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Clovis Technology at the Anzick Site, Montana

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CLOVIS is the archaeological culture believed to represent the initial occupation of the North American continent. After more than a half-century of study, Clovis origins, adaptations, and technology remain poorly understood (Haynes 1980; Bonnichsen and Turnmire 1991), although radiocarbon dates indicate the occupation began between 11,000 and 11,500 ^{14}C years ago (Haynes 1980, 1982:383-384, 1984, 1987: 84). Most Clovis artifact assemblages include fluted lance points, which have been found in many locations in the New World, primarily in the United States. Other aspects of Clovis technology, such as percussion blades (Green 1963; Hammatt 1969, 1970; Young and Collins 1989; Sanders 1990; Goode and Mallouf 1991), have been reported. An overall assessment of Clovis lithic technology has never been presented, although stages and sequences of lithic reduction evident in the Simon Clovis assemblage from Idaho have been described (Woods and Titmus 1985). This paper discusses our interpretation of Clovis lithic technology based on analysis of the assemblage from the Anzick site (Fig. 1) in southwestern Montana.

CLOVIS ASSEMBLAGES

A distinction is often made between western and eastern Clovis sites and assemblages based on differences in projectile point morphology and site contexts. An association of Clovis points with bones of mammoths (*Mammuthus*), upon which Clovis hunters preyed to one extent or another, has been documented at a number of sites on the Great Plains and in the Southwest.

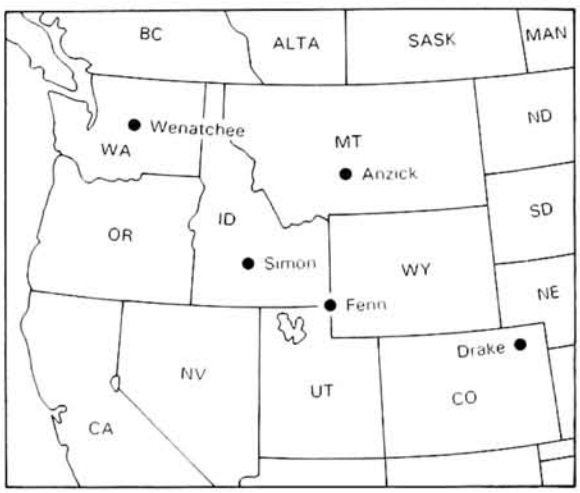

Fig. 1. Location of the Anzick site and other Clovis caches discussed in the text.

A clear association of a Clovis point with remains of mastodon (*Mammut americanum*) has been reported at Kimmswick, Missouri (Graham et al. 1981). Aside from isolated finds of fluted points, kill and butchery sites constitute the major body of published information on western Clovis culture. Thus, available technological information is narrow in scope, and dominated by hunting and butchering tools. This has led to potentially biased views of Clovis lifeways, because the use of plant foods, which must have been important, has never been documented. Few associations of Clovis fluted points and extinct fauna are reported from the eastern United States (Lepper and Meltzer 1991). Eastern Clovis sites also are not as well dated, and may be younger than their western counterparts (MacDonald 1968; Martin 1973; Haynes et al. 1984; Meltzer 1984; Haynes 1987:84, 86).

Western Clovis culture is documented by another assemblage type, of which there apparently are at least four known examples. They are represented by up to 100 or more lithic items deposited together, sometimes in the absence of any other cultural remains. These are often referred to as "caches" (Bonnichsen et al. 1987:408; Mehringer and Foit 1990; Stanford 1991; Willig 1991; Frison 1991), and perhaps they do represent assemblages so deposited in prehistory. However, given that the Anzick artifact assemblage apparently was buried with the remains of two subadults, it is not at all certain that the objects ever were intended for retrieval. Moreover, in such a case, the concept of a cache, which implies safe storage of goods with the intention of retrieving them, would not be appropriate, and another term, such as "burial assemblage," would be more descriptive. "Burial assemblage" implies objects placed with the dead, perhaps with the idea of intended use in the afterlife. These terms obviously carry very different cultural connotations. Moreover, of the several "cache-like" assemblages discussed briefly here, only Anzick appears to have human remains in possible association. A thorough exploration of these contextual matters is beyond the scope of this paper. For now, we retain the term "cache," recognizing that it may not correctly describe the contextual situation at the Anzick site.

Clovis caches are especially valuable analytically because they document the stages of the lithic reduction technology. These stages are difficult to discern in most Clovis assemblages because many aspects are not represented due to the situational contexts of kill and butchery locations. Although the assemblage from the Simon site has been described, no such assemblage has been characterized in terms of the lithic reduction strategy of Clovis peoples.

The first reported discovery of a Clovis cache occurred in 1961 during grading operations at what is now called the Simon site on Big Camas Prairie, south-central Idaho (Butler 1963; Butler and Fitzwater 1965; Woods and Titmus 1985). The ocher-stained assemblage included at least 34 bifaces representing stages of Clovis flaked-stone reduction technology including large bifacial flake cores, smaller bifaces, and finished Clovis points, but no bone.

A technologically similar assemblage, referred to as the Fenn Cache, was discovered, apparently during farming operations, many years ago. It is believed to have come from the region where the state boundaries of Idaho, Utah, and Wyoming converge (Frison 1991: 41ff). This assemblage consists of 56 specimens, most of which represent stages of lithic reduction from large bifacial flake cores to finished Clovis points.

A third assemblage of this general type, from the Wenatchee site, central Washington, is currently under study (Mehringer and Foit 1990). It was found during trenching for irrigation works in an apple orchard. This is the only Clovis cache yet found in undisturbed context, but not all of it has been unearthed, so the number and types of specimens it contains are unknown. It includes ocher-stained bifaces in various stages of reduction and completed Clovis points, some of which are twice as large as any ever found with the bones of extinct animals. Also present are distinctive beveled, rod-like artifacts of bone known from Clovis contexts across the continent.

Mention should be made also of the Drake assemblage, perhaps a true Clovis cache, found in a tilled field near Stoneham, northeastern Colorado (Stanford and Jodry 1988). Although from a disturbed context, the assemblage apparently consists of 13 complete Clovis points, small fragments of ivory, and a hammerstone.

Therefore, the Anzick assemblage is not an isolated occurrence; several other comparable collections are known. So similar are the Anzick, Simon, Fenn, and Wenatchee assemblages that they appear to represent a coherent tech-

nological adaptation of the initial colonizers of North America south of the ice sheets.

THE ANZICK SITE

The Anzick assemblage, the largest known Clovis cache, including approximately 112 recovered bifaces and bone artifacts, was obtained in 1968 on Flathead Creek just above its confluence with Shields River, just south of Wilsall, Park County, southwestern Montana (Taylor 1969; Lahren and Bonnichsen 1971; Fig. 1). The assemblage was displaced by heavy equipment while workers were removing talus material from the base of an escarpment. The escarpment appears to represent a very old collapsed rockshelter at the end of a long hogback. Overlying deposits contained many bison bones and apparently document use of the escarpment as a bison jump in late prehistoric time.

About 90 ocher-covered artifacts were found by the workers in a discrete area, along with the fragmentary remains of two subadult humans, suggesting a mortuary context. Given the circumstances under which the assemblage was discovered, the exact provenience of the artifacts and the potential association with the human remains cannot be determined. It follows therefore that any discussion of the functional context of the Anzick assemblage will always remain problematical. We believe, however, that the artifacts represent a burial assemblage placed in the grave or graves of two children. Artifacts included large bifacial flake cores, smaller bifaces, Clovis point blanks and preforms, Clovis points, miscellaneous flaked-stone items, and polished-and-beveled cylindrical bone tools or tool parts.

Approximately 19 additional stone and bone artifacts (represented individually or by conjoinable specimens) were recovered during subsequent excavations by the University of Montana. These specimens also came from deposits disturbed by the heavy equipment (Taylor 1969; D. C. Taylor, personal communication 1989).

Accelerator mass spectrometry (AMS) radiocarbon analyses have been reported on the human remains from the Anzick site, but the results are inconsistent. They are 10,500 ± 400, 8,940 ± 370, 8,690 ± 310, and 8,620 ± 340 B.P., and may reflect the anomalously recent radiocarbon age determinations often obtained on ancient bone organics (Stafford et al. 1987).

A definitive report on the Anzick assemblage has not been written. In addition to a brief note describing the discovery (Taylor 1969), an oral report was presented by Lahren and Bonnichsen (1971) at Society for American Archaeology meetings. The bone artifacts were described and interpreted as projectile foreshafts by Lahren and Bonnichsen (1974). Color photographs of some of the specimens, or of casts of them, appeared in a popular article (Canby 1979). In the context of other discussions, flaking patterns on two Clovis points from the Anzick site were discussed by Young and Bonnichsen (1984, repeated 1985). Those authors concluded that the primary thinning of the middle portions of the points was done by indirect percussion, that the ends of the points were thinned by pressure flaking, and that channel flakes were removed by either pressure or percussion (Young and Bonnichsen 1985:121-122).

Photographs of some of the specimens and of the site appeared in a nontechnical account (Fogelman 1990) and brief notices (e.g., Allison 1989) have been published. Thus, although the Anzick assemblage was found nearly 25 years ago, most of it has never been analyzed and described. It has, however, figured into numerous discussions of Clovis culture (e.g., Bonnichsen 1977; Haynes 1980; Bonnichsen et al. 1987; Stanford and Jodry 1988; Frison 1991).

Our analysis of the Anzick assemblage is based on examination of 90 specimens (minimum number based on conjoinable fragments), 84 of flaked stone and 6 of bone, on display at the Montana Historical Society in February 1988 (Table 1). We also undertook replicative

Table 1
ANALYZED SPECIMENS[a]

Artifact	Quantity
Bifacial Flake Core[b]	10
Percussion-flaked Bifacial Blank	55
Percussion- and Pressure-flaked Bifacial Preform	5
Clovis Point	8
Flake Blank	2
Uniface	2
Miscellaneous Debitage	2
Polished-and-beveled Bone Artifacts and Fragments	6
Total	90

[a] See text Note 1.
[b] Two specimens, one unreworked fragment and one reworked fragment, are conjoinable; see Figure 4.

experiments to explore the function of the beveled bone objects.[1]

CLOVIS LITHIC TECHNOLOGY

Analysis of the Anzick assemblage reveals remarkable details of Clovis lithic reduction technology. The well-designed and wholly integrated technology ensured a fail-proof reduction strategy with minimal loss of high-quality stone. While individual knapping actions emphasized reduction of bifacial flake cores through detachment of thin, flat flakes for apparent use as cutting tools and as blanks for production of flaked-stone tools, the entire reduction technology was focused ultimately toward Clovis point production. Production of all other unifacial and bifacial tools was embedded within the technology. Except for pressure flaking of stone tools to final form, all stages of the reduction technology yielded flake blanks for essential tools when Clovis people were on the landscape away from the sources of high-quality tool stone on which they depended.

Two distinct strategies are reflected in the Anzick bifacial core reduction technology. An *immediate strategy* involved reduction of bifacial flake cores to thin, flat, sharp, biface-thinning flakes for use as cutting tools, or for further reduction into flaked tools, as needed. An *ultimate strategy* was designed for the production of Clovis points, and guaranteed that exhausted cores and core fragments, as well as larger biface-thinning flakes, were of configurations readily reducible into such artifacts.

