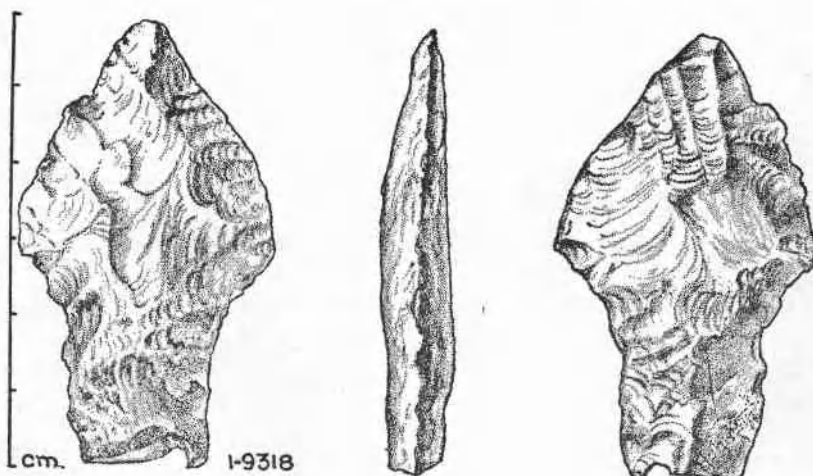


FIG. 16. Projectile Point from Fort Rock Cave (above pumice).

⁵ *The Archaeology of Pleistocene Lake Mohave*, Southwest Museum Paper No. 11 (1937), plate XLII, p. 82.

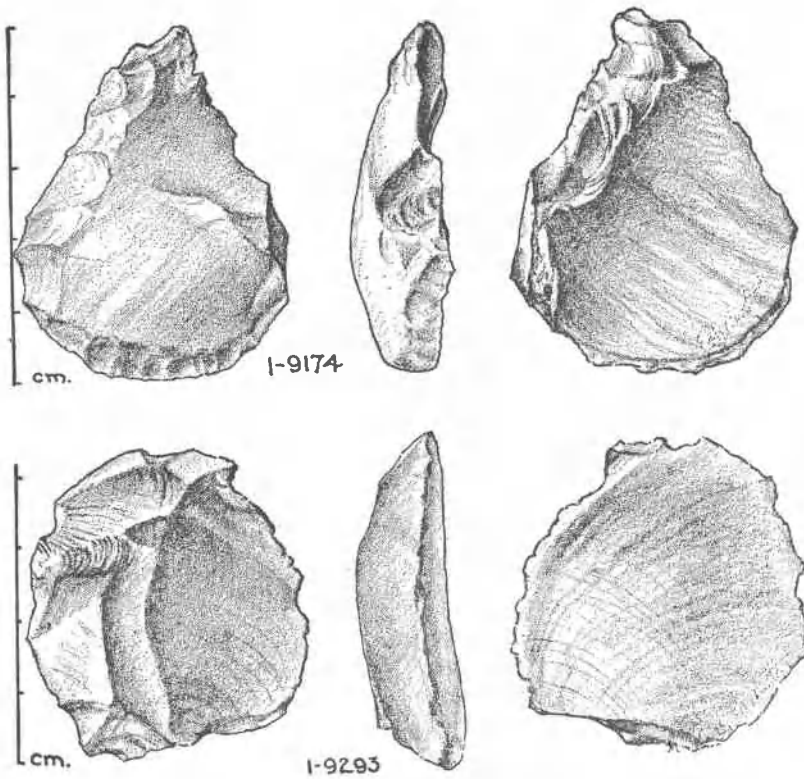


FIG. 17. Scrapers from Fort Rock Cave (above pumice).

from the point to the stem proper is 40 mm. The width of the stem is 18 mm. The over-all length is 56 mm. A small fragment is broken off the stem.

Scrapers. Our 63 scrapers fall into three classes: the snub-nose or thumb-nail scraper, side scraper, and the plano-convex scraper. No. 1-9174 (Fig. 17) is a good example of the snub-nose scraper in slaty grey obsidian; 1-9581 seems to have been a side scraper which broke and was then made into a snub-nose. There are 7 of this type. Side scrapers take almost all possible forms and sizes. Some are long spalls (1-9523) which have been retouched along the convex edge and sharpened at the point to serve as drills or gouges (Fig. 18). Others are short, almost round specimens, for example No. 1-9293 (Fig. 17). The plano-convex type is for the most part heavy and crudely worked. There are 7 specimens of these from this level.

Drills. Two drills (1-9539, 1-9192) were found (Plate XV).

Manos. One mano (1-9346) came from this level.

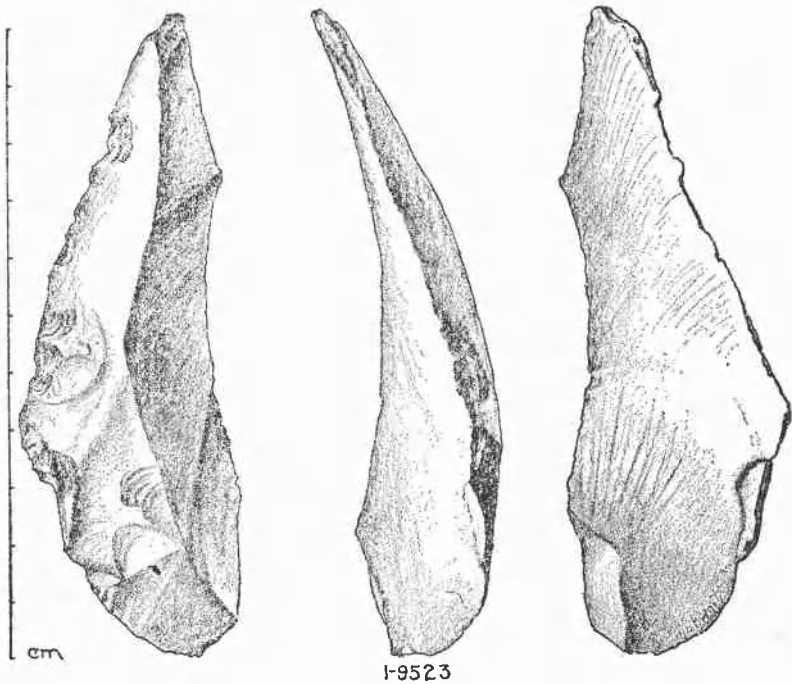


FIG. 18. Scraper from Fort Rock Cave (above pumice).

Fort Rock Cave—Below Pumice

Basketry. Only one piece of basketry (1-9661) was found. It may be of tule. It has fine twining on a single warp with the twist downward to the right. Decomposition is so advanced that it is impossible to tell if overlay was used.

