

Bedrock and Boulder Mortars, Basins, Slicks, and Cupules in the Southern Southwest

Allen Dart and Chris Reed



Figure 1. Cupules on a cave wall extension in Gila Cliff Dwellings Cave 5; each cupule is no more than 5 cm (2 inches) in diameter (Photo by Chris Reed)

If you've visited Gila Cliff Dwellings National Monument in New Mexico you may recall having seen the dimpled rock expanse in one of the cliff dwellings' caves, shown here in Figure 1. Or, if you've traipsed around elsewhere in the "southern Southwest" area of the United States you may have come across bedrock outcrops or large boulders similarly pitted with pockmarks or circular holes.

If you guessed these holes and depressions are human-made, created by grinding, pounding, pecking, or other abrasive action rather than by natural occurrences, you're probably right. If you think ancient American Indians used all of them for grinding things, you may be only partly right.

For purposes of this article we identify three basic types of human-made depressions in bedrock and boulders – mortars, cupules, and basins/slicks, which we define on page 2 and discuss thereafter.

We define the southern Southwest, for this article only, as the region of the U.S. south of 34 degrees north latitude that includes the California portion of the Lower Colorado River valley and southern portions of Arizona and New Mexico, and the portion of western Texas that includes El Paso, Hudspeth, Culberson, Loving, Winkler, Ward, Reeves, and Jeff Davis counties (roughly the part of Texas from El Paso eastward just past the southeastern corner of New Mexico, then south and southwestward to a point south of Fort Davis, then

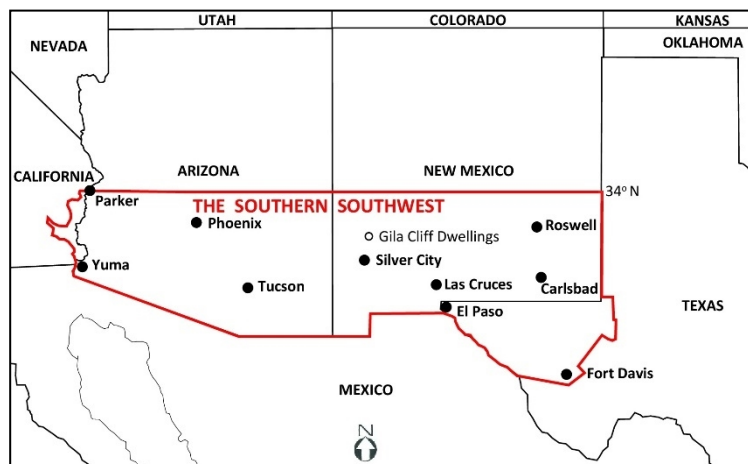


Figure 2. Map of the southern Southwest as defined in this article

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Figure 3. Aerial view from drone of bedrock mortars in Cienega Draw near Fort Davis, TX (Photo by Mark Willis, Sacred Sites Research, Inc.)



Figure 4. Bedrock mortars with “goggle-eye” and other petroglyphs in Hudspeth County west of Van Horn, TX (Photo by Mark Willis, Sacred Sites Research, Inc.)

westward to the Río Grande (Figure 2). Arbitrary? You bet, but we had to draw limits somewhere!

Definitions and Overview

For purposes of this article we define mortars, basins, slicks, and cupules as follows:

Mortar: A human-made cavity, ranging from circular to ovoid, that was created by pecking, pounding, and grinding with a pestle, which typically caused rotary or vertical wear in the cavity; typically U-shaped in cross-section and more than 9 cm (3.5 inches) in diameter.

Basin or slick (Also called basin metate and grinding slick, respectively): A human-made depression, ovoid or irregularly shaped, that was created by grinding, usually quite shallow but often highly polished; grinding striations, if visible, may be either ovoid or parallel to an axis of the feature.

Cupule: A human-made depression, circular or ovoid, that was pecked or ground into a horizontal, diagonal, or vertical rock face or underside; relatively shallow, often less than 5 cm (2 inches) and usually no more than 8 cm (3.2 inches) in diameter.

Mortars, basins, slicks, and cupules may occur alone, in groups of the same type, or in combination with other depression types. These three depression types also are often associated with petroglyphs or pictographs. For example, archaeologist Marc Thompson informed Dart in 2020 that bedrock mortars are present at 10 (77 percent) of 13 rock art sites he has visited in southwestern New Mexico’s Mimbres region, and Margaret Howard (2010:143) reported almost two-thirds of the mortars in Hueco Tanks State Park & Historic Site near El Paso are within 10 meters (33 feet) of imagery panels.

Mortars, cupules, and basins/slicks are widespread in the southern Southwest as evidenced by the locations given in our photo captions.

Mortars

Figures 3-10, 12, 18-28, 37, 43, 45, 48, and 54 show examples of mortars and similar depressions that have been found worn into exposed bedrock



and boulders. Most of the mortar photos are arranged sequentially to show locations of these features approximately in east-to-west order through the southern Southwest. (Photos of basins, slicks, and cupules discussed in following sections likewise are arranged approximately east to west.) Figure 11 shows natural resources that likely were processed in most of the southern Southwest's mortars. Figures 13, 16, and 17 illustrate some holes in vertical bedrock that were used as sockets for roofing poles and possibly for seating upright posts. Figures 14 and 15 are maps of features in the Gila Cliff Dwellings archaeological site that we discuss.

Mortars often occur in foothills locations where bedrock and large boulders are common, in bedrock exposures alongside streams and washes, and on rocky hilltops. The bedrock and boulder mortars are usually found away from archaeological habitation sites (likely because bedrock and densely bouldered areas are less than ideal locations for settlements), whereas portable mortars created in cobbles and small boulders (see Portable Boulder Mortars below) more often are found in dwelling sites, often during archaeological excavations of house ruins.

Mortar Grinding and Processing Functions.

Experimental archaeological studies indicate stone mortars and other basin-shaped milling stones (basin metates) are not very efficient for grinding corn, the most commonly farmed crop of ancient peoples in the Southwest. Actual archaeological discoveries indicate ancient southwestern peoples ground their corn kernels mainly on stone slab- or trough-shaped metates. Evidently, then, the ancient bedrock and boulder mortars were used for something else. The usual interpretation is that they were used primarily, if not exclusively, for processing wild plant resources, especially seeds and grains.

Outdoor bedrock and boulder mortars commonly are found in areas containing mesquite (genus *Prosopis*, several species) and other legume (bean-producing) trees. Not surprisingly, ethnographic studies that describe American Indian use of mortars in Arizona, New Mexico, and Sonora, Mexico, indicate their most common use in those regions was for milling bean pods of the mesquite trees (Figure 11) for food.

Mesquite pod milling was especially common among the Tohono O'odham of southern Arizona and northern Sonora, as documented by William H. Doelle (1976). Historically when the mesquite



Figure 5. Aerial view of bedrock mortars at an archaeological site near Jal, NM (Photo by Mark Willis, Sacred Sites Research, Inc.)



Figure 6. Bedrock mortars along the Pecos River near Carlsbad, NM, being recorded by archaeologists during a research project by SWCA Environmental Consultants; compressed air was used to excavate these mortars (Photo taken via Pole Aerial Photography by Mark Willis, Sacred Sites Research, Inc.)



Figure 7. Bedrock mortars between Three Rivers and Carrizozo, NM (Photo by Joan E. Price, Jornada Research Institute)

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Figure 8. Basin and mortar with in situ stone pestle on upturned slab boulder in the Tularosa Basin, NM; the slab could have been tipped over by direct human action or during an earthquake (Photo by Mark Willis, Sacred Sites Research, Inc.)



Figure 9. Bedrock grinding basin (foreground) and mortar in cliff overhang at Hueco Tanks State Park & Historic Site near El Paso; there also are cupules in the park (Photo by Amanda Castañeda)

beans ripened and dried up, Tohono O’odham women gathered pods still on the trees as well as ones that had dropped to the ground, and carried them to wherever stone mortars were located for processing. The small, hard mesquite beans take a lot of effort to process and cook, so unless their people were starving, the women normally would use baskets as sieves to winnow out the seeds and throw them away. What they were really after was the dried pods, which they ground up in mortars almost as finely as corn meal. The mesquite flour was then used much in the same ways as it is possible to utilize corn meal, for example, for making thin breads, small cakes, and gruels. Mesquite pods are high in carbohydrates and most of the ones from mesquite trees native to the Southwest are fairly sweet when dried.

Julian Hayden (1969) observed that O’odham in the Sierra Pinacate of Sonora (probably Hia C’ed O’odham) used communal “gyratory crushers” (specialized bedrock mortars) for initial milling of mesquite pods near where they were gathered, but that the roughly crushed material was then taken to the villages for grinding to *pechita* (flour) on individually owned metates. Wallace and Holmlund (1983) suggested this sequential rough and fine processing of mesquite may be attributed to the presence of rock outcrops throughout the non-riverine O’odham lands that are suitable for bedrock mortars, whereas where the Akimel O’odham live along the Gila River the mesquite bosques are situated where there were few or no bedrock outcrops.

Ethnographer Frank Russell (1975) wrote that the Pima (Akimel O’odham) also processed seeds of palo verde (*Cercidium* spp., a legume tree), cotton (*Gossypium* spp.) seeds, and the heads of salt-bush (*Atriplex* spp.) plants in mortars. Wallace and Holmlund (1983) reported that a Tohono O’odham woman, Juanita Ahill, indicated some Tohono O’odham also processed acorns in mortars.

Ethnobotanist Wendy C. Hodgson (2001:191-195) described ethnographies attesting that Tohono O’odham, Akimel O’odham, Cocopah, and Paipai in the southern Southwest, and, beyond our study area some other southern California Indians, Southern Tonto and Western Apache, and Yavapai consumed acorns from several oak species (*Quercus*

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spp.) historically. Sometimes they just cracked them open and ate them whole and raw but some of the groups processed the nuts by leaching, parching, or roasting. The only peoples Hodgson identified who pounded or ground their acorns are Western Apache, Southeastern Yavapai, Paipai, and some southern California and Baja California natives who apparently only did so on stone metates; and the Southern Tonto Apache of northern Arizona and Diegueños of southern California, who used mortars. Juanita Ahill's statement is the only one we have found indicating that O'odham sometimes used mortars to process acorns.

Paleoethnobotanist Lisa W. Huckell reported that burned acorn shells were recovered from two pre-Hispanic pithouses excavated at an archaeological site south of Tucson in Green Valley, Arizona, and that some of the shells were in a macrobotanical sample taken from the fill of a reconstructible pottery vessel. Huckell reasoned, however, that these acorn fragments were from the locally available Arizona oak, *Quercus arizonica*, which produces sweet acorns that require little or no pretreatment prior to consumption except leaching to remove the astringent, toxic tannin (Huckell 1997: 170, 172, 173). Therefore, even though four small boulder mortars and 27 pestles were recovered from excavations at this site (none from the same houses as the acorn shells), mesquite seed coats and cotyledon fragments also were present (Dart 2014), so the mortars or other grinding implements may not have been required for processing the acorns.

There are plenty of mountains in the southern Southwest where oak (*Quercus* spp.) trees abound and some oaks co-occur with archaeological sites that contain mortars. New Mexico's Gila Cliff Dwellings contain mortars (Figures 12 and 13) and are in mountains where oaks are present but no mesquites grow anywhere close today (Studd and Galvin 2019). The mortars in Gila Cliff Dwellings and other high-elevation sites, therefore, may have been used to process acorns or other items but probably not mesquite.

Ethnographers Willis H. Bell and Edward F. Castetter (1941:58) reported stone and wooden mortars in southwestern Texas also were used historically to prepare sotol (*Dasyliirion* spp.) for food. Castetter, Bell, and Alvin R. Grove (1938:50) wrote that Maricopa (Piipaash) Indians may have used mortars to pound the leaves on the baked hearts of agave (*Agave* spp.). Castetter and M. E. Opler



Figure 10. Bedrock mortars in the Organ Mountains portion of Organ Mountains-Desert Peaks National Monument east of Las Cruces, NM (Photo by Margaret K. Berrier)



Figure 11. Drying bean pods on a mesquite (*Prosopis velutina*) tree in southern Arizona; bedrock mortars in the southern Southwest typically are found in association with mesquite, and ethnographic studies indicate the pods of various mesquite species were the main resources processed in mortars (Photo by Paul R. Fish)



Figure 12. Bedrock mortar on ledge near Rooms 17, 18, and 20 in Gila Cliff Dwellings Cave 4 (Photo by Chris Reed)



(1936:55) speculated mortars also could have been used by the Mescalero Apache to crush small red fruits of “turkey or coyote cactus” (*Opuntia leptocaulis*) for mixing with tulpai (an alcoholic beverage) for narcotic effect.

Varied mortar shapes in different parts of the southern Southwest may provide another clue to what might have been processed in the mortars of some subregions versus others. Amanda Castañeda, for example, informed Dart that some bedrock mortars in southeastern New Mexico are intriguing because so many of them there are ovoid/oblong at the opening, so this shape may have been standardized there. Her observation is borne out in comparing the mortars in our Figure 5 and some of the ones in Figure 6 with the other photographs of mortars presented here.

Stone pestles have been found in and near bedrock and boulder mortars at some archaeological sites (Figure 8), attesting that at least some of these features were used for milling. If pestles are not present, one should consider whether they might have been kept elsewhere by their users, removed by persons later, or that the mortars may not really be mortars, but holes used for other purposes. The presence of pestles, or evidence of use-wear (polishing, abrasion, chipping, or pecking scars) on the interiors of mortars, cupules, or basins/slicks would support the idea they were used for milling. Indications of polishing, abrasion, and so on may be absent if the stone is very hard. Jenny Adams (in Burton and others 2017) suggested such indications also may not be visible if the humanmade depression has become deteriorated after its last use by natural processes such as growth of plant roots, lichen, or moss intruding into the depression, freeze-thaw interactions, or even chemical interactions such as oxidation or calcium carbonate (caliche) deposition.

Ethnographies attest that both stone and wooden pestles were used historically (Felger 1977:156; Bell and Castetter 1937:24; Rea 1997), so wooden ones presumably also were used in pre-Hispanic times even though wooden artifacts are rarely found in buried archaeological contexts.

Bedrock Post Sockets. Holes cut into vertical bedrock faces, for example in New Mexico’s Bandelier National Monument (Figure 16) and at the Patio House site in Arizona’s Petrified Forest National Park, are interpreted as archaeological sockets for roofing poles, so there is no reason why some holes in horizontal bedrock exposures cannot be interpreted as fence- or gate-post sockets. We have found two instances in the southern Southwest of holes in bedrock that have been interpreted as mortars but that may instead be post sockets.