Analytical data reported herein have been inferred from the technological attributes visible on the Anzick artifacts. Except for two examples, debitage was not recovered with the formed artifacts; therefore, direct evidence of reduction is not present, but is interpreted from flake scars and remnant broken edges on the formed artifacts.

Bifacial Flake Cores

Based on the Anzick assemblage, bifacial flake cores (n = 10, two of which are conjoinable; one of which has been partially reworked) were the primary technological stage of lithic reduction. (A number of small bifacial blanks in the collection are of uncertain origin; they may have been detached from cores of other configurations.) High-quality, check-free, inclusion-free lithic materials (usually microcrystalline quartzes such as chert, chalcedony, and jasper), were selected for core production. After the stone was quarried, tested, and percussion flaked into functional bifacial cores, the incipient cores were heat-treated to ensure optimum flakeability. Heat treatment also ensured that all cutting edge produced from the core was the sharpest possible (but not necessarily the most durable; Rick and Chappell 1983:74). Following successful heat treatment, core surface topography, symmetry, and margins were prepared by percussion flaking for the production of flake blanks for cutting tools and for probable working into a variety of other tools, as well as for Clovis points.

Most Clovis flake tools were produced from biface-thinning flakes.[2] Bifacial flake-core re-

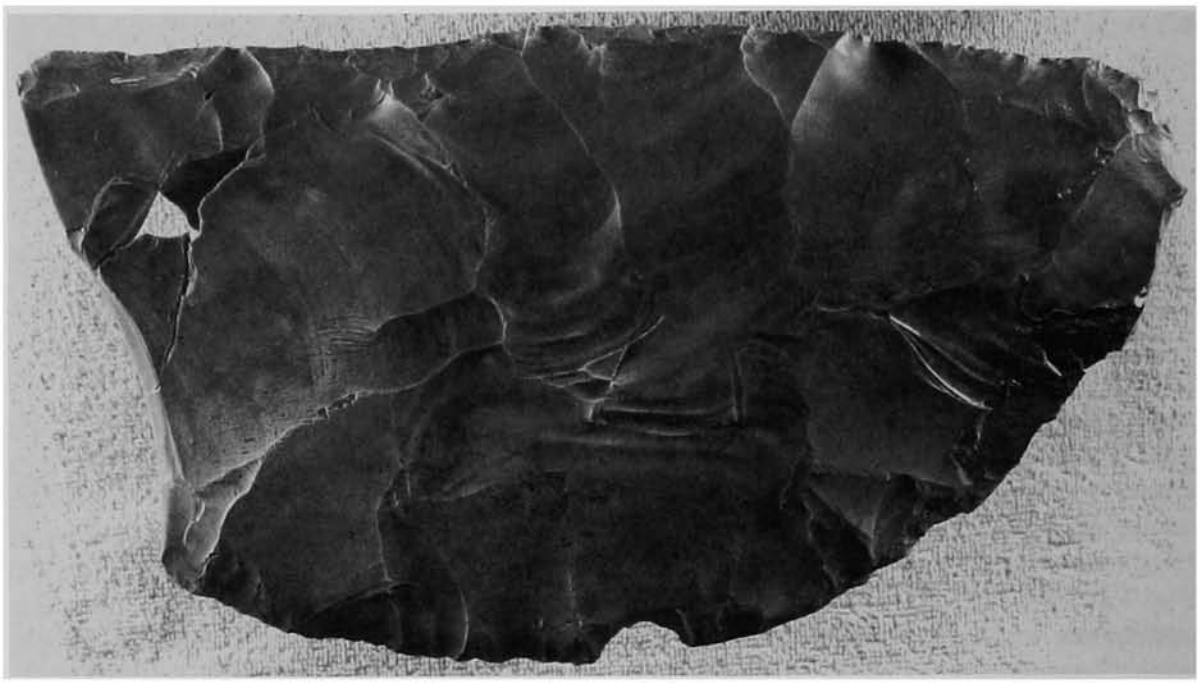

Fig. 2. Large, asymmetrical bifacial flake core, No. 88.68.15, brown/green chert, 31.6 x 17.0 x 1.7 cm. Thinning flakes for use as cutting tools or blanks for other tools have been driven straight into the core from the margins. Broken on lower left corner by heavy equipment.

duction occurred over the landscape as sharp cutting edges were needed. Flakes were removed by direct freehand percussion. Larger, earlier-stage (Fig. 2) cores are not symmetrical. Smaller, later-stage cores (Fig. 3) show removal of thinning flakes in a systematic sequence to maintain a symmetrical, leaf-shaped outline. They reflect a growing awareness of the need to develop a core form that ultimately could be worked into a Clovis point.

When a flake blank for any intended use was needed, the core was "set-up" by carefully removing guide flakes by percussion flaking until the surface topography required for successful flake-blank removal was achieved. The platform was carefully isolated by pressure flaking and abrasion to support the intended blow. The flake blank was then detached from the core by direct freehand percussion, possibly with a percussor of resilient material such as antler or hardwood. The large flake blanks most often were characterized by hinge terminations due to the angle of force being loaded almost directly into the lateral margin of the core (striking at an angle of approximately 10 degrees; Fig. 2).

After numerous flake blanks were removed, the bifacial flake core became thin and flat (Fig. 3). However, core margins were still maintained for further reduction, with the ultimate strategy being the production of a Clovis point. Core outline was maintained as bipointed, oval, or leaf-shaped in order to drive flakes into the central core mass and to minimize unwanted outrepassé flake terminations and bending fractures.

The one large, nearly exhausted bifacial flake core (length 31.6 cm.; Fig. 2) recovered from the Anzick site was made of tan to greenish-brown, heat-treated chert. The core had been reduced to approximately a 10:1 width-to-thickness ratio. Flake blank scars exhibited on

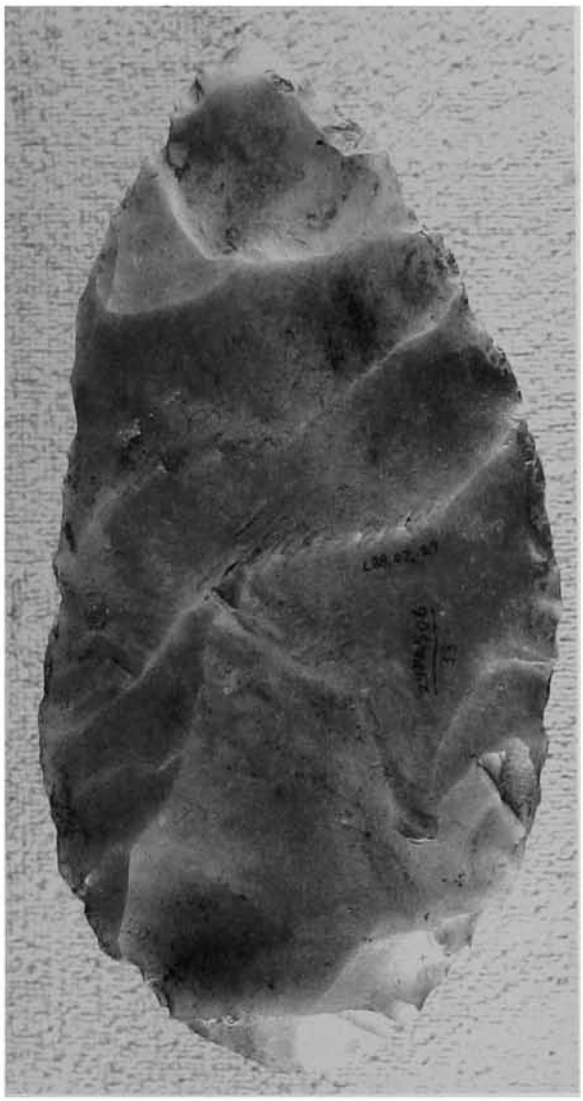

Fig. 3. Smaller, symmetrical bifacial flake core, No. 88. 07.29, white chalcedony, 21.5 x 11.8 x 1.9 cm.

the core are oriented perpendicular to the margins and most have shallow hinge or feather terminations. The margins of the core had been prepared for further reduction prior to deposition at the site. A technologically similar Clovis bifacial flake core was recovered at the Simon site (Butler and Fitzwater 1965).

At approximately a 10:1 width-to-thickness ratio, the thin, large, nearly exhausted bifacial flake cores (Fig. 4) usually broke through perverse fractures into two large fragments. Perverse fractures on such cores initiated at one margin, and the fracture twisted and crossed to the opposite margin at an angle to the direction of applied force. When such fractures occurred to leaf-shaped cores, the resulting fragments could be reworked into two smaller cores, often of the same general form, a process only partially completed on the specimens shown in Figure 4. The breakage, in a sense, rejuvenated the flattened bifacial core. Some of the observed fracture scars on larger bifaces in the Anzick assemblage probably are the result of bending breaks. Squared edges of broken cores, the result of perverse or bending fractures, were returned to bifacial configuration through alternate flaking, or biface-thinning flakes were detached from the opposite margin and intentionally overshot into the squared margin (Fig. 5). This technique is frequently represented in the Simon and Fenn Clovis assemblages. The process of flake blank production continued (Fig. 3) until the bifacial core again broke or became too small to produce effective flake blanks.

As noted above, the broken square margins of bifacial flake cores were reflaked into bifacial edges (Figs. 3, 5). Frequently, however, remnants of the square edges of the broken bifacial cores remain, documenting the breakage of larger cores and the reworking of the fragments into smaller leaf-shaped cores. Square edges on broken cores were reworked into a bifacial configuration only when further flake blanks were needed. This maintenance procedure preserved maximum lithic mass required to create each platform individually and, thereby, ensure successful flake-blank detachment. It ensured maximum core dimensions, especially width, at all times by retaining, as long as possible, any remnant platforms that might be needed for later flake blank detachment. These remnant platforms account for the sinuous margins of bifacial cores and of many Clovis point blanks, discussed below.

Fig. 4. Bifacial flake cores, Nos. 88.07.33 and 88.07.34, brown chert, conjoinably positioned, showing their origin as a result of the breakage of a larger leaf-shaped bifacial flake core. Dimensions 15.0 x 7.7 x 1.2 cm., 17.8 x 11.6 x 1.2 cm.

Fig. 5. Bifacial flake core, No. 88.68.10, brown/purple grainy chert, 18.6 x 13.4 x 1.8 cm., partially configured from a broken giant pot-lid expelled from a larger mass of stone perhaps during heat treatment. The concentric compression rings formed when the pot-lid was expelled are visible at both ends. A large thinning flake was detached from the right margin just above center and overshot into the square broken left margin, partially eliminating the square margin and creating a bifacial one. It established a ridge, equivalent to the upper margin of the flake scar, that would have guided the next overshot flake, had it been removed, to eliminate part or all of the square portion of the break that remains.

Bifacial Clovis Point Blanks

Bifacial blanks (n = 55) in the Anzick cache are percussion-flaked, oval or leaf-shaped pieces. Most appear to have been intended for reduction into Clovis points. They have the overall outline of intended Clovis points, but many of them are much larger, reflecting the size of the core remnants from which they were made. Most have rounded bases and sinuous margins with remnant platforms retained for use in further bifacial reduction.

