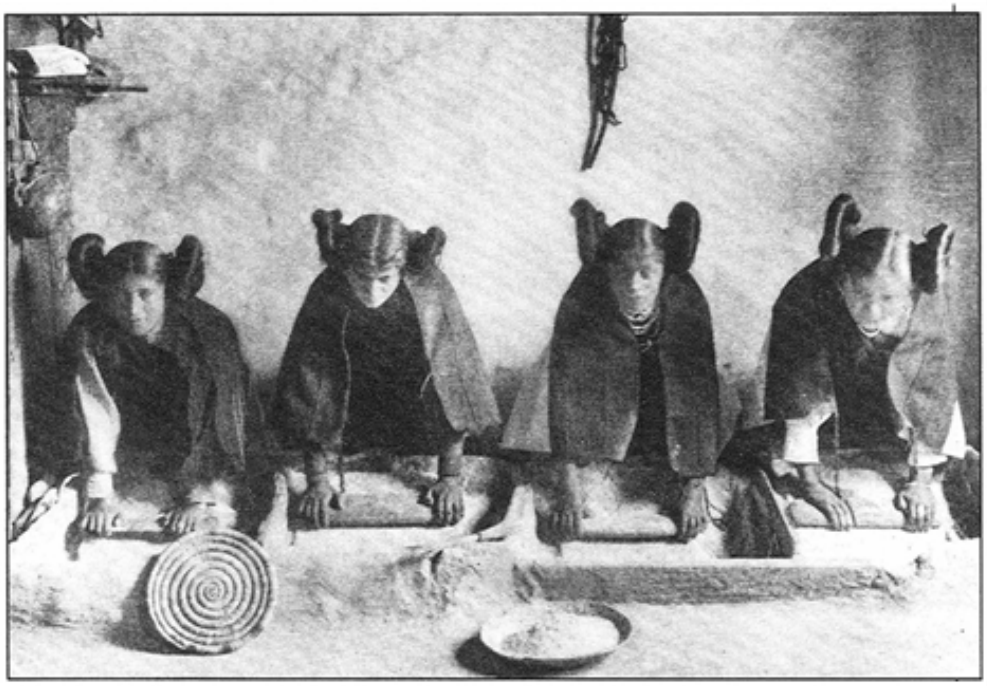
ARCHAEOLOGY IN TUCSON

Vol. 10, No. 4 Newsletter of the Center for Desert Archaeology Fall 1996

Bringing Stone Tools to Life

The People behind the Rocks

by Jenny L. Adams, Ph.D.
Center for Desert Archaeology



Four unmarried Hopi girls pose over bins with corn-grinding manos and metates (photo no. 42863 by E. S. Curtis, pre-1907, courtesy of the Arizona State Museum).

One of the most exciting challenges in archaeological research is to look at ancient tools and determine how they were used by prehistoric people. Typically, ceramic pots are associated with cooking and storage, chipped stone tools with cutting and scraping, and ground stone tools with crushing and grinding seeds. However, recent studies of grinding technology, along with research into what foods were available for processing, is revealing new information, forcing us to reassess long-held assumptions about how food-grinding tools were used. This research includes experimenting with the tools, studying various cultural traditions (ethnographic analogy), and examining tools under a microscope for distinctive use-wear patterns.

It's not hard to imagine how some tools were used prehistorically. We can observe living tool users and read reports written by those who studied native groups before they were affected by colonial technology. A few early photographs even document stone tools in use. Unfortunately, as soon as metal tools became available, many stone tools were replaced. For example, a search through Southwestern archives for a photograph of a Native American felling a tree with a stone axe would be futile. Metal axes brought into the Southwest by conquistadors, colonists, and missionaries quickly replaced their stone counterparts.

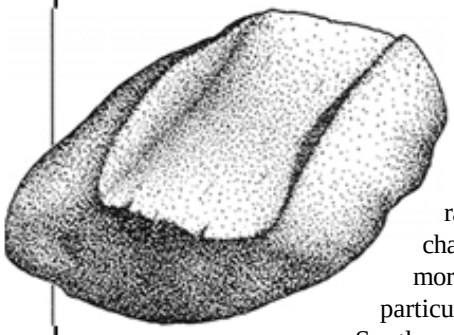


Illustration of trough metate by Chip Colwell.