The first instance is an array of six holes just west of Cave 1 (Figures 13 and 14) in southwestern New Mexico’s Gila Cliff Dwellings that extend from the upper cliff face across a nearly horizontal bedrock surface to an offset cliff drop-off. (The Gila Cliff Dwellings are mentioned several times in this article so Figures 14 and 15 are provided to show some of the places within that site that we discuss.) The only trail that enters and exits the Gila Cliff Dwellings caves runs along this nearly horizontal surface where the six holes are situated, and four of them are aligned perpendicular to the trail. The hole nearest the cliff drop-

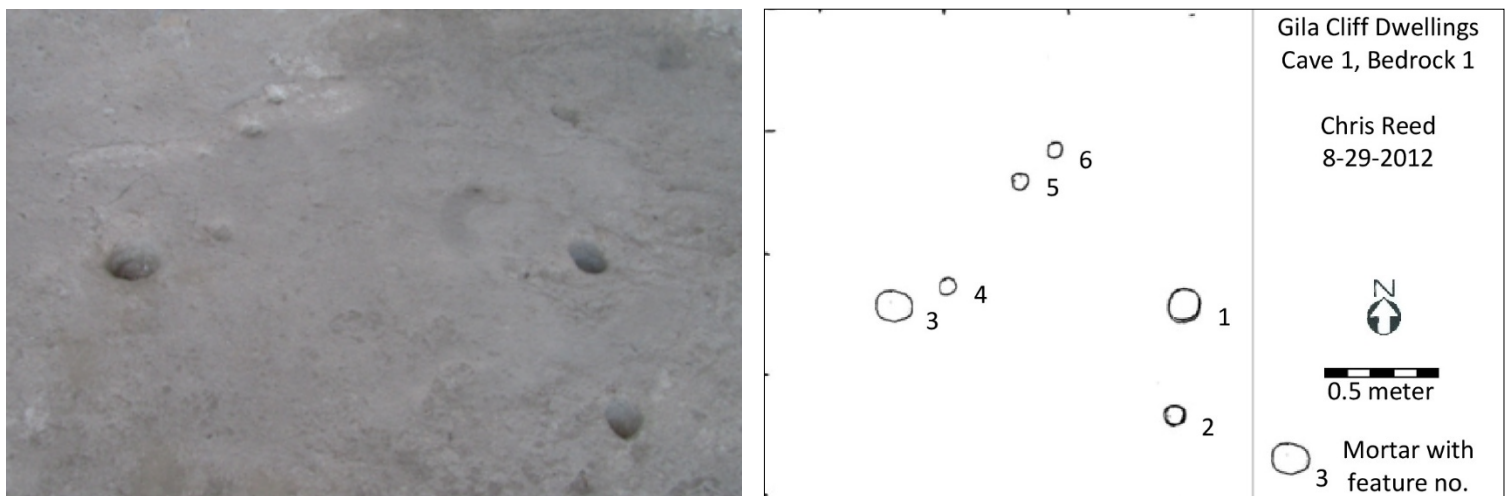


Figure 13 (above). Photo and plan drawing of six mortar-like holes in bedrock that may be sockets for fencing and brace posts along original trail that ran eastward into Gila Cliff Dwellings Cave 1 (Photo and drawing by Chris Reed)



Figure 14 (right). Gila Cliff Dwellings map with cupules and mortars identified by Reed

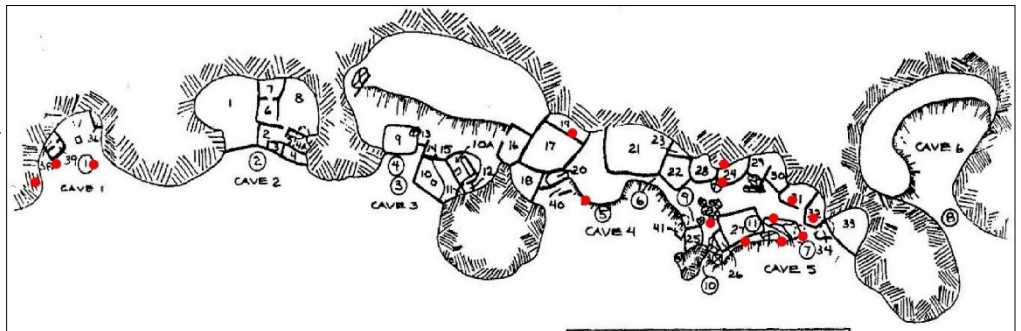


Figure 15 (below). Diagram showing Cave 5 and corresponding rooms, other archaeological features, and open areas (OAs)

Both maps adapted from Nordby (2011)

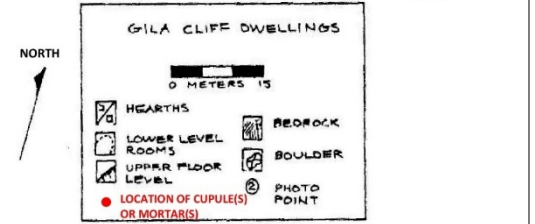
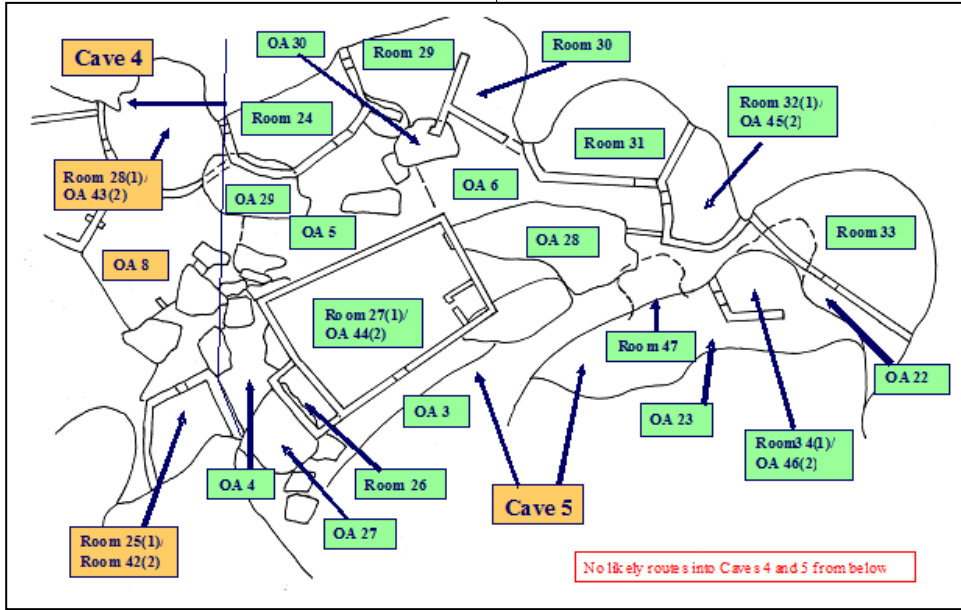


Table 1. Data for six holes in bedrock along trail into Gila Cliff Dwellings Cave 1

Hole No.	Diameter	Depth
1	12.0 cm	11.0 cm
2	10.0 cm	7.0 cm
3	12.5 cm	9.0 cm
4	6.0 cm	2.0 cm
5	7.0 cm	2.0 cm
6	7.0 cm	1.5 cm

off edge (no. 3 in Figure 13) is the largest and deepest of the four aligned holes (Table 1). The other two (nos. 1 and 2) are offset about 1 and 2 meters, respectively, from the aligned set.

The largest two of these six holes, nos. 1 and 3, fit our page 2 criteria for identification as mortars, and holes 4-6 meet our cupules definition. However, the six holes' spatial configuration relative to the trail, and the depths of holes 1, 2, and 3 relative to their diameters – unusually narrow and deep compared to other pre-Hispanic bedrock mortars – (compare Figure 13 with Table 1) suggest the aligned holes 3-6 were post sockets for a fence or gate to control access to the cave and that outlying holes 1 and 2 may have been seating holes for brace posts to support the fence or gate. Such a feature along the cave-entry trail could have been used for defense against perceived enemies, to deter wild animals from coming into the habitation area, to keep children from going out and getting into danger, or in other ways.

A second southern Southwest instance of holes in bedrock that have been interpreted as mortars but that may instead be post sockets is at the Reeve Ruin in the San Pedro River valley east of Tucson



Figure 16. Holes cut into cliff faces at sites like this one in Bandelier National Monument, NM, confirm that some holes in bedrock were used as pole sockets (Photo by Chris Reed)

Plate 13. *The North Trail.*

- a. Aerial view of trail looking SE
- b. Looking uptrail from first bench.
- c. Mortar holes on first bench.
- d. Mortar holes on second bench.

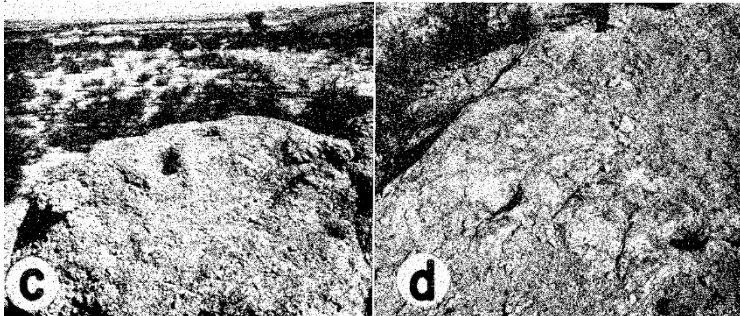


Figure 17. Photos of Reeve Ruin north trail and holes in bedrock on San Pedro River terrace benches beside the trail; photos b-d and Plate 13 caption scanned at 600 DPI from Di Peso (1958:27, Plate 13) with permission of The Amerind Foundation, Inc., Dragoon, AZ; upper photo is Amerind Negative No. RR-49, provided by Amerind President Eric J. Kaldahl, Ph.D., cropped by Old Pueblo Archaeology Center to show more clearly approximately the same view as the aerial photo in original Plate 13a (Amerind no longer retains original photos used in Plate 13)

(Figure 17). In his report on excavations there, archaeologist Charles Di Peso noted that the northern of two trails leading down from the mesa top where the Reeve Ruin is located:

led from the village entrance in Plaza 1 down the steep northern tongue of the mesa to the valley lands below. Crude steps and two natural bench work areas, complete with mortar holes in the live rock, clearly defined this approach. This steep trail began in the valley land, northwest of the village site. It rose sharply 9.30 m. (31 ft.) to the lowest bench where a series of mortar holes were located From this particular bench the trail ascended in a southerly direction along the narrow crest of the mesa which, along this course is approximately 20 m. wide and has an abrupt drop on the eastern and western flanks. A second stone bench with two mortars in the native rock was then encountered From this second bench . . . the trail continued upward along the precipitous back of the rising mesa to the summit. It was along this section that crude steps were cut in the path. [Di Peso 1958:27-28]

Di Peso noted that each of the four mortars along the Reeve Ruin trail was approximately 15 cm in diameter and 20 cm deep, proportions that would have served well to hold up posts, especially if sticks or chinking stones were pounded in beside the posts to wedge them in more firmly.

Other examples of pre-Hispanic human-made holes in bedrock elsewhere in the Southwest are or may be post sockets rather than mortars. One example, described and illustrated with photographs in Edmund Nequatewa's 1936 book *Truth of a Hopi*, is a set of "circular holes, about eight inches in diameter, cut in the rock at the cliff edge" near the 1200s CE pueblo of Pivahonkiapi. The photos, however, show these holes had vertical sides and suggest they were 12 inches (30 cm) or larger in diameter. An editor's note in this book says some Hopi believed the holes were associated with the Ladder Dance (Nequatewa 1936:103).

Northern Arizona University Professor Kelley

Hays-Gilpin informed Dart in 2020 she has seen similar large holes at Kawayka'a Pueblo on Antelope Mesa and that Hopi oral traditions attribute them to performance of the extinct Ladder Dance, in which tall poles were set in sockets in the edge of the mesa and performers climbed them and swung around, probably similar to central Mexican *voladores* dances in which men tied to ropes spun around the tops of poles. Hays-Gilpin also noted the Kawayka'a holes are "way too deep to be mortars, and are larger than most mortars."

Two examples of possible bedrock post sockets in the Southwest, beyond our study area, were reported to Dart in 2020 by archaeologists Thomas Windes and Dennis Gilpin. Windes wrote that on the cliffs of Chaco Canyon just west of Pueblo Bonito and above Richard Wetherill's grave, there is a row of holes in bedrock in stone circle site 29SJ 1572 that Windes interprets as sockets for some kind of fencing or



barrier rather than for a structure. Gilpin wrote that he had recorded two holes in bedrock beside the only access trail leading to a pueblo archaeological site at the top of a butte/mesa near Steamboat, Arizona, along a narrow neck of land at the top of the only gap in sheer cliffs. Gilpin originally interpreted the holes as bedrock mortars but now acknowledges their position is suitable for postholes for a gate of some sort.

Mortars as Containers. Mortars, especially the deeper ones, and some of the other stone depression types discussed here are naturally suited for use as containers. Archaeologist Jenny Adams suggested to Dart (2020) that some outdoor mortars or mortar-like holes actually could have been designed for water catchment, especially if connected with cracks or pecked/ground grooves that could channel water into them.

Regardless of whether they were intended to catch water, mortars can hold rainwater for up to several weeks after storms depending on weather conditions, so also may have been important drinking water sources in southern Southwest deserts. Herbert Yeo, an avocational archaeologist who in the 1930s and 1940s recorded hundreds of mortars in southern New Mexico, called them *pozos*, Spanish for ‘water wells.’ However, a colloquial meaning of *pozo* – ‘cesspool’ – may have been what inspired his choice of the *pozos* term, considering that mortars often become ripe with algae and other rotting vegetal detritus after rainwater stands in them for long (Figure 19).

Possibly some mortars were used for juicing fruits. If acorns were targets of pulverization, the deeper mortars also could have been used for soaking the smashed cotyledons (nut interiors) to leach out the tannins. Castetter, Bell, and Grove (1938:63) observed that the Tarahumara of northern Mexico used pockets or hollows in rocks to ferment baked agave crowns into an intoxicating beverage, so possibly some peoples in the southern Southwest used bedrock and boulder mortars as fermentation pits.

Mortars and basins in rock also could have been used intentionally as containers outright, in addition to or instead of using them exclusively as processing holes. Use as containers should be considered especially if no pestles have been found in or near mortars and basins or if the depressions show no evidence of abrasion or polishing.



Figure 18. Mortars and slicks on bedrock outcrop MK-2 at Los Morteros Hohokam archaeological site in Marana, AZ; MK-2 identification was assigned by Wallace and Holmlund (1983) (Photo by Katherine Page Burdick)



Figure 19. Bedrock mortars (one with standing water and algae), basins, and slicks in White Tank Mountains west of Phoenix (Photo by Christopher Doolittle courtesy of Statistical Research, Inc.)



Figure 20. Mortars within a slick (apron) on petroglyphs boulder at Painted Rocks Hohokam-Patayan site northwest of Gila Bend, AZ (Photo by Allen Dart)



Figure 21. Bedrock mortar, cupules, and petroglyph at Sears Point in lower Gila River valley, AZ (Photo courtesy of Evelyn Billo, Robert Mark, and other Rupestrian CyberServices associates)

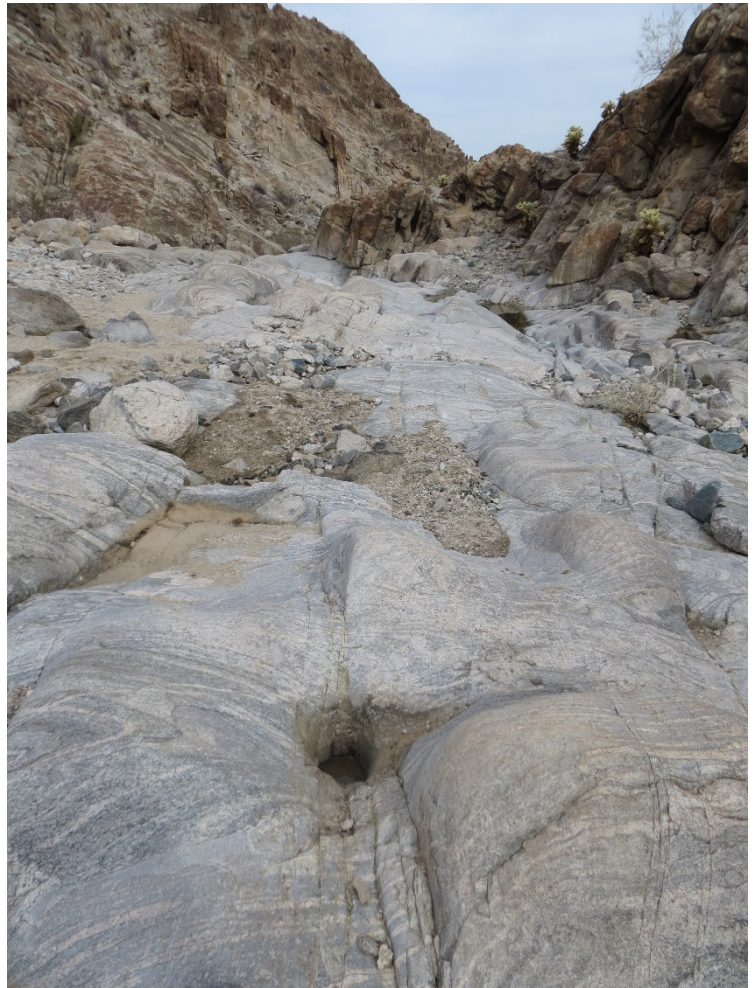


Figure 23. Bedrock mortar in Gila Mountains east of Yuma, AZ (Photo by Jeffrey H. Altschul courtesy of Statistical Research, Inc.)