Clovis point blanks were derived in several ways. Blanks were percussion flaked from exhausted, leaf-shaped, bifacial flake cores and from broken core fragments that could no longer be reworked into functional but smaller bifacial cores (Figs. 6-10). Remaining on one or both lateral margins of 21 specimens are the square remnant margins from breakage of the cores from which they were derived. Other blanks are asymmetrical, with one margin generally rounded and the other generally straight. The straighter margins resulted from partial reworking of straight, square edges on fragments of broken bifacial cores (Fig. 9).

Other bifacial point blanks were made from flake blanks detached from cores. Use of flake blanks is demonstrated by the presence of remnant detachment scars on one surface of each of 20 specimens. Seventeen of the Anzick bifacial blanks were reduced to the extent that their derivation (from flakes or directly from larger bifaces) could not be determined. Fifteen small bifacial blanks, mostly made from linear flakes of white chalcedony, were struck from one or more cores of undetermined configuration, perhaps single-platform cores (Fig. 10, left).

Clovis Point Preforms

Bifacial blanks produced by direct freehand percussion were further reduced by pressure flaking into preforms. Preforms (n = 5) are symmetrical, biconvex in cross section, free of surface irregularities, and partially prepared for channel-flake removal (Fig. 11). Three of the Anzick preforms retain remnant square edges that resulted from perverse or bending fractures of earlier stages. On one of these examples the square edge was partially reduced by removal of diagonal pressure flakes on the base (Fig. 11, left). One preform retains a trace of cortex.

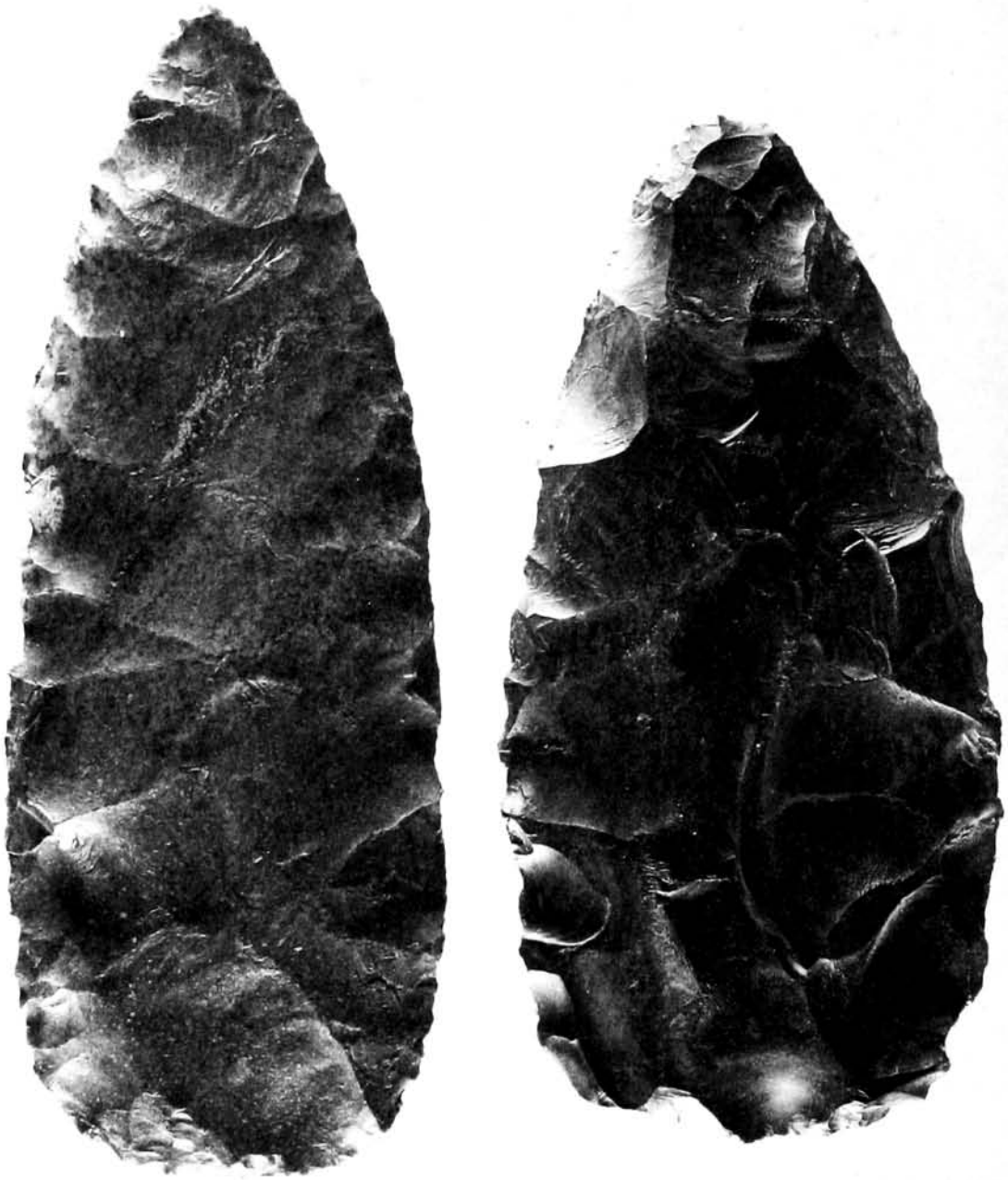

Fig. 6. Clovis point blanks. Left: No. 88.07.05, gray chert, 18.0 x 6.7 x 1.2 cm. Right: No. 88.07.06, tan/red chert, 15.7 x 7.7 x 1.4 cm. Both have small square edge remnants (which are not evident in the photo) along the upper right margins. These indicate that the blanks were made from fragments of larger bifaces.

Fig. 7. Clovis point blank, No. 88.07.03, of banded bluish chert, 19 x 5.5 x 1.2 cm. Note square remnant break on right margin near base.

One Anzick preform had been prepared for channel-flake removal. The proximal end was pressure flaked to bevel the basal margin asymmetrically to one face, isolate the central platform, and alter the proximal preform surface topography to facilitate fluting. The channel flake was not removed.

Clovis Points

Eight mostly complete Clovis points (Figs. 12, 13) are present in the Anzick assemblage. All but one are ground and/or polished on the bases and proximal lateral edges. All had short channel flakes or basal-thinning flakes removed by pressure, and one point was fluted by pressure on one face and by percussion on the other (Fig. 13). Four points (including that shown in Fig. 12, right) were reworked from larger ones, apparently following breakage, and two points exhibit detachment scars (Fig. 13), indicating their origin from flake blanks. The smaller of these was made from a flake, perhaps one detached from a prepared core, and lacks grinding on the base and proximal lateral edges. The other was made from a large percussion flake detached from a core that apparently had been heat-treated. In each case, most of one face is the unaltered detachment scar. The points may have been produced and/or reworked as grave offerings. The point assemblage therefore includes specimens apparently never used but perhaps prepared especially for deposit at the site, as well as those taken from functioning context, including reworked specimens.

Unifaces

Two unifaces are in the collection. Both are made on biface-thinning flakes. One is unifacially worked at one end of the flake. The other is unifacially worked on the dorsal surface all around its perimeter, and is made on a linear flake.

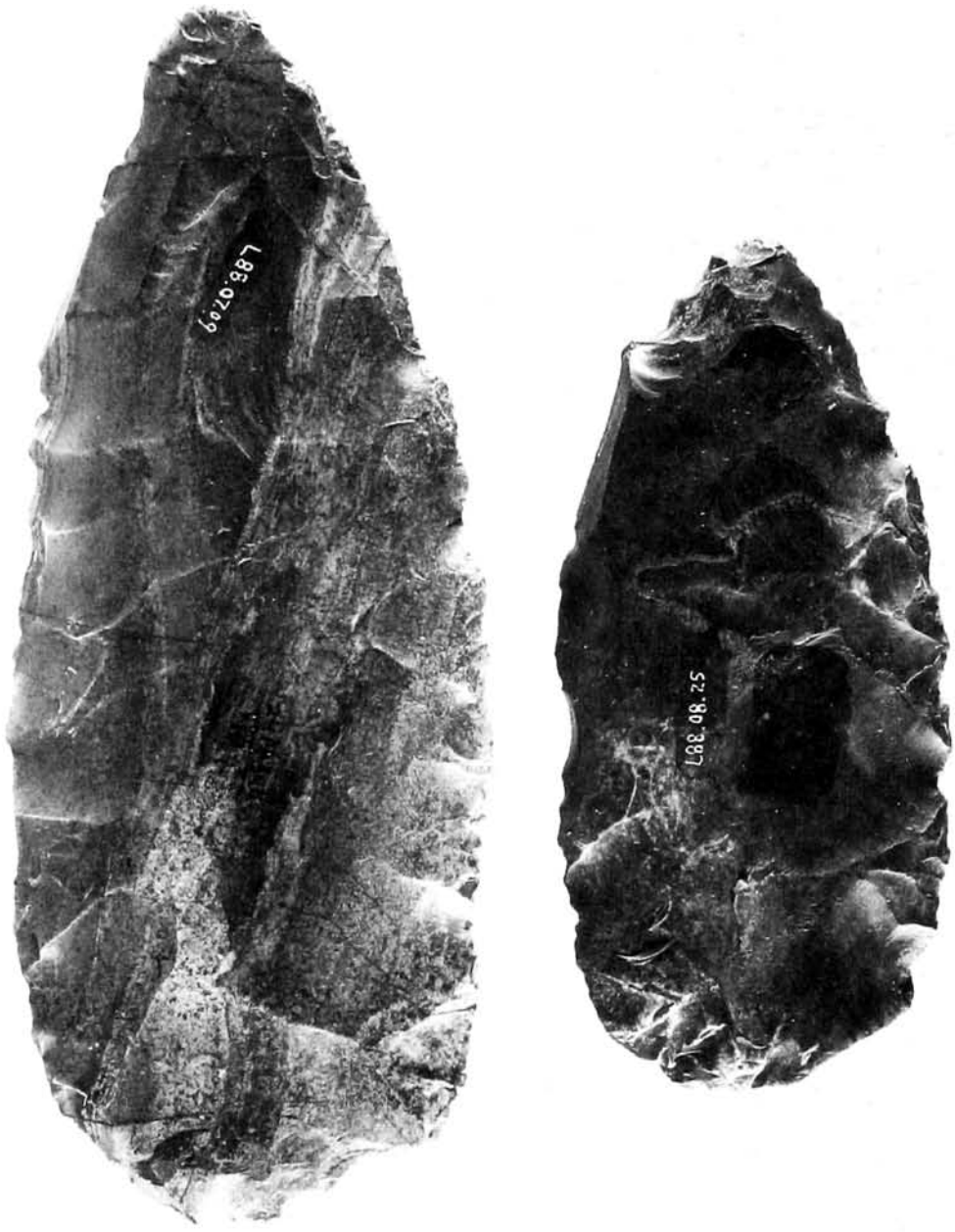

Fig. 8. Clovis point blanks. Left: No. 88.07.09, gray chert, 17.3 x 7.0 x 1.5 cm. Right: No. 88.08.25, purple chert, 12.0 x 5.6 x 0.6 cm. Both have square edge remnants along the upper left margins, showing that they were made from fragments of larger bifaces.