In contrast, technologies relating to food preparation have been the slowest to change, even when users have more efficient alternatives. This is particularly evident in the American Southwest where, even today, Native American women use stone manos and metates to grind com meal, especially for ceremonial occasions. A special type of bread called *piki* is cooked on large stone slabs over a hot fire in the modem pueblo villages of Hopi and Zuni. Modem electrical grinders and metal griddles simply cannot meet the unique cultural requirements for processing these foods.

TRADITIONAL ASSUMPTIONS ABOUT FOOD PROCESSING

Archaeologists have long held two basic assumptions that mano and metate forms were determined by what foods they were used to process, and that com was processed by first drying the kernels and then grinding them into flour. These assumptions were derived from specific ethnographic comparisons and archaeological evidence.

Early ethnographers reported that dry grinding was the most common method of food processing, so archaeologists depended on this model to interpret how prehistoric manos and metates were used. Also, archaeological evidence showed that the earliest metates were used to grind wild nuts and seeds. New mano and metate designs, along with corn, were believed to date sometime after A.D. 300.

Every archaeologist has been taught that basin metates, with their deep, oval basins and the small manos used within them, were used to grind gathered seeds and nuts. The same use was assumed for slab metates, which started out with flat surfaces but developed shallow basins if used long enough with manos shorter than the surface width. On the other hand, trough metates were part of an agricultural complex that came

Examples of experimentation: A basin mano is worked in a circular stroke around a basin metate (left), and a trough mano is worked in a trough metate with a reciprocal stroke (right).

into the American Southwest from Mexico around A.D. 300. They were designed with broad, straight-sided troughs to confine dried corn kernels, which were ground to flour with large manos.

Widespread recent findings of com in sites that date centuries earlier than those with the first trough metates are making archaeologists question their assumptions. In addition, a broader reading of the ethnographic literature has uncovered other techniques of processing corn, such as soaking and grinding while the kernels are moist. So if corn was actually processed long before mano and metate designs changed, what do the later design changes mean? Could these changes have anything to do with the differences between grinding dry and moist kernels? The answers to these questions were sought through a series of experiments.

LEARNING THROUGH EXPERIMENTS

For understanding how prehistoric food-processing tools were used, experimentation provides a perspective different from imagination or reading old reports. The experiments allow us to experience how certain foods are ground with the different types of manos and metates.

Dried amaranth, sunflower seed, pop corn, and blue corn were compared with soaked white corn kernels. It quickly became obvious that *all* seeds are easily ground with the basin mano and metate.

In contrast, dried seeds won't stay on the slab metate surface, so much time must be spent picking them up. However, both the soaked corn kernels and the oily sunflower seeds are easily ground, or mashed, with the broader slab metate and slightly larger mano.

The trough mano and metate seem to incorporate the best design features of the two earlier types. Like the basin metate, all the seed and kernel types were easily processed with the trough mano and metate. Also, the sides of the trough confine the seeds and kernels and keep them from slipping off the surface during grinding. And like the slab design, the trough mano provides a larger area of contact with the metate, allowing everything to be ground or mashed more efficiently.

These experiments support an interpretation that differs from our traditional assumptions. The archaeological record has made it clear that the major change in metate form was not due to a simple shift from wild to cultivated foods. Instead, it may have been a more subtle, and more complex, process. It may have involved a conversion to dry-grinding in combination with a desire for increased efficiency in the production of flour or dough. We will continue to pursue an improved understanding of these key changes.

ARCHAEOLOGY UNDER A MICROSCOPE

At some sites, archaeologists have found that food-processing manos were also used for other activities, such as grinding pigment or clay for pottery production. How do we learn about these secondary uses of tools? Using a microscope, sometimes we can see actual residues, such as traces of pigment that became caught in the deepest spaces between the stone grains. More often, the microscope allows us to examine wear patterns on a stone surface that provide clues about what was processed (see insert on pages 4-5).