Figure 22 (center left). Boulders with grinding features and stone artifacts found in situ during archaeological survey along lower Gila River near Agua Caliente, AZ; left boulder has grinding slick and associated toolkit on top, and petroglyphs in upper right part of photo); right boulder has mortar, pestle, and associated toolkit on top (Photos by Aaron M. Wright, Archaeology Southwest)



Figure 24. Bedrock outcrops with 12 mortars (left) and 48 mortars (right) on Ranegras Plain east of Quartzsite, AZ; dirt fillings in mortars at right were probed for depth before photographing; inset shows detail of 20-cm scale (Photos by Aaron M. Wright, Archaeology Southwest)



One thing that might help identify whether mortars or other human-made holes in bedrock or boulders are processing features, as opposed to containers, post sockets, markers, or something else is whether pestles have been found in or near them (for example, Figure 8) or whether the holes show evidence of use-wear. A study of mortars, cupules, basins, and slicks at archaeological sites near San Diego, identified many features we would identify as mortars under our page 2 definition, but only two pestles were found in their proximity. However, in that study, Jenny Adams observed evidence of polishing, abrasion, chipping, or impact wear in all mortars, basins, depressions, slicks, and worked stone surfaces she examined except ones that were too eroded or too covered with lichen or caliche to observe wear traces. She concluded the ones with use-wear were used as grinding features (Burton and others 2017).

Mortar Manufacture. A basic question that is beyond the scope of this article is how bedrock and large-boulder mortars were formed. One idea is that they were pecked to shape, form, and depth, like one might make a metate, and that some use wear occurred as the mortars were used, but not too much. An alternate idea is that mortars became deeper as a result of continued pounding and grinding after they were shaped originally.

If they did not become substantially deeper as a result of use, how would one explain mortars in Hueco Tanks State Park & Historic Site that Marc Thompson and Margaret Berrier independently told Dart about that are deeper than their arms can reach? Related questions include: How or why would people let a mortar get so deep that food in it was beyond their reach? Were these very deep holes really mortars and, if so, was whatever was processed in them retrieved in other ways than just reaching down into the hole, such as by using long spoon-like tools or perhaps filling the holes with water so the processed mesquite meal or other processed material would float to the top? If the holes are humanmade but were not mortars, at least not during their latest use, might they be some sort of symbolic feature? (See discussion below about possible functions of bedrock and boulder cupules.) Or are these very deep holes natural? Since we don't really know how mortars were initiated and we are not sure how fast they wear out and deepen (Adams 2002:132), these are questions for future research.

Portable Boulder Mortars. Mortars also were made in smaller boulders and large cobbles in the southern Southwest. These portable artifacts (called "rock mortars" by Adams [2002:128]) often are found in excavations of archaeological settlement sites. Stone pestles have been found together with some of them (Figures 25 and 26) as well as with some of the outdoor bedrock mortars in the Southwest (Figure 8).



Figure 25 (left). Portable boulder mortar with two matching stone pestles from a Hohokam pithouse floor in Tucson; mortar is 43 cm (17 inches) in diameter; pestle at left is 43 cm long (Photo by Ken Matesich for Old Pueblo Archaeology Center)
 Figure 26 (right). Portable boulder mortar with matching pestle found in Arizona sometime before the late 1940s (Photo by Laura Gann)



Are “portable boulder mortars” really mortars? If found together with pestles, probably so. However, Jenny Adams (2002:7-8) cautioned that form does not always define function, giving as examples what she at first interpreted as two portable mortars in her analysis of ground stone artifacts recovered from excavations at the Hopi village of Walpi. When those two artifacts were set out for people to look at and discuss during a community meeting, a village elder explained to her that one of them was an eagle watering bowl used when the birds were tethered during the Hopi ceremonial season, and the second was used to soften meat for old folks who no longer had teeth for chewing.

Adams noted these two items had basically the same attributes, each with a basin manufactured into a large rock. She later recognized that mortars may be distinguishable from water containers by distinctive design features and by use-wear patterns.



Figure 27. Basins, slick, mortars, and cupules on horizontal surface of a slab boulder in Alamo Canyon, Hudspeth County north of Fort Hancock, TX (Photo by Mark Willis, Sacred Sites Research, Inc.)



Figure 28. RMP-33 at Gila Cliff Dwellings National Monument, a sheltered bedrock outcrop with several mortars and grinding surfaces; scale is approximate (Photo from [Buonasera \(2016\)](#), released under a [Creative Commons Attribution 4.0 International \(CC BY 4.0\)](#) license)

Basins and Slicks

Figures 8, 9, 19, 20, 22, and 27-30, 32-35, and 50 show some examples of bedrock and boulder basins and slicks. Basins, as defined on page 2, differ from mortars in often being more ovoid or irregularly shaped than circular and less than 1 cm (0.4 inch) to just a few centimeters deep. Basins usually are on surfaces horizontal or at least nearly enough so that the basin rim is about the same elevation all the way around. Slicks often are irregular in shape and usually no more than 1 to 3 cm deep, sometimes abraded only enough to have worn away the cortex or weathered “desert varnish” surface of the base stone; and slicks may be on vertical, diagonal, or nearly horizontal surfaces. The key to identifying both basins and slicks using our definition is that they exhibit ground or polished surfaces unless they have eroded since the last use (for example, Figure 35).

Depending on their measurements, small basins could be classified as mortars or cupules if they are just slightly oval (for example, Figure 28). However, most basins we know about in the southern Southwest are ovoid, at least a few centimeters deep and no more than about 30 cm (about 1 ft) in the longer dimension, and exhibit at least some rotary abrasion on the interior (for example, Figures 29 and 33). By contrast, some slicks are more than 60 cm long and relatively narrow (Figures 32 and 33) indicating they were ground with a hand-held stone or other hard object using arm-length back-and-forth strokes. Slicks usually are highly polished so it may be impossible to tell the direction of abrasion.



Like portable slab and basin metates, bedrock and large-boulder slicks and the shallower basins could have been used for grinding just about anything, including minerals, wood, seeds, and roots. (Lydia Pyne [2020] reported residues of wild potato, *Solanum jamesii*, were found on a portable basin metate and mano excavated from a Utah rockshelter.) Most deeper basins likely functioned similarly to mortars, or to some cupules as discussed below, but basins could have served different functions from the other two feature types, especially if found together on a single rock exposure (for instance, Figures 27 and 28) or together with the other types at a single archaeological site or site cluster.

Jenny Adams (2002:130) wrote that among historical Pueblo groups a single basin pecked into a rock outcrop may be used to signify a trail or boundary, and that a use-wear analysis may be the only way to distinguish marker basins from grinding holes if weathering has not obliterated any evidence of wear caused by a pestle. She suggested to Dart in 2020 that a single basin at the head of a trail to a pre-Hispanic archaeological site atop Tumamoc Hill near downtown Tucson may be a trail marker.

Many researchers identify what we call bedrock and boulder basins as bedrock metates. Wallace and Holmlund (1983) identified both basin and trough metates on bedrock outcrops at Los Morteros, a Hohokam village site in Marana, Arizona, and at the Tumamoc Hill site in Tucson. The features they identify as basin type are ovoid and the trough ones are somewhat rectangular with rounded corners. For comparison, portable trough metates typically found in Hohokam habitation sites usually are rectangular with rounded corners and have prominent rims along the longer sides of the grinding surface (for example, Figure 31).

Wallace and Holmlund (1983) did not provide depth measurements or photographs of the features at Los Morteros that they called bedrock trough metates. Dart has observed that the ones they show on their page 169 map of that site's outcrop MK-2 (Figure 18) are each less than 2 cm deep so they are within the range of what we call slicks here.

Importantly, portable trough metates are usually more common than basin metates in Hohokam villages, and corn was a staple food for that culture. Wallace and Holmlund (1983) suggested the trough-shaped bedrock metates at Los Morteros were used mainly for grinding corn and the basin ones primarily for grinding lightweight, wild seeds and possibly for a second stage of mesquite milling after the pods were initially processed in mortars, as suggested by Hayden (1969). Therefore, possibly some nearly rectangular bedrock and boulder slicks (as we define them) were used for processing corn.

Smooth-ground areas surrounding some base-rock surfaces around mortars are called "aprons" by Wallace and Holmlund (1983), who suggested they formed as "the cumulative result of an activity that is performed during the use-life of the mortar." Examples of the aprons they describe are clearly visible in Figures 7 and 8. We identify these smooth-ground areas as slicks under our page 2 definitions but agree with Wallace and Holmlund about how they likely were formed.



Figure 29. Basin worn into boulder in foreground and cupules on the one beyond, in Sutherland Wash Archaeological District north of Tucson; the district is listed on the National Register of Historic Places for the significance of its petroglyphs and related cultural resources (Photo by Allen Dart)



Figure 30. Slick on a boulder in the Sutherland Wash Archaeological District north of Tucson (Photo by Allen Dart)



18-1 0 2 4 6cm

Figure 31. Typical Hohokam portable trough metate shape; this one is from an archaeological site in Marana, AZ (Photo by A. C. MacWilliams for Old Pueblo Archaeology Center)



Figure 32 (above right). Four slicks on boulder, with petroglyph beyond, in Ironwood Forest National Monument northwest of Tucson (Photo by Allen Dart)

Similar apron slicks found around and among cupule arrays also could have formed through cumulative use of the cupules. Other slicks with or without associated cupules could have resulted from intentional, extensive hand-rubbing of the base rock surface. If the slick encompasses cupules, the latter could have been receptacles for board-game tokens, or the cupule users may have attributed some religious importance to or held some special reverence for the cupules, or perhaps for the rock formation itself. For example, Ken Hedges described an unusual boulder in the Menifee Valley, California, that consisted of

a natural seat-like formation in the bedrock behind a rock protruding upward like a saddle horn. The “seat” and upright rock are polished over their entire surfaces, a trait shared by [the Cahuilla ringing rock described below in the Sound and Music section under the Cupules heading]. The vertical boulder face which forms the “backrest” for the “seat” has two small, highly polished slick areas, with small polished spots on other surfaces above and in front of the seat. The slick areas obviously are not milling surfaces, and no explanation presents itself for this curious feature. [Hedges 1980:77-78]

(See cupule functions discussion below).



Figure 33. General view (left) and detail (above) of a boulder with multiple slicks and a basin, in Ironwood Forest National Monument northwest of Tucson; most of these slicks exhibit longitudinal abrasion while others and the basin show rotary use-wear; note the petroglyphs on farther boulder in left photo (Photos by Allen Dart)



A possible intentional use of some slicks may have been shaping or sharpening wooden or ground stone tools such as pestles, ax heads, hoes, or chisels, or for cleaning mesquite or other sticky plant residues off of pestles or manos to continue pounding or grinding with them.

A particular kind of bedrock basin that has been reported elsewhere in the Southwest, but which we have not come across in our search for southern Southwest basins, is the “basin step.” As reported by James E. Snead (2002), some foot trails on northern New Mexico’s Pajarito Plateau in Bandelier National Monument include basin steps excavated to a depth of several centimeters into the plateau’s tuff formations, some of them in series of steps that seemingly involved labor investment far exceeding functional requirements. Snead (2002) concluded the Pajarito Plateau trails at Bandelier were made and used by Ancestral Pueblo people mainly between 1100 and 1600 CE. (Also see the “Transportation” function of cupules discussed below).

Cupules

There are examples throughout the world that ancient people created cupules – small pits in bedrock or boulders – as well as forming mortars, basins, and slicks (Bednarik 2010). Cupules are common on boulders and bedrock outcrops in the southern Southwest (Figure 2), especially in localities where petroglyphs are found. Examples of bedrock and boulder cupules are shown in Figures 1, 25, 29, 34 (possibly), 36-45, and 47-63. Single or multiple cupules also are sometimes found on small, portable boulders (Figure 64).

Some cupules occur alone or in small clusters, but in many cases hundreds of them can be found on a single bedrock expanse or on a large boulder. Some are close to ancient dwelling areas but probably most are in places away from ancient settlements. Cupules have been referred to as Pit-and-Groove style petroglyphs, and rocks with cupules also are called pitted stones (Minor 1975).

Possible Cupule Functions. As noted by Susan M. Hector (2009), for example, some



Figure 34. Bedrock grinding basins and petroglyphs at a secluded waterhole on the Sentinel Plain between Phoenix and Yuma, AZ (Photo by Aaron M. Wright, Archaeology Southwest)



Figure 35. Basin/slick and pottery sherds on diagonal bedrock surface in the Gila Mountains east of Yuma, AZ (Photo by Jeffrey H. Altschul courtesy of Statistical Research, Inc.)



Figure 36. Cupules and petroglyphs on a vertical rock face (left), and cupules on a horizontal slab (right) in an Alamo Canyon rockshelter, Hudspeth County north of Fort Hancock, TX (Photo by Margaret Berrier, who counted 83 cupules on the slab)



Figure 37. Cupules, mortars, and petroglyphs on horizontal bedrock near Barrilla Draw in Reeves County east of Balmorhea, TX (Photo by Mark Willis, Sacred Sites Research, Inc.)

researchers define cupules as nonutilitarian, that is, not having practical or useful functions. We do not include nonutilitarian in our definition because use of that term requires subjective judgment, whereas it may not always be possible to determine whether some cupules had practical functions and others did not, as indicated below.

Cupules and pitted stones certainly are more of an enigma than mortars, basins, and slicks because cupules are too small to process large amounts of food or other items, many of them show no grinding evidence (that is, they are only pecked into rock surfaces), and a lot of them are not circular like most mortars. If not used primarily for grinding or pulverizing, what else might cupules have been used for?

Ethnographic and archaeological studies provide evidence that people in all continents made these small cup-shaped features for many different reasons, and there has been rampant speculation about other possible functions that may not be backed up by actual reports of such uses.

Some possible cupule functions – documented as well as undocumented – are listed in Table 2 and discussed below. We caution that most of the functions that have been documented by ethnographic or archaeological evidence have been outside of the southern Southwest so not all of them, if any, may be applicable in our research area.

The potential food, plant, and mineral pounding and processing, board game, and paint preparation functions probably could only apply to cupules on nearly horizontal surfaces, or at least ones that face upward, whereas other uses might be appropriate for cupules on horizontal, vertical, diagonal, rock-underside, or curving surfaces, if not solely on nonhorizontal rock exposures.

Table 2. Some possible functions of bedrock and boulder cupules

1. Food processing*	9. Board games*	17. Calendar/time reckoning*
2. Other resource processing*	10. Post sockets*	18. Territory markers*
3. Paint palettes*	11. Consulting or decision making*	19. Communicating with other worlds*
4. Fertility and other rituals*	12. Trail markers or resting places*	20. Water symbolism*
5. Weather control*	13. Tool manufacturing or maintenance*	21. Death markers*
6. Terrestrial maps*	14. Rites of passage*	22. Transportation*
7. Sky maps or astronomy	15. Artistic endeavors	23. Incorporated into rock art*
8. Sound and music *	16. Placement of offerings*	24. A symbolism no longer recoverable

* There is ethnographic or archaeological documentation for this function as described below.



Food Processing. In general, the most common function of human-made depressions in rocks probably is for food processing. Corn and other grains, wild plant seeds, and some other foods may need to be ground into a flour ingredient. Acorns and other nuts need to be hulled to extract the edible seed part. It has been suggested that small cupules in bedrock or boulders (True 1993) as well as some in handstones (Huckell 1984:54,124,127) could have been used as nut-cracking implements. Wild walnuts could have been targeted, since Akimel O'odham and some other southwestern Indians occasionally consumed wild walnuts (Hodgson 2001: 196-197) and some cupules occur where walnut trees (*Juglans major*) grow (Figure 38). However, small pestles or pounding stones are rarely if ever found with cupules.



Figure 38. Cupules on bedrock under a huge old walnut tree in a canyon with many such trees near Ruidoso, NM (Photo by Margaret K. Berrier)

Sampling of residues from depressions in rock can provide some clues to whether at least some cupules were used for food processing. For example, Tammy Buonasera (2016) tested one cupule and one bedrock grinding surface in the Gila Cliff Dwellings for absorbed organic residues to determine whether the rock coatings in the depressions contain any ancient lipids or fatty acids that might indicate plant use. Her comparisons to experimentally aged residues, and the absence of a known biomarker for maize in the tested samples, indicate the bulk of the lipids preserved in the grinding feature's surface probably derived from processing an oily nut or seed resource, and not from processing maize. Specifically, high amounts of fatty acids recovered from the sampled bedrock grinding surface indicated that its residue probably was derived from an oily seed or nut type that may have been heated during processing.