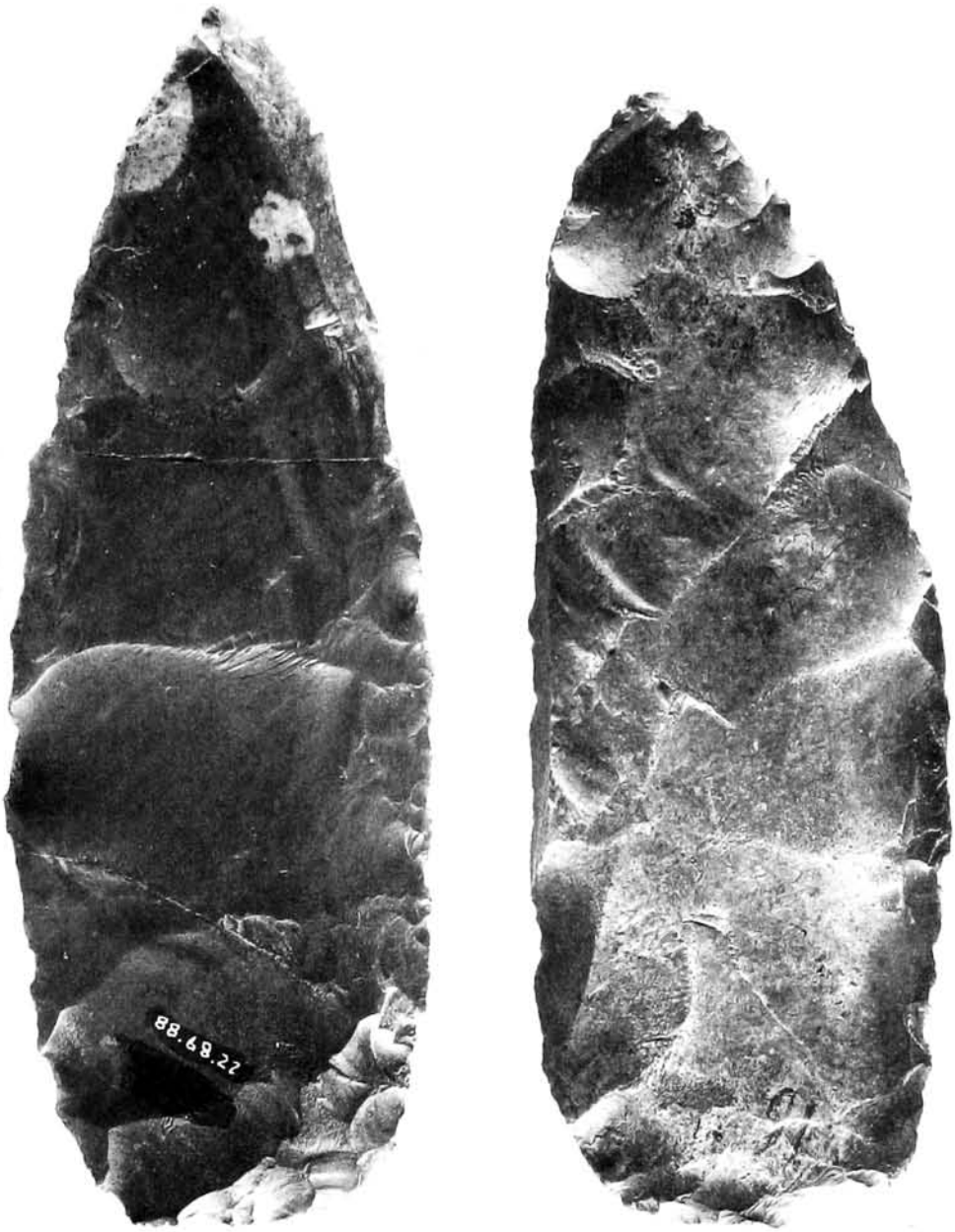

Fig. 9. Clovis point blanks. Left: No. 88.68.22, red/brown chert, 16.5 x 5.5 x 1.9 cm.; beveled edge from earlier-stage overshot termination on upper right margin, square edge (not discernible in photo) representing old break along center of right margin. Right: No. 88.07.02, purple chert, 15.2 x 5.6 x 1.3 cm.; straight, square edge remnant along entire center of left margin indicates reduction from a fragment that resulted from the failure of larger bifacial flake core.

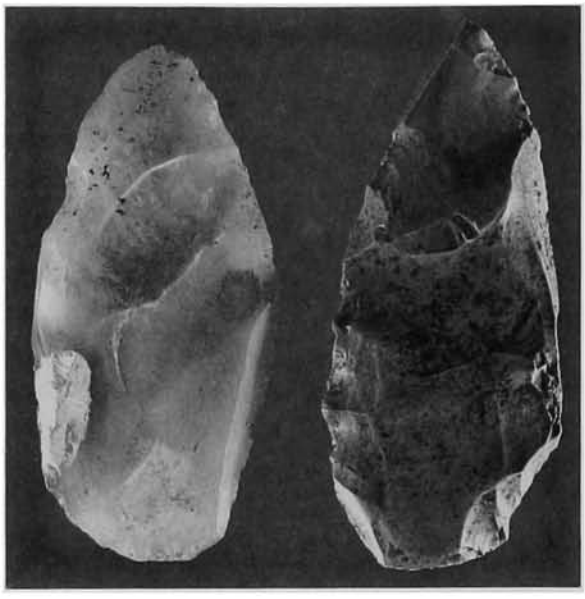

Fig. 10. Bifacial blanks. Left: No. 88.68.05, white chalcedony, 9.8 x 4.6 x 1.0 cm.; made from a flake. Right: No. 88.08.01, gray chert or porcelainite, 10.5 x 4.6 x 1.0 cm.; square edge remnant on upper left margin, large overshot flake scar crosses from center left to right.

Flake Blanks and Debitage

Although most stages of bifacial reduction are represented in the assemblage, there are only two secondary decortication flakes and two flake blanks. The secondary decortication flakes are of blue chert and both have outrepassé terminations. Of the flake blanks, one (Fig. 14) is a large biface-thinning flake of brown chert measuring 17 x 9.6 x 0.9 cm.

Heat Treatment of Raw Material

Most microcrystalline quartzes (flint, chert, jasper, chalcedony) are rendered far more easily flakeable by slowly heating to a temperature of about 165 to 300 degrees C., maintaining that temperature for several hours, and gradually returning it to normal (Crabtree and Butler 1964; Purdy 1974; Collins and Fenwick 1974; Rick and Chappell 1983). Different kinds of stone require heating to different temperatures or durations, and most respond favorably when the proper treatment is applied (Crabtree and Butler 1964). The process is known from very ancient times in the Old World (Collins 1973), and in the New World the waxy texture and luster of flaked-stone artifacts indicate it was known and used by Paleoindian peoples. Experience has shown that heat treatment can be accomplished easily by burying the stone in sand under a campfire that is maintained for a number of hours. The process is more successfully accomplished if the stone is first reduced by percussion to large flakes and trimmed to the configuration of early-stage bifaces to promote even heating throughout and lessen the chance of heat-spalling as a result of differential thermal expansion (Crabtree and Butler 1964).

Inadequately heated stone can be reheated at a higher temperature, often with satisfactory results. Overheated stone is crazed and, therefore, rendered useless for stone tool production. Often flat and circular or oval disks of stone, "pot-lids," are spalled from the surface of the stone during heat treatment due to excessive heating or to the presence of moisture in the stone (Purdy 1975). Some highly siliceous stone, such as certain high-quality flints, can readily be pressure flaked without heat treatment. However, heat treatment is necessary for successful pressure flaking of most microcrystalline quartzes such as those in the Anzick assemblage. Properly heat-treated stone displays improved flaking qualities, and freshly exposed flake scars are more waxy-textured and lustrous than flake scars present before heat treatment occurred (Rick and Chappell 1983). Sometimes color changes occur also, most notably in the case of iron minerals which oxidize to a red color, at least on and near the surface of the stone.

Heat treatment of raw tool stone is evident in the Anzick assemblage by the waxy texture

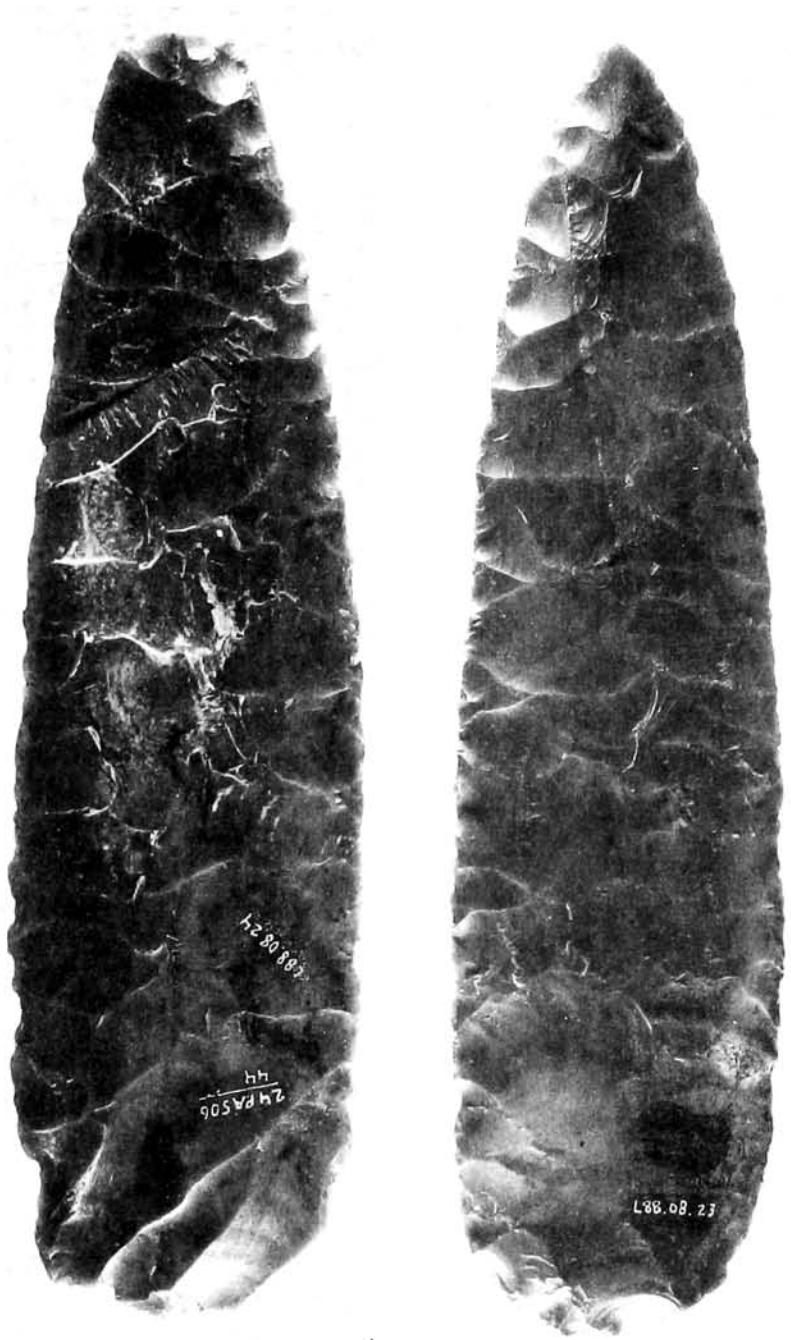

Fig. 11. Clovis point preforms. Left: No. 88.08.24, purple/green chert, 20.5 x 5.6 x 1.2 cm.; square edge remnant at lower right partially reduced by removal of diagonally oriented pressure flake. Right: No. 88.08.23, red/brown chert, 21.1 x 5.5 x 1.2 cm.; square edge remnant at lower right.