For example, grinding sunflower seeds causes very different microscopic damage patterns than grinding sherds for tempering pottery clay. The softness and oiliness of the seeds causes rounding of the individual stone grains and the development of a sheen across the surface. The hardness of the sherds causes individual stone grains to fracture and creates scratches across the mano surface.

Reusing a mano to grind sherds for temper or pigment for coloring would not prevent the mano from continuing to be used for food processing. In some situations, the secondary use of a tool is very obvious, such as a mano with a

Mano with abrader grooves fashioned across the surface (photo no. 89599 by K. Matesich, 1994, *courtesy of the Arizona State Museum).*

groove placed across it for straightening shafts. If the groove was placed on the grinding surface, the mano could no longer have been used for food processing, so its secondary use replaced its primary use. But if the groove was placed across the upper surface, the mano could have been used as a food-processing tool and a shaft-straightening tool at the same time.

Distinguishing secondary uses of ground stone tools allows us to consider differences in prehistoric behavior. If a tool user had limited access to raw material, she might make the most of her material by designing tools for more than one activity. If a tool user needed a shaftsmoother but all he could find was a mano, he might position the grooves across the mano surface without concern for its intended use. This secondary use might reflect scavenging of abandoned artifacts.

Woman using a portable metate (photo no. Pix 651-x-1976 by Frank Russell, 1902, courtesy of the Arizona State Museum).

RECONSTRUCTING PREHISTORIC GRINDING ACTIVITIES

How do archaeologists reconstruct the prehistoric activities in which stone tools were employed? In some situations, the archaeological record itself provides clues. For example, envision the floor of a masonry pueblo room. On the floor, excavators find several manos scattered around two slab-lined bins; each bin contains a metate positioned at an angle. One metate is flat, while the other has sides that create a shallow trough. Some of the manos on the floor have wear on the ends where they were rubbed against the sides of a metate trough. Most of these are compatible with the trough metate since the curvature of the surfaces match and the length of the mano fits within the width of the trough. The manos that don't match the trough fit the surface of the flat metate. From this, we can deduce which manos were intended for specific metates.

Because of the permanence of the metate bins, we can state with some certainty that food-grinding activities occurred in this room. The two bins also suggest that more than one person worked here at a time. Based on ethnographic descriptions of pueblo life at Hopi and Zuni, we know that women were the food grinders and that they often worked together. Thus, by the archaeological context of the artifacts (their position on the floor) and through ethnographic analogy, we infer that this room was where at least two women worked to prepare food.

Among the manos on the floor of this room are two that are too short and have the wrong surface configuration to have been used with either of the metates. Further inspection reveals that the upper surfaces have been altered by grooves, within which wooden shafts were straightened. These tools are portable, so we can't determine if they were used in this room or merely stored here. Such assemblages have been found at the Point of Pines sites on the Mogollon Rim of east-central Arizona, and they date to the thirteenth and fourteenth centuries.

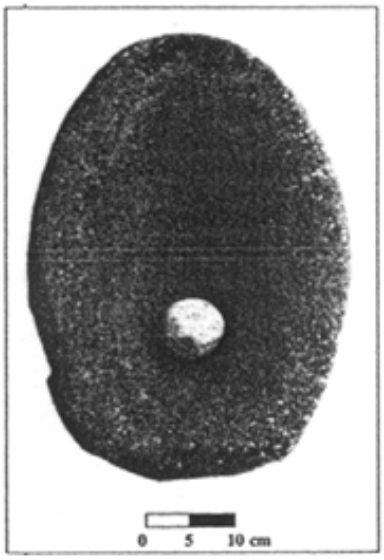
Room at W:10:51, a Point of Pines site. Note the double bins with metates and nearby manos (photo no. 1654 by E. B. Sayles, 1946, courtesy of the Arizona State Museum).

