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# AMS DATING OF PLAIN-WEAVE SANDALS FROM THE CENTRAL COLORADO PLATEAU

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*AMS radiocarbon dates on plain-weave sandals from caves of the central Colorado Plateau are reported. The sandals range in age from about 6900 to 3200 B.P. (ca. 5700–1450 cal. B.C.). The findings strengthen a case for both population and cultural continuity during the Archaic period, and support a related argument that middle Archaic breaks in the occupancy of several important shelters such as Cowboy Cave resulted from settlement pattern change and not regional abandonment. The dates demonstrate that living accumulations within some shelters of lower Glen Canyon resulted from Archaic foragers and not Puebloan farmers as previously claimed. Benchmark Cave, in particular, emerges as a site with an important record of hunter-gatherer occupancy during the middle and late Archaic.*

## INTRODUCTION

During the course of summarizing the radiocarbon record for Archaic occupancy of the Glen Canyon region (Geib 1995), I became interested in attempting to identify sites that might help to demonstrate a continued presence in the region from early through late Archaic periods. I was especially interested in sites that might help fill an apparent 1000-year gap in the radiocarbon record between 6000 and 5000 B.P. (ca. 4880–3780 cal. B.C.) (Berry and Berry 1986; Schroedl 1976). This radiocarbon gap and the evident discontinuation of human occupancy of several significant shelters, such as Cowboy Cave (Jennings 1980; Schroedl and Coulam 1994), may provide evidence for hunter-gatherer abandonment of the plateau (Berry and Berry 1986). Alternatively, the date gap may reflect a sampling problem, deriving both from the limited numbers of Archaic sites investigated and from differential visibility of the archaeological record produced by foragers during the 6000-year-long Archaic period. To investigate whether the date gap is a sampling problem and if settlement patterns may have changed, portions of plain weave sandals from several caves of the central Colorado Plateau (Figure 1) were submitted for accelerator mass spectrometry (AMS) radiocarbon dating. The dating results and their implications for both population and cultural continuity during the Archaic period are reported here.

## ARCHAIC SANDAL TYPES

The two principal sandal types (Figure 2) used by Archaic hunter-gatherers of the central Colorado Plateau were open-twined and plain weave (also called coarse warp faced [Lindsay et al. 1968:118] and woven [Lipe 1960:202-204]). Both were described by J. Richard Ambler (in Lindsay et al. 1968:95-97, 120-121; also Ambler 1996) from his excavations at Dust Devil and Sand Dune caves. The sandals were made of unprepared whole yucca leaves; the warp for both types was virtually identical, consisting of leaves folded at the toe of the sandals with the leaf butts and tips at the heel. What

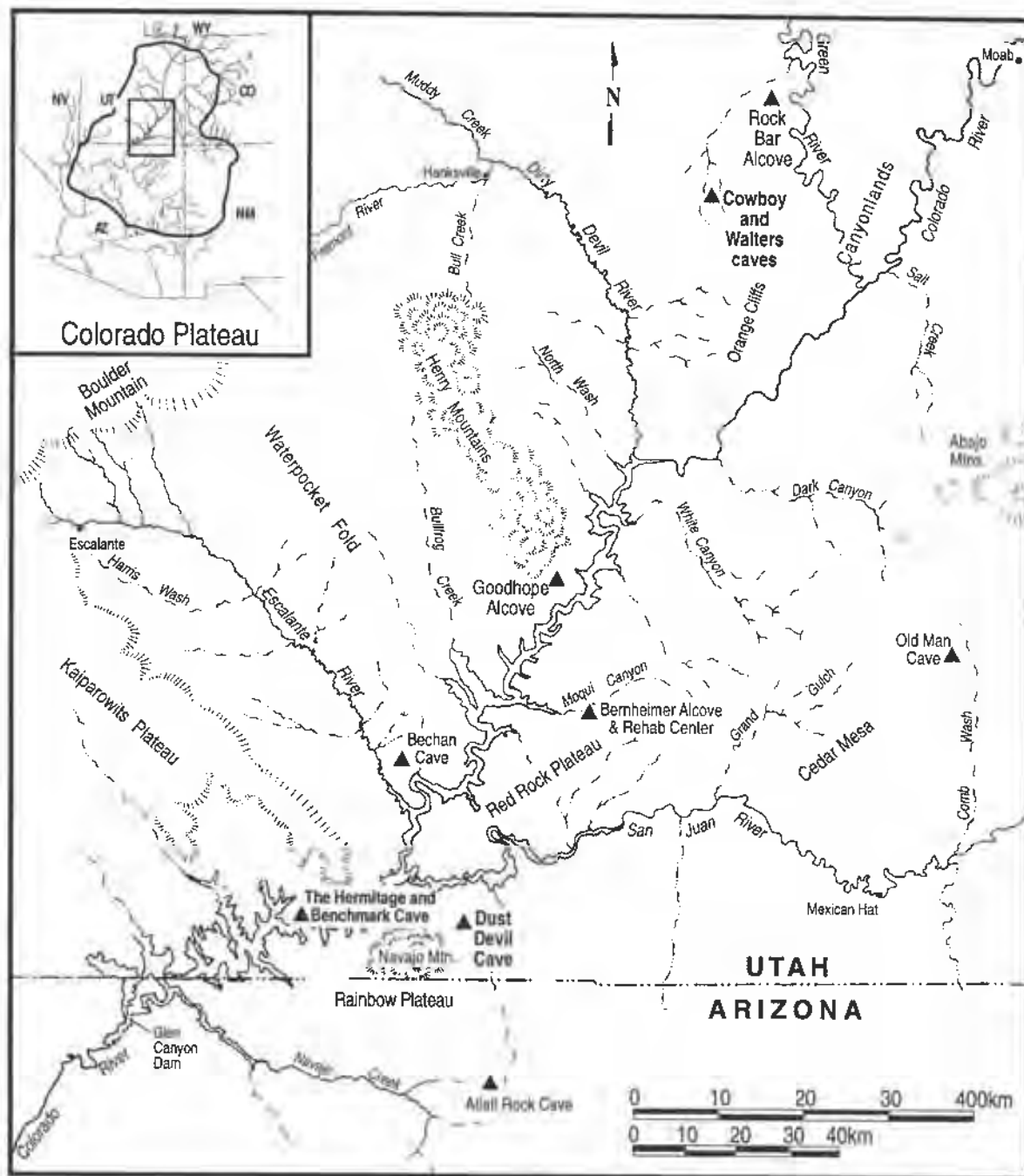
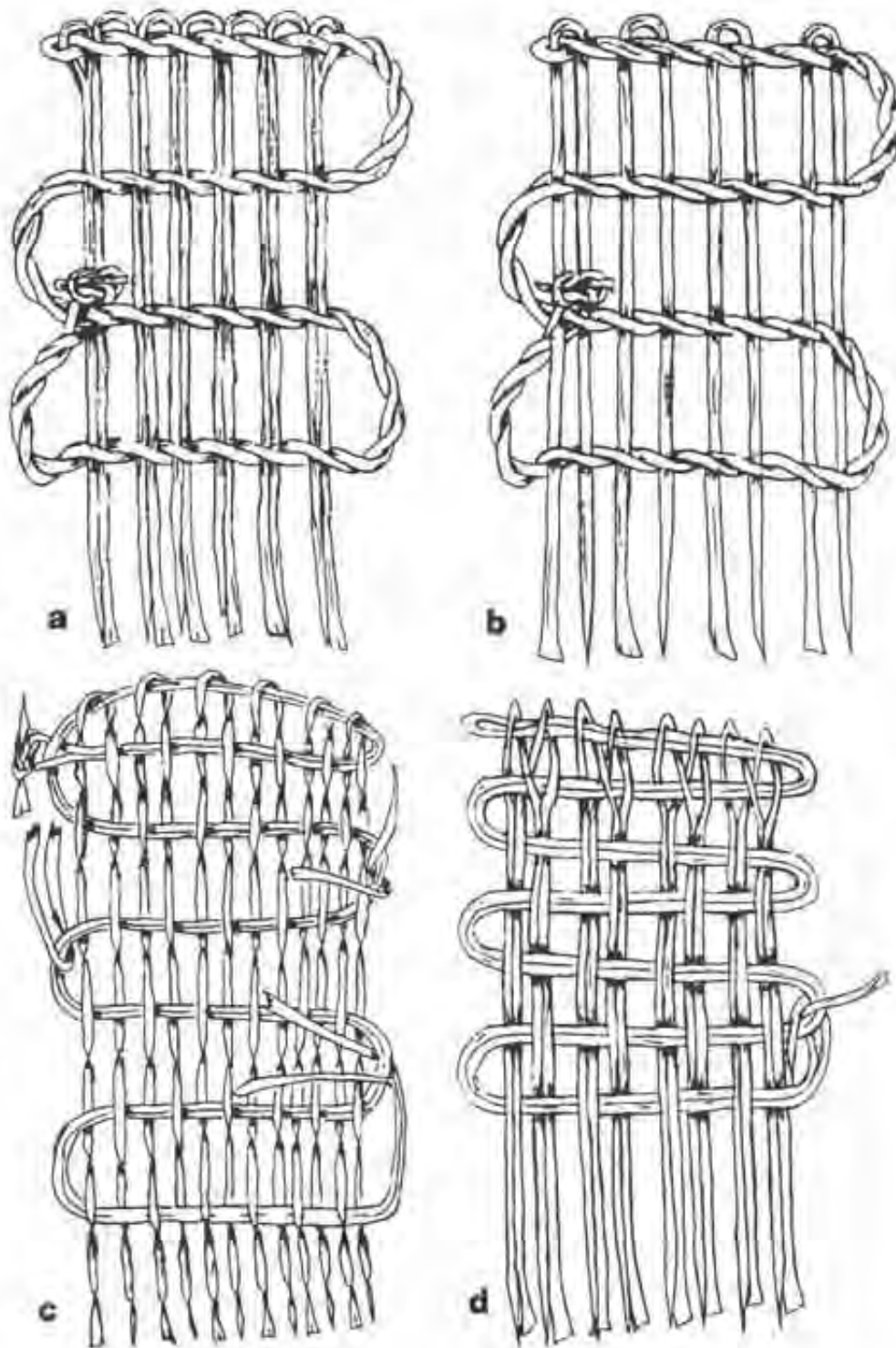


