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# Bedrock Holes

## Introduction

Holes in (typically) horizontal exposures of bedrock occur across the Southwestern United States from the Rocky Mountains to California. They are often interpreted as bedrock mortars, used with a stone or wood pestle to shell or crush acorns (d'Azevedo 1986:474-5), mesquite beans, or seeds. Bedrock holes for the Kawaiisu of California are described as reaching a size of "…10 inches deep and more than six inches across the top" (Zigmund 1986:408). Zigmund believes these holes were formed by pestle use, and abandoned when they grew too deep. It is unclear whether Zigmund's reference to house rings includes bedrock hole construction. Donna L. Arndt excavated a series of these holes at Arrowhead point in northeastern Utah (Breternitz 1970:118-123), inferring they were used as postholes for house construction, as mortars, and as a hearth. These holes are variously described as "dug" or "drilled" into bedrock. Arndt suggests the holes were dug through overlying soil then on into bedrock. Many of the holes were filled with ash or with adobe. An exposed bedrock mortar at an additional site (Breternitz 1970:77-8), is described as having a top diameter of 52 centimeters (cm), a base diameter of 30 cm, and a depth of 33 cm. Other suggested/inferred uses of bedrock or other holes in American prehistory include water storage, dry storage, firepit or hearth, symbolism or ceremony (sipapus), root baking, platforms for various purposes, "soupholes" or "corn mills" (DeVed and DeVed 1996:71-92), and more recently, astronomic observatories. Whatever their purposes, the effort required to construct bedrock holes implies either long term use or the expectation of long term reuse.

Studies in the Uinta Fremont area (except DeVed and DeVed 1996) treat bedrock holes as a peripheral issue. Rather than seek patterning to the morphology, placement, or distribution of bedrock holes as an archaeological feature, reports simply explain the presence and position of any bedrock holes in terms of inferred site use. The holes are routinely treated as incidental site feature, rather than as a subject for analysis. However, within any category of archaeological artifact or feature it is the presence of patterned variability that allows construction of hypotheses, or their testing. In other words, past studies tend to treat bedrock holes as the unintentional results of a site activity such as seed grinding, or as an occasional phenomenon, technologically very simple, morphologically randomly variable, instead of seeking patterns leading to testable hypotheses. Several Uinta Basin sites have apparent similarities of bedrock hole placement, diameter, shape and depth within and between sites, and considerable precision of shape and size, suggesting bedrock hole construction as technology should be examined further.

## Methodology

This study examines 104 bedrock holes at five sites in and around Dinosaur National Monument: 42UN1581, 42UN2007, 42UN87 (divided here into upper site and lower site elements by the suffix "U" or "L"), and a pillar with four bedrock holes on top located at the Cub Creek petroglyph site. The top of the Cub Creek pillar is inaccessible without equipment, although it can be observed closely from ledges immediately above. At the Cub Creek pillar, I was thus able only to take rough azimuths and note that visually hole diameter, shape, and depth appeared to approximate average measurements for simple holes (discussed below) in the 11-16 centimeter (cm) range. Therefore, Cub Creek pillar hole diameter, depth, azimuth, distance between holes are not included in the quantitative analysis, but the pattern of hole placement, and my estimate that these inaccessible holes are morphologically simple and fall within a certain size range, are used in the discussion. Information on 42UN66 and several other buried sites where bedrock holes are present (Breternitz 1970:118-123), and will be included in the discussion. Artifacts and locations suggest all these sites were used by the Uinta Fremont.

Holes on exposed bedrock locally are today empty of contents, or contain varying degrees of sterile, windblown fill depending on the time of year, wind, precipitation, and recent recreational visitation. In several cases where sites were revisited, individual holes were empty where they had previously contained fill, or contained more or less fill than previously noted. Although it is thus doubtful that holes on exposed surfaces today contain undisturbed deposits, the contents still should not be removed except under controlled conditions.

Since I had no excavation permit, hole morphology and depth measurements were obtained by gently inserting a thin stainless steel rod (ca. 1/8" diameter) into the fill. Diameter of the top of the hole was measured in two places, selecting the extremes in the case of eccentric holes. I plotted hole position with a compass and a tape measure, without elevation control; all measurements and azimuths are approximate. No effort was made to locate holes that might lie beneath soils adjacent to or overlying exposed bedrock, so patterns of hole placement for 42UN87U are assumed to be incomplete. Data gathered were: hole shape (morphology), maximum-minimum top hole diameter (or width), maximum-minimum hole depth, distance to next or center hole, and azimuth to next or center hole.

Additional data: site distance to water, exposure, elevation, occurrence of manos, bedrock metates, tertiary flakes, and rock art. During this phase, apparent patterns in hole shape, depth, arrangement and diameter suggested hypotheses on bedrock hole technology and hole use, some of which are discussed below.