Wooden Specimens. Wooden specimens are represented by a fragment of a simple fire drill (1-9140); a small piece (1-9270) shaped to a blunt point which might have been intended to be a fore-shaft for a fire drill but was not completed (neither illustrated); and a piece (1-9160) partially burned (Fig. 19). This last piece may be a part of an atlatl; it hardly appears to have the proper shape for a bow fragment. It is 11.4 cm. long in the center with a side fragment projecting 33 mm. beyond that. Its maximum breadth is 35 mm.; at the end it is 13 mm. broad. In thickness it is between 5 and 8 mm.

Bone. Two bone awls were found. One (1-9486) was made from the rib of a large animal, and the other (1-9119) from the tibia of some small animal, perhaps a coyote.

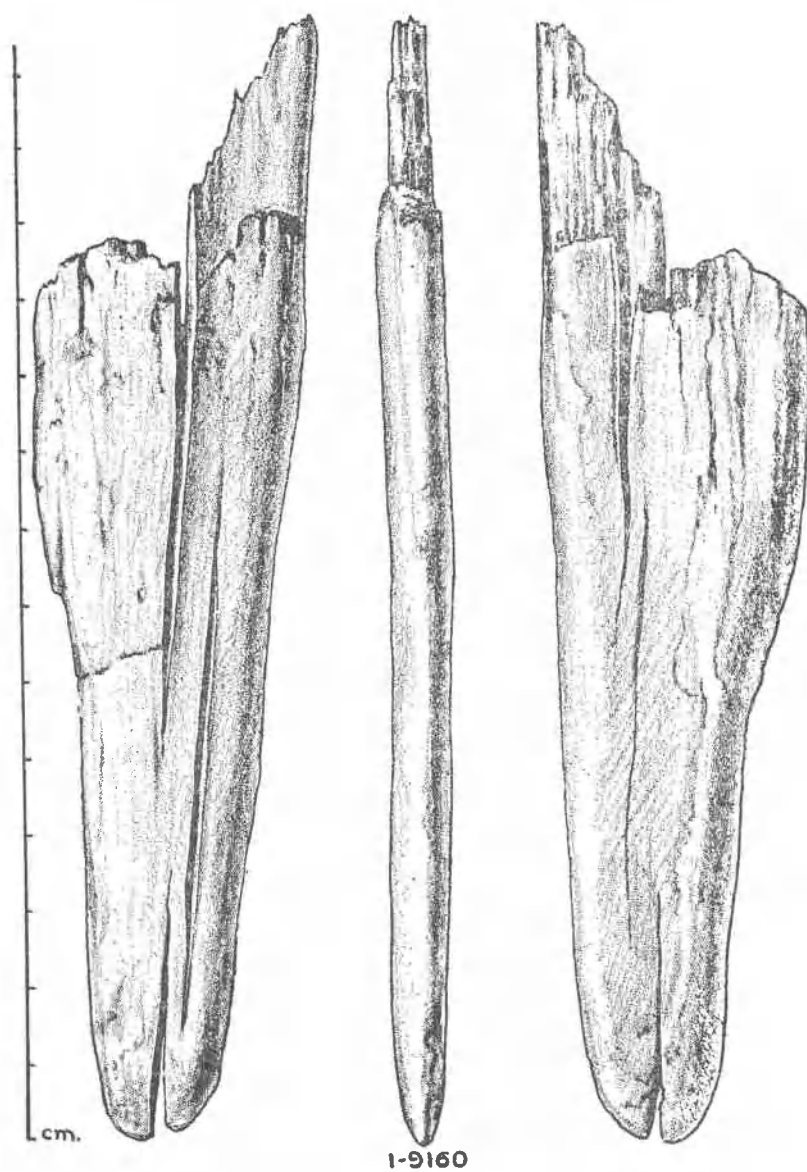


FIG. 19. Wood Specimen from Fort Rock Cave (below pumice).

Antler. No. 1-9219 is a flaking tool made from deer antler (Fig. 20).

Projectile Points. There are 9 stemmed points from below the pumice. Their average size is about 40 mm. plus, if we project the

sides of the broken ones. One (1-9107), which has the front part broken off, has a length of nearly 60 mm. The width from tip to tip of the barbs is 33 mm. This appears to be an atlatl point. Seven of these are corner notched and 2 are side notched.

There are 44 stemless points available for study; twice that many were found if fragments are also counted. These vary in size from 38 mm. long (1-9495) to 89 mm. long (1-9494). The longest has an average width of 13 mm. and a maximum of 23 mm. This may be a faulty piece of workmanship; it has a hump on one side, giving an appearance of a stem. It is possibly an atlatl point.

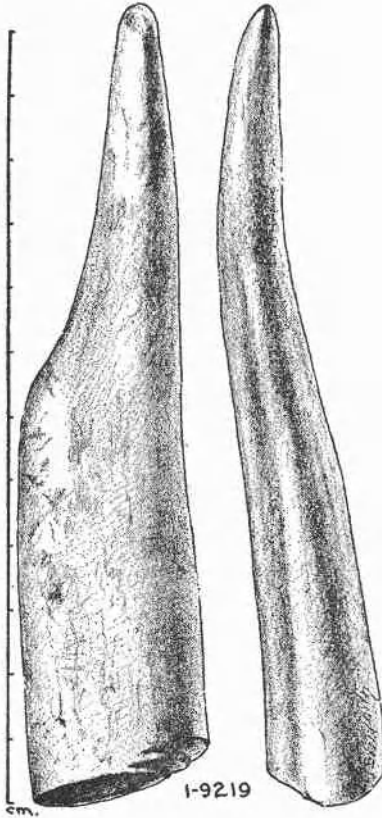


FIG. 20. Flaking Tool from Deer Antler, Fort Rock Cave (below pumice).

Scrapers. Eighty-five scrapers of all kinds were found. They were 34 side, 33 spall, 9 snub-nose, and 8 plano-convex scrapers, and 1 unclassifiable. This last one is probably a fragment broken from a side scraper. Among the plano-convex are 3 specimens of a distinct type (1-9308, 1-9309, 1-9574) (Fig. 21). One of this type occurred above the pumice (1-9302). The type is almost round in general outline and ap-

proximately 38 mm. across the base. It appears to be made from half of an obsidian pebble although it may be a spall from a large nodule. The base is the nodular surface. The outer surface contrasts with the ordinary spall scraper, having been flaked from the outer edge so that the top ends in a shortened ridge. In 1-9308 and 1-9309 the high point is well to the left of the center. In 1-9574 it is at the center, and the specimen is triangle-shaped. The height of these scrapers is approximately 23 mm. This type seems to be a localized variation, appearing as a distinctive type only in the Fort Rock Cave.