Figure 1. The central portion of the Colorado Plateau showing the location of sites discussed in the text. Bold site names are those yielding plain weave sandals radiocarbon dated for this study.



**Figure 2.** Archaic sandal types of the central Colorado Plateau: (a) and (b), open-twined sandals with different treatment of the warp; (c), fine warp-faced sandal; (d), plain weave sandal (from Ambler 1996).

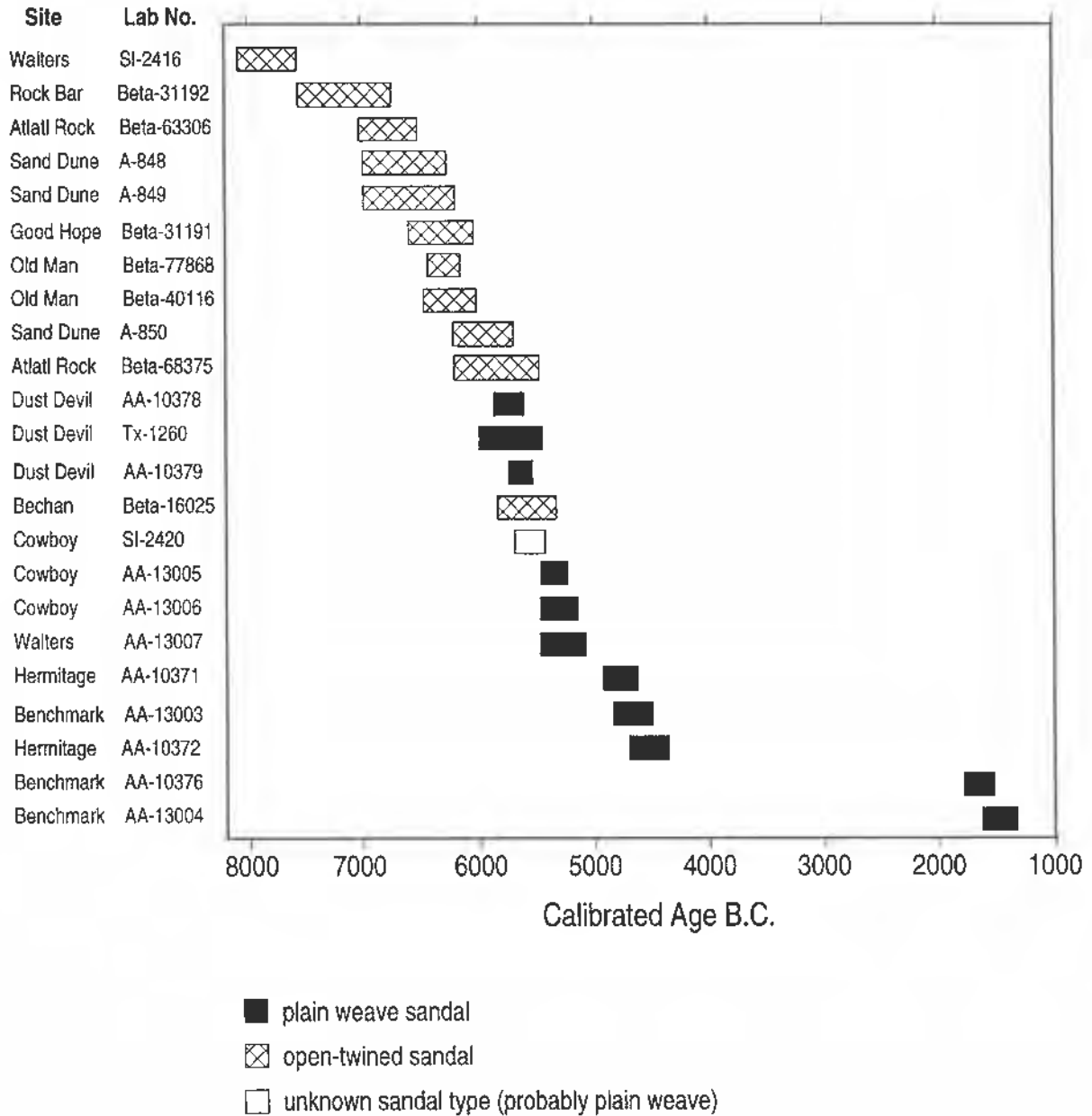
differed between the sandal types was the weft, which for open twined sandals consisted of Z-twining using two to four leaves, but simple over-one, under-one weaving with two to four leaves for plain-weave sandals.

Open-twined sandals have been found across a large region centered along the Colorado River of the central Colorado Plateau. Sites of the Glen Canyon lowlands yielding open-twined sandals include Bechan Cave (Agenbroad et al. 1989), Benchmark Cave (observed in the site collections housed at the Museum of Natural History, Salt Lake City; see Lipe [1960] and Sharrock [1964]), Bernheimer Alcove (Sharrock et al. 1963:Figure 77b; sandal misidentified as a yucca mat), and Good Hope Alcove (Geib 1989). The northernmost known occurrence is now Rock Bar Alcove (Geib 1994), an unexcavated site about 14 km NE of Cowboy Cave (previously the northernmost find location) on a highland overlooking the lower Green River. Dust Devil and Sand Dune caves at the foot of Navajo Mountain marked the southernmost distribution of the sandal until the recent study of Atlatl Rock Cave (Geib et al. 1996) on the southern edge of the Rainbow Plateau. The easternmost confirmed find of open-twined sandals is Old Man Cave (Geib and Davidson 1994) along Comb Wash. Hurst (1947:11-13) may have recovered fragments of this sandal type from Dolores Cave in SW Colorado, but this remains to be demonstrated by reanalysis of the collections. The known distribution of open-twined sandals is likely unrepresentative of the prehistoric distribution. It is perhaps no coincidence that the distribution closely matches that portion of the Colorado Plateau renowned for its numerous dry shelters.

Ambler identified open-twined sandals as a key diagnostic trait of the early Archaic Desha Complex northeast of Navajo Mountain (Lindsay et al. 1968:120-121). Excavations at Cowboy Cave, however, produced this sandal type from cultural units IV and V (Hewitt 1980:Table 12) dated between about 3700-3200 B.P. and 1900-1400 B.P. respectively. Ambler (1984) suggested that these occurrences in later strata at Cowboy Cave resulted from disturbance of early deposits by later occupants. Berry and Berry (1986:309-310) gave a similar argument to account for the presence of Gypsum points and split-twig figurines in Unit V at this cave. Subsequent to Ambler's assertion, open-twined sandals from five separate sites widely scattered across the central Colorado Plateau were directly dated, and all are within the early Archaic period. Ambler is therefore likely correct about the displacement of open-twined sandals upwards in the deposits of Cowboy Cave into later cultural units. Dates on 11 open-twined sandals from seven sites (Figure 3) provide sufficient justification to state that this type of footwear is restricted to the early Archaic, and may be expected anytime between 9000 and 6500 B.P. (ca. 8030 to 5440 cal. B.C.).