GROUND STONE AT THE SANTA CRUZ BEND SITE

Closer to Tucson is the Santa Cruz Bend site, which dates from about 600 B.C. to 1 A.D. The houses at this site were constructed in pits with brush superstructures, and the floors were often pocked with interior pits. None of the houses had metates, but

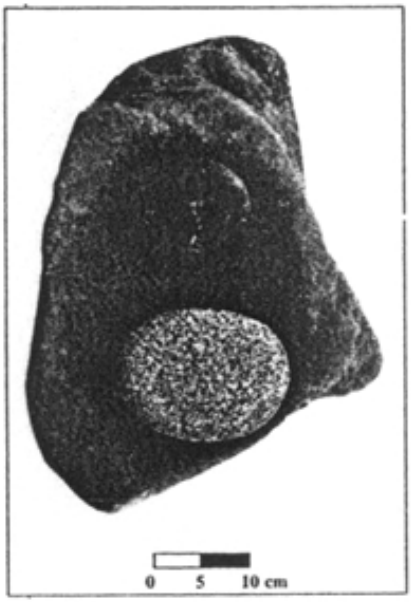
manos were found on several floors or in interior pits. A few manos were also found in pits located outside houses.

A careful examination of the manos uncovered an interesting pattern. Those found on house floors and in outside pits had been used to process food and reused to grind red pigment, or to make paint by mixing pigment with oil or water. In contrast, most of the manos found in the interior pits were more likely to have been used only for processing food. Were these interior pits used to protect tools for personal use? The artifacts left on floors or in outside structures may have been more visible, and anyone could have picked them up and used them.



A basin metate and compatible mano (not found together) from the Santa Cruz Bend site.

Another interesting pattern was found in the number and types of manos compared to the metates. Manos were far more abundant (38) than metates (5), and most of the manos were of a different design than most of the metates. Over half of the manos had been used in flat/concave metates, but only one flat/concave metate was recovered. The most common metate type was basin, but only three manos had been used in basin metates. Why this discrepancy between manos and metates?



A flat/concave metate with two compatible manos found in an exterior pit at the Santa Cruz Bend site.

Again, archaeological context and ethnographic analogy may provide some answers. Early accounts of the Piman and Yuman groups describe women grinding on portable metates outside their houses. If two or more women worked together, one did the grinding while the others cooked or otherwise processed the food. When they were finished, the metates were placed inside the houses. Therefore, the exact location of food-grinding activities would not be as visible in the archaeological record of the Piman and Yuman villages as it would for the Hopi and Zuni villages. Also, portable metates are easy to move when Structures or villages are abandoned.

Few metates were found at the Santa Cruz Bend site because most were probably removed as the site was abandoned or were scavenged later. Three of the recovered metates were found in exterior pits; two had probably been placed in storage. The third may have been some sort of ritual abandonment—it was buried with a human hand. Because all were in pits, they had been hidden from view and protected from scavenging. Since the metates used at the Santa Cruz Bend site had been removed, only mano data were available to help us discover how food processing might have been done.

Thus, the challenge of understanding prehistoric ground stone tool use can be met through a combination of old and new techniques. We'll continue to type, count, and describe the ground stone artifacts we find. But that is just the beginning. The true challenge is to interpret how these tools were used by the people who created them—to understand the people behind the rocks.

A mano and metate set up outside a Pima house (photo no. Pix 2083 W. Dinwiddie, 1894, courtesy of the Arizona State Museum).

Reading Ground Stone Wear Patterns

Use-wear analysis of ground stone artifacts is accomplished by classifying the different damage patterns caused when two surfaces come into contact. These patterns are best understood through several wear mechanisms identified by scientists called tribologists. Tribologists study friction, lubrication, and wear and are mostly employed in industry with the sole purpose of preventing damage from wear. Decades of research, experimentation, and the use of a variety of magnification techniques have led them to recognize many damage mechanisms. For research on ground stone surfaces, three are most appropriate: surface fatigue, abrasive wear, and tribochemical wear.