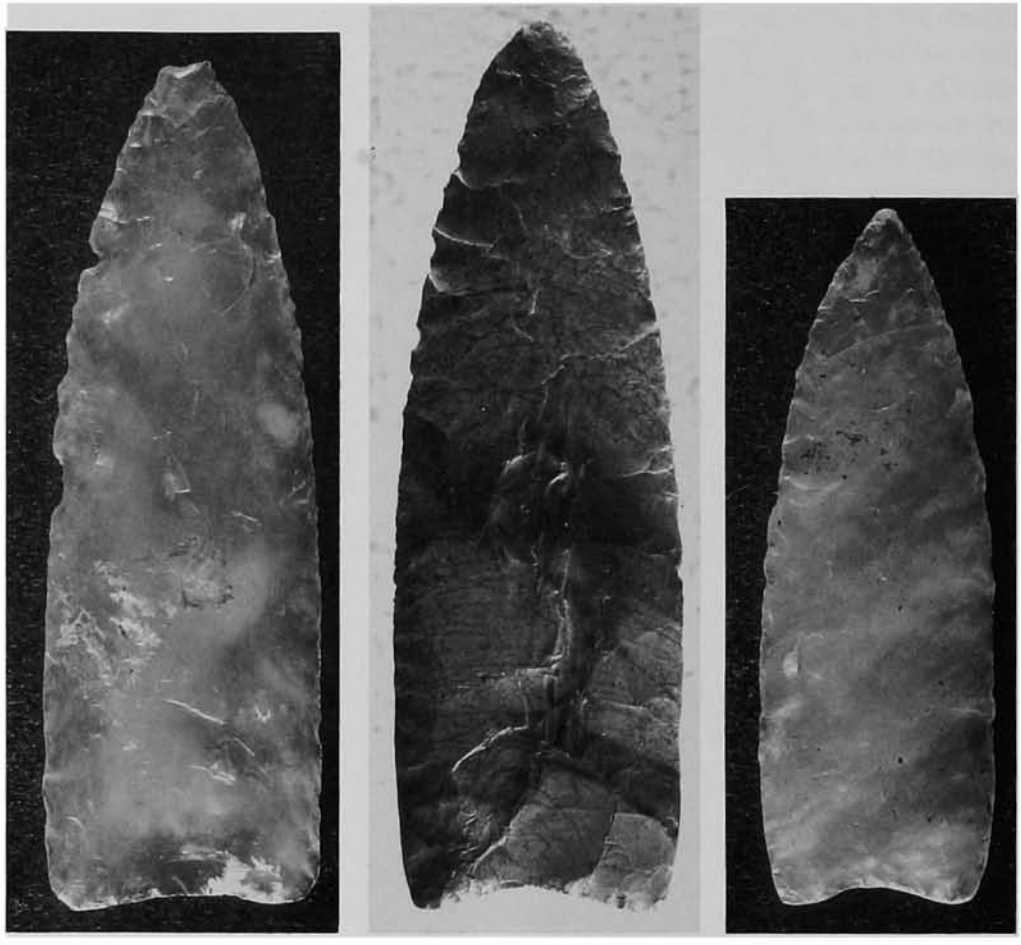

Fig. 12. Clovis points. Left: No. 88.07.30, translucent chalcedony, 9.6 x 3.7 x 0.7 cm. Center: No. 88.08.18, brown/red chert, 11.0 x 3.6 x 0.7 cm. Right: No. 88.08.12, translucent chalcedony, 7.9 x 2.7 x 1.0 cm.; reworked from the tip down most of the way on both margins. All basally thinned/fluted by pressure.

and luster displayed by most of the artifacts. In addition, a bifacial core (Fig. 5) measuring 18.6 x 13.4 x 1.8 cm. is a large modified pot-lid. While such a spall conceivably could have resulted from natural agencies at a chert outcrop, it probably resulted during intentional heat treatment of a large piece of stone by Clovis people. A large bifacial blank measuring 22.4 x 8.8 x 1.5 cm. displays four pot-lid scars, apparently from heat treatment while generally in its present form but slightly larger. Another bifacial blank is made from a pot-lid.

BEVELED BONE OBJECTS

Several complete and fragmentary beveled, rod-like bone objects were found at the Anzick site (Lahren and Bonnichsen 1974). They closely resemble similar objects of bone or ivory recovered from Washington to Florida. An ivory example was found at the Sheaman site, Wyoming (Frison and Craig 1982), and most or all of the reported Florida specimens are of ivory, with mammoth ivory predominating over mastodon ivory (Jenks 1941; Webb et al. 1990).

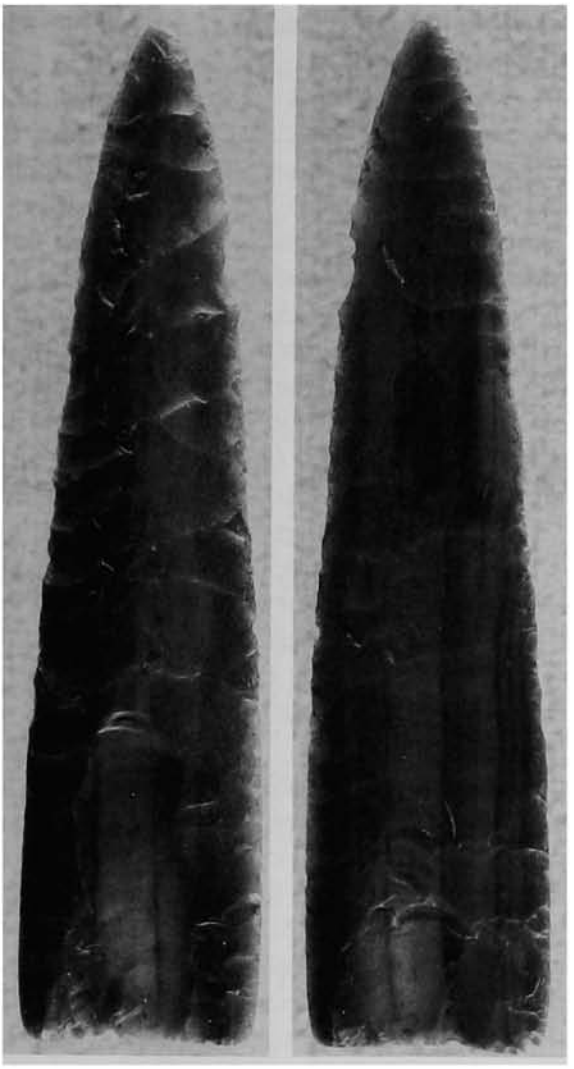

Fig. 13. Clovis point, No. 88.68.20, blue/brown chert, 15.3 x 3.6 x 1.1 cm. Left: the percussion-fluted face usually shown in publications. Right: original detachment scar remains in evidence over much of this flat face; pressure fluted.

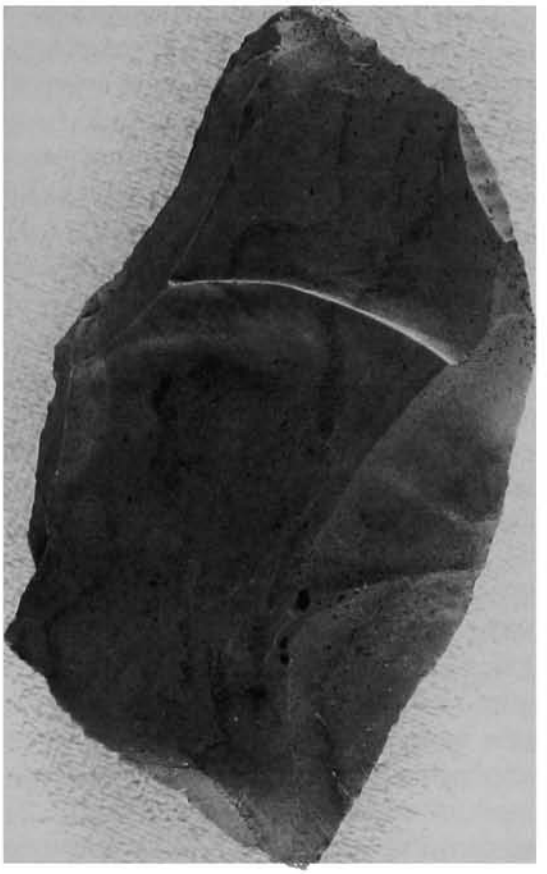

Fig. 14. Flake blank, No. 88.08.03, gold/brown chert with red banding, 17 x 9.6 x 0.9 cm., apparently struck from a large bifacial core.

In the American West, most examples are of compact bone, apparently from the thick limb bones of mammoths.

Whether of bone or ivory, two forms are represented in various collections. Bone examples usually are oval in cross section, and most are highly polished. One form has a single bevel on the same face at each end; the other has a single bevel on one end and is tapered and rounded or pointed at the other end. Among bone specimens, the beveled (ventral) surfaces are somewhat porous and include some cancellous material from the interior of the bone. The bevels on both bone and ivory specimens are scored or crosshatched. Additional scorings or incisings generally appear on dorsal and lateral surfaces at the beveled ends.

The function of Clovis beveled bone and ivory objects has been a source of speculation for more than a half century. Drawing attention to the beveled ends of the specimens, Lahren and Bonnichsen (1974; reflecting earlier suggestions of Cotter [1938:15-16] and Hester [1972: 117]) suggested they were lance foreshafts. According to their interpretation, Clovis points

were attached to the beveled surfaces of the objects, the other ends of which were joined to mainshafts by insertion of the pointed ends into sockets, or by conjoining opposed bevels. Complicated and improbable diagrams of such arrangements were offered, and the notion has gained some acceptance (Haynes 1980:117, 119, 1982:389-390, 1984:565-566; Frison 1982:156-157, 1991:41; Frison and Craig 1982:157, 173; Webb et al. 1990).

Drawing attention to the pointed ends of some specimens, writers have argued that the beveled ends were attached to similarly beveled mainshafts of lances, and served as actual projectile points (Cotter 1938:15-16; Hester 1966: 133, Fig. 4, 1972:117; Haynes 1980:117, 119, 1982:389-390, 1984:565; Frison 1982:156-157, 1983:111, 1991:43; Frison and Craig 1982:157, 173). This interpretation reflects widely held views of the function of bevel-based bone or antler projectile points in the Old World, including the *sagaies à base en biseau simple* of Upper Paleolithic Europe (Smith 1966:251, 331) and certain "arrow points" of Neolithic northeastern Siberia (Okladnikov 1964:138; Fedoseeva 1980; Mochanov 1983:104, 365; Argonov 1990:117; A. Tabarev, personal communication 1990). Haynes (1980:117) commented on the "almost needle sharp tips" on some ivory specimens from underwater sites in the Aucilla and Ichetucknee rivers of Florida, favoring the notion that they were projectile points. The same specimens were claimed by Webb et al. (1990) to be foreshafts. In any case, the "pointed" ends of specimens from across the continent vary widely in the extent to which they are pointed or merely rounded.