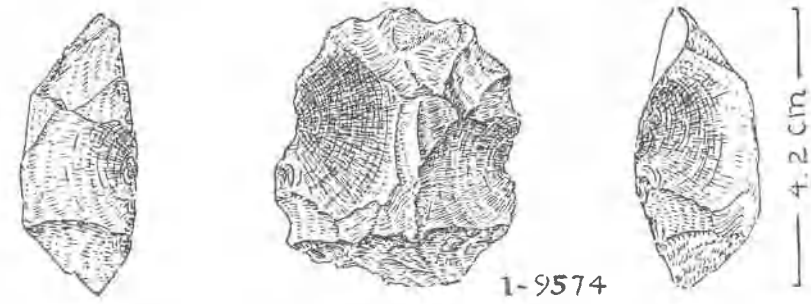
1-9302



1-9308



1-9309



1-9574

FIG. 21. Scrapers from Fort Rock Cave (below pumice).

Drills. Two large drills, both broken, were found. One of these (1-9263) has a base 51 mm. long after fracture, 25 mm. wide, with a point 22 mm. long; apparently half of the point is broken off. No. 1-9498 is made of fine-grain basalt. The base is broken, leaving a portion 13 mm. long and 18 mm. wide. The point is 40 mm. long. Plate XVI illustrates the drills.

Manos. Four manos came from this level. One specimen (1-9354) is a paint mano. It is broken and stained with red pigment on both the grinding and the broken surface.

Other Stones. No. 1-9646, probably a shaft polisher, is made from gravel. It has a groove on the flat surface, and is apparently polished from use. It appears that an effort was made to start a groove on the rounded surface.

Shells. One small olivella shell bead with the end ground off (1-9487) comes from this level.

Sandals. Between 75 and 100 sandals were removed from the stratum under the pumice. We cannot give the exact number because of the fragmentary condition of most of them. All of the sandals are more or less charred, as is practically all inflammable material from under the pumice. The impression one gains from examining the materials removed from this stratum, together with the deep brownish color of the soil and the characteristic odor which emanates from the soil of the stratum and everything in it, is that the pumice was sufficiently hot when it fell to ignite the inflammable materials. The covering of pumice acted as a blanket so that the fire burned slowly and unevenly, reducing most of the perishable material to charcoal. In some cases only fragments of sandals were found, but some practically whole specimens were recovered. The best preserved specimens are a pair (1-9439, 1-9440); these were but slightly burned (Plate XII).

It seems entirely unlikely that the subpumice charring could have come from any camp fires. Only one ash lens was found under the pumice. This was white, showing that it had been a surface fire. The ash was then covered with charred camp debris continuous with the rest of this bottom stratum. On top of this covering rested the pumice. Camp fires must have been built outside of the main cave. We must conclude that the pumice as it drifted down and back into the cave was hot enough to fire the inflammable materials in it.

All of these sandals were made on the same pattern and from the same material, shredded sagebrush bark. They have neither up-

pers nor supports around the heel. The warp bundles of the sole are separated into single untwisted shreds and turned back over the toe to form a toe flap. This was fastened at the sides. A series of loops on each side made it possible to fasten the sandals by means of a draw string.

It is difficult to account for the large number of sandals in this cave and at the same time the almost complete lack of basketry. A few fragments of tule mat and one small grass-lined cache in which the grass was charred were found beneath the pumice. No basketry other than the piece mentioned occurred in this level. No complete mats or tule bags were found. The situation suggests a specialization of labor—that the occupants of this cave were skillful sandal makers who used sandals to barter for their other needs. Yet this is unsatisfactory, since, if other material were in the cave, whether traded or manufactured, some should have been found.

Some of the sandals have mud caked in the sole between the wefts and hardened by burning. This might indicate climatic conditions different from present conditions. It is now difficult to find mud except for a short period in the spring.

GENERAL CONSIDERATIONS

Apparently no very long period of time elapsed between the deposition of the pumice and the reoccupation of the cave. If there had been any great lapse of time, a sterile stratum should have indicated it and difference in types of artifacts might have appeared. No such separation of strata existed as our profiles show. Artifacts from the top layer were tramped into the upper surface of the pumice in the Fort Rock Cave; and in the Paisley Cave, especially in the front, the top of the pumice was blackened by the fires built above. Our best conclusion is that a comparatively short time elapsed in both caves between the laying down of the pumice and the commencement of the overlying strata.

A striking thing about the Paisley and Fort Rock Caves is the almost total lack of basketry or similar materials underneath the pumice. This may represent a change in occupants of the cave. Or it may simply mean that perishable materials in the lower part of the bottom stratum rotted; however, the presence of other organic material does not support this alternative. In Roaring Springs Cave in Catlow Valley a similar situation was found in the lower stratum.

It is tempting to speculate concerning the possible population movements which might be associated with this apparent sharp

change in culture type. In Roaring Springs Cave, the change does not accompany any geological stratification. The lack of basketry in the Fort Rock Cave under the pumice can only be explained on the ground that it never was there, since we have the preservation of sandals; above the pumice it may have been burnt by the fires which produced the white ash. Another striking feature of the Fort Rock Cave is the apparent crudity of much of the stone work. Yet finely made pieces also occur. Typologically the more recent stone specimens are the cruder. Again we call attention to the half-pebble type of scraper from these two caves. It should also be remarked that the occupants of both caves depended on bark and tule rather than leather, as the almost complete absence of leather in both caves testifies.

Dr. Williams has indicated below the different time estimates which must be applied to the pumice strata in our two caves.

The Wikiup Site, a river-terrace locality, has been described in another paper. Here it need only be pointed out that the Wikiup knives lay well under the bottom of the pumice, under a stratum of fine soil and gravel and in the top of a stratum of partly cemented sand and gravel. This "hardpan" (about 4 inches thick) lay on a stratum of clean gravel. Though we must not forget all the possibilities for rapid deposition of the stratum overlying the knives, it is likely that the deposition of the knives considerably antedates the pumice. Further support is given this theory by the fact that sufficient time had elapsed for trees to grow on the subpumice stratum before the pumice fell.

Whatever the final date geologists may assign to the Mt. Mazama and the Newberry Crater explosions, which deposited the pumice in these caves and over the Wikiup country of the upper Deschutes River, our evidence is unmistakable that the Indians of the eastern Oregon country were witnesses to some of the last large-scale eruptions of the Cascade volcanoes in Oregon.

GEOLOGICAL NOTES ON THE PAISLEY, WIKIUP, AND FORT ROCK SITES⁶

The Paisley Cave

The dark brown deposit beneath the pumice layer in the Paisley Cave consists of basaltic ash, admixed with a small amount of decomposed basaltic lava, doubtless debris from the roof, and organic material. The ash is extremely fine and is made up principally of discrete crystals of basic plagioclase, pyroxene, and iron ores, accompanied

⁶ By Howel Williams.

by much brown glass. All these constituents are angular. Exactly how they were deposited is not certain. They could not have been water-borne. Nor could they have been carried far by wind. Either they were blown directly into the cave during a basaltic eruption, or they were drifted there by winds at a later date.