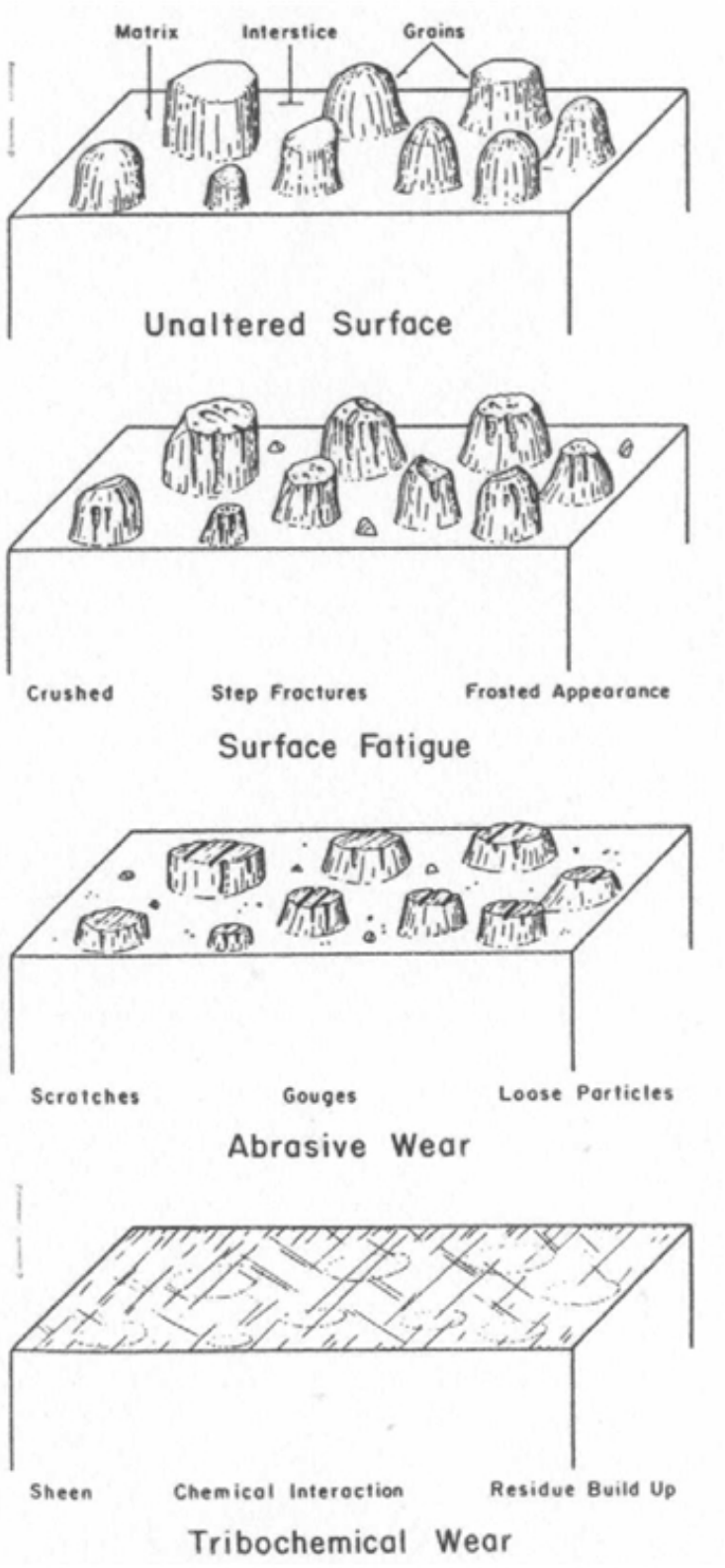
To identify the results of wear mechanisms on the relatively flat surfaces of ground stone tools, we first must recognize what unworn material looks like. Fresh breaks or unused areas of the artifact can provide this information. The spaces between grains are called interstices, and the material that holds everything in place is called the matrix.

Surface fatigue is caused when the heavy load of one surface weighs down on the opposite surface. The highest grains fracture and break if the load is more than they can bear. The loosened particles become free agents as they move between the two surfaces.