Buonasera's sample results from the blackened cupule she tested supported the possibility that some portion of the lipids in that cupule could have been deposited through years of exposure to wood smoke from heating and cooking fires within the caves. Buonasera's study suggests some grinding features in the Gila Cliff Dwellings and possibly other southwestern dry rockshelters could have been used for food processing, but that smaller ones such as the cupule she tested were less used or not used for this purpose.

Some cupules, especially the larger ones, could have been used for pounding and crushing nonfood plant or mineral resources like the Tarahumara used pockets or hollows in rocks to ferment the crowns of agave plants (Castetter and others 1938:63).

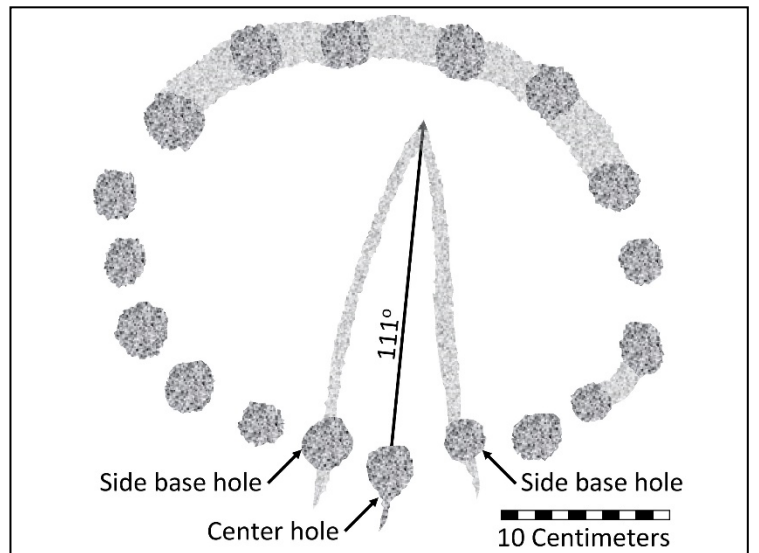


Figure 39. Left, petroglyphs and cupules on a large boulder overlooking the Río Bonito on the eastern slopes of Sierra Blanca, NM (Photo by Joan E. Price, Jornada Research Institute); right, detail of the oval petroglyph with cupules on lower left part of the rock surface, adapted by Dart from a drawing in Estes and Hood (1991)



Figure 40. Cupules panel along the Río Bonito, Lincoln County, NM; this panel is right above a bedrock mortar site and other smaller panels are in the general vicinity (Photo by J. James Sánchez courtesy of Lynda A. Sánchez)



Figure 41. Upper photo, petroglyphs with a single cupule on a horizontal-surface boulder ledge beneath the glyphs, at Three Rivers petroglyph site in the Tularosa Basin, NM; arrow shows the cupule's location on the ledge; lower photo, detail showing the same cupule under different lighting and seasonal conditions

(Both photos and arrow in upper one by Joan E. Price, Jornada Research Institute)

Jenny Adams (in Burton and others 2017) examined many cupules at sites near San Diego and found that all of them showed impact wear alone, with no abrasion indicative of grinding. Many cupules in the southern Southwest, however, obviously have been ground or polished, yet some are on diagonal, vertical, or even underhanging surfaces (Figures 36, 40, 44, 48, 49, 51, 53-56, 58-64), which would make it difficult or impossible to use the depressions for grinding anything other than the base rock itself.

Other Resource Processing. Pebbles or chunks of stone or mineral could be placed in cupules and pulverized or, if the stone a cupule was pecked into was a specific type or color, or soft enough to create a powder during cupule creation, the resulting dust could have been used for painting, dyeing, body decoration, adding to other mixtures, or even for human ingestion. In Europe, for instance, powder ground from cupules is said to have been used as or in medicine (Callahan 2000).

In a 2020 email, archaeologist Myles Miller informed Dart that remnants of red pigment were found in a single cupule below a pictograph panel during a recent archaeological documentation project in our research area, suggesting at least some southern Southwest cupules were used for pigment grinding.

In addition to minerals, possibly nonfood plant or animal products could have been processed in individual cupules or on cupule-pitted rock surfaces. Individual cupules, especially those on nearly horizontal surfaces, could have been used similarly to modern, small mortar-and-pestle sets to crush leaves, seeds, or flowers for herbal flavoring, medicine, inhaling, or smoking; to pulverize animal bones or teeth for use as calcium supplements; or to shred wood to make tinder.

Meade F. Kemrer and Wade Corder (2000:40-41) reported that the upper surface on a Gila Cliff Dwellings rock surface that contains numerous cupules, and the upper surfaces of two cupule “benches” in a cave near Virden, New Mexico (one of which is shown in Figure 48) are coated with a

glossy, light-colored mineral deposit apparently unlike any other place in either of those archaeological sites. Margaret Howard (2010) wrote that the interiors of

Figure 41. Upper photo, petroglyphs with a single cupule on a horizontal-surface boulder ledge beneath the glyphs, at Three Rivers petroglyph site in the Tularosa Basin, NM; arrow shows the cupule's location on the ledge; lower photo, detail showing the same cupule under different lighting and seasonal conditions



some of the 68 bedrock cupules in four locations at Hueco Tanks similarly are coated with a glossy substance. The Gila Cliff Dwellings and the Virden rockshelter are within relatively short distance of each other along the Gila River in the same mountain range, but were occupied at different time periods.

A chemical analysis of the glossy surface coating on some of the Gila Cliff Dwellings cupules rock (which is in Cave 5) by former Sandia National Laboratories geochemist Steven J. Lambert showed that the dominant secondary minerals (apart from the base rock composition) comprising that deposit were uric acid (2,6,8-trihydroxypurine hydrate), weddellite ($\text{Ca}(\text{C}_2\text{O}_4) \cdot 2\text{H}_2\text{O}$, dihydrated calcium oxalate), and whewellite ($\text{Ca}(\text{C}_2\text{O}_4) \cdot \text{H}_2\text{O}$, monohydrated calcium oxalate) – essentially the same mineral assemblage characteristic of kidney stones. Dr. Lambert suggested the glossy mineral accumulation on the Gila Cliff Dwellings cupules stone, if not a result of direct animal or human urination, may indicate the pitted surface was used in hide processing since it is known that urine was used as a tanning agent historically. Kemrer and Corder (2000:40-41) suggested the glossy deposits on the two Virden-area cupule stones also may have resulted from hide processing, whereas Howard (2010:143) suggested that if the glossy deposits in the Hueco Tanks cupules are uric acid residues they might indicate use for preparing pigment.

Paint Palettes. Smaller-sized cupules on relatively horizontal surfaces would be suitable for preparing and containing paints, so clusters of them could be used as palettes. Paint preparation is suggested by Myles Miller's account referenced above of red pigment in a cupule; if the pigment was prepared in the cupule, the cupule also could have been used as a palette receptacle to hold the coloring material. Would that represent a palette for just one color? Even for multiple colors, only a few cupules at a time would have been needed if used as palettes. Considering the hundreds of cupules in the Gila Cliff Dwellings and many other sites, and the small population sizes estimated for most early southwestern cultures, palette use is an unlikely explanation for all cupules found in the southern Southwest.

Fertility and Other Rituals. Samuel Alfred Barrett (1908) reported that Pomo women in Cali-



Figure 42. A rather large, possible cupule associated with a complex petroglyph at Three Rivers petroglyph site; cupules are very rare at Three Rivers, one of the largest petroglyph sites in the Southwest (Photo by Joan E. Price, Jornada Research Institute)



Figure 43. Boulder with cupules and a split mortar in Doña Ana Mountains, Organ Mountains-Desert Peaks National Monument north of Las Cruces, NM (Photo by Margaret K. Berrier)



Figure 44. Possible cupules in a boulder in Las Uvas Mountains, Organ Mountains-Desert Peaks National Monument near Las Cruces, NM (Photo by Margaret K. Berrier)



fornia placed rock powder from cupules on their skin or in their bodies before having coitus, to facilitate conception. Matilda Coxe Stevenson (1904) wrote that a cupule site on To'wa Yäl'länne (Corn Mountain) near Zuni Pueblo was used in fertility rituals: a pregnant woman would collect the mineral powder from the cupules into "a tiny vase made for the purpose" and deposit it in a wall cavity if she desired a daughter. Callahan (2000) suggested cupules could be used to create rock powder by hollowing out the cupule, for example, to ingest the powder (geophagy) for the purpose of inhering the potency of an (engraved) rock or to create visible passages to the spirit world, and possibly simultaneously to produce a powder that could be ingested in order to absorb metaphorically and literally the potency of the place.

There is abundant evidence ancient Puebloan women conducted fertility rituals, most of which were intended to lead to conception by the consumption of dust after pounding the cupule. However, given the small size of populations estimated for sites containing numerous cupules, such as the Gila Cliff Dwellings, only a few cupules at those sites would have been formed for this purpose, if such ritual even happened there. The same probably can be said for many of the cupule arrays elsewhere in the Southwest. Also see rite-of-passage comments below.

Weather Control. Cupules could have been used by some individuals or cultures as a means of influencing the weather. The sound of pounding or striking a cupule would imitate the sound of thunder, so could be intended to induce rainfall and wind. Anthropologist Leslie Spier (1930) indicated the Klamath of southern Oregon renewed cupules in order to summon the wind to change the weather. Robert F. Heizer (1953) wrote that the Shasta of northern California pounded cupules in "rain rocks" to induce rainfall and wind, sought to increase or decrease snowfall by incising straight parallel grooves into selected "rain rocks," and covered their rain rocks (presumably when they were not in use for their intended purpose) in order to prevent rain when it was not wanted. And Edward Breck Parkman (1992) wrote that Kashaya Pomo women who were grinding acorns in their mortars took special precautions to prevent summoning unwanted rain unintentionally by preparing shelters to muffle the pounding sound.

Terrestrial Maps. Some petroglyph panels have been interpreted as plan views of living areas or as actual maps of geographic features (Wallace and Holmlund 1986; Dart and others 1990:94; Dockal and Smith 2005; Hersted 2012). (The many connecting-lines petroglyphs inside Map Cave [Figure 45] near Hanover, New Mexico, according to Marc Thompson, Jason Jurgena, and Lora Jackson [2006], probably are mostly Archaic period abstract designs rather than map symbols.)

We have found one ethnographic instance in which an arrangement of cupules was identified as a terrestrial map: Hector (2009:71) reported that a pecked cupules rock was said by a Luiseño member of the San Luis Rey Band of Mission Indians to provide a map of southern California's entire Temecula Valley. If so, possibly some arrays of cupules in the southern Southwest may represent particular geographic features and so may be rudimentary maps if the cupules representing mapped features were in use at the

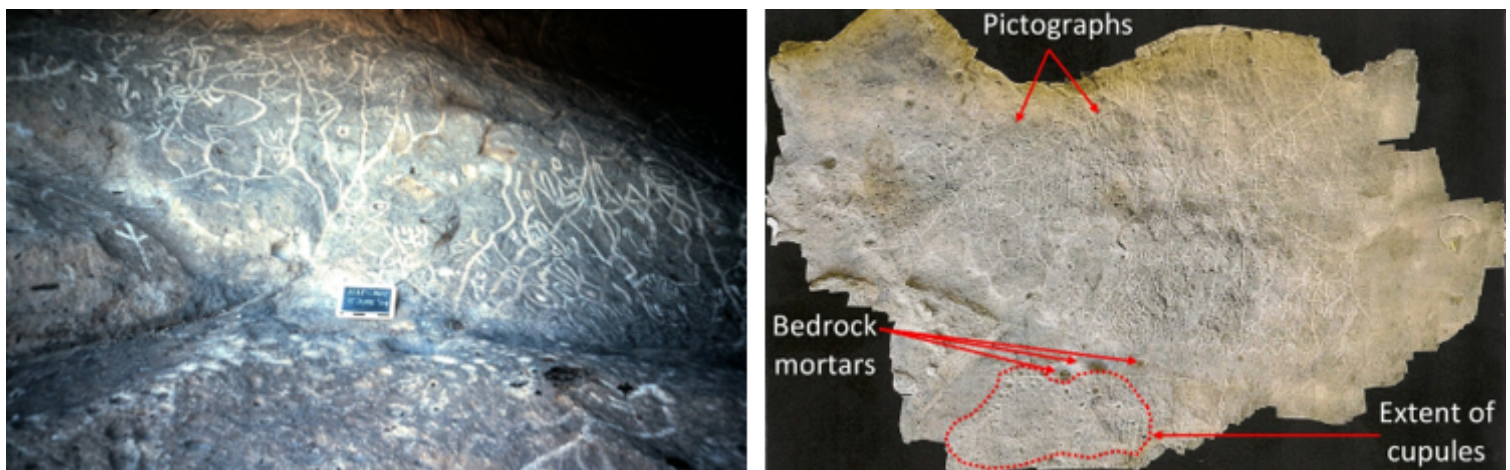


Figure 45. Bedrock cupules and mortars associated with petroglyphs in Map Cave near Hanover, NM; petroglyphs were painted white by a California photographer (Photo of cave interior by Marc Thompson; digital map of cave floor by Mark Willis, Sacred Sites Research, Inc.)



same time (some may have been made earlier than others) and if their arrangement duplicates or at least closely approximates the relative positions of the landscape features.

Sky Maps or Astronomy. Conceivably, some large arrays of cupules could symbolize the many stars in the heavens; and smaller numbers of cupules on a bedrock or large boulder surface could have been placed relative to each other in a way to represent particular constellations. Constellations by themselves are random arrangements of stars but, throughout history, people have imagined shapes of animals, humans, deities, and objects by drawing mental lines among or around clusters of stars. There is evidence that some U.S. rock art depicts stars: Navajo ethnographies have identified sites in several northern Southwest rockshelters as “star ceilings” (also called planetaria) that include small, precisely painted, cross-shaped pictographs that are said to depict stars, although not necessarily specific constellations (Schaafsma 1980:324-325).

We are aware of three publications that suggest cupules in the western U.S. (but not the southern Southwest as defined here) may represent sky maps. One is Dorothy Mayer’s (1977:109), which identified 53 cupule concentrations in the Great Basin that may depict stellar patterns and possibly the 1054 supernova (cited by John F. Romani [1981:80]). The other two are by Roger Boren and Benny Roberts (2016), and Boren (2017), who described a nearly horizontal boulder surface in the Texas Big Bend country’s Black Hills, not far southeast of our southern Southwest study area, on which are five cupules thought to represent the five brightest stars in the Pleiades star cluster, an additional seven cupules that resemble stars in the front end of the Scorpius constellation, and 11 “unreconciled cupules” that are scattered between the Pleiades and Scorpius cupule sets and among the Scorpius cupules. Boren (2017) suggested the “Scorpius” set only represents the head portion of the scorpion and not the stinger part because some eastern North American and Great Plains native cultures interpret the head part of the Scorpius constellation as a serpent.

The Pleiades constellation is an open star cluster in which seven of the stars are interpreted as Seven Sisters based on Greek mythology. Ethnographies indicate the Pleiades also were important in Hopi and O’odham traditions (Parsons 1936; Castetter and Bell 1942:143).

Some visitors to the Gila Cliff Dwellings have remarked that a subgroup of the cupules on the Cave 5 boulder in Figure 46 is a representation of the Pleiades cluster. The number of stars in the Pleiades cluster is far more than seven, they all have different brightnesses, and without the use of a telescope this star group is so dim in the night sky that different cultures or individuals might not even identify the same seven stars as its most important ones. Notably, the Gila Cliff Dwellings cupules cluster in Figure 46 includes 11 cupules on a high spot on the boulder so does not exactly match the seven (or eight or nine?) brightest stars in the Pleiades cluster.

We would not be surprised if other cupule arrays in the southern Southwest have been interpreted as constellations, or that some cupule groupings may represent astronomical observations such as solstice or



Figure 46. Cupules array in Gila Cliff Dwellings Cave 5, left, which some people suggest is an image of the Pleiades constellation, right (Cupules photo by Chris Reed; Pleiades photo by Mark E. Killion courtesy of James B. Kaler)



Figure 47. The rear cave wall in Gila Cliff Dwellings Cave 3, Room 19 (Photo by Chris Reed)

equinox reckonings, or certain solar, lunar, or planetary observations. Regardless, such astronomy-related hypotheses could only apply if all the cupules believed to represent sky features were made at the same time or at least were used in that way after most or all cupules in the group had been completed.