The spatial distribution of plain-weave sandals is similar to that of open-twined sandals, but includes some different sites. Cowboy and Dust Devil caves have produced the greatest number of plain weave sandals and provide the northern- and southernmost known occurrences of the type for the central portion of the Colorado Plateau. Other sites yielding plain-weave sandals are mostly within lower Glen Canyon along the Colorado River, including Benchmark Cave, The Hermitage, and Lizard Alcove (Lipe 1960). Cottonwood Cave, another site excavated by Hurst (1948:Plate IV), yielded the easternmost example of this sandal type (identification made on the basis of the published photo).

Prior to this study only one plain-weave sandal had been directly dated; it came from the top of Stratum IV of Dust Devil Cave with an age of  $6840 \pm 120$  B.P. (Ambler 1996). A dated sandal from Stratum IIIi of Cowboy Cave had similar antiquity ( $6675 \pm 75$  B.P.; Jennings 1980:Table 3) but was not described prior to its destruction. It was likely a plain-weave sandal, given the abundance of this type from the stratum. The finding of plain-weave sandals from Unit IV of Cowboy Cave suggested the continuation of this type into the late Archaic, contemporaneous with split-twig figurines and Gypsum points. Yet, these sandals easily could have been vertically displaced in the deposits, as were the open-twined sandals at this site. Based on the set of radiocarbon dates reported below, plain-weave sandals were evidently first made during the end of the early Archaic, after 7000 B.P. (ca. 5840 cal. B.C.). Both plain weave and open-twined styles overlapped during the first half of the seventh millennium B.P., but plain-weave sandals continued to be manufactured through the middle Archaic, extending into the late Archaic, up to almost 3000 years ago (ca. 1240 cal. B.C.). That the plain-weave style developed out of the open-twined style is exemplified by certain sandals that exhibit aspects of both construction techniques. For example, on sandal FS 1822.3 from Cowboy Cave, the first pass of the weft is twined and the other passes consist of simple over-one, under-one plain weaving. I also observed this construction technique on a plain-weave sandal from Benchmark Cave (FS 120.1).



**Figure 3.** Graph of all direct dates on Archaic sandals of the central Colorado Plateau, including the dated plain weave sandals reported herein. Dates calibrated using the CALIB program, version 3.0.3A (Stuiver and Reimer 1993) using the 20 year data set and method A.

A third but rare Archaic sandal style, fine warp-faced (Ambler 1996; in Lindsay et al. 1968:118), is essentially a variant of the plain-weave type, where the weft is so widely spaced that it is barely discernible between the warp. Temporal placement of fine warp-faced sandals is not certain since none have been directly dated and few have been recovered; all extant examples come from Dust Devil Cave. Ambler (1996) postulates that this sandal type precedes the open-twined style because most of the few fine warp-faced sandals recovered from Dust Devil Cave came from the lowest portion of the early Archaic Stratum IV. It is easy to envision sandals of this type, though, as early experiments with the plain-weave technique, which would place them in the time of overlap between the two major sandal styles. Whatever the case proves to be, it seems certain that fine warp-faced sandals are restricted to the early Archaic.

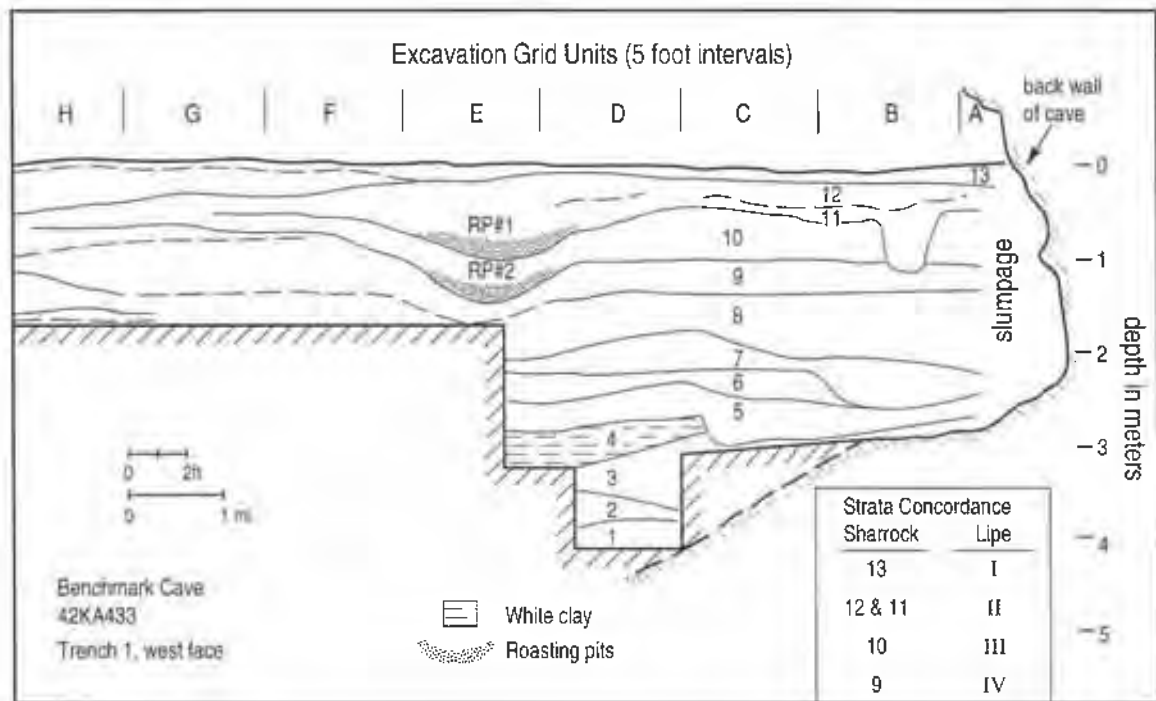
### DATING PLAIN-WEAVE SANDALS

The five sites that produced the sandals dated here are Benchmark Cave (42KA433), Cowboy Cave (42WN420), Dust Devil Cave (NA7613), The Hermitage (42KA443), and Walters Cave (42WN421) (see Figure 1). Formed within Navajo Sandstone, a geologic unit renowned for the production of natural shelters, these sites yielded a variety of perishable remains. Benchmark Cave and The Hermitage are located less than 2.4 km apart from each other along the north side of the Colorado River in Lower Glen Canyon, at an elevation of about 994 m. Both sites were excavated during the Glen Canyon Project of the late 1950s and early 1960s, prior to the creation of Lake Powell (Lipe 1960; Sharrock 1964). The information presented below about these two sites comes from excavation reports and field notes on file at the Utah Museum of Natural History. Slightly more detail is presented about these sites than the other three because the Archaic deposits were not recognized at either site during excavation.<sup>1</sup> Dust Devil Cave occupies a benchland above the canyon of the lower San Juan River on the northern edge of the Rainbow Plateau at an elevation of 1490 m. The cave was initially tested as part of the Glen Canyon Project (Lindsay et al. 1968), and was fully excavated in 1970 as part of a separate research project (Ambler 1996). Cowboy and Walters caves are adjacent grottos at an elevation of 1700 m along a tributary of Horseshoe Canyon on a highland to the west of the confluence of the Green and Colorado rivers. Both caves were excavated in 1975 by a University of Utah field school (Jennings 1980; Schroedl and Coulam 1994), Cowboy almost completely, and Walters just partially.

#### Benchmark Cave

*Site Description.* Benchmark Cave is a small grotto that is triangular in both plan and section; it measures about 7.6 m wide at its mouth and 7.6 m deep from front to back. Bedrock occurs about 4.3 m below the ground surface and cultural deposits were found at almost this depth (Figure 4). The cave is located at the base of a south-facing cliff; it opens upon a broad alluvial terrace of the Colorado River, which flows about 14 m below the cave. Evidence of occupation also occurs on this terrace outside the cave proper, but most of the excavation effort was devoted to the dry deposits within the cave. The site was initially excavated during the 1958 field season of the Glen Canyon Project; several long trenches were dug outside the cave by arbitrary levels and a good portion of the cultural deposits from the eastern two-thirds of the cave interior were removed by natural divisions (Lipe 1960). Based on this effort, Lipe (1960:99) thought that the site "probably was used intermittently over a fairly long period of time as a base camp for hunting, gathering and in the later stage, farming." The two stages of occupation identified for the site included a preceramic and preagricultural occupation (Stratum IV), and a ceramic, agricultural occupation that spanned Strata III through I. No dates were assigned to the first occupation, but the later occupation was ceramically assigned to an approximate 100-year interval from about A.D. 1025 to 1125.