The data were first used to draw rough site sketches, which revealed some repetitious patterns of both hole placement and hole morphology within and across sites. I inferred possible purposes for many holes based on hole placement patterns and variations in hole morphology and size. Purposes inferred from multiple hole patterns include activity areas with cooking facilities, enclosure, storage or other closed structure, ramada or other open structure. Purposes inferred from variation in hole diameter and depth include post holes, corner posts, roof supports, wall supports, racks, and areas for specific seasonal activities. Data were plotted in several ways suggested by hole formal patterns apparent in the raw data, or by inferred purpose of multiple hole patterns. One inference regarding a recurrent hole placement pattern: that of a relatively large central hole with closely outlying small shallow holes, was tested experimentally.

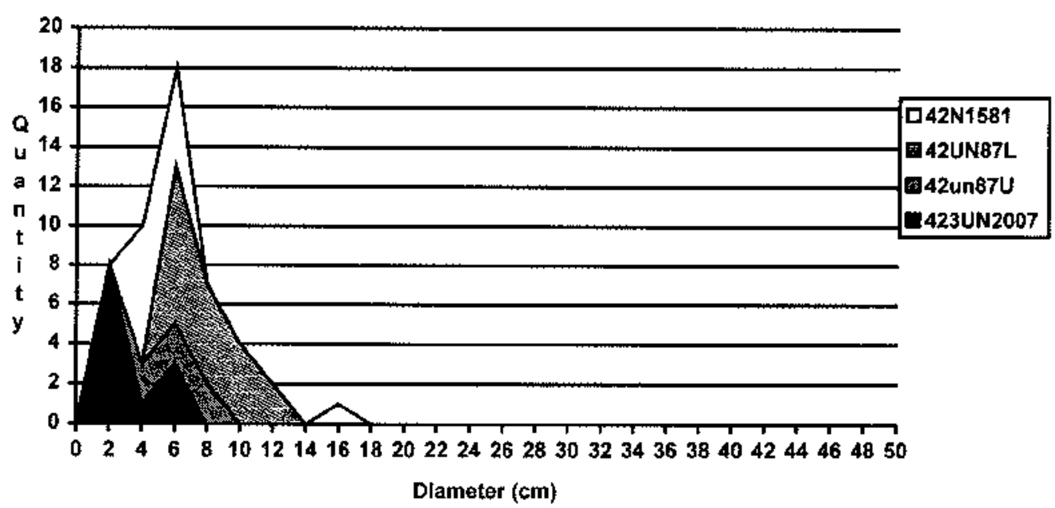
## Discussion

At the sites examined, bedrock holes typically take three forms as shown in profile below: the dimple, the simple hole, and the double hole. The dimple and the simple hole are common, indeed ubiquitous, while the double hole appears at two of the four sites examined. There are of course exceptions to these typical shapes. The double hole morphology may exist only at these two sites, or it may be widespread but unreported. Occasional bedrock holes are tapered, and one hole rectangular at the top was noted: this shape appears to have been formed, perhaps purposefully, on an initially round hole.

a) Dimple b) Simple Hole c) Double hole

**Dimples** usually occur in one of two site situations: as intermediate holes between larger, deeper holes on linear runs of holes, or closely clustered around a much larger and deeper central hole. Dimples typically are from 2-8 cm top diameter, dish shaped, and appear to be pecked or beaten into the bedrock. However, there is a difference in smoothness for the dimples that form the lower element of double holes. These tend to be much smoother and more symmetrical. The distinguishing criterion of a dimple is hole profile: dimples do not have straight sides and a distinct beginning to the hole bottom. Depth typically is less than to approximately equal to diameter (mean top diameter 6.5 cm, mean depth 3.6 cm, $n$=50). Figure 1 below plots dimple top diameter by site. As the sample of lower elements of double holes in the data is indistinguishable in profile and size range from the sample of dimples as a whole, the lower elements of double holes are treated as dimples and included in the dimple data plotted in Figure 1.