Abrasive wear occurs when the harder, rougher grains of one surface dig into the softer, smoother material of the other surface. Movement displaces the softer material, creating scratches in the direction of movement.

Tribochemical wear occurs when surface fatigue and abrasive wear create an environment for chemical interactions. These interactions produce films and oxides that build up on smooth surfaces and are seen as shiny areas. Tribochemical wear is always occurring, but unless the reaction products are allowed to build up, they cannot be seen. While the other two mechanisms are constantly exposing fresh surfaces upon which interactions can occur, they are removing the films and oxides at the same time. This continues until the surfaces have been crushed to the point that surface fatigue is no longer a factor, and the grains of the two surfaces are no longer scratching each other. Then the surfaces are flat enough and smooth enough for the build-up of the oxides and films.

The result of all of these mechanisms on a flat surface is called wear. Wear is the progressive loss of substance from the surfaces as a result of relative motion. The damage patterns visible on the surfaces of ground stone tools are, therefore, indicative of the wear mechanism most recently in operation. Traces of earlier uses may be removed by the last use.



Illustrations by Ron Beckwith

Ten Years of *Archaeology in Tucson*

The following list of articles found in back issues of *Archaeology in Tucson* was recently compiled by the editor, J. Homer Thiel. If you would like to order back issues, please fill out the order form on page 7 and mail it to the Center for Desert Archaeology.

VOLUME 1

No.1, Fall 1986
- What is Archaeology in Tucson?
- Artifact Profile: Rillito Red-on-Brown Bowl
- Archaeological Site Profile: The Valencia Site

No.2, Winter 1986
- First Hohokam Canal System in the Tucson Basin
- An Ancient Map Pecked into Stone?

No.3, Spring 1987
- San Agustín: The Original Tucson
- Hohokam Research and Exhibit at Del Webb's Sun City Vistoso
- Excavations along the Northern Santa Cruz River

No.4, Summer 1987
- Truly the Original Tucson (Mission Road Testing)
- Catalina State Park Survey

VOLUME 2

No.1, Fall 1987
- Pottery and Tucson's Past
- From the Archaeologist's Notebook (article on site records)

No.2, Winter 1988
- The Institute Celebrates Its 20th Year
- Volunteer Archaeological Survey Gets Grants to Continue

No.3, Spring 1988
- Arizona Archaeology Week
- From the Archaeologist's Notebook (Los Morteros)
- Los Morteros Testing Results

No.4, Summer 1988
- Excavations at Los Morteros
- From the Archaeologist's Notebook (Huntington Ruin)

No.5, Fall 1988
- Ancient Adobe Walls Uncovered
- The Volunteer Program at Los Morteros

VOLUME 3

No.1, Winter 1989
- Exploring Honey Bee Village
- Volunteer of the Year (Valerie Conforti)
- Restoring the Valencia Site
- Fairfield Wins Presidential Award for Archaeology Project at Camp Cooper
- New Directions for AIT
- Gunsight Mountain Survey Winding Up
- Rye Creek Project Takes Us Out of the Tucson Basin

No.2, Spring 1989
- Return to Honey Bee Village
- Archaeology Week 1989: A Review
- Profile of an Institute Volunteer (Patty Whitley)
- Gila Bend: An Institute Hot Spot

No.3, Summer 1989
- Gunsight Mountain, Future Preserve
- Profile of an Institute Volunteer (Harry Ashby)
- The Sabino Canyon Ruin: An Introduction
- Early Excavations at the Sabino Canyon Ruin, *by John Welch*

No.4, Fall 1989
- Desert Archaeology. . . New Beginnings, a Look Back

VOLUME 4

No.1, Winter 1990
- San Pedro River Prehistory

No.2, Spring 1990
- Thousand Year Old Census: Tucson in A.D. 990

No.3, October 1990
- Volunteers Aid Site Preservation
- San Pedro Survey Continues