The 1958 field season was early in the work of the Glen Canyon Project; thus as more was learned about the archaeological record of the region, the need for more complete excavation of the site became apparent. This was



**Figure 4.** Stratigraphic section of Benchmark Cave (modified from the profile in the field notes prepared by Dave Read and Floyd W. Sharrock).

accomplished in 1962 (Sharrock 1964) when a crew expanded the excavation area within the cave both horizontally and vertically and widened and deepened the main trench to locate bedrock and obtain a better exposure of deposits from the rear of the cave to well beyond its mouth. Sharrock (1964:9) concluded that “the 1962 findings modify the earlier report [Lipe 1960] in so many respects that ... the first interpretation of the site will be ignored.”

The 1962 trench exposed over 4 m of fill consisting mainly of eolian sand mixed to varying degrees with cultural additions such as charcoal, ash, organic debris and artifacts. The one exception to this was a basin-shaped deposit of alluvial clay almost 3 m below the present surface (Stratum 4). The origin of this deposit was interpreted as a settling pool formed by high flood waters of the Colorado River (Stratum 4 was about 11.5 m above average river level) that occurred “sometime in the past 1000 years and after the first cave occupation” (Sharrock 1964:10). Sharrock (1964:16) believed that the numerous layers that comprised the fill accumulated rapidly without any apparent break or long-term hiatus in occupancy. No radiocarbon dating was done to determine the length of time represented by the 4.3 m of fill, but Sharrock (1964:18) believed that as little as 100 years was probable. A lack of pottery from Strata 1-7 was attributed to a failure by the earliest cave users to bring any to the site. Sharrock (1964:18) concluded that all findings from the cave “leave little doubt as to [site] function and time lapse: this was a popular camp or way station used intermittently perhaps as much as 100 years (probably less) prior to ca. A.D. 1150.”

I have no qualms with the functional interpretation or the conclusion that there was no long-term hiatus in human occupancy, but the time depth seems excessively truncated. It would be extraordinary if the 4+ m of fill at Benchmark Cave actually represented 100 years of deposition as claimed. Rapid and deep alluvial burial of sites is well documented in the Glen Canyon region (e.g., Red Ant Kiva, Sharrock et al. 1963), but not so for eolian burial. Excavated caves that have been radiocarbon dated reveal comparatively slow rates of eolian deposition, or virtually no deposition whatsoever during times when humans did not occupy the sites (Schroedl and Coulam 1994). For example, at both Cowboy and Dust Devil caves described below, 9000 years of deposition are represented by less than 2 m of



fill.

Sharrock's dismissal of Lipe's claim for a preceramic and preagricultural occupation of Benchmark Cave is unsupported by the excavation notes. Sharrock recovered two sherds below the layer that Lipe attributed as being preceramic and preagricultural, Lipe's Stratum IV, or Stratum 9 in the 1963 report. One came from Stratum 7, the other from Stratum 8, but there are problems with these finds. In the field notes (Feature 29, page 2) Sharrock observes that the corrugated sherd from Stratum 7 "could have fallen in the trench—i.e. not a positive association." The other sherd, a Tusayan Black-on-red, seemed to have a certain vertical provenience, but came from outside the cave proper where strata could not be accurately correlated with those within the cave. Sharrock admits as much in the field notes (Feature 30, page 3): "one [Tusayan Black-on-red] sherd may have been associated [with Stratum 8] but outside the cave. Here all strata become so blended that separation of strata is very tenuous."

*Sample Selection.* For radiocarbon analysis I selected portions of three plain-weave sandals from the collections of Benchmark Cave. These sandals represent a stratigraphic sequence from just below the surface (Stratum 12) to near the bottom of cultural deposits (Stratum 5). At a depth of over 2 m below the ground surface, Stratum 5 was the deepest cultural deposit from which perishable remains were recovered, and, except for Stratum 3, the deepest cultural deposit at the site. Several plain-weave sandals were recovered from the small exposure of this deposit, and one of these, a child's nearly whole sandal (FS 77.5), was selected for dating (see Kankainen 1995:49 for photo and description of sandal). A date on this artifact would provide the earliest record for this sandal type at the site and close to a maximum age for site occupancy.

The plain-weave sandals from Stratum 5 were the only ones recovered from prepottery contexts; the other examples came from Strata 10 and 12 where pottery was recovered. A sandal from each of these layers was selected for radiocarbon dating: FS 142.11 from Stratum 10 and FS 35.1 from Stratum 12. The several plain-weave sandals recovered from Stratum 10 may be in situ finds. All were large artifacts, unlikely to have been moved upward within the deposits except by human pit digging, and no deep features originated from this stratum. Only one sherd was recovered from Stratum 10, but the 1958 excavations obtained 23 sherds from the approximately equivalent Stratum III. Many of these refit, however, to sherds from higher strata (12 and 13), so they are likely intrusive from above, perhaps because pits from Strata 12 or 13 went unrecognized and their artifacts were included in Stratum 10 (examples include a jar filled with salt and a hide pouch filled with cottonseeds [Lipe 1960:97]).

The highest sandal in the sequence was FS 35.1 (see Kankainen 1995:47 for photo and description of the sandal), recovered during the 1958 excavations from what was then Stratum II, a cultural deposit just below the ground surface; Sharrock later redesignated this layer as Stratum 12. Stratum 12 contained pottery and other diagnostics of Pueblo culture dating to around A.D. 1000-1100. Based on my assumption that plain-weave sandals were an Archaic style, it seems likely that the sandal had been displaced upwards in the deposits of the cave by later digging of various pit features. If the sandal was actually contemporaneous with the pottery, then its radiocarbon date would confirm this, revealing that the sandal style was temporally widespread.

## The Hermitage

*Site Description.* The Hermitage occupies a narrow level area, approximately 40 m long and 1-4 m wide, atop a talus slope that is sheltered by a high, slightly overhanging cliff. The Hermitage was interpreted as a single-component Pueblo site occupied during the late A.D. 1000s and early 1100s (Pueblo II). An organic-rich trash deposit that reached a thickness of 1 m was interpreted as evidence for an intensive and continuous occupation. No plan map of The Hermitage was included in the excavation report; thus, one prepared by Peter Bodenheimer at the close of excavation is included here (Figure 5). The principal features at this site included a trash deposit (Feature 9), a pit house (Feature 2), four cists (Features 3, 4, 17, and 23), two packed use surfaces (Features 7 and 16), and a Glen Canyon Linear petroglyph panel (Figure 6, Feature 20).

The trash midden consisted of a medium to light gray deposit of varying proportions of ash, charcoal, and sand, and

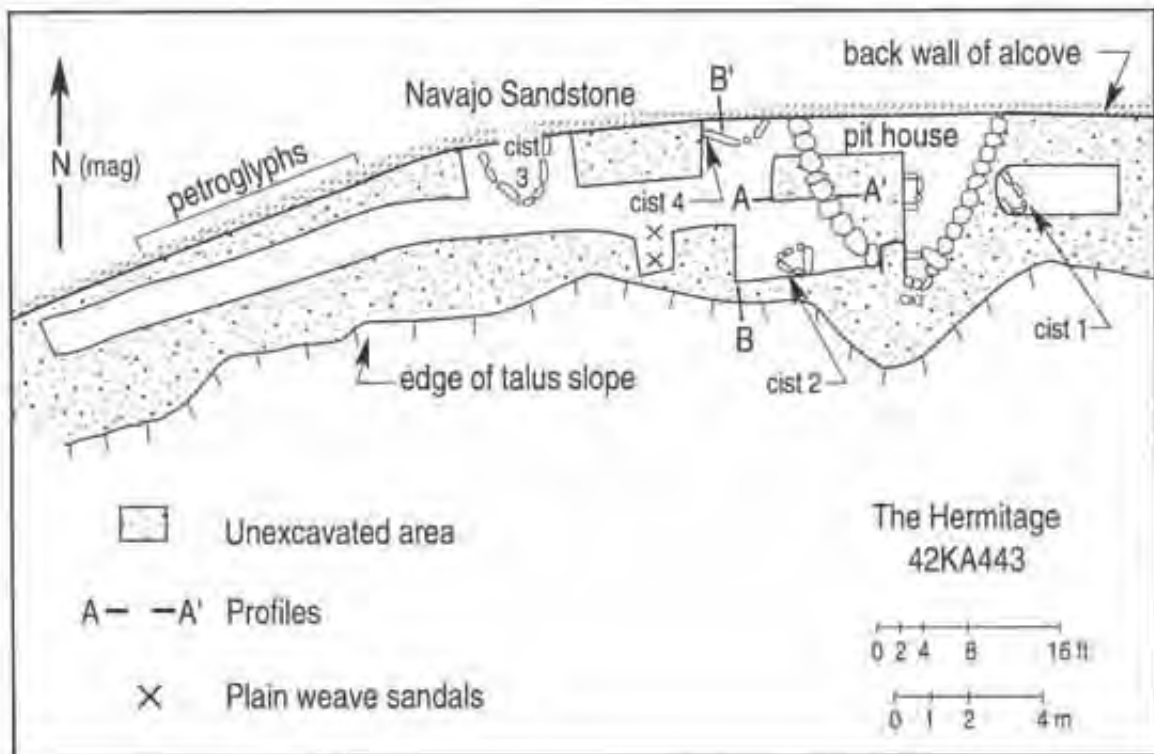


Figure 5. Planimetric map of the Hermitage after excavation, showing the location of profiles of Figure 6 (after the field map prepared by Peter Bodenheimer).