**Figure 1: DIMPLES**

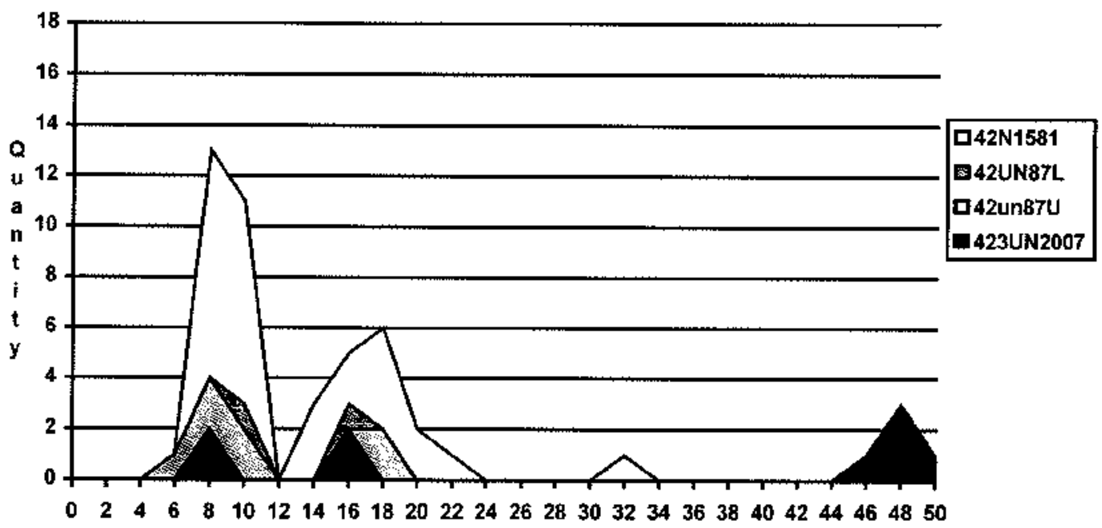


**Simple holes** occur at all sites and situations, but are most common as the central hole of a hole arrangement, and as part of linear hole arrangements. Figure 2 plots simple hole top diameter by site. It is apparent there are three distinct clusters of simple hole top diameters. Simple hole diameter varies first with hole purpose or use as inferred from the patterning, and the sample data includes holes attributed to several different uses. For comparison with the dimple data above, a selective sample *excluding* those simple holes inferred to be activity area centers (discussed below) yields: mean top diameter 11.8 cm, mean depth 15.2 cm, $n$=41. Simple holes are typically startlingly round, straight sided, and vertical (78% of simple holes were less than 1 cm eccentric at the top, most were round to the limits of scale measurement). Most simple holes have relatively smooth, uniform sides and concentric, slightly rounded bottoms that do not appear to result from pecking or striking with a harder rock. As is apparent from the plot, simple holes tend to cluster in two size ranges. Holes at 42UN2007 are exceptionally large compared with those at the other sites.

**Double holes** (Figure 3) occur at two of the sites: 42UN2007 and 42UN87L (Arndt does not mention any double holes for 42UN66), where they represent 20-35% of the holes present. Two thirds of these double holes have an upper, large hole diameter within the 17-19 cm range, a lower hole diameter within the 6-11 cm range, with combined depth of both holes within the 10-16 cm range. The depth typically is divided somewhat equally between large and small hole diameters ($n$=14).

The upper hole tends to have straight sides and a rounded to flattened bottom, while the lower hole element is essentially a dimple in the bottom of the upper hole. In contrast to typical dimples, the lower element of the typical double hole observed is very round, smooth, with a rounded bottom profile, as if it had been ground. Double holes occur as both surrounding larger central holes and as part of linear hole arrangements, where they

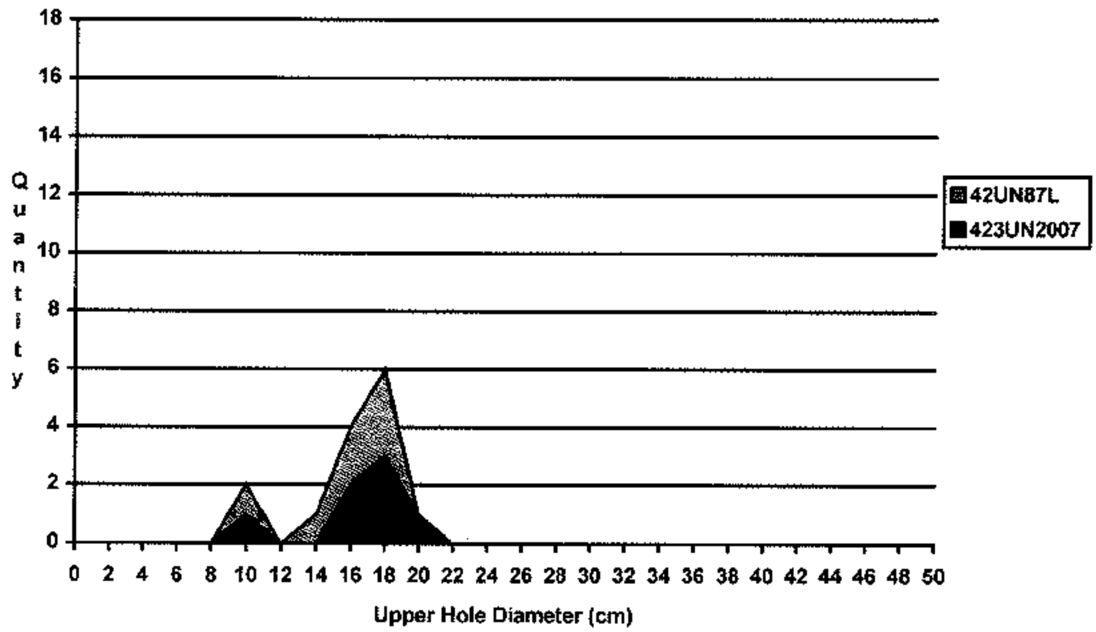
**Figure 2: SIMPLE HOLES**



most often occupy a corner position in a linear pattern of holes.