Sound and Music. As indicated in the above discussion about weather control, ethnographies clearly indicate that some rocks with cupules were used to make ringing or thunder-like sounds, but apparently the cupules were not used individually for these purposes.

Some rocks called bell rocks, ringing rocks, rock gongs, gong rocks, singing stones, or litho-

phones make chimes or tones when struck with a stick or mallet. Different tones may be heard when clustered bell rocks are struck separately, or when some single boulders are struck in different places.

In a *Los Angeles Times* article, Charles Hillinger (1991) described a 2- by 3-foot (ca. 60 by 90 cm) granite boulder in the Menifee Valley, Riverside County, California, that was used by Cahuilla Indians as a “singing stone.” The boulder contains a large deep circular indentation embraced by six smaller circular indentations, which San Diego Museum of Man rock art researcher Ken Hedges identified as cupules and said “The rock's special sonorous characteristics are believed caused by the way it is positioned and balanced on a giant boulder. There is considerable air space beneath the ringing rock.”

In a separate publication, Hedges (1980:78) reported that this boulder is smoothed over most of its surface and is flanked by petroglyphs on a near vertical surface nearby with the cupules. His Figure 12 (1980:79) shows that “The Ringing Rock” cupules are fairly large – we estimate 8-10 cm in diameter – and deep. Hedges (1980:80) also noted other ringing rocks in southern California, Nevada, and Arizona: Bell Rock, originally located in Orange County, California’s Santa Ana Mountains (but later moved to a museum) that was marked with numerous cupules on which native Indians pounded with stone pestles to make it ring; a cupules rock at the Pahpahwits site in California’s Tulare County that Yokuts Indians pounded to make ring; a ringing rock without cupules along the San Dieguito River south of Escondido, California; one near Zion Wash near Desert Center, California; a locality near Virginia City, Nevada; and the Hohokam site of Cocoraque Butte in southern Arizona. Hillinger (1991) wrote that Hedges also had seen at least one ringing rock in the Colorado Desert in far-southeastern California’s Imperial County. Neither article says whether cupules are present at the San Dieguito River, Zion Wash, Virginia City, or Cocoraque Butte sites.

Rock art researcher Janine Hernbrode recently led an Arizona Archaeological and Historical Society project that recorded over 11,000 petroglyphs and multiple bell rocks at the Cocoraque Butte archaeological site west of Tucson. Hernbrode informed Dart in 2020 that there are a few cupules on bell rocks there and she thinks the cupules “are likely use wear from ringing the rock in the same location over time. The smallest of them are about 2 cm in diameter but at Cocoraque well-used bell rocks have cupule-like use wear measuring in the 9-11 cm range.” She said there are also cupules on some rocks at the site that today do not ring.

Considering Hedges’ remark to Hillinger (1991) that the Menifee Valley rock's sonorous characteristics derive from its position balanced on another boulder, ideally the rock that makes the tones is relatively long and slender and supported primarily at one end. One therefore might expect that stalactites in limestone caves might be suitable natural bell rocks. However, we do not know of any stalactites that exhibit cupules.

There are no stalactites in the Gila Cliff Dwellings. However, the cave wall in the rear of that site’s small Room 19 (Figure 14) is an inclined panel with 35 cupules (Figure 47). The percussion sounds on



this cave wall do not resonate unhindered like a “singing stone” as described above, but striking and drumming on the wall does create sound and the shape of the cave causes echoes. Since this cupules panel is in the rear of Gila Cliff Dwellings Cave 3 and adjacent to a space large enough for social gatherings (Figure 14) it is possible the cupules there were made with bell tones or music in mind.

Robert G. Bednarik (2010) reported a case in which “a properly knowledgeable” man in Madhya Pradesh, India, demonstrated renewal of a cupule on a lithophone. The informant explained and demonstrated to Bednarik that the presence of the cupule on the rock was incidental, and that “its relative position to other cupules is irrelevant; it does not represent astronomical observations or whatever else ethnocentric observers like to invent” (Bednarik 2010:112). Bednarik also cited an interpretation by Franz Trost (1993) that cupules were present on lithophones in Burkina Faso, western Africa.

As to using cupule rocks for music, Constance Goddard DuBois (1908:158) reported that when some southern California Luiseño Indians migrated they “would scoop out a hollow in a rock with their hands The different parties of people had their own marks.” DuBois does not say how big were the scooped out parts of the rock (see Territory Markers discussion below). However, Rick Minor (1975:15-16) suggested the scooped out hollows in the rock were cupules and they were related to the Luiseño initiatory rites conducted for girls upon their entrance into womanhood. Minor wrote that DuBois’s (1908:115) description of this puberty rite said that during this ceremony, one man sang to the accompaniment of the ringing stones while others danced. Therefore, one might surmise that some cupules were associated with singing, at least indirectly, if the cupules were on bell rocks (ringing stones), but would this also be the case for any cupules not on bell rocks? Hard to say.

Board Games. Southwestern ethnographies tell of games played by Hopi, O’odham, and other Native Americans like board games, usually on bare ground or on rock surfaces without cupules. Some of these games featured layouts for gaming pieces, usually in closely packed geometric alignments or multiple rows. Such arrangements could be duplicated by cupules in some rock surfaces, allowing participants to move rocks or other game tokens around the cupules. A patterned layout of the cupules might not be required, however. For example, in a June 26, 2020 Arizona State Museum webinar, University of Arizona Professor Emerita Suzanne K. Fish reported that some Tohono O’odham informants suggested at least five cupules along the crest of a large boulder at the Tumamoc Hill archaeological site in Tucson were used for playing a game. A photo provided by Dr. Fish shows those cupules are apparently not arranged in any kind of pattern.

Osaga Odak (1992) wrote about a number of separate cupule pavements that Kenya’s Kuria people interpret as game boards. Apparently, however, the cupules predate the Kuria so their interpretation may not be that of the cupule makers. Bednarik



Figure 48. Over 200 cupules and several mortars on undulating bedrock outcrop in a rockshelter north of the Gila River near Virden, NM (Photo by Margaret Berrier)



Figure 49. Boulders with cupules incorporated into petroglyphs, along eastern front of the Tortolita Mountains north of Tucson (Photos by Aaron M. Wright, Archaeology Southwest)



Figure 50. Cupules within a boulder slick in the Sutherland Wash Archaeological District north of Tucson; this highly polished slick may have resulted from initial smoothing with a grinding stone (mano) followed by extensive hand-rubbing around the cupules; petroglyphs are in the vicinity (Photo by Allen Dart)



Figure 51. Boulder with cupules and petroglyphs in the Sutherland Wash Archaeological District north of Tucson (Photo by Allen Dart)

(2010) cited other cases in Congo, Nepal, the Indus valley, and China in which cupule arrangements were used in board games.

Figure 1 shows an extension of the cave wall in Gila Cliff Dwellings Cave 5 on which there are 18 cupules on the high side of the boulder. The depth of each cupule is deep enough for a corn kernel or small token. Figure 50 illustrates a horizontal-top boulder with small cupules contained within a slick that would have been a suitable surface for playing board games.

Post Sockets. See the above discussion about mortar-like holes in the Gila Cliff Dwellings and near the Reeve Ruin that may have been fence or brace post sockets. Holes 4-6 in our Gila Cliff Dwellings fence post discussion (pages 6-7) meet our page 2 size specifications for cupules whereas holes 1-3 meet our mortar size criteria. Other cupules in the southern Southwest also could have been used to set posts for fences or other structures.

Consulting or Decision Making. One of us (Dart) has been told by Tohono O'odham informants of cupule boulders that were used for making personal decisions. In one such activity, a young man will visit a boulder that has cupules on its top to receive a sign about whether he will marry an older woman or a younger one. The man tosses a pebble onto the top of the boulder, and it is said that if it lands in one of the larger cupules it means he will marry an older woman whereas if it comes to rest in one of the smaller ones his bride will be younger.

In a second kind of divining use, a fellow will use the same cupules boulder to try and predict the success of an upcoming hunting trip. In this version, the hunter tosses a pebble onto the cupules rock, and if his pebble lands in one of the smallest cupules it ensures a successful hunt. However, if his tossed piece settles in one of the bigger cupules or bounces off the boulder he might as well go home because the omen is that the hunt will be unsuccessful.

A third version of how Tohono O'odham use this same cupules boulder, told by Brian W. Kenny (2003), is that travelers leave coins underneath a pillar-shaped boulder (said to represent a woman) next to the larger cupules boulder, as wish payments. After the payment is made, the wish-maker stands back a few feet and tosses several small, rounded and shaped pebbles at the cupules. If the tossed pebbles come to rest in the cupules, the wish comes true. Some of the wishes, according to Kenny's informants, are by men who believe a successful toss leads to a sexual liaison, others are by women who believe successful targeting indicates an upcoming pregnancy. One of Dart's informants said Tohono O'odham visit at least five places in southern Arizona where cupules are used in these ways, so probably even more cupule sites were used similarly. None of these pebble-toss uses would work on a vertical rock face with cupules, however, so we can rest assured that not all cupules were used in exactly these ways.



Trail Markers or Resting Places. As noted above, Adams (2002:130) reported that historical Pueblo peoples marked a trail or boundary with a single basin pecked into a rock outcrop. Elsewhere outside the southern Southwest, cupules, or groups of them, were used similarly.

Francisco Patencio (1943) described an old trail used by California's Palm Springs Indians, along which there were two large rocks in each of which was a mortar-like hole not more than three inches across, one hole shallower than the other. He wrote that these holes "were never used for grinding, but to make the sign of the trail." The two rocks were close to another rock about 3 feet (0.91 m) high and "smooth on the top, like a table" that the Indians called 'a place of rest' – people who passed the table-like rock leaned against it, resting themselves of the weight of their packs.

Minor (1975:8,9) noted that in the Great Basin some sites with cupules (Pit-and-Groove petroglyphs) have been interpreted as hunting-related because they are associated with trails. He also identified a few cupules sites in southern California that were near trails but doubted the significance of the association because relatively few of the Pit-and-Groove petroglyphs sites he identified in his study area are along trails.

Presumably trails led to or beside many of the cupule-rock locations in the southern Southwest, so possibly some of them were considered to be trail markers or resting places regardless of whether the trails had anything to do with hunting.

Tool Manufacturing or Maintenance. Cupules most often are basin-shaped or conical in cross section, so some of the deeper ones could have been used to sharpen, smooth, remove splinters from, or round off the ends of sticks or bone tools. Hector (2007:71) cited Hill and Nolasquez (1973:98) and White (1963:125, 186) as indicating Cupeño and Luiseño Indians in southern California used pitted boulders for sharpening wood and bone arrow points. It is possible some cupules also were used to resharpen or reshape rounded or pointed stones such as petroglyph-making hammerstones.

Rites of Passage. Horace Parker described the old ceremonial grounds used for girls' and boys' initiation (puberty) rites in the Luiseño Indian village of Aguanga, California, then wrote:

In a nearby wash on the undersurface of a boulder was a cluster of round peckings in the boulder about the size of a silver dollar. I was told by the Indians who lived here that these were a kind of score card with each peck representing an initiate of the ceremony. They neglected to state whether the round markers were for the boys or the girls. [Parker 1965:31-32]

Following up on this Parker passage, Rick Minor (1975) wrote that Luiseño ethnographer Paul Chace had been told by Parker in 1965 that the story about the function of the cupules (which Minor called Pit-and-Groove style petroglyphs) had been told to Parker about 1953 by an Indian of Aguanga who probably was by that time in his late sixties. Minor speculated that the meanings attached to these "petroglyphs" by the Luiseño were the same among the neighboring Diegueño, because ethnographer T. T. Waterman (1910:274) had written that most of the ceremonies the two groups had in common centered around initiation rites and the Diegueño and Luiseño initiatory ceremonies corresponded very closely in detail; and because the Pit-and-Groove petroglyphs (cupules) occur in similar locations in both Luiseño and Diegueño territories and often are associated with pictographs, which DuBois (1908:77-96) identified as being associated with initiation ceremonies (Minor 1975:16-17).



Figure 52. Cupules on boulder atop Tumamoc Hill west of downtown Tucson; there are also petroglyphs on the hilltop (Photo by Allen Dart)



Figure 53. Cupules on diagonal face of bedrock outcrop MK-1 at Los Morteros Hohokam archaeological site in Marana, AZ; there are also mortars and petroglyphs on this outcrop (Photo by Katherine Page Burdick)

Regardless of whether the Diegueño used cupule rocks in initiation rites, it is clear the Luiseño did, so it is possible some cupule-making cultures in the southern Southwest did likewise.

Artistic endeavors. Just as some petroglyph panels appear to represent beings, scenes, or histories (for example, Figures 4, 41, 58, and 63), obvious or subtle patterns in some cupule arrays could represent animals, persons, deities, scenes, stories, or events in ancient people's histories, the meanings of which modern viewers may or may not be able to figure out. Some cupules also could have been placed on distinctive-shape rocks to make them more like an imagined entity. For example, the hundreds of cupules on the large boulder shown in Figure 54 give that boulder an appearance much like the only poisonous lizard in the Southwest, the Gila monster. We have not found ethnographic evidence for such an interpretation, however.

Placement of Offerings. Placement of a cupule at a distinctive location on a horizontal bedrock or boulder surface, or in a specific horizontal location relative to a distinctive attribute of the surrounding bedrock or boulder(s), could suggest a cupule was created to hold offerings. Myles Miller's example cited above (see Paint Palattes) that red pigment residues were found in a single

cupule below a pictograph panel is suggestive of an offering associated with a religious icon, as are Joan Price's photos at the Three Rivers petroglyphs site showing a single cupule on a boulder ledge beneath distinctive petroglyphs (Figure 41) and a possible cupule on another Three Rivers boulder with complex glyphs (Figure 42).

Bednarik (2010) noted that the most commonly mentioned archaeological interpretations of cupules include the placement of offerings, "including human blood and semen." He did not provide descriptions



Figure 54. Mortars and cupules on a large boulder in the Cerro Colorado Mountains southwest of Tucson; the boulder resembles a Gila Monster lizard (Boulder photo by Jesse Mailloux; Gila monster photo from National Park Service:

<https://www.nps.gov/sagu/learn/nature/gila-monster.htm>)



Figure 55. Cupules on two boulders partly embedded in a wash in the Spur Cross Conservation Area near Carefree, AZ; the one in left photo originally may have been oriented with the cupules on top and later may have tumbled into the wash; photo at right includes a quarter for scale; several petroglyphs are on larger boulders not far away (Photos by Allen Dart)

or references for such practices, however. Sutton and others (2011), having found objects interpreted as quids deposited in small natural concavities in southern California mountains, suggested that some manufactured cupules on horizontal surfaces could have been used as containers to hold a variety of physical or perceivedly supernatural substances. These authors speculated that the quids they found were associated with ritual activities such as ingestion of mind-altering substances, possibly jimson weed (*Datura stramonium*).

Calendar/Time Reckoning. At several petroglyph sites in the American Southwest it has been documented that a point or an edge of a sunlight or moonlight ray, or of a shadow, will fall on a specific petroglyph or on a certain part of a glyph at a certain time of day on certain days of the year, so the petroglyph or its part functions as a calendric device. A prime example is the famous Three-slab site on Fajada Butte in Chaco Canyon, New Mexico, where Anna P. Sofaer, Rolf M. Sinclair, and other researchers photographed and reported a large spiral petroglyph on which a dagger-like ray of sunlight pointed to the center of the glyph just before noon on each summer solstice day (Sofaer and Sinclair 1983). Two separate dagger-like rays shone on opposite edges of that spiral, framing it, on each winter solstice around midday, and Sofaer and Sinclair stated that the Three-slab site also marks the northern minor and major extremes of the 18.6- year lunar standstill cycle by a separate pattern of light and shadow at moonrise.

Use of cupules for time-keeping based on sunlight, moonlight, or shadow interaction would require the cupules to be positioned on or in relation to a geographic feature such as a rockshelter edge, a separate bedrock outcrop or boulder, an aperture through bedrock, or a horizon line, or a temporary gnomon (such as a stick inserted into a hole in the rock or into the ground at the same exact location for every observation, which would cause a sun or moon ray, or a shadow, to fall onto a cupule or an array of cupules, mortars, other depressions, or petroglyphs. Because sun and moon are constantly in motion, the time of day when the interactions are observed is critical for consistency year after year.