VOLUME 5

No.1, April1991
- Roosevelt Community Development Study Awarded

No.2, June 1991
- Digging Downtown at the Ronstadt Transit Center Site, *by Jonathan Mabry*
- The Archaeology Scene (first archaeology summary for Arizona)

No.3, August 1991
- Hohokam T-Shaped Stones (part 1), *by Alan Ferg*
- Archaeology in Tucson's Volunteer Surveyed Area Gets National Recognition

No.4, October 1991
- Hohokam T-Shaped Stones (concluded), *by Alan Ferg*

VOLUME 6

No.1, January 1992
- Excavations at the Rooney Ranch Site *(various authors)*

No.2, April 1992
- Old Presidio Cemetery Encountered Downtown, *by Michael Faught*

No.3, July 1992
- The Northern Tucson Basin Archaeological Survey, *by John Madsen, Paul Fish, and Suzanne Fish*

No.4, October 1992
- Hohokam Reservoirs and Their Role in an Ancient Desert Economy, *by James Bayman*

VOLUME 7

No.1, January 1993
- In Search of the Sobaipuri Pima: Archaeology of the Plain and Subtle, *by Deni Seymour*
- The Construction and Architecture of the Casa Grande (rice krispie model), *by Pat Stein*

No.2, April1993
- Hidden Heritage Resources of the Southwest: The Western Archeological and Conservation Center
- Archaeology in Tucson Member John Murray Gets Statewide Recognition

No.3, July 1993
- Archaeology in the Heart of Down town Tucson, *by Homer Thiel, Michael Faught, and James Bayman*
- How Old Is It? Dating in Archaeology, *by Jeffrey Dean*

No.4, October 1993
- Kentucky Camp: Big Dreams, Small Prospects, *by Mary Farrell*
- Calabasas Park Archaeology, *by Heidi Roberts*

VOLUME 8

No.1, January 1994
- Early Village Life on the Santa Cruz River, *by Jonathan Mabry and Jeffery Clark*

No.2, April 1994
- People without Pots: Preceramic Archaeology of the Tucson Basin, *by Bruce Huckell*
- The Legend and the Lowdown (article on archaeological jobs), *by Steven Stacey*
- Recent Excavations at the Rooney Ranch Site, AZ BB:9:93 (ASM), *by Lea Mason*

No.3, July 1994
- Archaeology on the Border, *by Homer Thiel*
- Discovery of an Early "Big House" at Vacas Muertas, *by Jonathan Mabry*

No.4, October 1994
- The Gibbon Springs Site: A Hohokam Village in the Foothills, *by Mark Slaughter*
- Archaeology along the Interstate: The Story Continues, *by Deborah Swartz*

- An Introduction to Rock Art in the Tucson Area, *by Homer Thiel and Patty Whitley*

VOLUME 9

No.1, January 1995

- The Trade and Manufacture of Shell and Obsidian in Classic Hohokam Society, *by Jim Bayman*
- A Bird Effigy Vessel from Sabino Canyon Ruin, *by Homer Thiel and William Neil Smith*

No.2, April 1995

- The Centuries before Coronado: The Classic Period on the San Pedro River, *by William Doelle*
- A Survey in the Saguaro National Park, *by Kevin Wellman*

No.3, Summer 1995

- Highlights of Tonto Basin Prehistory, *by Mark Elson*
- An Architectural Reconstruction of the Griffin Wash Site, *by Ziba Ghassemi*

No.4, Fall1995

- A Thousand Years of Irrigation in Tucson, *by Jonathan Mabry and Homer Thiel*
- Reading the Stories of Ancient Canals, *by Andrea Freeman*

VOLUME 10

No.1, Winter 1996

- The Archaeology of an Ancient Town, *by Henry Wallace*
- 1822 Ferdinand VII Coin Found along Cienega Creek, *by Michelle N. Stevens*
- San Pedro Valley Archaeology: Protecting Our Legacy