The five sites investigated have several situational similarities. They are relatively exposed, occupying ridges or monoliths somewhat above the surrounding flat lands. No bedrock holes were noted in lower-lying bedrock expanses adjacent to these sites. All sites appear to have been constructed on exposed bedrock surfaces, rather than into bedrock underlying soil deposits. All sites overlook year-round stream water sources, and except for 42UN1581 (1.5 km from the Green River), are within 200 meters (m) of water. Site elevations range from 1500-1660 meters. One-handed mano fragments were found on all sites, but no portable metates were noted. Bedrock trough metates occur occasionally in the Uintah Basin. No bedrock trough metates were identified at these sites, although Arndt describes some "oval depressions" for 42UN66 Unit two (Breternitz 1970:119). Tertiary flakes were present at all sites. No portable metates, adobe fragments, or wood structural remains were noted, but a thousand years of exposure and a hundred years of Anglo presence may have removed such evidence from open sites. As I have noted elsewhere (Johnson 1997) for rock art sites, the plots above reveal some variation in diameter or morphology at the site level.

**Fgure 3: DOUBLE HOLES**




No leveling, smoothing, or other alteration of the bedrock surfaces appears within enclosures or presumed structures. At all sites bedrock holes are placed without apparent regard for surface irregularities: holes may be constructed into flat, cracked, rough, smooth, or raised surfaces, or even bisect bedrock ridges or ledges several centimeter high. An inference from this is that bedrock hole placement is not determined by ease of construction, or by casual appropriation of an area of smooth flat surface, but instead is based on other requirements, which remain to be discovered. None of the holes appeared specifically sited or constructed to exclude or to acquire runoff water.

Rock art attributed to the Uinta Fremont is associated with all sites except 42UN2007. Uinta Fremont rock art is of interactive design (Johnson 1993:71-88), and field studies show that at Uinta Fremont sites investigated, rock art typically results from year-round, rather than from seasonal presence. However, some rock art panels and other site features such as bedrock holes may be for seasonal use even on a site occupied year-around. At 42UN1581, associated rock art of interactive design is centered on the summer half of the year, and the most impressive panels receive no direct sun during the winter (Johnson 1997-1998, data in author's possession). At 42UN87, upper and lower site bedrock holes are most closely associated with panels emphasizing the summer half of the year, as is the case with the Cub Creek Pillar holes discussed below.

Site 42UN66. In Breternitz (1970:119-123), Arndt describes bedrock hole clusters at this excavated site, which is characterized as an open campsite. Unit 1 is described as a bedrock firepit 145 cm maximum diameter by 67 cm deep, filled with ash and windblown sand. Unit 2 is described as a house structure approximately 5 meters (m) by 3 m, with 5 bedrock postholes with adobe fill and a number of other shallow depressions. The pattern is very roughly circular. Unit 3 is described as a firepit with a maximum diameter of 156 cm, and a depth of 40 cm, covered with ashy fill. Unit 6 is described as a structure, 25 postholes from 5cm to 25 cm deep in a roughly circular pattern, surrounding a semi-circular firepit of added rocks. The cluster appears to be approximately 5 m in diameter. Unit 8 is described as one bedrock posthole and one ash filled depression. Arndt suggests this site was a summer seasonal encampment, with structures being lean-tos or ramadas (Breternitz 1970:123). The amount of effort necessary to build these bedrock holes seems inconsistent with mere seasonal encampments unless long term reuse is intended.

The Cub Creek pillar site consists of 4 holes arranged on a quadrangular pattern approximately 2 meters to a side on top of a sandstone pillar. The pillar top is inaccessible without a ladder or rock climbing expertise. West of and above the pillar is an impressive rock art lizard, with interactions centered in the summer half of the year. The holes are very near the edges of the pillar except at the east end.

Site 42UN87L consists of 20 holes forming a roughly square pattern approximately 2 meters to a side on a pitched slope of exposed bedrock at the east end of Elephant Toes Butte. Although the overall shape and size of the hole pattern is similar to that at Cub Creek pillar, note that situation, hole morphology, and hole spacing are very different. Feat ure outline is similar to that of Fremont Playhouse, 42UN83 (Breternitz 1970:41-44). The bedrock at 42UN87L has considerable pitch and the holes are very closely spaced. Holes on the lower two sides are mostly double in profile, while the upper two sides consist mostly of dimples in double rows, with a 16 cm morphologically simple post hole at the uppermost corner.

Site 42UN2007. These holes occur on a bedrock exposure just below a sandy point overlooking Cliff Creek. Total 19 (exposed) holes: five large holes, three of which are surrounded by smaller, shallow holes, one of which has one outlying small, shallow hole, and the last of which is approximately half the depth of the other four, with no outlying holes.

Site 42UN87U is an approximately circular arrangement of 7 (exposed) bedrock holes surrounding a larger central hole, and an additional pattern of 3 (exposed) bedrock holes associated with a larger hole approximately 11 meters to the east. These holes occur where today soil covers part of a flat bedrock area lying below and east of the highest part of the monolith. The exposed holes are surrounded today by areas of (probably shallow) soil cover. Additional holes may lie under this soil. This site may or may not have been exposed bedrock at time of hole construction; soil cover if present was likely only a few centimeters.