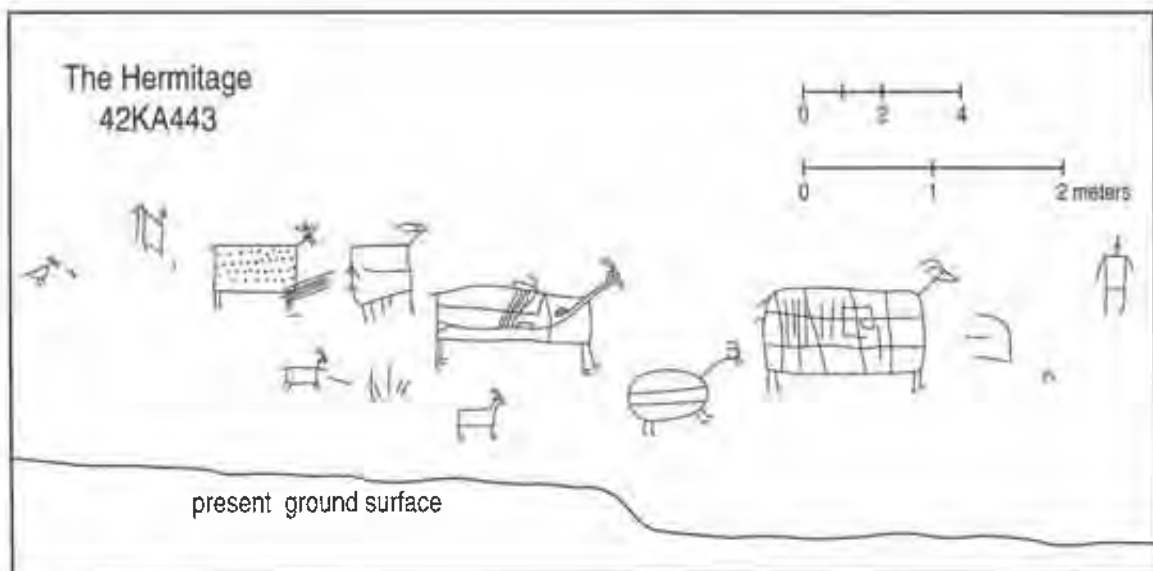


Figure 6. Glen Canyon Linear petroglyphs on the back wall of the Hermitage (after field sketch by William D. Lipe).

organic debris. The field notes reveal that many thin (1-3 cm) layers of ash, sand, and matted organic matter were observable in section, but that individual layers could not be followed horizontally (Feature 9, page 1). Besides individual thin layers, two major divisions of the trash midden were discernible in several places; the best field sketches of this were from the area of thickest trash accumulation immediately west of the pit house (Figure 7). The upper part (Feature 9A) contained considerable organic material and was more consolidated, while the lower part (Feature 9B) was mostly ash and loose sand with few organics. The deposit in this area was removed by arbitrary 12-inch levels that do not correspond neatly with this division. The trash deposit was removed from the rest of the site as a single undifferentiated layer except for near the western edge, where the two packed use surfaces provided separation for materials as either above or below these surfaces.

Some evidence gleaned from the field notes suggests that the site may have been occupied well before the Pueblo period. First of all, as Figure 7 reveals, the Pueblo II pit house postdates the trash deposit. The builders excavated a large pit through the trash deposit and into the underlying sterile to accommodate the pit house. Rubble fill was added between the masonry wall and trash deposit and extended out over the top of the trash deposit. A second point is that most sherds from Level 1 (0-12") of the excavation area west of the pit house came from the rubble and not from the trash midden (Feature 15, page 5). With the recovery of several plain-weave sandals from the trash deposit, it seems likely that most or all of the trash accumulated prior to the Pueblo period.

*Sample Selection.* Portions of two whole plain-weave sandals from the trash deposit were selected for radiocarbon analysis: FS 19.1 and 24 (see Kankainen 1995:84, 86 for photos and descriptions of the sandals). Based on size differences, the sandals were clearly not a pair. Both were padded with a mass of shredded grass that had conformed to the contours of the wearer's foot. With no vertical differentiation of the aceramic trash deposit, dates on the two sandals would suffice for initial temporal control over this likely Archaic cultural deposit.

## Dust Devil Cave

*Site Description.* Dust Devil Cave occurs within a dome-shaped erosional sandstone remnant, one of many that occur on the northern portion of the Rainbow Plateau. The cave measures about 14 m deep and 8 m wide; it occurs on the south side of a large U-shaped alcove that provides additional partially sheltered living space (Lindsay et al. 1968:Figure 80). Cultural deposits that reached a depth of 2 m within the cave spanned almost 9000 years. During the early Archaic, from about 9000 to 6800 B.P., foragers occupied the site frequently, resulting in a thick accumulation of ash, charcoal, and vegetation interspersed with sand (Stratum IV; Ambler 1996). Stratum IV at Dust Devil Cave was buried beneath a layer of eolian dune sand containing little evidence of human occupation (Stratum V). This stratum was deposited during an apparently lengthy period when the cave was seldom used and never intensively, perhaps as just an occasional rest stop by hunters en route to elsewhere (Ambler 1996). Use of the cave increased greatly during deposition of the overlying Stratum VI, when early farmers (Basketmaker Anasazi) occupied the site. The recovery of several Gypsum points from Stratum VI suggests that late Archaic hunters used the site sporadically as well. Farmers continued to use the cave on a limited basis throughout the Pueblo Period, resulting in the deposition of Strata VII and VIII. During historic times Navajo/Paiute herders penned sheep and goats in the cave, forming a dung layer designated as Stratum IX.

As of yet, only Stratum IV is well dated, with seven stratigraphically consistent radiocarbon assays ranging from 8830 to 6740 years B.P. (Ambler 1996:Table 7). The only dates yet available for Strata V and VI are two recently obtained radiocarbon assays on maize. At  $1480 \pm 80$  and  $1370 \pm 70$  B.P. (both corrected for isotopic fractionation), these dates are notably younger than anticipated, revealing that considerably more radiocarbon dating is required before the depositional histories of Strata V and VI are fully understood. Nonetheless, based on the age of Stratum IV and the occurrence of both late Archaic and Basketmaker remains from Stratum VI, the largely sterile eolian sand of Stratum V was likely deposited during the middle Archaic. Eolian sand had been continuously accumulating within the cave since the early Archaic, but was also receiving a heavy admixture of cultural debris (ash, charcoal, organics, artifacts).