Like petroglyphic solar calendars, some cupules, as well as mortars, basins, and slicks, in the southern Southwest likewise may have been used as calendars or time-reckoning devices. One reported example is at Papago Buttes Hole in the Rock, a “window rock” formation in Phoenix, which during midday on the summer solstice casts a beam of sunlight across a ledge on bedrock below the rock window until the beam fills one of two cupules inside a grinding slick (Bostwick 2010:180-181). Benjamin Mixon and Raymond E. White (1991) identified several other solar interactions with cupules at Hole in the Rock involving winter solstice and the equinoxes but Todd Bostwick (2010) noted these are less dramatic than the summer solstice interaction.

Delton Estes and Dean Hood (1991) reported that the oval petroglyph shown in our Figure 39 photo and detail drawing measures 36 by 27 cm (14.2 by 10.6 inches) and is partly deteriorated but appears to



Figure 56. View upward (left) at a large cupule on the underside of a boulder that forms the roof of an alcove over a spring (right) in Arizona's South Mountains south of Phoenix (Photos by Aaron M. Wright, Archaeology Southwest)

include 18 “pecked holes or circles” averaging about 3 cm (1.2 inches) in diameter, arranged around an 18 cm (7.1 inch) long “arrow pointer” petroglyph that extends across the ellipse’s center. Weathering of the stone may have caused some of the holes (which we identify as cupules) to merge together into an arch-shaped channel. The sides of the arrow pointer begin outside of and extend through the two side base holes shown in our Figure 39 inset to about 9 cm (3.5 inches) past the ellipse’s center. Estes and Hood (1991) used a Brunton compass to determine that the direction from the labeled center hole in Figure 39 to the tip of the pointer is 111 degrees, and suggested this petroglyph arrow points southeastward toward the winter solstice sunrise location on the Capitan Mountains horizon.

We obtained longitude and latitude coordinates for this Río Bonito petroglyph area from the U.S. Bureau of Land Management and determined from the U.S. National Oceanic and Atmospheric Administration’s Solar Calculator website (<https://www.esrl.noaa.gov/gmd/grad/solcalc/>) that the actual azimuth for the winter solstice sunrise from that site is 113.44 degrees, not far off of Estes and Hood’s measurement. We suggest that if an upright stick or stone were to be placed at one or more specific positions on or near this oval petroglyph as a gnomon, the gnomon might cast a shadow onto individual cupules in the ellipse at different times to mark either times of day like a sundial, or specific times of each year.

Another possible example of cupule use for time reckoning in the southern Southwest is a rockshelter opening in which boulders appear to have been intentionally piled to direct a pointed ray of sunlight onto a horizontal slab containing numerous cupules (Figure 36). By observing a directed sun ray pointing to, or the edge of a shadow falling on, different cupules on different days of the year or at different times of day, an observant viewer might be able to identify the day of the year or the time of day on other dates besides solstices and equinoxes.

Parkman (1988) cited a case in which the Hupa of California used rock slabs containing cupules as calendar stones, and commented that contemporary Hupa believe the stones had an astronomical role. Parkman’s informants were unable to explain the actual function of the cupules, however.

On a more basic level that might not have anything to do with timekeeping, Sutton and others (2011) suggested some cupules might have been perceived as containers to capture certain phenomena such as sunlight and water that are at the same time conceptual and ephemeral.

Territory Markers. Ethnographies of some northern New Mexico and southern California peoples indicate some cupule stones marked specific cultural groups territorial boundaries, so possibly some cupules in the southern Southwest were so used.



For Tewa Pueblos in northern New Mexico, some cupule stones still mark a sacred geography and are used by specific people with specific purposes in Tewa social and ceremonial organization, thereby helping define the shape and structure of the Tewa worldview (Duwe 2016). This example suggests some cupule locations play a role in how people build and interact with their landscapes.

DuBois (1908:158) reported that some migrating Luiseño Indians of southern California “would scoop out a hollow in a rock with their hands to have that for their mark as a claim upon the land. The different parties of people had their own marks.” DuBois does not say, however, how big the scooped out places were, so they could have been cupules, basins, or mortars.

Communicating with Other Worlds. Samuel Duwe (2016) wrote that people of the Tewa Pueblos in northern New Mexico historically prayed and made offerings at some cupule locations, and pounded the cupules on boulders, cobbles, and bedrock to communicate with the spiritual world.

This idea is intriguing in light of Polly Schaafsma’s (2009) essay that noted caves and other natural earth openings have been viewed in Mesoamerican and related cosmologies, including of Pueblo Indians in the Southwest, as symbolic supernatural passageways into layered worlds. Schaafsma (2009) suggested that niches created in the walls of Pueblo Indian underground ceremonial rooms called kivas, and wall paintings associated with the kiva niches, represent a supernatural passageway to the underworld that in traditional Pueblo belief was perceived as a watery place, the source of rain, fertility, and the related supernaturals essential to the success of corn-growing farmers, and hence a life of abundance.

Might some cupules in the southern Southwest have been thought of by their makers or users as similar symbolic passageways into other worlds, as portals for transformation to better places?

Water Symbolism. Sutton and others (2011) cited Parkman (1992) as postulating that some cupules functioned to catch one of life’s essentials, water, for ritual purposes. Since cupules on horizontal surfaces always have some potential to capture rain water, might they be conceptualized as having a



Figure 57. Cupules on large boulder in the Cabeza Prieta National Wildlife Refuge west of Ajo, AZ; many petroglyphs are in the vicinity, some dating between 500 and 1700 CE but others perhaps thousands of years older (Photo by Allen Dart)



Figure 58. Hundreds of cupules on a vertical-to-underhanging alcove face below petroglyphs and pictographs in the Eagletail Mountains, about 120 km (75 miles) west of Phoenix (Photo by Aaron M. Wright, Archaeology Southwest)



Figure 59. A plethora of cupules on a vertical face in the Eagletail Mountains about 120 km (75 miles) west of Phoenix (Photo courtesy of Evelyn Billo, Robert Mark, and other Rupestrian CyberServices associates)



direct association with water?

In May 2020, archaeologist Larry Nordby, who spent a lot of time at Gila Cliff Dwellings National Monument, acknowledged to Dart the many cupules in the caves there and noted, “It isn't clear to me that they are utilitarian features because they occur on horizontal surfaces, vertical surfaces, and inclined surfaces. On inclined surfaces, sometimes they look like they are arranged to help water flow from one to the other down the face or the boulder. These seem to me to be related to non-utilitarian (social interaction – as in gaming; or perhaps socio-religious/calendrical?) purposes.”

Death Markers. Hector (2007:71) cited Kenneth Fritz and others (1977:16) as indicating a cupule was made for each person in a Luiseño clan who died.

Sutton and others (2011) cited Belle C. Ewing (1948) as writing in a *Desert Spotlight Magazine* that some cupules functioned as markers to signify a death in the community. Before completing this article we were unable to locate the Ewing article to determine what people Ewing referred to or where *Desert Spotlight Magazine* was published in the 1940s, so we cannot say how relevant the article might be to interpreting cupules in the southern Southwest.

Transportation. Larry Nordby wrote in a May 2020 email to Dart that cupules at Inscription House in Navajo National Monument were used as toe-hold steps to climb up bedrock faces. Snead (2002:760) reported small cavities, which probably meet our definition of cupules, in Bandelier National Monument that were pecked into bedrock to serve as simple and expedient hand-and-toe holds to provide better purchase on short climbs. As yet, however, we are unaware of any cupules in the southern Southwest that appear to have been used as hand or toe holds for climbing or other transportation-related functions.

Incorporated into Rock Art. In the May 2020 email cited above, Nordby indicated cupules at Inscription House in Navajo National Monument are parts of petroglyph panels but did not say whether the cupules are parts of other petroglyphs. Lynda A. Sánchez (2009) wrote that cupules are incorporated into rock art, usually on human figures at “power points” such as the heart, wrists and abdomen.

Figures 36, 39, 49, and 62 show cupules in the southern Southwest that are integrated directly into petroglyphs, and Figures 58 and 63 show cupules very close to petroglyphs. We do not know of any cupules in our research area that are actually incorporated into human-figure petroglyphs, however.

A Symbolism No Longer Recoverable. Traces of red paint were reported by Hedges (1980:76) in several cupules on the vertical face of a large cupules boulder in the Menifee Valley, California, indicating the cupules there were intentionally decorated rather than being receptacles for mixing paint.

At Gila Cliff Dwellings, Cave 5 encompasses the largest number of family residence structures along with a large community room (Figure 14). All in open space outside these rooms are seven boulders with



Figure 60. Photomosaic of bedrock cupules at Sears Point in lower Gila River valley, AZ (Photo courtesy of Evelyn Billo, Robert Mark, and other Rupestrian CyberServices associates)

cupules. This cave's large open space provides the setting for the closest thing to a true village plaza or community gathering area, analogous to the plazas in Ancestral Pueblo and modern Puebloan open-air sites that are surrounded by enclosed rooms (family residences) and that were and are used for work, play, and communal gatherings. The making of cupules was a major activity in Gila Cliff Dwellings Cave 5 and its seven cupule boulders appear to be related to the large community room and the cave's large open space, suggesting the cupules had a symbolic function.

What the functions of the red paint in the Menifee Valley cupules might have been and



what the placement of cupules in the Gila Cliff Dwellings and other locations might mean is speculative, though. In fact, nearly all of the potential uses of cupules suggested here for the southern Southwest are speculative, since virtually none of the ethnographic examples cited are for cultures who were known to inhabit this research area.

Furthermore, Bednarik (2010) cited scientific evidence from numerous archaeological sites that cupules were reused after they were first created, sometimes many millennia later. Therefore, without being able to interview the original makers of the southern Southwest cupules, we cannot know their original intended uses, and if we find cases in which cupules are still being used today but cannot document how old the cupules are, we will not know whether or how their functions may have changed through time.

In many cases, the act of creating cupules may have been as or more important as the resulting cupule itself (Bednarik 2008). As suggested by Duwe (2016), while the meaning and function of cupules are probably as diverse and nuanced as the numerous cultures in which they are found, many ethnographic examples suggest cupules were not just features to be used, but also artifacts of practice; and the context, and possibly the meanings, of cupule practice changed through time.

Ages and Cultural Affiliations

How old are these human-created bedrock and boulder depressions in the southern Southwest, and who used them? To give some culture context for this discussion, Table 3 provides approximate chronologies of pre- and post-Hispanic cultures who have lived in the region, and shows that beginning with the Formative period the cultures there became quite diversified (and they didn't share each others' timelines for progressing from one culture stage to the next!).

Ages. Some mortars, grinding basins, and cupules beyond this continent are believed to be thousands of years older than the earliest archaeologically documented presence of humans in the Americas. Slicks, which probably are the simplest to create of all the features we have discussed, probably date even earlier worldwide. But how old are these bedrock and boulder features in the southern Southwest?

Stone mortars, basins, slicks, and cupules cannot be directly dated by common absolute dating techniques such as radiocarbon assays, and as far as we know none of the other dating techniques that can be used directly on stone artifacts (for example, optically stimulated luminescence) have not been tried on these outdoor rock features. Mortars, cupules, or basins made on small boulders may be dated by contextual association with directly datable archaeological material when found in house ruins or other well preserved archaeological features, but mortars, cupules, basins, and slicks strewn across the countryside or in rockshelters often are not directly associated with datable archaeological artifacts. Even when they are, one cannot assume the rock depressions were only used by the people who happen to have left some arti-



Figure 61. Two completely reweathered cupules to the right of less-weathered petroglyphs on boulder at Sears Point in the lower Gila River valley, AZ (Photo courtesy of Evelyn Billo, Robert Mark, and other Rupestrian CyberServices associates)



Figure 62. Cupules over petroglyph elements on boulder at Sears Point in lower Gila River valley, AZ (Photo courtesy of Evelyn Billo, Robert Mark, and other Rupestrian CyberServices associates)



Table 3. Approximate culture chronologies for the subareas of the southern Southwest

		Western Part	Central Part	Eastern Part		
General culture period	Approximate dates	Far-southeastern California & southwestern Arizona	South-central Arizona	Southeastern Arizona & southwestern New Mexico	Río Grande Valley, south-central New Mexico & far-western Texas	Southeastern New Mexico and Trans-Pecos western Texas
Post-Spanish	Post-1691 to 1700 CE	Cocopah, Halyikwamai, Kohuana, Kumeyaay, Mojave, Paipai, Piipaash, Quechan, Xalychidom,	O'odham; Apache, other nomadic cultures, Spanish, Mexican, U.S. (post-1691 CE)	Apache, other nomadic cultures, Spanish, Mexican, U.S. (post-1700s CE)	Post-Pueblo Revolt missions and presidios near El Paso, Apache & other nomadic cultures, Spanish, Mexican, U.S. (post-1700s CE)	Apache, Comanche, Kiowa & other nomadic cultures, Spanish, Mexican, U.S. (post-1700s CE)
Protohistoric	1450 to 1650-1700 CE	Yavapai (all Patayan III); & Spanish, Mexican, U.S. (1650-1900 CE)	Protohistoric O'odham; Apache & other nomadic cultures (1450-1691 CE)	Apache & other nomadic cultures (1450-early 1700s CE)	Apache, Manso, Suma & other nomadic cultures (1450-early 1700s CE)	Apache, Comanche, & other nomadic cultures (1450-early 1700s CE)
Late Formative	1000-1150 to 1450-1650 CE	Patayan II (1000-1650 CE)	Hohokam Classic, Salado, & early nomadic cultures (1150-1450 CE)	Late Mogollon & Western Pueblo (Mimbres, Reserve & Tularosa phases) (1000-1450 CE)	Jornada Mogollon Doña Ana & El Paso phases (1000-1450 CE)	Mobile villagers (1000-1300 CE); Ochoa phase Puebloan migration (1300-1450 CE)
Early Formative	200-700 to 1000-1150 CE	Patayan I (700-1000 CE)	Hohokam pre-Classical (450-1150 CE)	Pit House periods (200-1000 CE)	Jornada Mogollon Mesilla phase (200-500 to 1000 CE)	Maljamar and Querecho phases (900-1300 CE)
Late Archaic-Early Agricultural	2100 BCE to 200-700 CE	Early agricultural & early ceramic (not identified as such in reported regional chronologies) (1000 BCE-700 CE)	Early Agricultural & Early Ceramic (2100 BCE-450 CE)	Early Agricultural (2100 BCE-200 CE)	Late Archaic Fresnal and Hueco phases (2400 BCE to 200-500 CE)	Late Archaic (2100 BCE-900 CE)
Archaic	8000-6000 to 2100-1000 BCE	Amargosa (general Archaic for Western Desert) (6000-1000 BCE)	Archaic			
Paleoindian	11,000 to 8000-6000 BCE	San Dieguito (regional late Paleoindian & early Archaic) (10000-6000 BCE)	Paleoindian			

facts there and only during the times when those particular folk were present, because the depressions also could have been used before and after those times.

The ages of slicks in the southern Southwest may not be determinable. Most likely they date to the Archaic period and later (Table 3) because ground stone artifacts first show up in the archaeological record of the Southwest during the early Archaic period (Cordell and McBrinn 2012).

Though the ages of bedrock and boulder mortars, basins, and cupules are difficult to determine, ancient artifacts and rock art motifs of datable styles that are sometimes spatially associated with these indentations in the American Southwest suggest they were in use from several thousand years ago up to the present.

Burton and Farrell (1989) and Thompson and others (2006) suggested most mortars and cupules in southern Arizona and southwestern New Mexico, respectively, date to the Archaic period. Thompson (2013) felt that the petroglyphs in Map Cave (Figure 45) date to the Late Archaic period because they are similar to other images broadly defined as the Western Archaic Tradition (Burton and Farrell 1989). These Archaic petroglyphs include “abstract designs, large abstract anthropomorphs, confusing superim-



positions, zigzags, circles, rakes, nets, crosshatching and crosses, and with small irregularities of the rock incorporated into the design” (Burton and Farrell 1989:4). Burton and Farrell attributed a similar age to the cupules and bedrock mortars associated with the Western Archaic Tradition petroglyphs. Thus, it seems probable that the bulk of the petroglyphs in Map Cave, and therefore the mortar holes and cupules therein, were established during the Late Archaic period.