Site 42UN1581 is a pattern of 50 bedrock holes located on top of a sandstone knoll on a Pleistocene bench southeast of Vernal approximately 1.4 kilometers (km) northwest of and overlooking the Green River. The pattern is complex, but can be described as roughly rectangular, enclosing the entire top surface of the knoll, with a bisecting line of holes across the center. The outer perimeter of holes lies close (within a few tens of centimeters) to the edge of the knoll, especially along the steepest sides. The remains of an apparent rough rock wall occupy a gap in the hole perimeter. Informant Dewey Paulson of Vernal states that when he was a child (ca 1950) some of these holes "…had stone pestles in them".

Examination of overall patterning of hole placement, morphology, diameter and depth with regard to site topography suggest that bedrock holes at these five sites tend to fall into three categories.

1) Enclosure holes serve to delineate an interior space. The space may be round (perimeter postholes for a pithouse wall), square (a ramada), or irregular (a stockade wall or sheep trap). In each case, the inferred purpose is to locate and anchor a pattern of posts. This purpose and use are best inferred through a combination of overall pattern, surrounding terrain and associated artifacts or features.
2) Support holes serve to support the vertical load of some structure, like a floor or a roof. Examples of such structures include platforms and ramadas.
3) Activity area holes serve as the focus for a particular human activity or activities (Binford 1983:146-167). Hole clusters inferred to be activity areas occur here as large, deep central holes surrounded by smaller, much shallower holes. As Binford notes, similarities of size and shape, dictated by human body form and capabilities, can be expected for activity areas of similar function.

In support of the enclosure hypothesis, the physical reality is that corner posts, end posts, or widely spaced posts require more support than intermediate posts in a fence or wall. Thus we expect that intermediate post or wall holes be shallower than corner, end, or widely spaced posts. In the Figure 4 below, holes are described as line post holes if the angle to adjacent post holes is less than 25°, and/or if distance to next hole is less than 2 meters (*n*=52). As Figure 4 indicates, intermediate line or wall post h oles are shallower than the others, supporting the argument.

The central holes attributed to the presence of activity areas are remarkably similar. For six central holes at 42UN1581 and 42UN87U, top hole diameter ranges from 18-22 cm and depth averages 30 cm (with four holes at 30-31 cm). For central holes at 42 UN2007, for which a different specific activity is inferred, top diameter of four holes ranges from 45-50 cm (with 3 holes at 47 cm) and depth from 35-55 cm.

An intuitive inference is that this patterning is designed to stabilize of some kind of wooden racks or structures over the central holes.

An experiment was performed to determine the feasibility of such structures in the context of the hole patterns observed. Tripods (or pyramidal structures using more than three legs) are self-supporting and stable only within a limited range. The position of the tripod center is controlled by both leg position and by stability constraints on tripod height. For any structure with three (or more) radially arranged supports leaned to form a central peak, structural stability dictates the height (H) be between one half and one and one half times the base diameter (D). This type of structure is most stable when H≈D. An excellent illustration is the Plains tipi (Mails 1972:18). Mails' figures suggest that for this example, height ranged from .9 to 1.25 the diameter. Additionally, structure legs must be spaced to include more than half a circle, or the structure will not be self-supporting.

For hole arrangements suspected to have been activity centers featuring possible "tripods", the pattern of each cluster was replicated on a large sheet of cardboard, and a self-supporting structure centered over the center hole attempted using ½"x1½" wood lathes. Structures were erected by placing the base of each leg on its mark, then leaning the supports together above the mark for the central hole, after which some intuitive adjustment for height was attempted if the structure collapsed or appeared too tall to be stable. This allowed testing structure stability, relationship to central hole, and an estimate of structure height. A total of seven "classic" activity area arrangements were tested. For 42UN2007, reconstruction of the three multiple hole arrangements inferred to be completed activity areas yielded three stable structures with the structure peaks centered over the central holes, one with a basal diameter of 115 cm and height of 80 cm, one with 126 cm basal diameter and 82 cm in height, and one with 135 cm basal diameter and 92 cm. These heights range in proportion to diameter from .65 to .7 D, within the lower end of the range, but self-supporting and stable. Re-creation of patterning at 42UN87U yielded a centered, self-supporting tripod 60 cm diameter and 51 cm high, or H=.85D. At 42UN1581, while an effective "tripod" support structure could be erected over at least one of the inferred activity area holes, the general patterning of satellite holes suggests a more likely structure is a rack of some sort constructed over two large holes. Restricting the test to structures covering a single central hole, we find that five of the seven inferred completed activity areas support stable, centered "tripods". Patterning of satellite holes around two "activity area" holes at 42UN1581suggests a possible rack-like structure over the two adjacent central holes.

## Conclusions

Interpretation of the use or purpose of bedrock hole patterns at the sites discussed here is based on experiment, on patterns in the data for multiple sites, and on details of the sites themselves.