The overlying stratum of pumice also seems to have been deposited from the air rather than in water, as the following considerations suggest: (1) Similar pumice, though sparse, may be found among the basaltic debris on the summit of the hill, 200 feet or more above the cave. At that level there are no signs of water action. (2) There is no indication of a pumice beach adjacent to the cave. (3) Had the pumice fallen in shallow water, open to wind and waves, it must surely have been admixed with the upper parts of the soil layer beneath. Actually the contact is clean cut. (4) Even if the water had been stagnant so that mechanical stirring was prevented, the underlying occupational layers and soil would be deeply rotted. (5) In detail the base of the pumice is minutely irregular.

Nature of the Pumice. Two samples of pumice, separated according to grade sizes, gave the following weight percentages:

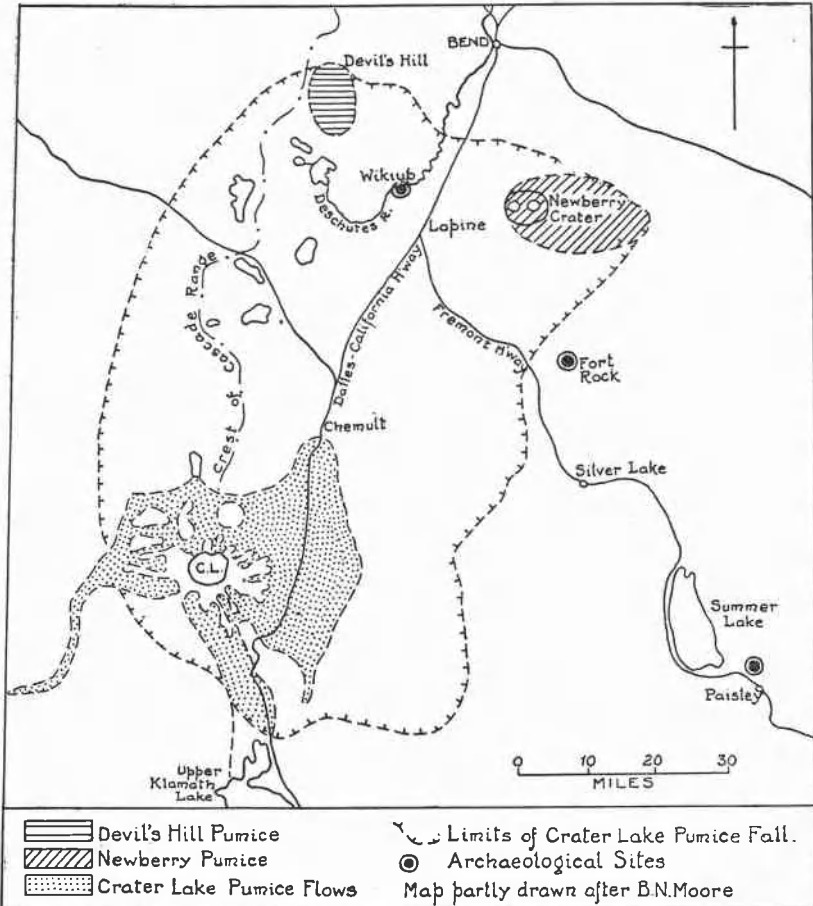
	More than 2 mm.	1-2 mm.	1/2-1 mm.	1/4-1/2 mm.	Less than 1/4 mm.
Sample 1	2.39	23.12	51.77	19.60	3.12
Sample 2	1.52	12.18	41.06	42.20	3.04

Except for a few minute feldspars and still fewer pyroxenes, the pumice is completely free from crystals. The refractive index and pale buff to white color indicate it to be either rhyolite or dacite in composition. Were chemical analysis to prove it rhyolite, the possibility would still remain that the parent magma was dacitic; for, under the influence of sorting by gravity, volcanic ejecta usually become more acid with increasing distance from the vent.

Was Crater Lake the Source? The fineness of the Paisley pumice and the paucity of crystals imply either violent eruption from a distant source or a mild explosion from a nearby volcano. Although little is known concerning the geology of the region close to the cave, the possibility of an adjacent source is very remote. The nearest known pumice cones are those in and on the outer flanks of the Newberry Crater, 75 miles distant toward the northwest. But when these were active the winds were directed mainly toward the east.

Of the major volcanoes that constitute the southern Cascades, only a few are known to have erupted pumice in post-Pleistocene times. Among them, Mount Mazama, the ancestral cone in which Crater

Lake lies, was incomparably the most important. The pumice erupted from this volcano immediately prior to the collapse of its summit and the formation of Crater Lake covers an immense area in southcentral Oregon (see Map 3). Some of the pumice is extremely coarse and was laid down by glowing clouds (*nués ardentes*) in the canyons that radiate from the lake; but most of it was hurled high above the volcano and drifted by winds, chiefly toward the north and east, falling on hill and valley alike. Although the Paisley Cave lies beyond the limits of this pumice (as depicted in Map 3), it must be emphasized that those limits merely enclose the area in which the pumice forms a well-defined stratum, not less than about a foot in thickness at the margins. Beyond this area, the pumice ex-



MAP 3. Archaeological Sites in Relation to Crater Lake Pumice Fall.

tends for an unknown distance, probably for scores of miles, becoming finer, freer from crystals, and increasingly admixed with soil. But, even in these outlying regions, patches of pure pumice may be found in sheltered localities. Facing toward the southwest, approximately toward Crater Lake, the Paisley Cave was especially well situated to act as a trap for the pumice. It is not surprising, therefore, that the pumice in the cave reaches a thickness of 6 inches, though it requires careful search to find any on the hill above. Even within a few miles of Crater Lake, hillsides may be almost bare of pumice while slight depressions are deeply infilled.

Measurements of the lateral variation in grade size of the Crater Lake pumice, too numerous to list here, also support the idea that the pumice in the Paisley Cave came from that source.