Marc Thompson, in a 2020 email to Dart, suggested bedrock and boulder mortars in southern New Mexico and far-western Texas may have been created and used by Archaic period nomads but probably were reused by the more sedentary Puebloans such as the Mimbres, and still later by Apaches and other late pre-Hispanic nomadic cultures (who were similar in hunting-gathering adaptation to the Archaic people). Thompson noted that some mortars at Mimbres petroglyph sites and at the Hueco Tanks pictograph locations in El Paso are incredibly deep, even beyond the reach of a human arm, suggesting hundreds, if not thousands, of years of use. He also has noted that 39 mortars (mean depth and diameter 20 cm), 19 cupules, and hundreds of Late Archaic period projectile points, but few sherds, have been recorded south of Alamogordo, New Mexico, in the eastern Tularosa Basin’s Dog Canyon, suggesting the mortars and cupules there were established during the Late Archaic period.

Mortars continued in use after the Archaic period. Mortars in White Rock Cave (EPAS-49) in the Franklin Mountains of El Paso County, Texas, are associated with pictographs of both Archaic (6000 BCE to 600 CE) and later styles (Jornada Mogollon Mesilla or El Paso phase, 800-1200 CE). Numerous bedrock and large-boulder mortars, and at least one stone pestle, in Dog Canyon south of Alamogordo, New Mexico, were speculated to mostly “reflect an Archaic Period economy, or that of the Hueco Phase of the Jornada Mogollon but they could also be Apache” though it was acknowledged there were a few sherds found on the same site as the Dog Canyon mortars that tentatively dated to the Mesilla or El Paso phase, ca. 900-1300 CE (Dart 1977).

Besides Map Cave, another example that seems to bear out an Archaic age for cupules was reported by Margaret Berrier and LeRoy Unglaub (2013): The only cupules they found while recording three petroglyph localities near Cottonwood Springs in the Río Grande Valley were associated with a locality in which 60-plus percent of the glyphs were interpreted as Archaic style, whereas in the other two recorded loci that did not have cupules, the majority of petroglyphs were attributed to the later Jornada Mogollon culture.

Varied weathering patterns evident on some cupules indicate some are extremely old whereas others are less so. For example, the different reweathering patterns over the cupules in Figures 61 and 62 clearly demonstrate that some cupules are quite old (probably Archaic period, Figure 62) whereas others likely date to, or at least were last used, during the Formative period or later (Figure 61).



Figure 63. Boulder with single cupule to the right of a large anthropomorph petroglyph’s head at Antelope Hill east of Wellton in the lower Gila River valley, AZ (Photo courtesy of Evelyn Billo, Robert Mark, and other Rupestrian CyberServices associates)



Figure 64. A 46 X 36 X 25-cm (18 X 14 X 10-inch) boulder with cupules and a larger hole that may be a mortar, found near Sunizona in southeastern Arizona (Photo by Kathleen Nash)

Formative period use also seems likely for the cupules, mortars, basins, and slicks in the Gila Cliff Dwellings, since the most intensive use of that site was by Puebloan people during the local Tularosa phase (Table 3) between 1276 and 1325 CE (Bradford 1992:121). It is feasible, however, that many of the cupules in the Gila Cliff Dwellings caves were created before the Tularosa phase people arrived. A few Mimbres Black-on-white sherds found in the cliff dwellings suggest use of the caves between 1000 and 1130 CE, and even earlier uses are suggested by black soot from fires on the ceiling and walls of Cave 3 (which contrasts with the tan wall and ceiling color of the adjoining cliff dwelling rooms), and with the placement of pictographs in Cave 6. The Tularosa phase population of the Gila Cliff Dwellings has been estimated at just 40

to 60 or slightly more. It is difficult to comprehend that this group alone created the 14 mortar and cupule features with over 250 human-made depressions, mostly small cupules. It seems more feasible that many of the depressions already were there, perhaps made by Archaic period peoples, and that the Tularosa phase people just continued the trend after they arrived.

Two boulders in Gila Cliff Dwellings Cave 5 (Figure 14 map) indicate at least two relative-dated periods in which depressions in boulders were created prior to construction of the Tularosa phase pueblo rooms. The bottom boulder (Figure 65, left) has a large cupule or grinding basin. Above it is a fallen slab from the roof of the cave that contains six cupules, and on top of that slab is a Tularosa phase masonry room wall (Figure 65, right), showing that the two cupule-making episodes occurred earlier than the Tularosa phase wall construction. How much earlier has not been determined.

We can also make reasoned judgments about the times of year that mortars, at least, were most used, and who used them most. Bell and Castetter (1937) found that both the Tohono O'odham and Akimel O'odham of southern Arizona gathered the mesquite pods annually in late summer, after the saguaro cactus-fruit harvest. Harvesting mesquite for the Akimel O'odham, at least, was a communal event in which large parties constituted the expeditions and in which the women were the principal gatherers. The mesquite pods were collected in cylindrical granary baskets, which usually were stored on the roofs of houses or sheds, or on platforms, to keep the food safe from rodents.

Assuming mesquite was the primary resource that mortars were used for, and that throughout the southern Southwest (not just in southern Arizona) mesquite produces beans in late summer, it seems likely

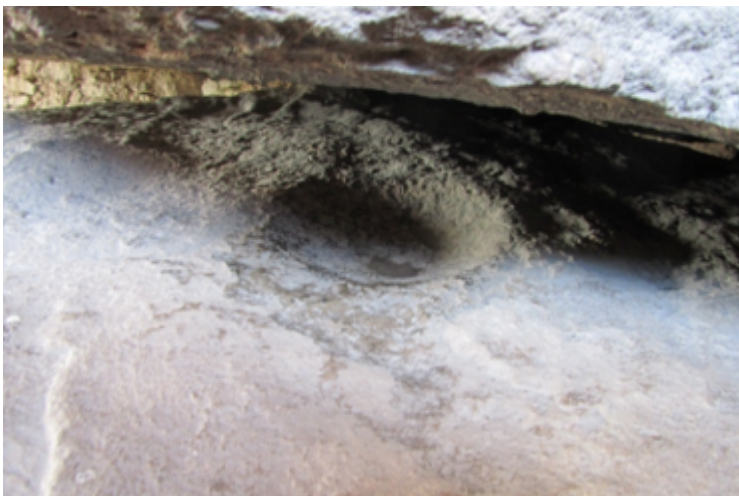


Figure 65. Sequentially created depressions and pueblo wall on two superposed boulder slabs in Gila Cliff Dwellings Cave 5; left, earliest depression (basin) on lower slab; right, upper slab with six cupules and wall remnant (Photos by Chris Reed)



that all other cultures who used mortars besides the O'odham did so mostly in late summers. Cupules, basins, and slicks, however, if not used primarily for mesquite processing, could have been used any time of the year, or perhaps only during certain times if so preferred by the cultures who used those features.

Cultures. As suggested throughout this article and in the above section about ages, mortars appear to have been used by southern Southwest native cultures from Archaic times through the Formative, Proto-historic, and Spanish and later periods (Table 3). We have shown that individual cupules occur in many places throughout the southern Southwest. However, large boulders and bedrock exposures with hundreds of them seem to be common in some subregions but rare in the Mimbres and Jornada Mogollon areas of southwestern New Mexico, in the Phoenix Basin, and in southwestern Arizona-southeastern California west of the Gila Bend/Sears point area of Arizona. In emails to Dart, rock art researchers Marc Thompson and Joan Price commented that cupules seem to be less common in the Mimbres and Jornada Mogollon areas than that in other southern Southwest regions they have explored; and archaeologist Todd Bostwick wrote that in the Phoenix region cupules are not common whereas bedrock mortars are present in that area. Bostwick suggested that if cupules were used for rituals, the rites associated with them were not part of the Phoenix Basin ceremonial practices. If cupules really are relatively rarer in some parts of the southern Southwest than in others, might this be because the ritual practices of some cultures (for example, Mimbres and Jornada Mogollon in south-central New Mexico) were noticeably different from the practices of other contemporaneous cultures (e.g., Hohokam in Arizona, and the southeastern New Mexico and Trans-Pecos Texas Formative cultures to the east) (Table 3)?

Archaeologist Myles Miller countered that one reason why cupules may seem rarer in some areas than others is because not all researchers agree on what is “common,” noting he and his associates have found at least a couple of cupules at each of the 50-plus rock art sites they have fully documented in the Mimbres and Jornada Mogollon areas, so cupules are common there in terms of their presence at rock art sites. On the other hand, Miller agreed cupule boulders and surfaces covered with cupules are somewhat rare in these areas so might be less “common” in terms of actual counts than in other regions.

Other possible reasons cupules seem to be rarer in some areas than others is that fewer archaeological inventory surveys have been done in some subregions (for example, in the lower Colorado River Valley) than in others (such as southern New Mexico); because data on archaeological sites on some Indian lands is not readily made public by the tribes who occupy those areas; and perhaps because not all archaeologists have consistently recorded cupules when they have seen them.

Mesquite processing by the O'odham and in northwestern Mexico by the Seri, and acorn preparation by the California Chumash, are documented female activities. Pounding hard seeds is hard work. For the Mimbres apparently there was no need for the presence of men to guard the women from raiders or kidnapers, and this probably was the case for the Seri and Chumash as well. Rather than working the pestles, the men would be engaged in “hunting” much like – as Marc Thompson wryly commented – today's beer hunters.

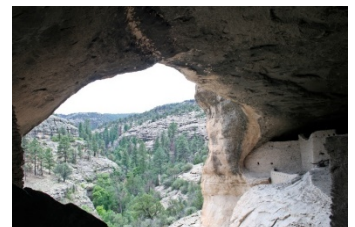
We mentioned on page 1 that our study area boundaries are arbitrary. Bedrock and boulder mortars, basins, slicks, and cupules have been recorded in areas in and well beyond our area of interest here, as attested by our mention of archaeological and ethnographic studies in the U.S. and elsewhere. We hope this overview provides some comparative information for identifying and understanding these features wherever they may be found.

About the Authors

Allen Dart, a Registered Professional Archaeologist, has worked professionally in archaeology since 1975 and has been Old Pueblo Archaeology Center's executive director since 1993.

Chris Reed has volunteered at several National Parks and Monuments (including Gila Cliff Dwellings) as an Interpretive Ranger, has taken several classroom and fieldwork classes through the Arizona Archaeological Society, and has participated in fieldwork with the U.S. Forest Service and National Park Service.

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Gila Cliff Dwellings photo by Chris Reed



chronologies for the Río Grande Valley, south-central and southeastern New Mexico, and western Texas cultures), Aaron Wright (who did likewise for the far-southeastern California & southwestern Arizona ones in Table 3), Mark Willis, Dennis Gilpin, Kelley Hays-Gilpin, Eric Kaldahl, Todd Bostwick, Jenny Adams, Glenn Omundson, Steve Lekson, Tom Windes, Joan Price, James Snead, Tineke Van Zandt, Lynda Sánchez, Delton Estes, Karl Laumbach, Alan Ferg, Larry Nordby, Joan Price, Dave Daniel, Janine Hernbrode, Phil Shelley, Chuck Adams, Rich Lange, Peter Pilles, Jeff Clark, Henry Wallace, Meade Kemrer, Brad Vierra, Regge Wiseman, Ellen Dubinsky, Karl Laumbach, Dan Garcia, Brian Kenny, Kelsey Hanson, LeRoy Unglaub, Jamie Civitello, and Gila Cliff Dwellings National Monument's Steve Riley, Rod Sauter, and volunteers for providing input, publications, permissions, assistance, and general support in our research and for their encouragement and friendship. We also thank Marglyph, Marc, Amanda, Aaron, Mark, Lynda (and husband James), and Joan from the above list, plus Jeff Altschul, Evelyn Billo, Robert Mark, and their Rupestrian Cyber-Services associates, Kathy Burdick, Chris Doolittle, Paul and Suzy Fish, Laura Gann, Donn Grenda, Mark Killion and Jim Kaler, Chip Littlefield, Art MacWilliams, Jesse Mailloux, Ken Matesich, Maria Molina, Kathleen Nash, and the organizations with which they are or were affiliated for providing us with illustrations to include in this article, or permissions to use them.

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Remembering Doug Craig

Archaeologist Douglas B. Craig, Jr., passed away after an extended illness on May 14 at the age of 64. He is survived by Rebecca (Becky) Craig, his wife of many years. Memorial events are not currently scheduled.

Doug received his B.A. in history from Harvard and his M.A. and Ph.D. in anthropology from the University of Arizona. Since the early 1980s, during employment with Tucson's Pima Community College and later with consulting companies Desert Archaeology and Northland Research he became one of the best-known Hohokam archaeologists, conducting exemplary research at many places in southern Arizona including the Grewe archaeological site adjacent to the Casa Grande Ruins. He was the author of numerous monographs and professional papers, focusing on Hohokam community organization, political economy, population dynamics, and the changing character of Hohokam households.

In January 2009 Doug was elected to Old Pueblo Archaeology Center's Board of Directors and he continued to serve on it through January 2015. He was Old Pueblo's vice president nearly that whole time, and was editor of the June 2009-September 2011 issues of the Old Pueblo Archaeology bulletin. He had served as President of the Arizona Archaeological Council prior to joining Old Pueblo's Board and afterward became President of the Friends of Casa Grande Ruins. Doug gave numerous public and professional presentations about Arizona archaeology (including for Old Pueblo Archaeology Center) and led many tours at the Casa Grande Ruins and other archaeological sites, always telling stories and sharing his love and knowledge of the desert, history, and people of Arizona.



Arizona Humanities-National Endowment for the Humanities CARES Act Award to Old Pueblo

Since 1997, Old Pueblo Archaeology Center has been the recipient of multiple grants provided by Arizona Humanities, formerly known as the Arizona Humanities Council. The grants have provided funding for Old Pueblo to provide classroom scholarships that allow schools with high percentages of students from low-income families to have their students participate in our children's education programs, and to provide archaeology workshops for teachers.

The March 2020 business-closure orders issued by the City of Tucson and the State of Arizona to help slow the spread of the COVID-19 coronavirus pandemic that hit the United States earlier this year forced Old Pueblo to cancel all of our remaining children's education programs, archaeological site tours, and public presentations that had been scheduled for mid-March through May. Those closures resulted in serious losses of revenues generated by the children's programs and by donations we had anticipated for the tours and presentations.

On April 29, Arizona Humanities launched its CARES Act Emergency Grant Program to help support cultural organizations affected by the COVID-19 crisis. Arizona Humanities' CARES Act emergency grants were offered to provide unrestricted program and operational support of up to \$10,000 for humanities-focused cultural nonprofit organizations in Arizona. The grant funds, originating through the National Endowment for the Humanities, come from the Coronavirus Aid, Relief, and Economic Security (CARES Act) of 2020 passed earlier this year by Congress.

In announcing the availability of these funds to Arizona nonprofit organizations, Arizona Humanities Executive Director Brenda Thomson wrote, "We cannot say thank you enough. We know that these funds are critical for the museums, cultural and community centers, libraries and historic sites all hard hit by the pandemic. They serve everyone... rural and urban towns, families and children, and students and workers from across Arizona. We hope that we can reach areas that receive few other cultural resources."

Old Pueblo applied to Arizona Humanities for one of its CARES Act grants on May 3. In our application we noted Old Pueblo's annual education program and tours revenues normally constitute over 40 percent of the organization's total annual income. Through May 31, 2020, the closure was estimated to have resulted in loss of about 2.5 months' worth of Old Pueblo's education program revenues (considering that nearly all of the education programs per year are offered during just eight months out of each year) and loss of donation revenues for the tours scheduled between March 17 and May 31 that we had to cancel.

To help cover these revenue losses, Arizona Humanities awarded Old Pueblo a CARES Act grant of \$8,551. The funds will be spent to provide all of Old Pueblo's regular staff who would have been employed from May 17-May 31 with stipends to encourage them to return to work when closure orders are lifted, and to continue paying Old Pueblo's other normal expenses during that period.

Old Pueblo Archaeology Center is extremely grateful to Arizona Humanities and the National Endowment for the Humanities for their support. For information about Arizona Humanities please visit www.azhumanities.org.

Arizona Humanities Mission Statement

Arizona Humanities builds a just and civil society by creating opportunities to explore our shared human experiences through discussion, learning and reflection.



HUMANITIES

EXPLORE. SHARE. EXPERIENCE.