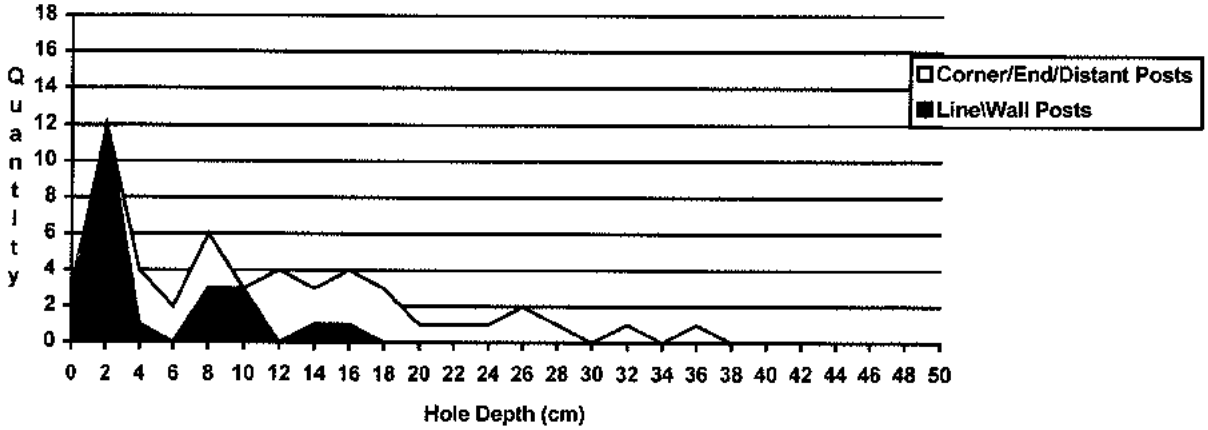
Cub Creek pillar: The holes are very near the edges of the pillar except at the east end, so that walls of adobe, brush or rock using these poles as corners are unlikely. I infer summer use, and speculate that hole purpose is support for a platform or lightweight roof, perhaps a ramada. The site could have served as a shaded observation post for the rock art panel or possibly a lookout tower from which to observe the area. However, it is not well located to observe any distance down the valley of Cub Creek.

42UN87L: The situation, patterning of hole placement, spacing and choice of hole shapes suggest they supported an adobe structure. The doubling of the two walls highest on the slope would help prevent water from entering, while the two walls lowest on the slope would both bear the greatest load and prevent the structure from sliding down the sloping slickrock. I offer the hypothesis that the double hole shape is designed specifically to locate and "glue in" a wooden post. The lower hole element positions the post and secures the base, while adobe applied around the post and filling the upper hole element stabilizes and secures the post. This solution is more cost efficient that constructing a hole oversize to the full depth to allow adobe "cement". Use of adobe in postholes has been noted nearby (Breternitz 1970:119-123). Future excavations of buried bedrock hole sites can, if carefully done, test this idea, which is further discussed below for site 42UN2007.

42UN2007: Binford inferred by analogy that roughly similar arrangements of earthen holes and wood supports were used for hide smoking (Binford 1967:1-11), which is widely reported in North American ethnography. The holes are described as straight sided and flat bottomed, the activity as seasonal. A preferred fuel seems to have been corn cobs, which were allowed to smolder in a hole over which a wood supporting structure had been arranged, and the hide draped or sewn over the structure so as to capture all the smoke. Documented sizes range from 15.24-30.48 cm in diameter and 15.24-60.96 cm in depth, with Binford's sites having an approximate mean diameter of 28 cm and a mean depth of 33.53 cm. Unfortunately, Binford has no dimensional information on the wood structures used to support the hides. The Uinta Fremont also grew corn, hunted extensively, and used hides. The central holes at 42UN2007 average 48.75 cm diameter (nearly 60% larger) and 47.66 cm deep (within the range of depths reported). In bedrock as opposed to soil, diameter is easier to achieve than depth, thus bedrock holes might be expected to be comparable shallow in relation to their diameter. Binford's sites were probably whitetail deer habitat, whereas mule deer are considerably larger. Thus, the pattern at 42UN2007 varies in the manner expected from the change in game and ground surface. Corncobs, sagebrush, or readily available riparian vegetation smoldering in these holes would efficiently smoke a hide wrapped tipi-like around the wooden "tripod". Use of double holes for some tripod legs may have been necessary to stabilize these relatively large tripods when hides were draped over them. There are two large diameter holes that may represent partially complete hide smoking areas, or may be designed for some other activity or phase of hide processing. One hole is singular; the other has one outlying dimple. Both these holes are typical in diameter (47 cm), but conspicuously shallow (20-35 cm) in relation to the other holes discussed above.