The Wikiup Site

Before proceeding to a discussion of the age of the Paisley deposits, it seems proper to say a few words concerning the site at Wikiup, on the Deschutes River, since there also obsidian knives have been found beneath pumice. This locality lies well within the area covered by the main sheet of Crater Lake ejecta (Map 3). Cressman's paper⁷ shows that the knives were overlain first by coarse and then by fine pumice, products of eruptions of different intensity. The grade sizes of these two varieties are as follows in weight percentage:

	<i>More than 2 mm.</i>	<i>1-2 mm.</i>	<i>1/2-1 mm.</i>	<i>1/4-1/2 mm.</i>	<i>Less than 1/4 mm.</i>
Coarse pumice	13.16	22.19	33.81	28.58	2.26
Fine pumice	1.32	15.28	35.58	46.50	1.32

In the coarse pumice, lumps up to 20 mm. across are not uncommon; in the fine pumice, few fragments exceed even 5 mm. across. These measurements, when compared with others made on pumice collected to the south whose source is beyond dispute, are in themselves strong support for the belief that the Wikiup pumice came from Crater Lake. If to this evidence is added the fact that the Wikiup pumice is identical mineralogically with that adjacent to Crater Lake, the question of provenance admits but one answer. Accordingly we feel justified in saying that the catastrophic eruptions which led to the formation of Crater Lake were witnessed by the knife makers in this part of Oregon.⁸

⁷ L. S. Cressman, "The Wikiup Damsite No. 1 Knives," *American Antiquity*, vol. 3 (1937), pp. 53-67.

⁸ On Dec. 12, 1938 Mr. Phil Brogan of Bend informed Cressman of the finding of another knife at the Wikiup Site. In reply to his request for information con-

Age of the Crater Lake Pumice

It is beyond the scope of this paper to discuss in detail the relation between the pumice eruptions of Mount Mazama and the collapse of its summit to produce the caldera of Crater Lake. It is sufficient to say that it was the rapid explosion of many cubic miles of pumice from the reservoir beneath the volcano which withdrew support and led to the engulfment of the summit. The collapse of Krakatau in 1883 was brought about in a similar fashion, by the hurried expulsion of vast quantities of pumice from the underlying magma chamber.

Field evidence warrants the conclusion that the collapse which formed Crater Lake occurred during and immediately after the pumice explosions. If this catastrophe can be dated, then we can assign a minimum age to the artifacts beneath the pumice at Paisley and Wikiup. Unfortunately the available criteria permit only an approximate estimate. These may now be summarized.

cerning the find, Mr. C. C. Fisher, construction engineer, wrote under date of Dec. 28, 1938 as follows:

"Regarding the recent find of another knife this was found in the vicinity of and under similar conditions to the two we found a few years ago of which you know. This one was found in test pit excavation on the right, or Wickiup Butte side of the river, and at the upper, or No. 4 Wickiup Damsite, about 3/4 miles up stream from the lower or damsite No. 1, where the other knives were found, and also on the opposite side of the river. This knife was found in pit No. 71 located not far from the river bank and at a depth of about four feet. The man who found the knife is Victor G. Keeney, 1988 Awbrey Road, Bend, Oregon, who wishes that it be turned over to you for safe keeping at the University, so we are sending it herewith by registered mail."

The elevation of Test Pit No. 71 is 4267.5 feet and the log is as follows:

0'-2.5' Pumice
2.5'-10.5' Boulders and clay
10.5'-13' Boulders, very tight in clay to bed rock.

Since the knife was found at a depth of 4 feet it comes from the "boulder and clay" stratum.

Upon receipt of the knife and a specimen of the pumice at the Museum of Natural History, they were forwarded to Dr. Williams for examination and comparison with the other knives and pumice samples. Dr. Williams' report follows:

"The pumice is not notably different from that which you sent earlier from the Wikiup site. It seems to be from Crater Lake and is only slightly different from the previous samples in being somewhat water worn. The particles of pumice are subangular to rounded and admixed with a small amount of sedimentary detritus.

"As to the knives, all three consist of obsidian. Not wishing to flake them for microscopic study I determined their specific gravities with the following results:

1-758—2.39 1-759—2.45 1-9670—2.36

These figures indicate the obsidian to be rhyolitic or dacitic. The highest figure on knife 1-759 suggests that this obsidian is partly devitrified.

"As you know there are several obsidian flows in the Cascades and to the east in Oregon. I doubt if it will be possible by microscopic or chemical analysis to determine from which flow or flows the material was obtained. There is too little difference in their character."

A third knife must now be added to the others from this site covered by pumice from Mt. Mazama. L.S.C.

(1) The slopes that lead westward and southwestward from the rim of Crater Lake are largely free from pumice. So also are the upper 1 or 2 miles of the valleys that radiate down the southern flanks of the mountain. For this only one satisfactory explanation can be offered, namely that those parts of the volcano were still mantled with ice when the eruptions took place. If this be true, then, just before the top of Mount Mazama disappeared, the canyons on its south side were occupied by glaciers between 4 and 5 miles in length; for the summit of the original cone lay approximately above the center of Crater Lake. Where these glaciers crossed the present rim of the crater they were not much more than 100 feet thick. On the cooler northern side of the volcano, the ice had retreated to a level at least as high as 7,000 feet, since a thick blanket of pumice rests on that side of the crater rim. Clearly, therefore, the great Pleistocene glaciers had suffered prolonged withdrawal, for they had once covered the entire volcano and had swept down the western side to an elevation of approximately 4,000 feet. In some of the canyons the late Pleistocene glaciers had a thickness of 1,200 feet in places and a length of at least 10 miles.

Before its destruction, Mount Mazama rose approximately 12,000 or 13,000 feet, or almost as high as Mt. Shasta. It lay 80 miles further north. Yet some of the glaciers on Shasta are still more than 2 miles long and on the northern slope they descend below 10,000 feet. In Pleistocene times, the northern glaciers were 7 miles long and descended to an elevation of less than 3,000 feet. Were Mount Mazama still in existence, surely its glaciers would be at least as long as those that remain on Shasta. And, since the largest were only 4 or 5 miles long when the great pumice eruptions occurred, it may be supposed with confidence that the explosions which led to the formation of Crater Lake took place in the geologically Recent period.

(2) A second but less satisfactory criterion of age is the degree to which the pumice has been eroded from the canyons on the south side of Crater Lake. These canyons are narrow and steep walled and some of them are about 300 feet deep. They are cut almost entirely in massive pumice and scoria, which is characterized by strong vertical jointing and of such lithology as to facilitate quick erosion. Suppose, for example, that the pumice were erupted only 3,000 years ago; it would require an annual deepening of the canyons amounting to little more than an inch to produce the present forms. Considering that the valley heads were occupied for some time by melting glaciers, and considering also the steep gradient of the canyon floors, as much as

200 feet per mile in the case of Annie Creek, this rate of erosion does not seem excessive. The problem calls, however, for a closer field analysis, though even a casual inspection will convince the geologist that both the canyons and the morainic mounds at their heads are extremely youthful features.

(3) The climate of the region was not essentially different from the present when the pumice was erupted; the charred logs found in the deposits are of trees identical with those that now grow in the vicinity.