Cotter (1938:15-16) also suggested the objects were joined end to end to make lance mainshafts, and Taylor (1969:148) thought they might have been used as fleshing tools. In the absence of published accounts that describe convincing results of experimental replication and use of Clovis beveled bone and ivory artifacts, all these ideas must be regarded as highly speculative.

Among the Anzick specimens, one reconstructed example, which we have not seen, is beveled on both ends and is complete (Lahren and Bonnichsen 1974). Another specimen reconstructed from fragments is beveled on one end and roughly tapered to a rounded point on the other end (Figs. 15, 16). There also are four beveled end fragments (Fig. 17) and one mid section in the Montana Historical Society collection, and additional specimens, now unaccounted for, were reported by Lahren and Bonnichsen (1974:Table 1). The reconstructed specimen shown in Figures 15 and 16 is worn and damaged at the beveled end. Traces of what appears to be some type of pitch remain in the crosshatched incised lines on the beveled surface. The tapered end is weakly faceted. Other fragmentary examples (Fig. 17) show little evidence of wear.

Functions previously suggested for Clovis beveled bone and ivory artifacts are not convincing. As foreshafts, experiments have shown that it is impossible to align a Clovis point on the beveled end so that it is parallel to the weapon shaft. As composite spear shafts, they seem to be too fragile and too difficult to construct, given that other materials were available. As cylindrical projectile points, they would pierce but would cause little hemorrhaging. As fleshing tools, they lack the serrated spatulate edge seen on ethnographic and archaeological specimens.

The examination of the Anzick collection, evaluation of Clovis literature, and extensive experimentation with replicated tools led to the conclusion that these objects are parts of composite tools. They represent a type of hand-held tool that once had an additional part attached to the beveled end with pitch and sinew. Such an implement would be a pressure flaker, with an antler bit bound to the beveled end or ends of a bone or ivory handle. Overall similarity to ab-

Fig. 15. Beveled bone object, No. 88.08.10, apparently of mammoth (*Mammuthus*) bone, 22.8 x 1.5 x 1.3 cm., dorsal (left) and ventral (right) views.

original pressure flakers[3] led to replicative studies that support this interpretation.

Handles of composite pressure flakers were replicated from both bone and ivory. A femur of Asian elephant (*Elephas maximus indicus*) provided bone thick enough for the specimen shown in Figure 15. Similar examples were made of walrus (*Odobenus rosmarus*) tusk. Bits for pressure flakers were made of moose (*Alces alces*) and caribou (*Rangifer tarandus*) antler, flattened and scored on one side, and attached to the beveled ends of the handles with pitch and sinew. It was found that pitch was necessary to keep the bit from slipping on the bevel, and incisions on the lateral and dorsal surfaces of the beveled ends of the handles were necessary to keep the sinew from slipping toward the end.

A replicated pressure flaker (Figs. 18, 19) was used to produce Clovis points (Fig. 20) from percussion-flaked bifacial blanks of heat-treated opalite from Tosawihi, Nevada. The blunt antler bit removed large pressure flakes with diffuse bulbs of force from the preforms. Margins were beveled with the pressure flaker, and little grinding of platforms was required. The flake scars match closely those on archaeologically recovered Clovis points.

For added leverage, the tapered end of the pressure flaker can be inserted into the socketed end of an extension made of a branch with a pithy center (such as elderberry [*Sambucus* sp.]), or a length of bone or antler. Handles beveled on both ends can be fitted with antler pressure-flaking bits at either end, a smaller bit for preparing platforms, and a larger one for detaching large pressure flakes.

The efficiency of the replicated pressure flakers and the ease with which they are used are impressive. The handles can be refitted with bits and used indefinitely. The bits, which wear down in use, must periodically be extended beyond the handle and refitted, or wear results distally on the beveled end of the handle

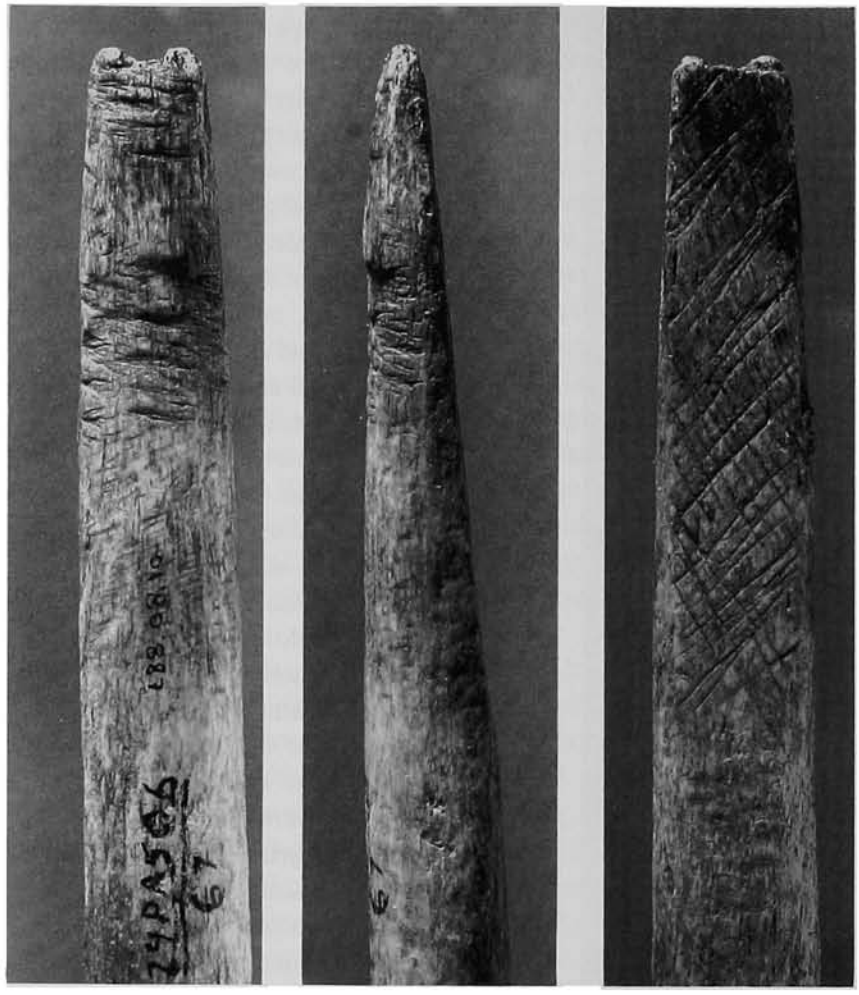

Fig. 16. Beveled bone object, No. 88.08.10. Dorsal, lateral, and ventral views. Note cross-hatched incised lines and apparent damage to the end. Compare with Figure 15. The specimen gives the appearance of having seen hard use.

(Fig. 19). Aboriginal pressure flakers referenced above have similarly refittable bits. Wear suggestive of failure to reposition a worn bit in a timely manner appears at the distal end of the bevel of the Anzick specimen shown in Figures 15 and 16. This wear is strong support for our interpretation that Clovis beveled bone and ivory objects are handles of pressure flakers.

It should be noted that the bits used with the pressure flakers have never been found in association with the beveled artifacts. We believe antler is far less likely to survive in archaeological contexts than either bone or ivory. Only the handles would become polished during prolonged use. Based on the frequent recovery of highly polished bone awls and other objects of bone, it appears that polish promotes preservation of bone, as do the fats and oils that abound in fresh bone. Handling over a long period of time would impart additional oils to the bone. Ivory is the dentine of tusks, which are teeth, the hardest and ordinarily the most resistant matter produced by mammalian bodies (Goodyear 1971:148). Thus, under equal conditions,

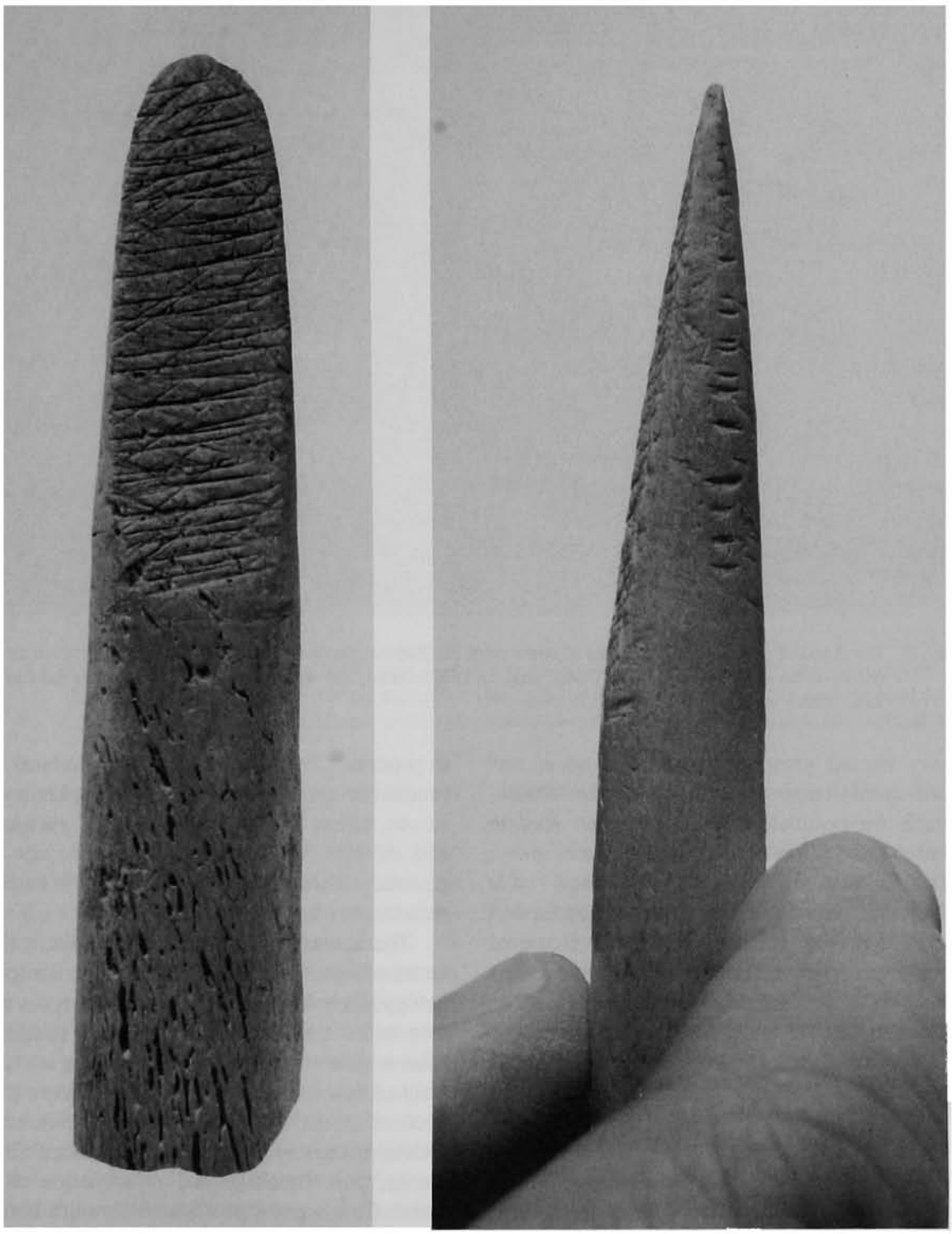

Fig. 17. Beveled end of fragmentary bone object, No. 88.68.13, maximum diameters 1.2 and 1.3 cm., ventral and lateral views. The specimen gives the appearance of having seen little or no use.