No.2, Spring 1996

- Reflections on Our First Decade, *by William Doelle*
- Tracing the Production of Rincon Polychrome Ceramics, *by James Heidke*
- Classic Period Projectile Points: A New Typology for the Tonto Basin, *by R. Jane Sliva*
- Hohokam Images Provide Rare Glimpse of Prehistoric Lives, *by Henry Wallace*
- AIT Volunteers Help Explore Sunset Park, *by Homer Thiel*
- Introducing the Center's New Program Manager
- Glen Loftis, Clovis Hunter, *by Lisa Armstrong*

No.3, Summer 1996

- Building Tucson in the Nineteenth and Twentieth Centuries, *by Allison Cohen Diehl and Michael W. Diehl*
- Center for Desert Archaeology Honored

No.4, Fall 1996

- Bringing Stone Tools to Life: The People behind the Rocks, *by Jenny L Adams*

Center Receives Grant from Arizona Humanities Council

"Ranches, Mines, Tracks, and Trails: Living the Pioneer's Life in the Santa Catalina Mountains" is a project that will take a step back in time to uncover personal remembrances, family photographs, and recorded memoirs that reflect the experiences of settlers in the locale. Connie Allen-Bacon, public archaeologist and Tour Director for the Center, will shoulder most of the research responsibilities for the project. She will draw upon oral histories and interviews, library research, and field experience to document the settlers' perspectives of the Santa Catalina Mountains and the resources they depended on for life and prosperity.

Results of the research will be presented in March 1997 as part of the programming for Arizona's Archaeology Awareness month. A public lecture and field trip to the historic sites of ranches, mines, tracks, and trails will bring the pioneers of the Santa Catalinas to life.

The Arizona Humanities Council (AHC) is an independent affiliate of the National Endowment for the Humanities that supports projects which encourage dialogue between humanities scholars and members of the general public. This is the first AHC grant awarded to the Center.

New Benefit Announced for AIT Membership Categories

The Center for Desert Archaeology announces a new benefit for $50 and higher categories. Contributing members ($50 annual donation) will receive their choice of an Archaeology Library publication, and individuals donating $100 or more will automatically receive all Archaeology Library publications.

So far, the new Archaeology Library series includes *Tucson at the Turn of the Century: The Archaeology of a City Block*, by Jonathan B. Mabry, James E. Ayres, and Regina L. Chapin-Pyritz, and *Archaeology in the Mountain Shadows: Exploring the Romero Ruin*, by Deborah L. Swartz and William H. Doelle. *Rock Art in Arizona*, by J. Homer Thiel, is also scheduled to be published this year.

Fall Workshops in Stone Tool Technology

November 9

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See enclosed flyer for more details.

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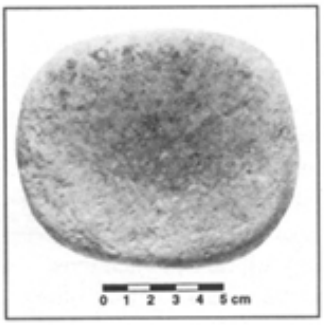

This mano from the Santa Cruz Bend site was first used to grind food. Later; a basin was pecked into it, and it was used to process pigment (see story, page 1).

Time to Renew?

If your address label indicates that your *Archaeology in Tucson* membership has expired, please renew promptly to remain eligible for all activities, newsletters, and discounts on T-shirts and Center for Desert Archaeology publications.

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The Center for Desert Archaeology

The Center for Desert Archaeology is a nonprofit research and education organization that specializes in the study of archaeology and history of desert regions. Our primary research focus has been southern Arizona.

Archaeology in Tucson

is the Center for Desert Archaeology's membership program. Center members receive the *Archaeology in Tucson* quarterly Newsletter; discounts on the Center's publications; and opportunities to participate in its archaeological projects, attend site tours, and come to archaeology lectures. Memberships runs for one year from when the dues are received.

For further information about the Center for Desert Archaeology or about the Archaeology in Tucson program, call Lisa Armstrong at 520-881-2244. For information on the ***Archaeology in Tucson*** newsletter specifically, please contact the editor, Homer Thiel.

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