(4) The walls of Crater Lake have suffered comparatively little degradation. The talus banks that descend from the cliffs to the water's edge may well have been formed in a few thousand years, as all will agree who have seen the devastation that attends a single summer storm. And, for all we know, much, perhaps most of the talus was actually formed at the time when the summit of Mount Mazama collapsed, just as the talus banks at Krakatau were largely formed during the formation of the caldera in 1883.

(5) Finally, a minimum age is given by the trees on Wizard Island, one of the cones that rose within the caldera. On this evidence, the last eruptions at Crater Lake occurred about 1,000 years ago. But the cone of Wizard Island rises between 1,500 and 2,000 feet above the floor of the caldera. To build such a high pile of ejecta requires a considerable time. Besides, there may have been a long interval of quiescence between the formation of the caldera and the first eruptions of the Wizard Island cone.

Lacking in accuracy as all of the above criteria are, they yet combine to show that Crater Lake, and therewith the pumice deposits at Paisley and Wikiup, are, geologically, of Recent origin. They suggest that the warm, post-Pleistocene climate had prevailed for a considerable time before the summit of Mount Mazama was destroyed. Probably we shall not err in estimating that this event took place between about 4,000 and 10,000 years ago; and the presumption is in favor of a figure nearer the smaller. This, therefore, is a *minimum* age for the artifacts at Wikiup and Paisley. We may reasonably hope that further studies of glaciation in this part of the Cascade Range, coupled with a detailed examination of the present and past lakes in the neighboring lowlands in relation to the pumice deposits, will provide more accurate estimates of age than are now possible.

The Caves at Fort Rock

The two caves at Fort Rock are cut in the sides of a denuded cone of basaltic scoria. In an air line they lie 60 miles northeast of Crater Lake and 20 miles south of the Newberry Crater, the two major sources of pumice in southern Oregon. One of the caves faces almost due north, approximately towards the Newberry Crater; the other, which contained all the artifacts, faces almost due south.

Nature of the Pumice Deposits. In the north cave, the pumice is extremely coarse, including lumps the size of a clenched fist. Obviously such large fragments cannot have been blown from Crater Lake, for pumice from that source is well exposed along the Fremont Highway not far to the south (Map 3), and rarely contains pieces even half an inch across.

In the south cave, the pumice is much finer. In places toward the rear, it rests on water-worn gravel; elsewhere it rests on the occupational layer (Fig. 15). Few of the fragments in this pumice exceed the size of a garden pea. Judged on this basis alone, the pumice might have come from Crater Lake. But several features render this impossible. In the first place, the pumice contains far more fine dust (smaller than $\frac{1}{4}$ mm.) than the pumice of Crater Lake where it is seen on the Fremont Highway, at its nearest point to the cave. In the cave pumice, the weight percentage of the fine dust is 25; in the Crater Lake pumice on the highway, the percentage is only 3.4. Again, the weight percentage of cave pumice exceeding 2 mm. in size is 5 as against 30. A lateral variation of this degree within the same pumice sheet over such a small area seems impossible. No less conclusive is the fact that the cave pumice is more finely vesicular than that from Crater Lake. Seen through a hand lens, it appears minutely arborescent; and, seen through a microscope, it appears crowded with ovoid and tubular vesicles, precisely like those in the pumice which forms the cones inside Newberry Crater. Mineralogically and in chemical composition the Crater Lake and Newberry pumices are not very different, but texturally they may be distinguished. Moreover, the Newberry pumice at its source contains abundant minute chips of smoke-grey and black obsidian, and some of these chips pass into pumice on the edges. Similar chips of dense and pumiceous obsidian are to be found in the cave at Fort Rock. They have never been detected in pumice from Crater Lake.

We feel justified in concluding, therefore, that the pumice in the Fort Rock caves came from the Newberry Crater or from the cones immediately to the east, and that it was blown into the caves by wind;

for, although it partly overlies water-rolled gravel, the pumice itself shows no features suggestive of water deposition. We feel the more certain of our conclusions from the fact that the pumice was still hot enough to char the sagebrush bark sandals as it fell to earth, and must therefore have been erupted from a source not very far away.

Age of the Fort Rock Pumice. Within the Newberry Crater there are four pumice cones; others rise at the eastern base of the volcano. Unfortunately, there is no means of telling from which of these cones the cave pumice was erupted. But, except where they have been partly demolished by later flows of obsidian, all the cones are well preserved. Their craters and flanks are not seriously modified by denudation. Considered solely from this point of view, they must be younger than the pumice deposits of Crater Lake. Even so they may be several thousand years old. From the data at hand, it would be rash to be more precise.

PLATES



PLATE I. Looking Out of Paisley Cave toward Winter Rim.



PLATE II. Paisley Cave. Profile I and floor (see fig. 12).



PLATE III. Paisley Cave. Detail of Plate II at point of circle. Unbroken line is decomposed pumice.

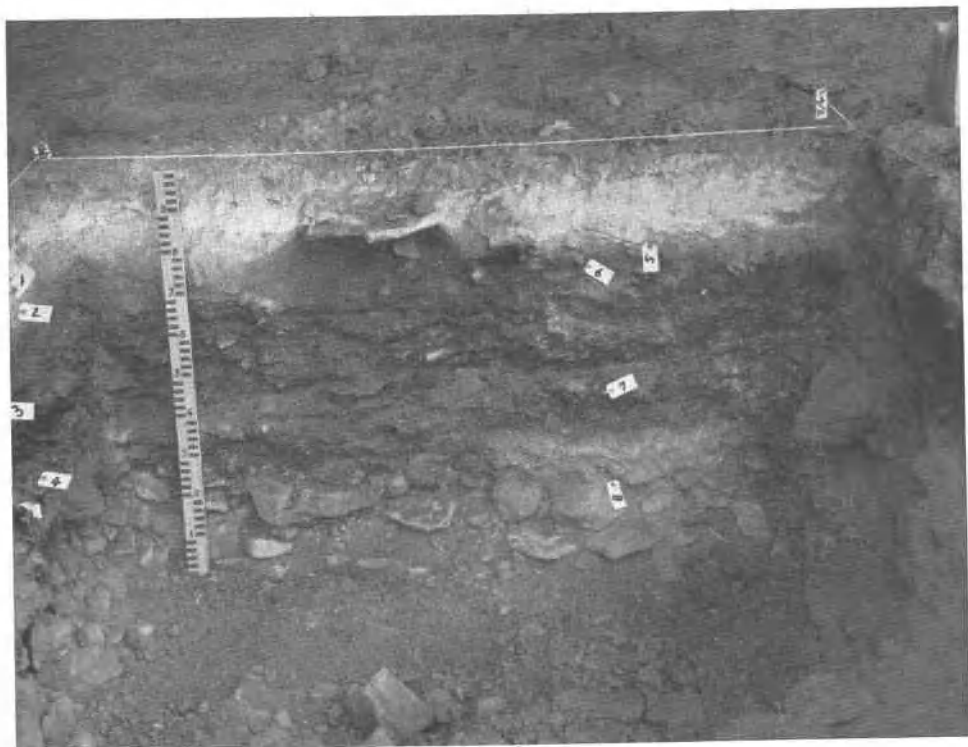


PLATE IV. Fort Rock Cave. Profiles in stratigraphic trench.