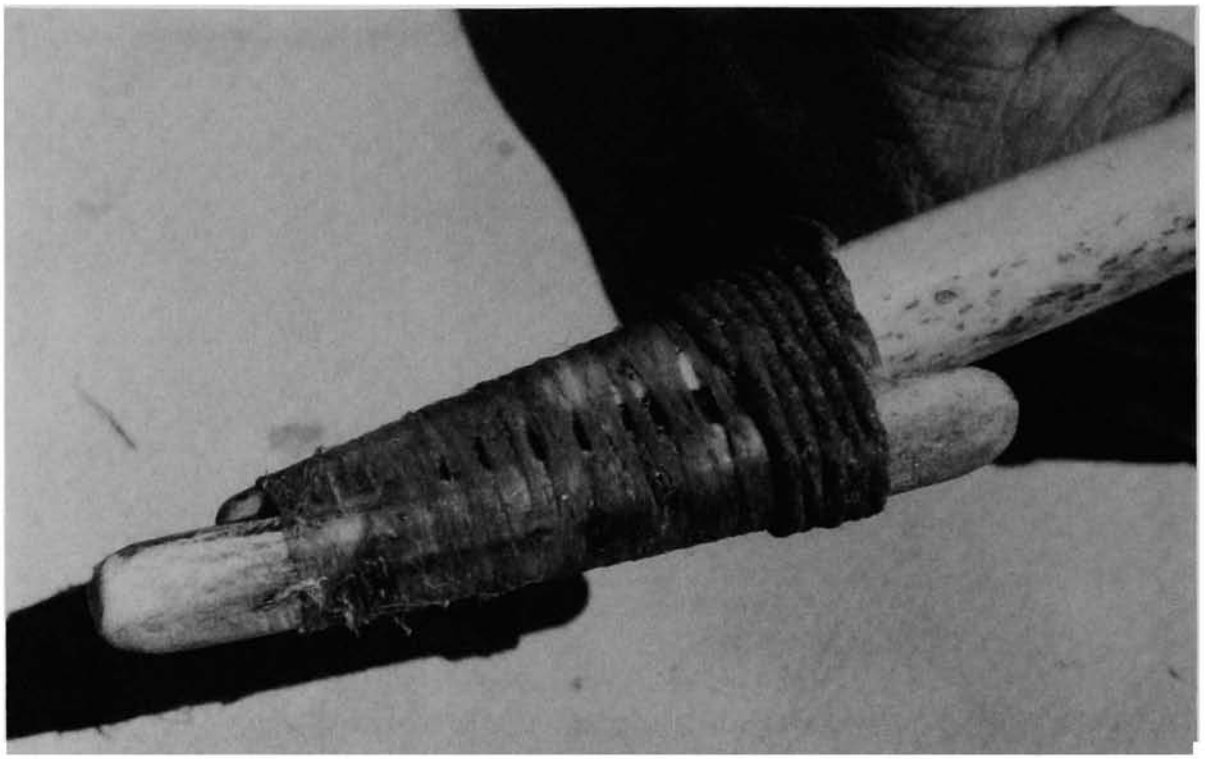

Fig. 18. Distal end of pressure flaker, handle of Asian elephant (*Elephas maximus indicus*) femur, bit made from moose (*Alces alces*) antler, attached with mastic made of conifer resin, and with sinew. Used to pressure flake replicated Clovis points.

ivory should preserve better than bone, and bone should preserve better than antler. Sinew, which we postulate would have been used to bind the antler bits to handles of bone or ivory, is a soft protein very susceptible to decay. It is likely that under most conditions the antler bits would have become weathered and separated from the handles in antiquity. They are also less likely to be recognized archaeologically. The failure to recover antler bits in association with the beveled objects is therefore not unexpected.

TECHNOLOGICAL SIGNIFICANCE OF THE ANZICK ASSEMBLAGE

The assemblage includes all the reduction stages of Clovis lithic technology from large cores of prepared tool stone to finished Clovis points. Also present are beveled bone objects here interpreted as parts of pressure flakers used to produce Clovis points. Other postulated essential parts of the tool kit, including hammerstones, billets of antler or hardwood, abraders, and the bits of pressure flakers were not recovered. They may or may not have been represented at the site.

The assemblage contains clear information on most aspects of Clovis lithic reduction technology, including the following: stone types and sources known to Clovis people that inhabited what is now southwestern Montana; heat treatment of raw tool stone; bifacial flake core production; reduction of flake cores of bifacial and undetermined configurations to produce flake blanks; core breakage and rejuvenation strategies; Clovis point production through blank, preform, fluting, and rejuvenation stages; and the apparent design of composite pressure-flaking tools. Each stage of the reduction sequence

Fig. 19. Pressure flaker shown in Figure 18 being used to prepare the base of a replicated Clovis point preform for fluting. Note the place where damage will occur to the handle if the bit is not repositioned when it wears down. Compare with the location of damage seen on the beveled end of specimen No. 88.08.10 shown in Figures 15 and 16.

is represented by at least one specimen, and most are represented by several.

Information on the strategy of the lithic reduction sequence from bifacial cores through finished Clovis points is easily discerned from the flake scars on the individual pieces. A large, leaf-shaped bifacial core was broken in the course of removing a thinning-flake blank (Fig. 4). The fragments are still conjoinable. The larger piece was partially reworked to eliminate the squared break and re-create a leaf-shaped outline characteristic of such cores, which were intended for ultimate reduction into Clovis points. Lateral margins and square remnant breaks on the rejuvenated core fragments clearly indicate the way anticipated fractures were used to advantage by Clovis flintknappers to salvage broken cores and continue the reduction strategy toward completed Clovis points.

Closely related to the above are a number of Clovis point blanks that are asymmetrical in that one lateral margin is rounded and the other generally straight. Some of these straighter margins have remnant square areas representing earlier breaks. These two lines of evidence (lateral asymmetry and the presence of square edge remnants) document the lateral cycling (Schiffer 1972) of Clovis point blanks from broken bifacial flake cores (Fig. 21). These straighter margins and the square remnant breaks on them would have been eliminated by additional flaking. Such work would have destroyed all the critical information on recovery of Clovis point blanks from broken cores. Instead, the bifacial blanks were placed in the

Fig. 20. Clovis point replica (Tosawihi opalite, Nevada). The pressure flaking was accomplished entirely with the replicated implement shown in Figures 18 and 19. Note the size of the pressure-flake scars and compare with Figure 13, left. The channel flake was removed by percussion with a hammerstone.

cache, with considerable technological information discernible on them. The same pattern is represented in the Wenatchee and Fenn caches.

A large pot-lid measuring 18.6 cm. in maximum dimension was salvaged as a bifacial flake core, since the rather grainy material was not ruined during heating (Fig. 5). Whether or not the piece was unintentionally spalled from a larger mass undergoing heat treatment cannot be determined, but it may well have been so produced. The pot-lid had a square, broken edge along its long axis. As shown in Figure 5, this square margin was partially eliminated by a flake removal initiated from the opposite margin and terminated as an overshot into the square break. Flakes follow ridges, and the upper edge

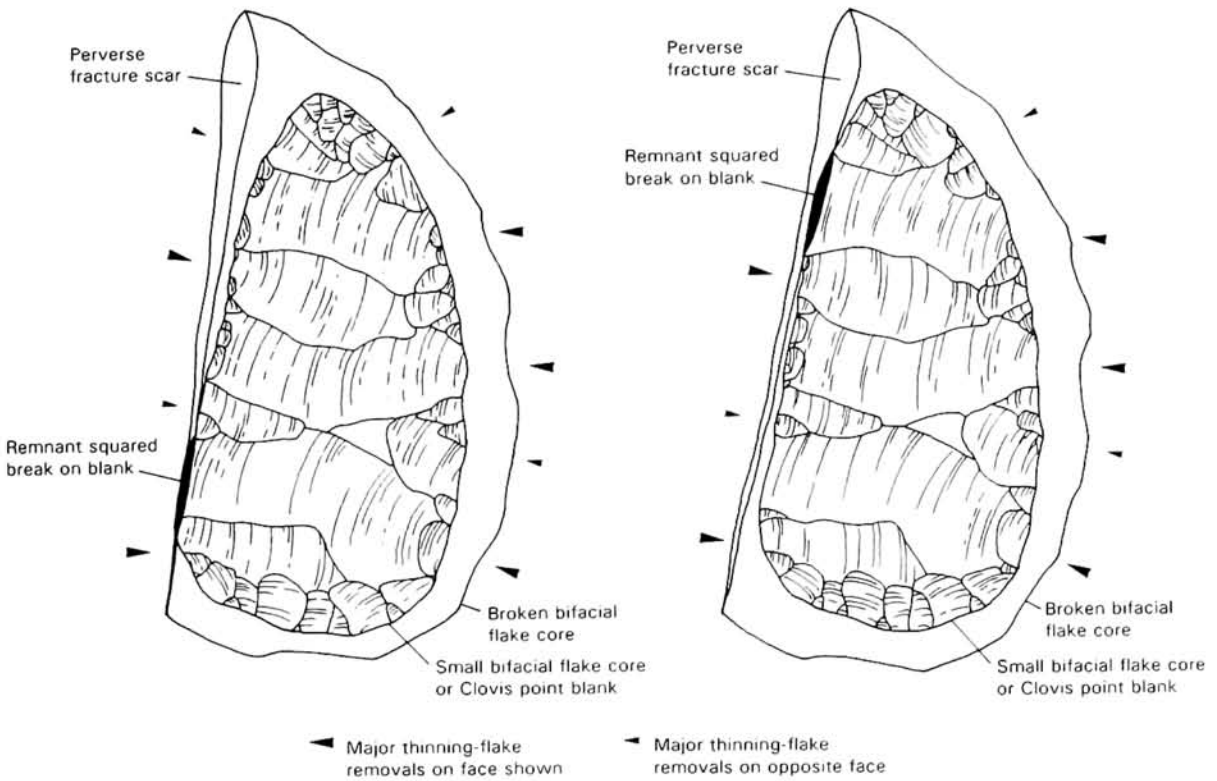

Fig. 21. Recovery of smaller cores or bifacial blanks from larger cores broken by perverse fracture during flake-blank removal. Recovery of smaller cores or blanks from fragments of large bifacial flake cores broken by bending fracture (endshock) would yield essentially similar results, although the remnant squared break would sometimes occur on the base of the blank. The drawings graphically show the origin of the remnant squared edges and overall straighter margin near the old break, as seen on many of the Anzick Clovis point blanks and preforms.

of the scar (Fig. 5) created by this overshot flake forms a ridge perfectly aligned to permit a similarly executed overshot flake to remove the remaining square margin.