42UN87U: I suggest the two hole clusters inferred to be activity areas here are for specialized summer cooking, specifically, boiling in ceramic vessels. The diameter and depth of the central holes would make it difficult to sustain an active fire. However, if live coals were placed in such a hole, or a fire of small twigs started and allowed to fall in, hole morphology would dictate all heat (and smoke and light) were focused upward. Fremont ceramic cooking vessels are typically largest near the bottom, tapering to a rounded bottom, with one, or

**Fgure 4: POST HOLE DEPTH**




one, or two opposed loop handles at the rim. My impression is that the average vessel is as shown for Caldwell Village ceramics (Jennings 1978:183), perhaps 20 cm with the range being 10-30 cm. Vessels with a diameter of 20-25 cm would sit evenly and with great stability on the central holes at this site. Alternately, vessels with two handles could be suspended from a tripod, or from a forked branch "pothook" supported in the single small simple hole that appears close to most central holes. This method has several advantages to placing a ceramic cooking vessel amid coals in a typical hearth. The vessel is firmly supported, more evenly heated, easier to retrieve once cooking is complete, all heat is focused on cooking while no heat or light are spent in heating or lighting surrounding space, and less fuel is required. These factors would be disadvantages during a winter night in a pithouse, but would be advantageous in summer under a ramada structure, or where fuel was scarce or small in size. If these holes are central features of respective structures then, I expect those structures to be ramada-like rather than pithouse-like. The patterning of peripheral holes surrounding the activity area clusters at this site would fit either a roughly square or circular structure approximately 2.5 m meters across. A possible buried additional pattern of supports, suggested by one exposed hole, would result in a structure 5 meters across, centered on the activity area.

42UN1581: This site represents by far the greatest expenditure of construction effort. The sides of the sandstone monolith are quite steep except along the center third of the east side. There, a relatively gentle natural ramp winds up onto the top of the monolith where there is a central flat area with activity centers. The activity area holes here closely match the pattern at 42UN87U, and may have served the same or a closely related purpose. A rock wall, now fallen, guides access to the flat top of the monolith. Immediately north of the flat central area one ascends a small ledge to another relatively flat area that pitches slightly upward to the north edge of the monolith, with several (possibly uncompleted) activity centers. The entire top of the monolith, out to when the sides drop off steeply to the terrain below, is enclosed by a series of postholes. The extensive bedrock holes outline an enclosure that, based on placement, situation and hole depth as shown in Figure 4, was a fence. It could serve either to keep something out (defensive, wind protection) or to keep something in (child, pet, or domestic animal restraint, or bighorn sheep trap). A wildlife biologist familiar with sheep behavior believes that the site situation would result in pursued sheep accessing the monolith top, although his assessment of the terrain was that it didn't look like bighorn habitat today (Dr. Rich Etchberger 1997 personal communication). Bighorn sheep are portrayed in the rock art panels on-site, as are snakes, both rock art elements that refer to the summer half of the year.

Four commonly proffered hypotheses as to hole purpose or use were considered and rejected for these sites: water storage, dry food storage, hearths, and archaeoastronomical alignments.

1. Water storage. All sites are relatively close to dependable water sources. Additionally, at the site most distant from water (1.5 km) the five largest holes are less than half the diameter and about 32% of the volume of the five largest holes at the site closest to water (80 m).
2. Dry storage. Other corn horticulturists used much larger, earthen pits for storage, both for reasons of concealment and for preservation of the foodstuffs involved (Weltfish 1965, Wilson 1987). The Uinta Fremont also used earthen pit storage structures (Talbot and Richens 1996). Holes are not located to effect concealment or to exclude moisture, both of which might be factors in storage of some relatively non-biodegradable commodity such as lithics, bone artifacts, or ceramics.
3. Hearths. Typically, features archaeologically interpreted as hearths range from approximately 50-100 cm in diameter (Breternitz 1970, Truesdale 1993, Talbot and Richens 1996) with a shallow basin profile, and frequently are oblong or eccentric in shape. This morphology allows a good draft for combustion, the use of random lengths and sizes of fuel material, warmth and light dispersed outward from the hearth, and the room for multiple cooking activities to occur simultaneously. Only one of the hundred holes examined is 50 cm in diameter, and it is 55 cm deep, with straight sides. This morphology leads to problems with combustion, fuel shape and size, and limited usable surface area for cooking. Warming and lighting functions of hearths are also not fulfilled, as heat and light tend to disperse vertically rather than radially. No bedrock hole examined here resembles the multipurpose hearths typical to Fremont pithouses, and as reported for 42UN66.
4. The hypothesis that these holes held posts as sight lines for prehistoric astronomical observations was rejected, not because I doubt that Formative peoples observed the sun. The problem lies in what constitutes an acceptable level of proof for the hypothesis. Archaeoastronomers infer that, at minimum, more than a dozen sunrise and moonrise and set positions were of interest prehistorically. The number of azimuths (A) obtainable across the centers of any given number of holes (X) can be calculated as $A = X(X-1)$. Any random cluster of seven holes thus yields 42 azimuths. The sun subtends approximately ½ degree of arc to the human eye. A 6 cm diameter pole, when viewed from a distance of three meters, subtends considerably more than ½ degree at the horizon. As distance from observer to pole decreases, or as pole diameter increases, the situation worsens. Additionally, there is no way to quantify the diameter, height, profile, straightness, or tilt of wood poles that prehistorically may have occupied a bedrock hole.