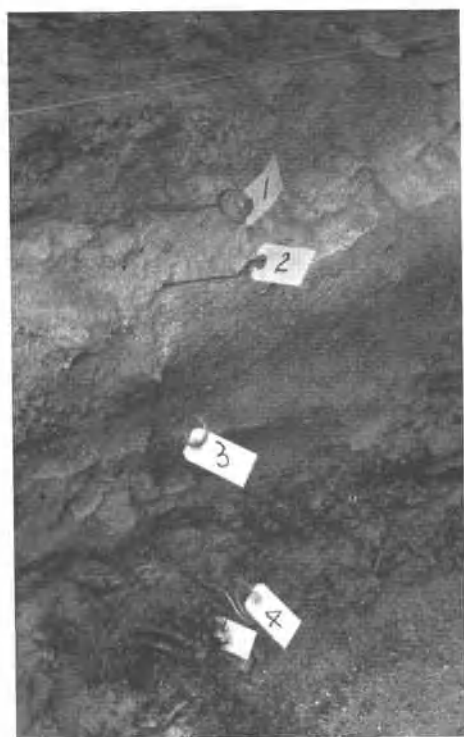


PLATE V. Fort Rock Cave. Detail of Plate IV. Shows stratigraphic series on west wall of main trench. Stake 1, bottom of mixed ash and manure. Stake 2, bottom of ash. Stake 3, bottom of pumice. Stake 4, sandals (charred) in subpumice stratum.



PLATE VI. Fort Rock Cave. Detail of Plate IV. Shows stratigraphic series in face of main trench. Stake 5, bottom of ash. Stake 6, bottom of pumice. Stake 7, sandals (charred) in subpumice stratum.

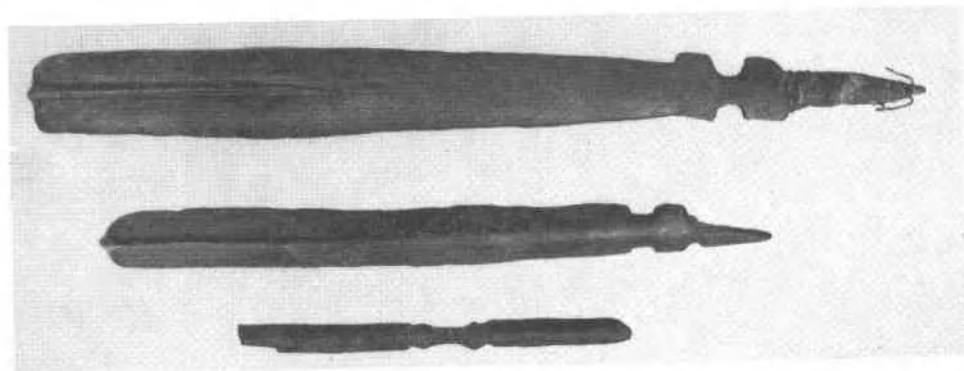
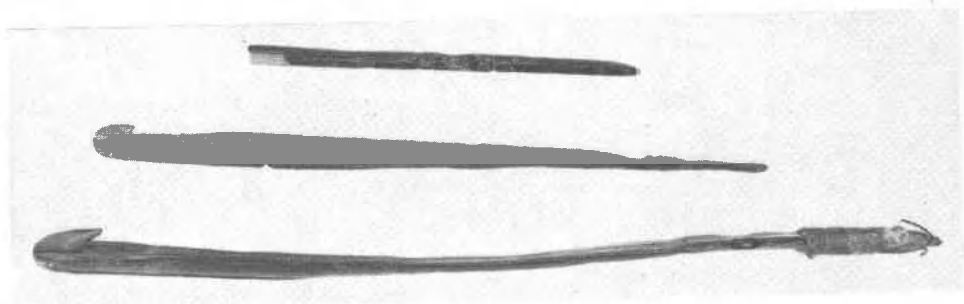
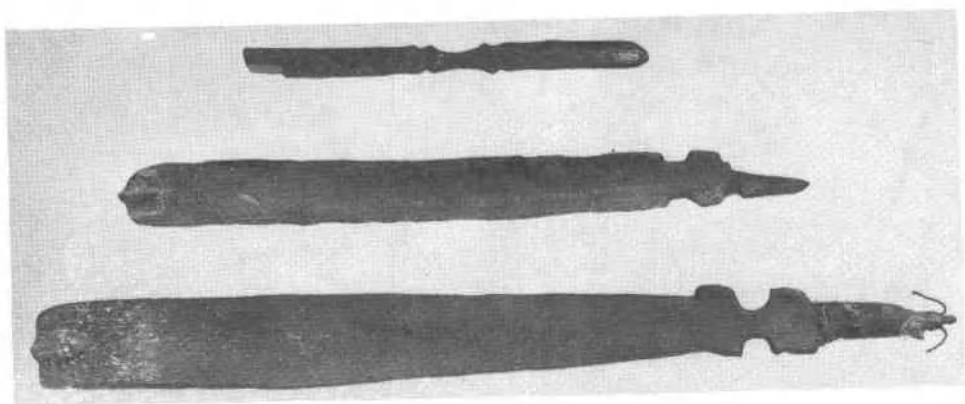


PLATE VII. Atlatls from Roaring Springs Cave and Warner Valley.

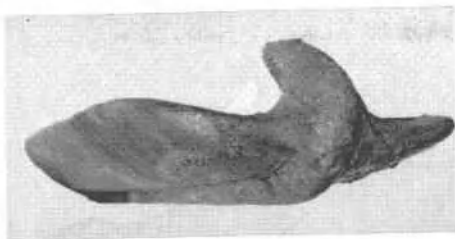
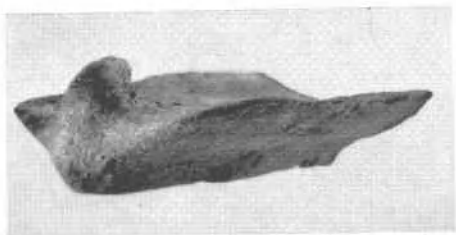


PLATE VIII. Distal End of Atlatl from Roaring Springs Cave. Closeup showing hook and keel arrangement



PLATE IX. Sagebrush Bark Mat from Paisley Cave (below pumice).