Further evidence of heat treatment of raw material is seen on one Clovis point blank. This specimen has two large pot-lid scars on each face. Part of one of these pot-lid scars has been eliminated by subsequent percussion flaking, indicating that the piece was slightly larger when heat-treated.

Forty-two bifaces retain remnant square margins resulting from earlier breakage of larger bifaces. These remnants usually occur near one end, most often near the distal or narrow end, but a few remain midway along the margin or near the proximal or wide end (Figs. 4, 7, 8, 9, 10). Further percussion flaking to remove remnant square margins near the ends of the bifaces was avoided because of the risk of breaking the piece through endshock. Instead, the square remnant breaks were left for removal by alternate pressure flaking (Fig. 11, left). One Clovis point preform was pressure flaked to near final form but was not fluted. The base was beveled to create a platform for detachment of one of the channel flakes. Several Clovis points were rejuvenated from broken specimens.

DISCUSSION

Both in terms of material remains and in terms of the information it contains, the Anzick assemblage is a time-capsule of information on Clovis technology that has never been reported

previously. The lithic assemblage represents a substantial amount of high-quality, heat-treated, microcrystalline tool stone of diverse lithologies that was permanently "taken out of circulation"[4] and placed in an apparent burial context. The amount of tool stone deposited at the site suggests that Clovis people must have moved over the landscape carrying large amounts of tool stone with them. This would be expected if Clovis people represent the earliest colonizers of the New World, and if they were nomadic hunters and gatherers with no knowledge of tool stone sources in yet-unexplored regions that lay ahead of them.

Several problems remain. The beveled bone artifacts are all broken, and some of the breaks appear to be ancient. Whether they were broken intentionally at the time of deposition, broken during the millennia while in archaeological context (perhaps as a result of collapse of the overhead rock formation), or broken by heavy equipment when exposed cannot be determined. If they are claimed to have been broken intentionally ("ceremonial breakage" [Lahren and Bonnichsen 1974:148]), why were not the many stone artifacts also broken? Similar bone and ivory artifacts were recovered essentially intact at other sites across the continent.

Clovis points occur in a wide range of sizes. Although one of the finished Clovis points from the Anzick site is 15.3 cm. long, most are "normal-sized" points of sizes commonly found in mammoth kill sites, and some show evidence of reworking, indicating that they were once larger and taken from functioning context and deposited at the site. Some of the Clovis point preforms are very large, examples being 21.2, 21.1, and 20.5 cm. long. Large and apparently functional Clovis points occur in the Drake (Stanford and Jodry 1988) and Simon (Butler 1963; Woods and Titmus 1985) assemblages, although these collections also include smaller points. For comparison, Clovis points in the Wenatchee assemblage are huge, and others from Lehner, Arizona (Haury et al. 1959), are tiny by comparison. This suggests the possibility that ritual objects, made large and impressive for some special contexts, are indicated in some of these Clovis assemblages. Another possibility is that some Clovis peoples made projectile points large with the intention that they be reworked following breakage. Whatever the case, many of the blanks and half of the preforms in the Anzick assemblage are large when compared to most Clovis points recovered archaeologically in the American West.

Our analysis shows that a systemic, technological approach to studying Clovis assemblages such as Anzick, Simon, Wenatchee, and Fenn leads to a better understanding of the flaked-stone technology of the first Americans. These assemblages came from widely separated sites in the northern Rocky Mountains and the Pacific Northwest. Yet the overall pattern is strikingly similar, as indicated by the following: (1) the diversity of high-quality lithic materials represented; (2) the presence of staged reduction products from large bifacial flake cores to bifacial tool blanks, preforms, completed Clovis points, and reworked points (Fig. 22); (3) the strategies employed in biface reduction, including recovery of oval or leaf-shaped bifacial forms from broken cores with a minimum number of flake detachments and a minimum loss of useful stone; (4) the detachment by percussion of thinning flakes from one margin of a biface and stopping them at the other margin with maximum efficiency and minimum loss of material or symmetry through overshot; and (5) the careful maintenance of cores and blanks, detaching flakes to restore symmetry only when needed to facilitate flake blank removal or to shift to Clovis point production trajectory.

All of this suggests that as Clovis people moved over what is now the northwestern part of the United States, they manipulated tool stone within the same tightly integrated technology, perhaps with little knowledge of when and

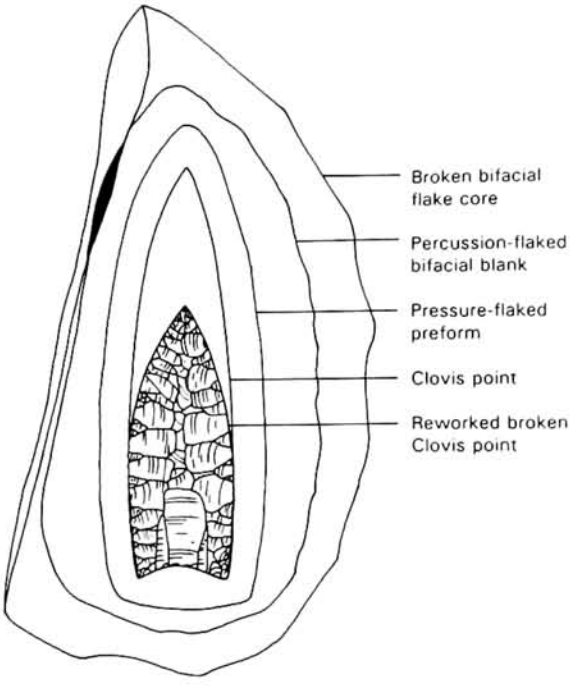

Fig. 22. Reduction of broken core fragments through blank, preform, completed Clovis point, and reworked Clovis point stages.

where supplies of raw material could be replenished. The similarities seen in these widely separated assemblages suggest that the people responsible for the industry were in fact the first Americans whose cultural adaptations and technological traditions had not yet diversified.

What cultural factors account for deposition of assemblages such as Anzick, Simon, Fenn, and Wenatchee in the archaeological record? Several possibilities are apparent. First, the assemblages may simply be caches of tools and tool stone that represent the normal equipment of Clovis peoples. Raymond's (1990) functional interpretation of the late prehistoric Nicholarsen Cache from Winnemucca Lake, Nevada (Hester 1974), may provide a model. Among other things, that cache included a skin pouch containing a large number of arrow or dart point blanks or preforms, and completed points, a sort of working tool kit. Raymond suggested that as completed points were taken out of the kit and used, they were replaced by working a few blanks or preforms into completed points. Completed tools were always in the kit ready for use, new material was constantly added to the kit as needed or as available, and pieces of stone were constantly being modified as they moved through the various intermediate stages represented in the technology. Ultimately, each object was used up or worn out, and was discarded on the landscape. Nevertheless, the functioning kit was ever-changing in terms of the inventory of objects it contained and the lithic material represented, and it was constantly replenished and maintained in a sort of equilibrium between the various staged items.

We can envision a similar interpretation for the Anzick assemblage and the other related examples discussed here. The attraction of this interpretation is that one would expect that flake cores would constantly be added to the assemblage and undergo reduction as cutting tools and flake blanks were needed. Projectile points would be taken out as needed, and there might be a large number of blanks and preforms in the kit at all times. More than two-thirds of the analyzed specimens in the Anzick assemblage are Clovis point blanks and preforms. A number of blanks or preforms of a given material would indicate acquisition of that material through quarrying or barter, and replenishing the tool kit with it on some previous occasion.

Another possibility is that assemblages such as Anzick are grave accompaniments of tool stone and tools placed with the deceased to materially equip them in the afterlife. The comments made in the previous paragraph regarding functioning tool kits would apply here also, the only difference being that the assemblage was never intended to be retrieved by the persons that supplied it; it was intended for use by the deceased in the afterlife.

Closely related is another possibility, namely that while assemblages such as Anzick

may be burial accompaniments consisting of Clovis tool kits, they also embody all of the necessary *information* needed for an effective lithic technological system in the afterlife. We have presented our interpretation of the technology represented by the assemblage. The technological information inherent in the physical attributes of the assemblage may have constituted a sort of "teaching kit" for the use of individuals in the afterlife. If that interpretation has merit, perhaps this study has also helped to elucidate some aspects of Clovis intellect.

Admittedly, these ideas are difficult or impossible to test, given the limits of theoretical approaches and the lack of contextual information on all known Clovis cache assemblages. An awareness of some of the possible behavioral contexts responsible for the deposition of these assemblages should, however, lead to more sophisticated interpretations should additional caches ever be carefully and completely excavated under controlled conditions.

NOTES

1. We were unable to examine the specimens obtained at the Anzick site by the University of Montana. These were lent to the National Museum of Natural History/National Museum of Man, Smithsonian Institution, Washington, DC, for casting. Although many years have passed, the specimens were never returned to Montana (D. C. Taylor, personal communication 1989).

A cast was made of one of the beveled bone tools from the Anzick site by the National Museum of Natural History/National Museum of Man. It was lent to the Center for the Study of the First Americans, University of Maine, Orono, and our request to borrow it went unanswered. The whereabouts of the original of this specimen, which is beveled on both ends, is unknown. It was illustrated by Lahren and Bonnichsen (1974:Fig. 1d-f), and either it or a cast of it was illustrated by Canby (1979:349). Our study would have been more thorough had we been able to examine these additional 20 specimens. However, given the numbers of specimens we were able to study, we believe our interpretations were not substantially compromised by these problems.

Finally, a large collection of ivory beveled tools, perhaps of Clovis affiliation, has been recovered from underwater sites in Florida. At least some of them apparently are of the same type as those from the Anzick site (Jenks 1941). Many of these objects are housed at the Florida Museum of Natural History, University of Florida, Gainesville, and 60 specimens were reported by Webb et al. (1990). Our requests to examine these specimens or merely to obtain xerox illustrations of them to learn how pointed they are were denied. Lack of publication, combined with information control, has profoundly hindered Paleoindian studies in the United States.

2. Technical terminology used here generally follows Crabtree (1982).

3. Ethnographic composite pressure flakers from the western United States are described and illustrated by Murdoch (1892:287-289), Goddard (1903:34, Pl. 12, Fig. 3), Dixon (1905:134), Pope (1918:116, Pl. 27, Fig. 1), and Holmes (1919:304-329). An archaeological specimen was described by Hester (1974:10, Fig. 6c), and Muto et al. (1976: 273-274) provided a reconstruction of an archaeological example based on recovery from a burial context of a bone (or antler?) bit with minute obsidian flakes embedded in it.

4. We are indebted to George Frison for articulating this concept.

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examine some of the specimens. Andrew Tabarev, Heidi Knecht, and Leslie Quintero supplied research material. Walrus ivory and elephant bone were made available to the University of California for replicative experiments by Dennis Crouch, U.S. Fish and Wildlife Service, and Julie Medlock, Zoological Society of San Diego, respectively. Martin Wilke was instrumental in our obtaining raw materials for replicative experiments. Robert Hicks prepared the photographs from our negatives. Alan Beals and Sylvia Broadbent offered useful suggestions and comments. The ideas reported here were initially presented in 1990 at the annual meeting of the Northwest Anthropological Conference, Eugene (Wilke et al. 1990), with the support of a Travel to Meetings grant from the Academic Senate of the University of California, Riverside. This research was partially supported by an Intramural Research Travel grant from the Academic Senate of the University of California, Riverside, to the senior author.

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