The funding source for this grant award is the National Endowment for the Humanities/SO-50519. The grant is administered by Arizona Humanities.



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Any views, findings, conclusions or recommendations expressed in this publication do not necessarily represent those of the National Endowment for the Humanities or of Arizona Humanities.



Imago Dei Students Report on Excavations at the OPEN3 Site

Fifth grade teacher Carolyn Hollis brought her Imago Dei Middle School class to Old Pueblo Archaeology Center to participate in the OPEN3 simulated archaeological excavation under the direction of Old Pueblo archaeologist Ginger Thompson. After their field trip, Ms. Hollis and the students sent Old Pueblo their hand-written report on their OPEN3 experience. Their report pages appear on this page and the following two.

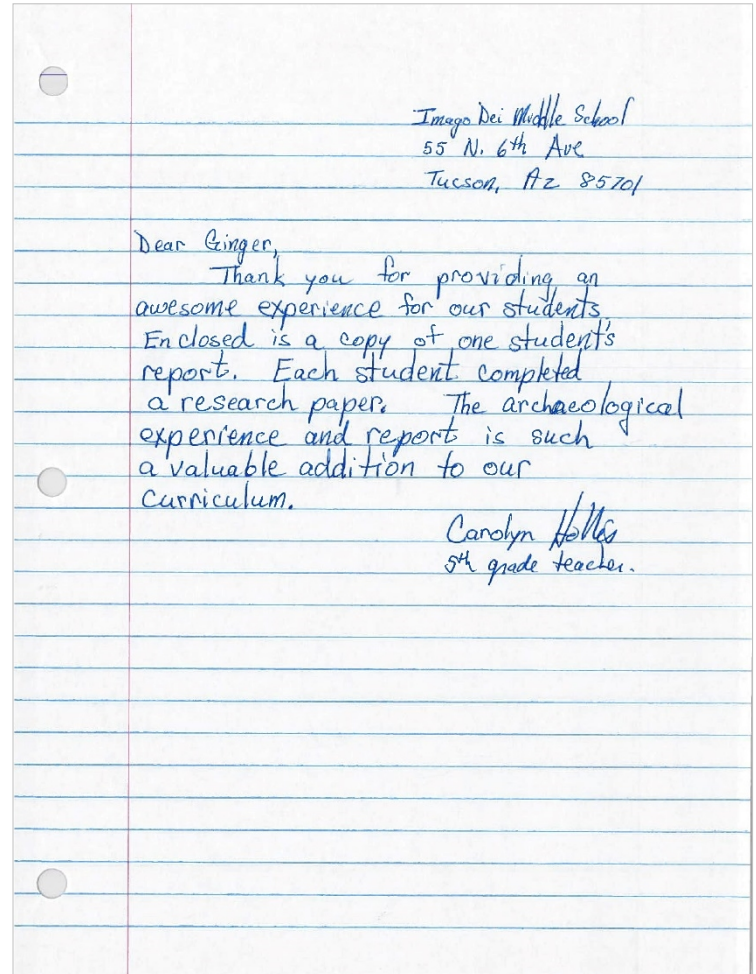
The Old Pueblo Educational Neighborhood (OPEN) program allows students and adults to learn what archaeology is all about by excavation in "OPEN3," a full-scale model of an archaeological site. OPEN3 is a simulated excavation site that archaeologists have constructed to resemble a southern Arizona Hohokam Indian archaeological site. It has full-size replicas of prehistoric pithouses and outdoor features that the Hohokam used for cooking, storage, and other purposes.

Students participating in the OPEN3 program get to learn and practice techniques used to excavate real archaeological sites. They are exposed to the scientific method of forming and testing hypotheses, make to-scale drawings of their discoveries, and construct graphs to analyzed and interpret their data. In the process they gain insights into how ancient people constructed their houses, what they looked like, ate, and believed in, and how they created beauty in their lives.

Old Pueblo also offers our OPENOUT (Old Pueblo Educational Neighborhood Outreach) program in which professional archaeologists offer 45-60 minute presentations to children to show them how some aspects of everyday life have changed while others have stayed the same. Our OPENOUT presentations include **Ancient People of Arizona**, which gives kids an overview of how the Ancestral Pueblo, Mogollon, and Hohokam peoples lived; **Lifestyle of the Hohokam**, which introduces children to southern Arizona's Hohokam archaeological culture; and **What is an Archaeologist?** – a program designed to give children an idea of what archaeologists do, how they do it, and how they help us learn about past peoples. The hands-on materials and fun lesson plans in our OPENOUT programs bring archaeology and the past alive for children and are a perfect prelude for the OPEN3 simulated archaeological excavation.

In addition to the OPEN3 and OPENOUT programs, Old Pueblo provides opportunities for organized children's groups to go on guided tours to real archaeological sites. Heritage sites that can be visited include the Picture Rocks petroglyphs site, Los Morteros Hohokam Village, and Vista del Rio Hohokam Village. Each youth tour is a guided visit that does not include archaeological excavation; participants are not allowed to collect artifacts.

For details and pricing of our children's education programs please visit Old Pueblo Archaeology Center's <http://www.oldpueblo.org/programs/educational-programs/childrens-programs/> web page.



Imago Dei Students Report on Excavations at the OPEN3 Site (Continued)

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11-5-18
Science

Excavation of Hohokam Site

Organization: Imago Dei Middle school
Reserchers: Andrea
Nathalia
Dalono
Mahamudi
Tyrell

Date: October, 29, 2018

Background Research:

There are many ways to identify a pithouse. If there is charcoal about a meter away from what you think is the door, then that's a pithouse. The reason for that is that there used to be a fire pit where you found charcoal. Burnt wood is charcoal. If you find stone around the fire pit, it is to protect the fire from spreading. Another way to know it's a pithouse is if it has low floors with walls. Those are some ways to know it's a pithouse.

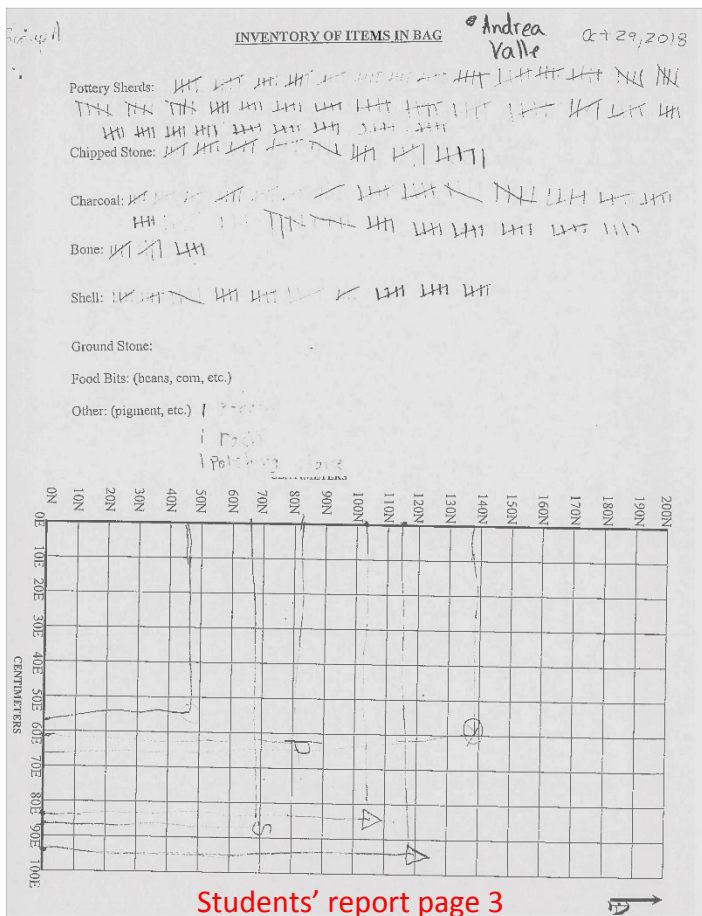
Students' report page 1

There are many ways to identify a ramada. You can find charcoal as well because in a ramada you can cook. There would be shells in the ramada to make any type of jewelry. To make a bracelet you grab a big enough shell and drill a hole into it to make a cool design. You might also find a devil's claw. A ramada doesn't have walls. Those are some ways to identify a ramada

Hypothesis: I think we excavated a pithouse.

Data:
Opening elevation: 9 centimeters
Closing elevation: 20 centimeters

Students' report page 2



Students' report page 3

©Andrea Valle 10-30-18 Math

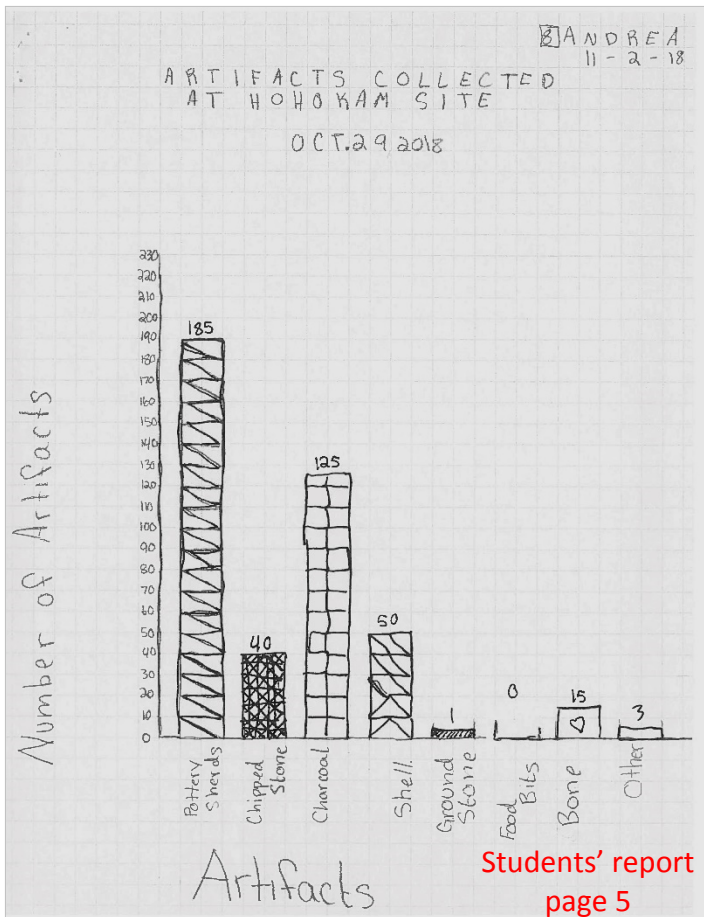
Group A Number of Artifacts collected at Hohokam Site. Results

Artifacts	Number of items
Pottery Sherds	185
Chipped Stone	40
Charcoal	125
Bone	15
Shell	50
Ground Stone	1
Food Bits	0
Other	3

Students' report page 4



Imago Dei Students Report on Excavations at the OPEN3 Site (Continued)



Andrea V.
11-5-18
Science

Hohokam Report
Conclusion:

We excavated a Hohokam pithouse. We found charcoal, which means that there used to be a little campfire. You can also figure out that it's a pithouse because the fire is about a meter away from the door. You can also find out it's a pithouse because you'll find stone around where the campfire would be. The stone is there so that the fire doesn't spread and start a fire.

Students' report
page 6

Archaeology Opportunities Membership/Old Pueblo Archaeology Subscription Application Form
Please return this form with check payable to "OPAC" or with credit card information completed,
To Old Pueblo Archaeology Center, PO Box 40577, Tucson AZ 85717-0577

Name (Mr., Ms. Mrs.) _____

Address _____

City, State, Zip _____

Area Code & Phone (____) _____

Email address _____

Questions? 520-798-1201 or info@oldpueblo.org.

I am submitting the following payment for:

Archaeology Opportunities membership: \$ _____

Donation to Old Pueblo Archaeology Center: \$ _____

TOTAL ENCLOSED: \$ _____

Please select membership category from the list below:

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<input type="checkbox"/> Sustaining	\$100	
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Provides 1-year subscription to the *Old Pueblo Archaeology* electronic bulletin (4 issues); does not provide discounts or participation in member-assisted field research programs.

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Please complete section below only if paying with credit card - Old Pueblo accepts Visa, MasterCard, Discover, and Diners Club cards.

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Some Upcoming Old Pueblo Archaeology Center Classes and Tours

For information on any of them contact Old Pueblo Archaeology Center: 520-798-1201 or info@oldpueblo.org.



Wednesdays September 16-December 16, 2020: “Archaeology of the Southwest” 12-session class with archaeologist Allen Dart at Old Pueblo Archaeology Center, 2201 W. 44th Street, Tucson, and online via Zoom

Photo by Allen Dart

Tuesday September 22, 2020: “Autumn Equinox Tour to Los Morteros and Picture Rocks Petroglyphs Sites” with archaeologist Allen Dart departing from near Silverbell Road and Linda Vista Blvd. in Marana, Arizona

Photo by Tom Herrick



Saturday October 3, 2020: “Historic Camp Rucker: Apache Wars Outpost” heritage education tour with archaeologist Bill Gillespie in Arizona’s Chiricahua Mountains, starting at Interstate-10 Exit 275, Tucson
Coronado National Forest photo

Saturday October 10, 2020: “Archaeology and History of Canoa Ranch” presentation and tours with archaeologist Allen Dart, historic architect Simon Herbert, and Pima County Parks volunteers at Historic Canoa Ranch, 5375 S. I-19 Frontage Road, Green Valley, Arizona

Photo by Michael Mock and Random Orbit Photography



Saturday October 17, 2020: “Santa Cruz de Terrenate and Pitaitutgam Archaeological Sites” tour with archaeologist Dr. Deni J. Seymour starting at AZ-90/AZ-82 intersection in Whetstone, Arizona

Photos by Deni J. Seymour

Saturday October 24, 2020: “Arrowhead-making and Flintknapping Workshop” – Learn to make flaked stone tools with flintknapper Sam Greenleaf at Old Pueblo Archaeology Center, 2201 W. 44th Street, Tucson

Photo by Allen Dart



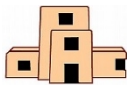
Saturday November 21, 2020: “Catalina Highway Prison Camp at the Gordon Hirabayashi Recreation Area” heritage education tour with archaeologist Bill Gillespie meets at 9125 E. Tanque Verde Rd., Tucson
Coronado National Forest photo

Saturday December 12, 2020: “Journey to the Fiesta of Guadalupe in the Town of Guadalupe, Arizona” with Yoeme (Yaqui Indian) traditional culture specialist Felipe S. Molina, visiting the plaza of the Yoeme Village of Guadalupe, Arizona

Photo from www.commonswikipedia.org



Saturday February 6, 2021: Old Pueblo Archaeology Center’s “Tucson and Marana Yoeme (Yaqui Indian) Communities” cultural sites tour with Yoeme traditional culture specialist Felipe S. Molina starting at 1317 W. Irvington Road, Tucson
R. B. Spicer photo courtesy of Felipe Molina



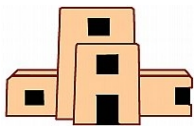
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www.oldpueblo.org

520-798-1201

info@oldpueblo.org

Old Pueblo Archaeology Center's *Archaeology Opportunities* Membership and Discounts Program

Archaeology Opportunities is a membership program for persons who wish to support Old Pueblo Archaeology Center's education efforts and perhaps even to experience for themselves the thrill of discovery by participating in research. Membership is also a means of getting discounts on the fees Old Pueblo normally charges for publications, education programs, and tours. Members of *Archaeology Opportunities* at the Individual membership level and above are allowed to participate in certain of Old Pueblo's archaeological excavation, survey, and other field research projects, and can assist with studies and reconstruction of pottery and other artifacts in the archaeology laboratory. Membership benefits include a 1-year subscription to the **Old Pueblo Archaeology** electronic quarterly bulletin, opportunities to participate in Old Pueblo's member-assisted field research programs, discounts on publications and archaeology-related items, and invitations and discounts for field trips and other events.

Old Pueblo Archaeology is the electronic quarterly bulletin of Old Pueblo Archaeology Center, a 501(c)(3) nonprofit corporation. Questions, comments, and news items can be addressed to the editor, Allen Dart, at info@oldpueblo.org or 520-798-1201, or by mail to Old Pueblo Archaeology Center, PO Box 40577, Tucson AZ 85717-0577. For more information please visit our web site: www.oldpueblo.org. Your *Archaeology Opportunities* membership helps support Old Pueblo's children's education programs.