Thus, only an exceptional site would allow unambiguous archaeoastronomic interpretation.

## Summary

Bedrock hole morphology and spatial patterning suggests these holes in northeastern Utah were constructed for varying specific long-term uses (or for long-term episodes of punctuated use). Morphology and spatial patterning appear similar across sites, but vary with probable use. Therefore, hole purpose, and perhaps season of use, may be inferred through examination of variables such as diameter, depth, shape, and cluster patterning.

On the basis of this investigation, simple bedrock holes of 8-12 cm are inferred to be postholes. Slightly larger and relatively deeper holes occur in situations implying structural support: either where linear arrangements change direction, or at corners of more substantial structures. Simple holes of 17-22 cm with a surrounding pattern of outlier holes or a single deep outlier within 40 cm are inferred to be activity (summer boiling) centers. Large, deep holes with a surrounding pattern of outlier holes are inferred to be special purpose (hide smoking) activity centers. Dimples offer support for tripods or intermediate between more stable posts in walls or enclosures. Double holes are designed specifically for an adobe collar that stabilizes and positions the post. Excepting 42UN87L (use unknown) and 42UN2007 (season unknown), structures postulated for these sites would be for summer use.

To further test these ideas, if ceramic vessels were used as suggested above, a use wear ring might appear around the vessel somewhat below the largest diameter, or in the case of suspension, on the handles of double handled vessels. Fremont ceramic vessel use wear might be analyzed in terms of variables of size, shape, and handle detail. Buried sites may hold signs of tripod arrangements or pothooks associated with activity centers. Single holes associated with activity centers as described above might, given a sufficient sample, allow inference about some ceremonial purpose. Fremont hide goods might be tested to determine if they were smoked. Experiments to replicate hole construction would be useful. Possibly these holes were drilled using a juniper log butt with sand and water. Use of wood or stone drills, pestles, mauls or other stone tools, either to purposely form a hole, or while forming a hole incidental to repeated use, or even alternate heating and/or freezing regimes, should result in distinguishable differences in hole morphology. Additional attempts to erect structural components using the data from actual sites might be illuminating.

Hole descriptions from excavated sites need to be more detailed. Bedrock holes are probably more prevalent than is currently understood, and archaeologists should be alert to the possibility of bedrock holes (and hole patterns) in buried contexts, where better information on construction and purpose may be preserved.

## References Cited


Binford, Lewis R.

1967 Smudge Pits And Hide Smoking: The Use Of Analogy In Archaeological Reasoning. *American Antiquity,* Vol. 32, No. 1.

1983 *In Pursuit of the Past: Decoding the Archaeological Record.* Thames and Hudson, New York, New York

Breternitz, David A.

1970 Archaeological Excavations in Dinosaur National Monument, Colorado-Utah, 1964-1965. *University of Colorado Studies, Series in Anthropology,* No. 17. Boulder

D'Azevedo, Warren L.

1986 *Handbook of North American Indians: Great Basin,* Vol.11, ed Warren L. D'Azevedo. Smithsonian Institution. Washington, D. C.

DeVed, C. Lawrence, and Rhoda Thorne DeVed

1996:71-92. Some Prehistoric Holes Along Cliff and Cub Creeks, And At Dead Horse Spring, Uintah County, Utah. In: *Utah Archaeology,* Volume *9, No. 1.* Salt Lake City, Utah

Jennings, Jesse D.

1978 Prehistory of Utah and the Eastern Great Basin. *University of Utah Anthropological Papers,* No. 98. Salt Lake City

Johnson, Clay

1993 McKee Spring Rock Art Research: A Discussion. In: Archaeological Investigations at Two Sites in Dinosaur National Monument: 42UN1724 and 5MF2645. Selections from the Division of Cultural Resources, No. 4. Rocky Mountain Region, National Park Service. Denver, Colorado

Johnson, Clay

1997 Toward a Stylish GUT. In: *Utah Rock Art,* Volume. Utah Rock Art Research Association. Salt Lake City, Utah.

Mails, Thomas E.

1972 *The Mystic Warriors of the Plains.* Doubleday & Company, Inc. Garden City, New York.

Talbot, Richard K., and Lane D. Richens

1996 Steinaker Gap: An Early Fremont Farmstead. *Museum of Peoples and Cultures,* Occasional Papers No. 2. Brigham Young University.

Truesdale, James A.

1993 Archaeological Investigations at Two Sites in Dinosaur National Monument: 42UN1724 and 5MF-2645. *Selections from the Division of Cultural Resources,* No. 4. Rocky Mountain Region, National Park Service. Denver, Colorado

Weltfish, Gene

1965 *The Lost Universe.* University of Nebraska Press. Lincoln.

Wilson, Gilbert L.

1987 *Buffalo Bird Woman's Garden.* Minnesota Historical Society Press. St. Paul.

Zigmund, Maurice L.

1986 Kawaiisu. In: *Handbook of North American Indians: Great Basin,* Vol.11, ed. Warren L. D'Azevedo. Smithsonian Institution. Washington, D. C.