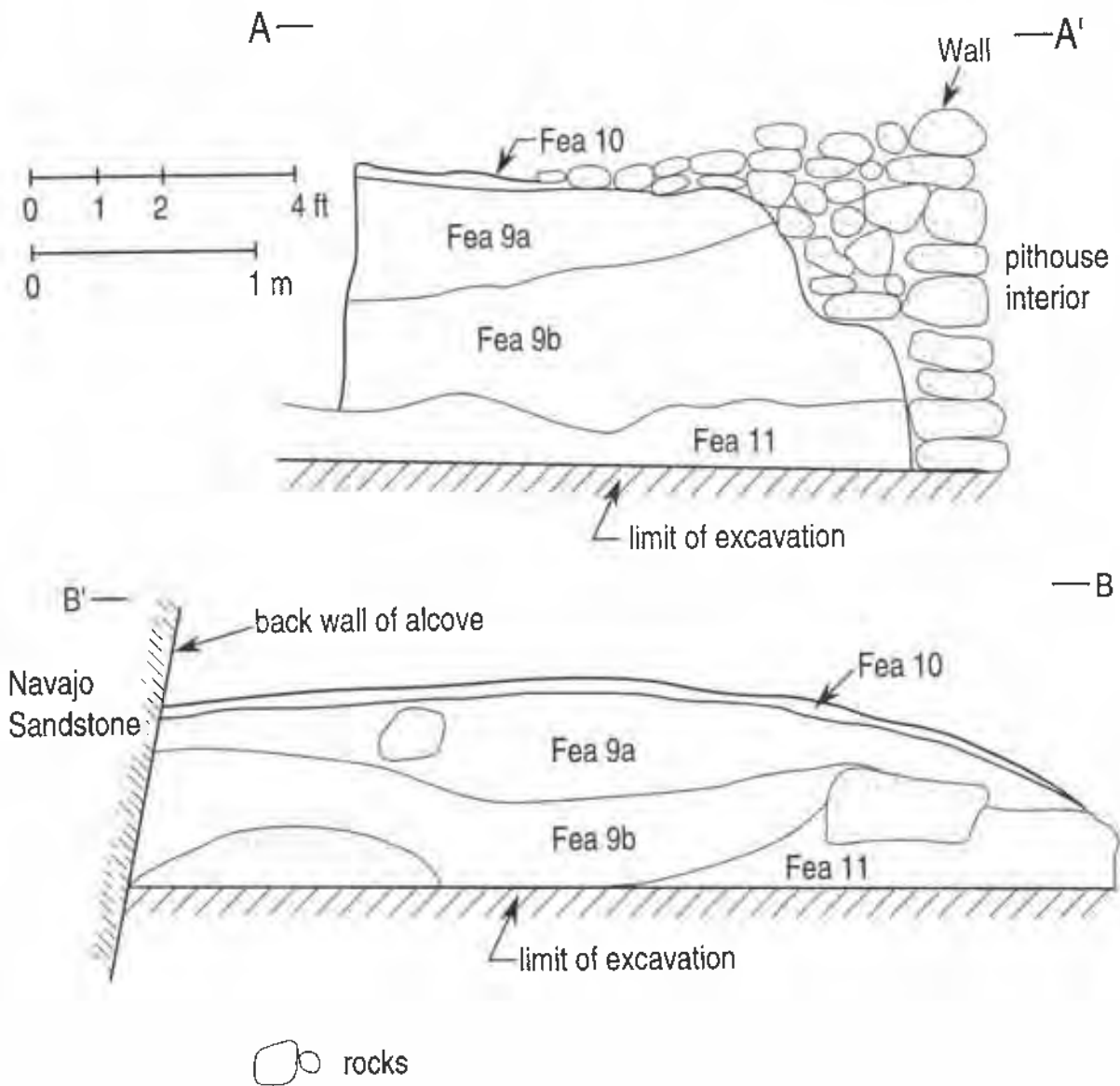


Figure 7. Stratigraphic sections of the deposits identified at the Hermitage (after field sketches by William D. Lipe).

As residential use of the site declined, cultural additions lessened, leaving the eolian sand that continued to accumulate within the cave appearing comparatively sterile.

From the 1970 excavations, Ambler (1996:Table 8) recovered eight plain-weave sandals—six whole or nearly whole examples from the upper portion of the early Archaic deposit, some from the very top at the contact with Stratum V, and two fragments from the middle portion of Stratum IV where open-twined sandals were more numerous. One plain-weave sandal from the top of Stratum IV (Square F9) was dated to  $6840 \pm 130$  B.P. (Ambler 1996:Table 7); along with a hearth charcoal date of  $6740 \pm 110$  B.P. (Ambler 1996:Table 7), it provided the upper temporal bracket for the early Archaic deposit.

*Sample Selection.* The two sandals from Dust Devil Cave selected for dating came from the top of Stratum IV, one from Square F8 (F8.6) and the other from F10 (F10.2). Portions of yucca leaf ties used in securing the sandals to feet were removed from both of the artifacts for radiocarbon dating. Because plain-weave sandals were not found in any younger strata at the cave, the examples from the top of Stratum IV represent the final interval during which this artifact type was disposed at the site. The one prior date on a plain-weave sandal from the top of Stratum IV (TX-1260) suggested that this interval occurred during the early portion of the sixth millennium B.P. (fifth millennium cal. B.C.), but with the overlying strata so poorly dated there was reason for caution. Assaying two additional plain-weave sandals from the top of Stratum IV would conclusively demonstrate when this type of footwear was last used at the site and whether the occupation of Stratum IV extended into the middle Archaic.

### Cowboy and Walters Caves

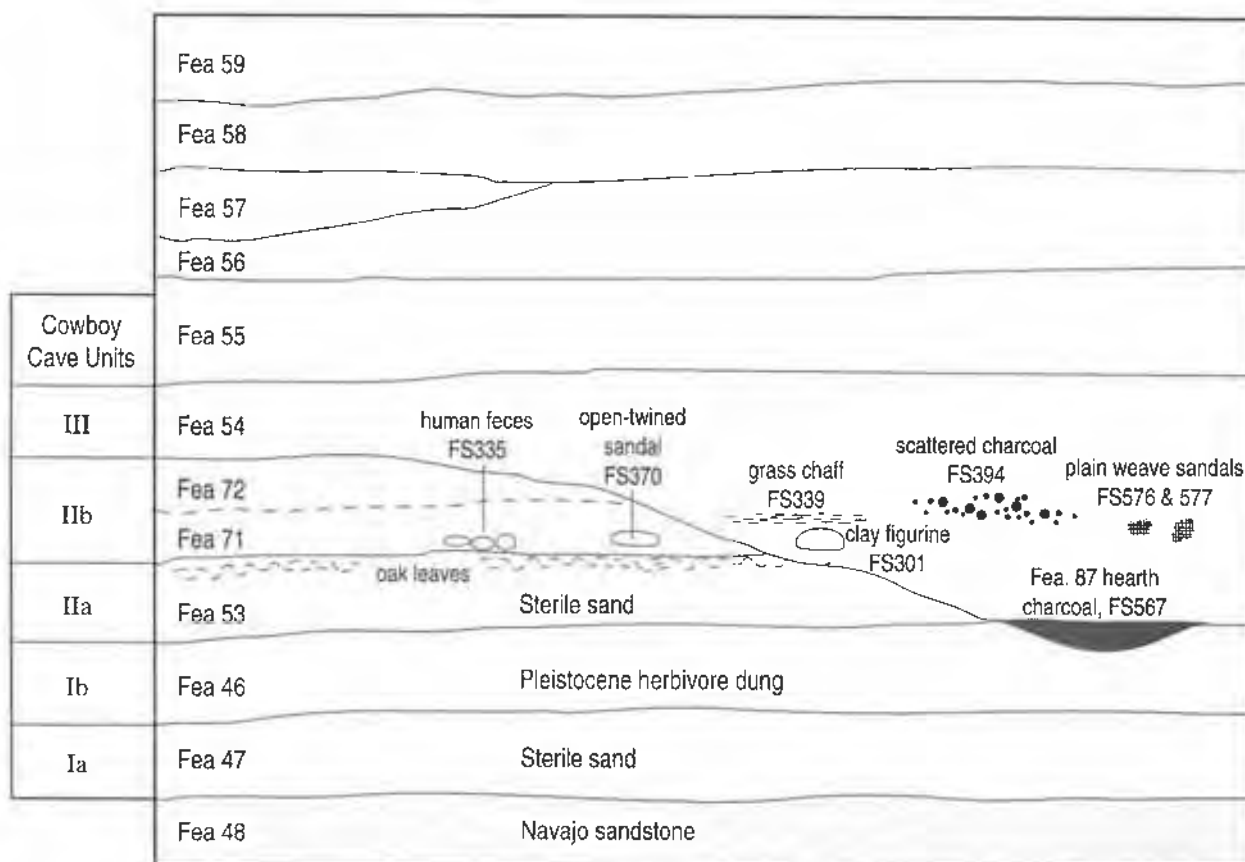
*Site Descriptions.* Cowboy Cave is the largest and deepest of all the shelters considered here, measuring 12 m wide at its mouth and 33 m deep. The adjacent Walters Cave is more comparable to Dust Devil in size, measuring 11 m wide at its mouth and 15 m deep. The most habitable portion of Cowboy Cave (the front lighted part), an area of about 110 m<sup>2</sup>, was completely excavated to or below a culturally sterile layer of Pleistocene herbivore dung. Excavations revealed 1-2 m of complexly stratified deposits from a history of occupation that spanned almost 7000 years. Jennings (1980:9-26) grouped the numerous individual strata of the site into four cultural units (II-V) thought to represent coherent intervals of occupation separated by periods of site abandonment. Schroedl and Coulam (1994) recently reviewed the evidence from the cave, clarifying site stratigraphy and artifact associations to arrive at a slightly revised sequence of occupancy. Strata IIb-IVb represent early Archaic deposition that is temporally similar to Stratum IV of Dust Devil Cave except that Cowboy Cave continued to be occupied for an additional 500 years or so after Dust Devil Cave was essentially abandoned. There was a large hiatus in occupation about 6300-3800 B.P., during which time there was virtually no deposition within the cave (Schroedl and Coulam 1994:22). The cave was reoccupied during the late Archaic, sometime after 3800 B.P., resulting in the accumulation of Strata IVc-Va. This was followed by another long hiatus from about 3200 to 1900 B.P., then reoccupation for about 500 years between 1900 and 1400 B.P.