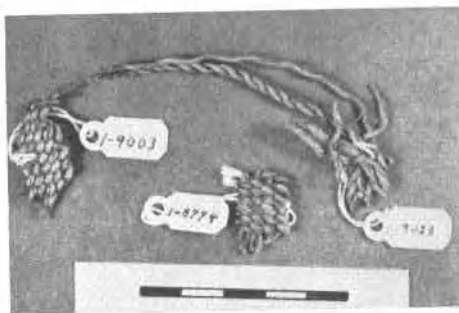


PLATE X. Twined Basketry from Paisley Cave (above pumice).



PLATE XI. From Paisley Cave (below pumice).

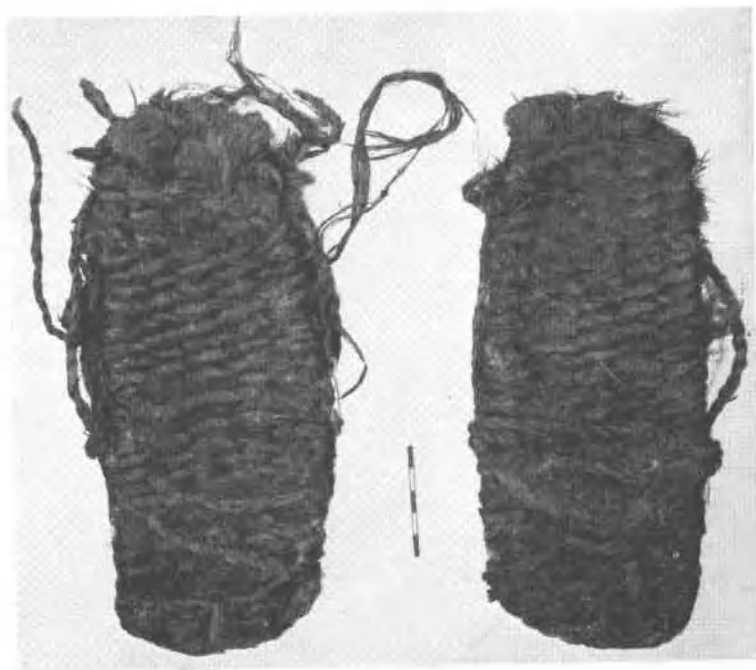


PLATE XII. Sandals from Fort Rock Cave (below pumice).

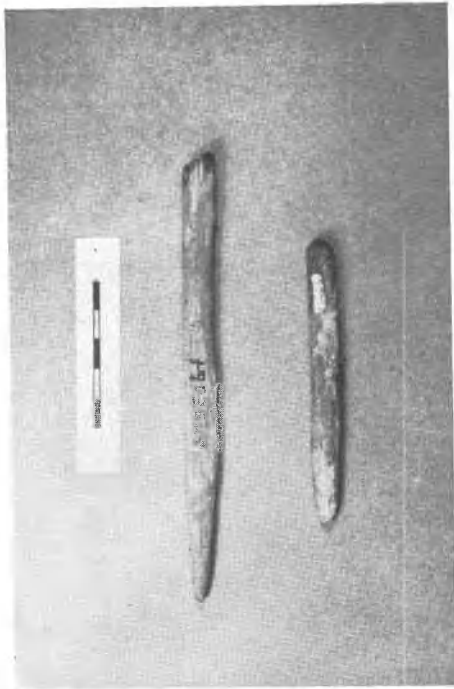


PLATE XIII. Wooden Artifacts from Paisley Cave (above pumice).

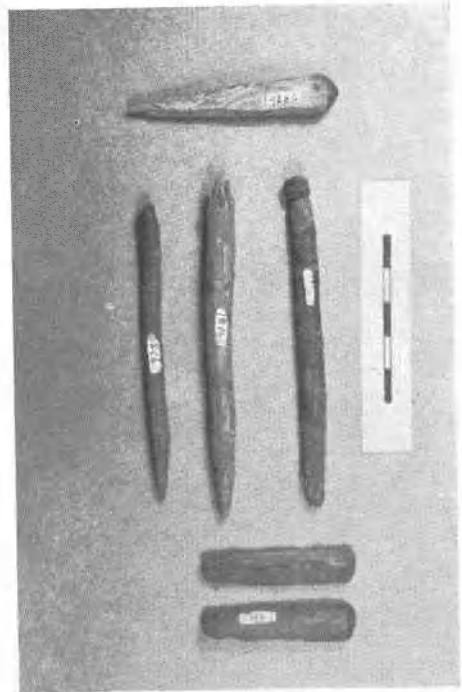


PLATE XIV. Wooden Artifacts from Fort Rock Cave (above pumice).

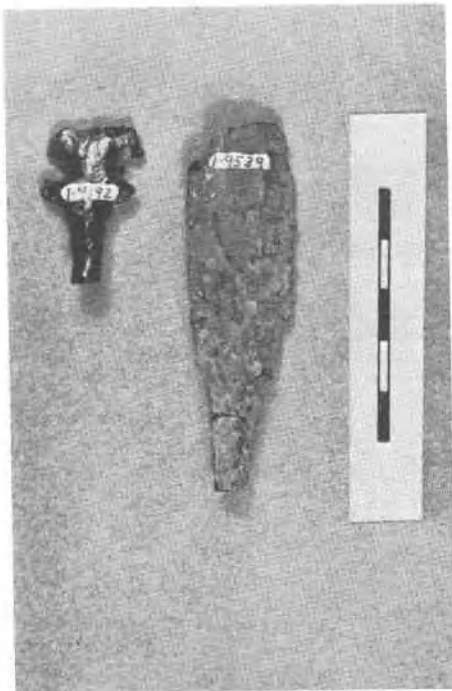


PLATE XV. Drills from Fort Rock Cave (above pumice).

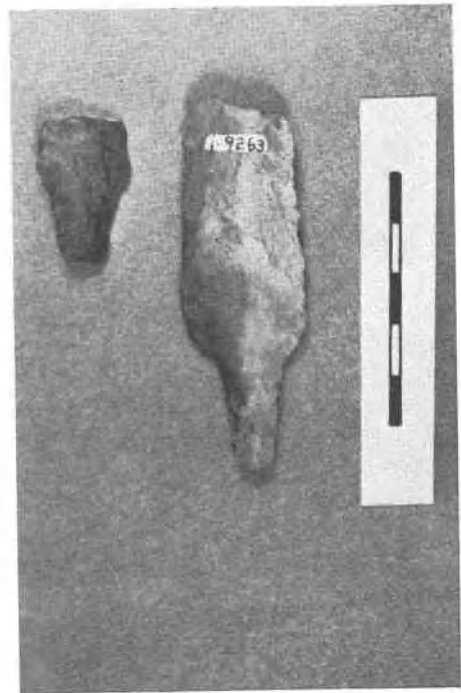


PLATE XVI. Drills from Fort Rock Cave (below pumice).