Both plain-weave and open-twined sandals were recovered from Cowboy Cave. Most examples of these sandals came from the early Archaic Unit III, but a few examples were found in higher strata. As discussed earlier, the occurrence of open-twined sandals in the late Archaic and the more recent strata is attributed to prehistoric pit digging within the cave and a clerical error (see endnote 2). There is sufficient direct chronometric evidence to be certain that this sandal type has considerable antiquity no matter the age of its discovery context. This is not the case with plain-weave sandals, however; in fact, the occurrence of plain-weave sandals in later deposits of the cave may represent one aspect of cultural continuity during the Archaic period.

A 16 m<sup>2</sup> block excavated near the front of Walters Cave revealed almost 2 m of strata that were similar although not identical to those of Cowboy Cave, and the same general units of occupation were recognized. Because both caves had such similar deposits and histories of use, Jennings decided to leave the rest of Walters Cave untouched for future study. Unfortunately, as with several other partially excavated caves in Utah, looters subsequently mined the strata for artifacts, leaving little for future researchers (Jennings 1980:3).

*Sample Selection.* The two dated sandals from Cowboy Cave are FS 1692.1 and FS 1790. The former is from Stratum IVc (Feature 37), the depositional unit that represented the reuse of the cave during the late Archaic sometime after around 3800 B.P. A date on this sandal would reveal whether this artifact type continued in use at the site after the reputed 2000+ year occupation hiatus during the middle Archaic, or if the artifacts had been brought up from some lower depositional layer by prehistoric pit digging. Sandal FS 1790 came from Stratum IVb, once thought to represent a culturally sterile depositional layer that separated early from late Archaic strata within the cave. The cultural materials recovered from this and other sterile layers within the cave were attributed to intrusion from the overlying cultural strata (Jennings 1980:26). If the sandal had actually been deposited within the eolian sand of Stratum IVb as it accumulated, then the sandal would date to the middle Archaic or earlier.

The Walters Cave sandal is FS 576; it was one of two plain-weave sandals recovered from the limited work at this site. Both plain-weave sandals came from a layer (Feature 54) that seemed broadly comparable to Unit III of Cowboy Cave (Figure 8). Schroedl and Coulam (1994:26) do not believe that this reconstruction is accurate, but both the difference in sandal types between the strata (open-twined in Feature 71 and plain weave in Feature 54) and the dating of the sandals support my reconstruction. Two other sandals recovered from Walters Cave were open-twined specimens that came from a layer (Feature 71) comparable to Unit II of Cowboy Cave. One of these was radiocarbon dated to  $8875 \pm 125$  B.P.<sup>2</sup>



**Figure 8.** Schematic section of the strata exposed in the test of Walters Cave (reconstructed from field notes).

## RESULTS

The minute portions (0.6 to 0.04 g) removed from each of the plain-weave sandals were submitted to the NSF Accelerator Facility at the University of Arizona for AMS radiocarbon assay. Prior to their submission, I inspected each sample under a 40x microscope for any visual traces of contamination such as rodent urine or charcoal adhesions that would not be eliminated in normal laboratory pretreatment; there were none. Radiocarbon analysis of the samples proceeded normally and the results, corrected for  $^{13}\text{C}$  fractionation, are presented in Table 1. This table also gives the calibrated 2 sigma age range for each date as calculated by the CALIB program (Stuiver and Reimer 1993, revision 3.0.3A) using the 20-year data set and method A (results rounded to the nearest five years). The calibrated date ranges are graphed in Figure 3 along with the calibrated date ranges for all direct dates on open-twined sandals.

The plain-weave sandals range in age from about 6900 years B.P. at the oldest to 3200 B.P. for the youngest. The two sandals from Dust Devil Cave are the oldest of the lot and are comparable with the previous date on a plain-weave sandal from this site ( $6840 \pm 130$  B.P., Ambler 1996:Table 7). The average of these three statistically contemporaneous dates ( $T\phi = 1.47$ ,  $X\chi^2 = 5.99$ ) is  $6838 \pm 41$  B.P. Based on the calibrated age range of the average, it is evident that plain-weave sandals were last deposited in the cave between 5735 and 5600 cal. B.C. This was also the last time that Archaic hunter-gatherers used the site as a base camp judging from the near lack of cultural deposition within the cave during the formation of Stratum V.

The dates on the plain-weave sandals from Cowboy and Walters caves form a tight statistically contemporaneous group ( $T\phi = .14$ ,  $X\chi^2 = 5.99$ ), with an average of  $6378 \pm 45$  B.P. (2 sigma range is 5430-5250 cal. B.C.), at least three centuries after the last occurrence of the sandal type at Dust Devil Cave. The Cowboy Cave dates fail to support the contextual evidence that indicates a continuation of plain-weave sandals into the late Archaic. Perhaps some of the plain-weave sandals recovered from Stratum IVc actually belong to that depositional interval, but the evidence at hand suggests otherwise.

These two Cowboy Cave dates helped to bolster Schroedl and Coulam's (1994) argument that the "sterile" sand layers of Unit IV (Strata IVa and IVb) actually represent the end of early Archaic occupancy and not a natural depositional interval separating cultural layers. It is perhaps no coincidence that the sandal dates are almost identical to a date on charcoal ( $6390 \pm 90$ ; Jennings 1980:Table 3) recovered from Stratum IVa. Jennings questioned the stratum association once the radiocarbon result was known, and used the date as the upper temporal bracket for Unit III (Jennings 1980:Table 2) rather than as a beginning date for Unit IV.

The dated sandal from Walters Cave provides the only age determination for the stratum of this site that is comparable to Unit III of Cowboy Cave. This date is also important because of an associated painted clay anthropomorphic figurine (Hull and White 1980:Figure 47) that some authors (Schaafsma 1986:225; Schroedl 1989:17) hold up as indirect evidence for the considerable antiquity of the Barrier Canyon rock art style.<sup>3</sup>

Three of the sandals date to the middle Archaic, between 5600 and 5900 B.P., during the early part of the purported gap in the radiocarbon record for the Colorado Plateau. These are the two sandals from the preceramic midden deposit of The Hermitage and the sandal from the lowest cultural layer of Benchmark Cave that yielded perishable artifacts—Stratum 5. Unlike at Cowboy Cave, the plain-weave sandals from The Hermitage could not have been intruded up from some deeper cultural layers, since there were none. The sandal dates, therefore, also apply to the trash deposit. The presence of substantial middle Archaic trash accumulation suggests that this site likely served as a seasonally used residential base. At Benchmark Cave, too, the find context of the Stratum 5 sandal was doubtless its context of use; recall that the underlying Stratum 4 was the noncultural alluvial clay, which effectively sealed Stratum III, the lowest cultural deposit of the site. The roughly 1.5 m of cultural and noncultural deposits that separate Stratum 5 from the probable late Archaic Stratum 10 (see below) represent considerable middle Archaic deposition within the cave. Sharrock (1964) is still likely right that the numerous layers that comprised the fill accumulated without any apparent long-term hiatus in occupancy, but in light of the dates, the layers did not accumulate rapidly but rather over many millennia.

**Table 1.** Radiocarbon Dating Results for Plain Weave Sandals.

Site	Sample No.	Laboratory No.	Radiocarbon Age (BP)	$\delta^{13}C^*$	Calibrated 2 $\sigma$ Range
Benchmark Cave	FS 35.1	AA-10376	3355 $\pm$ 50	(-25.0)	B.C. 1745 - 1515
	FS 77.5	AA-13003	5810 $\pm$ 70	-23.5	B.C. 4835 - 4495
	FS 142.11	AA-13004	3210 $\pm$ 55	-23.3	B.C. 1605 - 1325
Cowboy Cave	FS 1692.1	AA-13005	6390 $\pm$ 65	-22.0	B.C. 5440 - 5225
	FS 1790	AA-13006	6385 $\pm$ 85	-21.9	B.C. 5445 - 5140
Dust Devil Cave	F8.6	AA-10379	6785 $\pm$ 60	(-25.0)	B.C. 5725 - 5525
	F10.2	AA-10378	6890 $\pm$ 60	(-25.0)	B.C. 5850 - 5610
Hermitge Site	FS 19.1	AA-10371	5890 $\pm$ 55	-12.1	B.C. 4905 - 4615
	FS 24	AA-10372	5665 $\pm$ 60	(-25.0)	B.C. 4680 - 4360
Walters Cave	FS 576.1	AA-13007	6350 $\pm$ 85	-22.9	B.C. 5440 - 5075

\*Numbers in parentheses are values assumed by the laboratory.

The surprise dates were those within the second millennium B.C. from Benchmark Cave. Prior to submitting any samples I thought that plain-weave sandals were being used well into the middle Archaic, but not later, and that the finds of this sandal type from late Archaic and younger strata at Cowboy Cave were due to prehistoric mixing of the deposits. At Cowboy Cave this may still be the case, but the current dates from Benchmark Cave confirm that plain-weave sandals were still in use during the late Archaic. A sandal technology that began during the end of the early Archaic, persisted during the middle Archaic, and extended into the late Archaic provides strong evidence for cultural continuity and casts further doubt on the notion of an occupational hiatus separating the early and late Archaic.

The sandal from Stratum 12 at Benchmark is now known to have been made about 2000 years prior to the start of pottery use within the region; thus its association with the pottery of Stratum 12 is spurious. The sandal was likely displaced upwards in the deposits by the Puebloan occupants who dug various pits within the cave. A likely origin for this sandal was Stratum 10, where several plain-weave sandals were recovered, one of which has an age similar to that from Stratum 12. Until additional dating proves otherwise, I find sufficient reason to believe that Stratum 10 of Benchmark Cave is a late Archaic cultural deposit.

By establishing the true antiquity of its deposits, Benchmark Cave takes on new significance with regard to



understanding the Archaic period and the adoption of agriculture. Indeed, if it were possible, a third round of excavation at this site would be called for (unfortunately the cave is now about 140 m below the waters of Lake Powell). The existing collections certainly deserve additional study and reconsideration in this new temporal light.

Both sites with plain-weave sandals dated to the middle Archaic are located in the Glen Canyon lowlands adjacent to the Colorado River. As evidenced by heavy trash accumulation, these riverine sites were evidently used extensively and frequently during the middle Archaic. In contrast, despite selecting sandals with the greatest possibility of dating to this interval, especially in the case of Cowboy Cave, the plain-weave sandals from the caves of the highlands date to the early Archaic. The sandal dates continue to support the notion that Cowboy and Dust Devil caves were either totally abandoned during the middle Archaic or used rarely. The abandonment or drastic reduction in use of previously well-used sites can be attributed, I believe, to a change in settlement pattern resulting from the culmination of early to middle Holocene drying and warming. During the middle Archaic for the central Colorado Plateau, water availability became a key factor in deciding which sites were and were not used as residential bases.

Reed and Nickens (1980:60) gave a similar explanation for the discovery of middle Archaic cultural deposits at DeBeque Rockshelter on the Northern Colorado Plateau. They suggested that the proximity of this shelter to the Colorado River may have made it a more suitable residence relative to other areas of the Colorado Plateau during a time of deteriorating environmental conditions.

## CONCLUSIONS

The dating of plain-weave sandals has helped to partially fill the reputed middle Archaic gap in the Colorado Plateau radiocarbon record. The sandals dated to between 5600 and 5900 B.P. come from two shelters of the Glen Canyon lowlands (The Hermitage and Benchmark Cave) that contain trashy layers from fairly substantial and repeated forager occupation. A series of dates from Benchmark Cave alone would likely reveal nearly continuous occupation from early through late Archaic. Had the preceramic deposits at The Hermitage and Benchmark Cave been radiocarbon dated when the sites were excavated, the whole notion of a middle Archaic date gap might never have occurred.

The dates presented here, plus others obtained in the past 15 years (see Geib 1995), do not support the notion that the Archaic Period of the central Colorado Plateau was characterized by a sequence of major population abandonments and intrusions. Middle Archaic dates between roughly 6000 and 4000 B.P. are still few in number, especially compared to the numerous examples of early and late Archaic dates, but there is good reason to suggest that the central Colorado Plateau was continuously occupied from about 9000 B.P. up through the introduction of agriculture and the end of the Archaic.

The sandal dates also demonstrate continuity in a perishable technology over a span of almost 4000 years. Plain-weave sandals provide a cultural link between the early and late Archaic occupations of the central Colorado Plateau. They were first manufactured during the end of the early Archaic and their production overlapped open-twined sandals during the first half of the seventh millennium B.P. Because certain sandals exhibit aspects of both plain-weave and open-twined construction techniques, it is evident that the plain-weave style developed out of the open-twined style. Plain-weave sandals continued in use through the middle Archaic and into the late Archaic, up to 3000 years ago. This reveals long-term stability and continuity in one aspect of perishable technology during a time when new projectile point styles were adopted and settlement and mobility patterns were significantly altered.

The sandal dates appear to support the idea that well-watered portions of the central Colorado Plateau became more focal to settlement-subsistence patterns during a time of maximum Holocene warmth and dryness. The sites with abundant evidence of middle Archaic occupancy are those situated alongside the Colorado River, while caves in dry upland settings that had previously served as residential bases were seldom occupied.

## ACKNOWLEDGMENTS

The sandal samples were dated at the NSF–Arizona AMS Facility at the University of Arizona, which receives partial funding from the National Science Foundation. I greatly appreciate the efforts of A.J.T. Jull and the rest of the staff at the AMS facility. Most of the samples came from the Utah Museum of Natural History, University of Utah; Laurel Casjens and Kathy Kankainen of the museum were invaluable in researching the collections. J. Richard Ambler sparked my interest in the Archaic many years ago and has continued to stimulate ideas. William D. Lipe encouraged me to research the Glen Canyon Project collections from sites such as The Hermitage and Benchmark Cave because he was sure that Archaic components had gone unreported. His comments on a draft of this paper, as well as those of R.G. Matson, Miranda Warburton and Francis E. Smiley, are greatly appreciated. I thank Louella Holter for word processing and editing and Ron Redsteer for the excellent maps. As a final note, it is a credit to Jesse Jennings's system of note taking and collections management that I could so readily use the collections and notes housed at the Utah Museum of Natural History to pursue new lines of research.

## NOTES

<sup>1</sup>Lipe (1960:99) identified a "preceramic and preagricultural" occupation of the cave, but this interpretation was superseded by Sharrock's (1964) conclusion that the site was occupied for just a brief 100-year or so interval during Pueblo II.

<sup>2</sup>The dated sandal was not described prior to being destroyed for a radiocarbon date. Examination of field photographic archives housed at the University of Utah leave no doubt that it was an open-twined sandal. Hewitt (1980:Table 14) does not list any open-twined sandals recovered from Walters Cave, yet a field photograph clearly shows two open-twined sandals in situ in the lowest cultural deposit (Feature 71) at the cave. One of these was specifically identified as a sandal in the field notes and field specimen log and this was the artifact submitted for radiocarbon dating (FS370). The other artifact was identified as basketry in the field notes and specimen log, yet no basketry is listed as coming from Walters Cave (Hewitt 1980:Table 14). This discrepancy resulted because the field specimen number for this other woven artifact was written down by the analyst as 1370.2 instead of 370.2 (Nancy Hewitt's sandal analysis notes on file at UMNH). In the field specimen log, FS1370 is listed as a metate fragment from Cowboy Cave, not Walters Cave. Hewitt describes the 1370.2 artifact as a poorly preserved fragment of an open-twined sandal, which is exactly what the field photograph shows. There are no other artifacts in the collections with the FS370 designation, just the sandal fragment that Hewitt describes as 1370. Resolving this discrepancy also removes the one open-twined sandal listed as coming from Unit V of Cowboy Cave. It is abundantly clear that use of this type of sandal had discontinued thousands of years prior to Unit V occupancy. It is now evident that a simple clerical error added the sandal to Unit V of Cowboy Cave instead of its proper provenience as Unit II of Walters Cave.

<sup>3</sup>The type site for the Barrier Canyon style is located within the same drainage system as Cowboy Cave, only about 18 km from the cave. Recent attempts at directly dating Barrier Canyon rock have not yet obtained a determination as old as the sandal associated with the figurine (Tipps 1995).

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