THE EXPERIMENTAL REPLICATION OF A GRINDING SLICK ON GRANITE

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The current study attempted to experimentally replicate a slick milling surface, one of the most common archaeological features in the southern Sierra. Using a quartz mano without lubrication, a slick surface measuring approximately 300 cm^2 was produced in about five hours. A number of additional experimental avenues were suggested, including the effects of lubrication and the efficacy of different materials for manos. Further research and experiment is needed to be able to use replicated slick milling surfaces as a tool for understanding the patterns of behavior associated with slick surface production.

Prior to contact, the mountains and valleys on the eastern border of California were home to a number of Native American tribes including the Owens Valley Paiute, Tubatulabal, Kawaiisu, Monache, and Foothill Yokuts. Cultural remains from the southern Sierra are important to the archaeological record and the current research project because all of these tribes employed groundstone milling tools for food processing (Garfinkel and Williams 2011; Smith 1978; Spier 1978a, 1978b; Steward 1933). One of the defining attributes of groundstone technology used for food preparation is the wear or polish of working surfaces. The purpose of the present study is to recreate a slick milling surface and record the processes used and the time expended. Information gained from the experimental grinding slick will give archaeologists a better sense of the actual human occupation associated with the creation and use of grinding slicks.

Slick milling surfaces, also known as grinding slicks, are some of the most common prehistoric archaeological resources of the southern Sierra Nevada. Ethnographic evidence suggests that slicks were used by Native peoples for a variety of tasks associated with food gathering and preparation. Slick milling surfaces may be found on a number of features or artifacts associated with prehistoric Native American food processing, such as upon the surface of metates or on the surface surrounding bedrock mortar cups. Slick milling surfaces may also be found on boulders that are completely unassociated with bedrock mortar cups. Ethnographic accounts suggest that grinding slicks were created by a process of abrasion, using a rectangular- or oval-shaped rock that fits into one's hand (a mano) to grind in a back and forth motion across the surface of a portable slab or bedrock outcrop (Euler 1964; Steward 1933). The goal was to produce a smooth, flat surface upon which food could be prepared.

Owens Valley Paiute Indians, located between the southern Sierra and the Inyo Mountains, were seed gatherers and therefore left behind many seed processing cultural materials (Steward 1933). Owens Valley Paiute peoples collected seeds from wild plants such as grasses and sunflowers which were then ground up: "For eating, seeds were ground on a metate, *mat*, a slab of rock about 12 by 18 inches and 2 to 5 inches thick, with a muller or mano, *tusu*, a flattish, hard rock roughly rectangular and worn on both sides," (Steward 1933:239).

The Tubatulabal, a tribe from the southern Sierra Nevada, utilized pinyon nuts and acorns as staples in their subsistence (Smith 1978). Before consumption the nuts had to first be pounded or ground down fine enough to form a mush when mixed with water. Acorns and pinyon were removed from their shells at gathering sites; pinyon cones had to be burned first to open the cone to extract the seeds. Acorn and pinyon nut shells were removed by pounding in a mortar at the gathering site. Grinding was completed at hamlets, where the meal could be leached and prepared for consumption (Smith 1978). Monache and Foothill Yokuts Tribes occupied the upper and lower western slope of the southern Sierra Nevada, respectively. Both Monache peoples and Foothill Yokuts relied on acorns in their subsistence strategies, using bedrock mortars to grind the acorns into meal (Spier 1978a, 1978b). Though Spier (1978a, 1978b) does not specifically mention milling slicks in his writings about the Monache or the Foothill Yokuts, personal experience in the field demonstrates that slicks are generally found near food processing sites.

SIGNIFICANCE TO CULUTURAL RESOURCE MANAGEMENT

Current archaeological site definitions of the southern Sierra Nevada tend to be based on straight forward quantification and do not consider the patterns of behavior responsible for the formation of archaeological sites. Sequoia National Forest site recording standards, for example, state that a site is defined as five objects within a 500 square meter area, cultural features with an association of more than one artifact, or milling features with more than one mortar cup or slick (Kelly, personal communication, 2016). Simple quantification may not adequately represent the past occupation of a site nor its place in past patterns of human behavior. For some site types, such as lithic scatters, a high artifact count does not necessarily equate to an extended period of occupation. Other site types such as slick surfaces or bedrock mortars may represent extended periods of occupation with only one or a few features. Without understanding the patterns of behavior responsible for depositing an artifact or feature in the archaeological record, management decisions for that resource tend to be arbitrary and may result in the loss of important material. Results from the grinding slick replication experiment will be able to play a part in developing an effectual set of archaeological site definitions for the southern Sierras.

Understanding the time consumed when creating a slick milling surface is important because the slick represents an investment in manual labor put forth by a Native American from long ago. The narratives from slick milling surfaces contribute greatly to the archaeological record by providing a measurable set of data for minimal human occupation times spent at a site. Sites with very simple assemblages such as slick milling surfaces are often ignored or overlooked. Having a tool for estimating the length of human occupation associated with slicks may encourage archaeologists to reexamine resources previously ignored or considered insignificant during archaeological surveys or site recordation.

PREVIOUS RESEARCH

Currently, no other research has been conducted to determine the amount of time and labor that goes into the creation of slick milling surfaces. A somewhat similar experiment that addressed bedrock mortars was conducted by Richard H. Osborne in 1998. Briefly, Osborne described the processes and tools he used to create an experimental bedrock mortar cup. Osborne spent a total of eight hours on creating the mortar cup, resulting in a cup that has a diameter of eleven centimeters, a depth of three and a half centimeters, and a volume of 140 mL (Osborne 1998:120). Osborne (1998) clearly states that further research is necessary, specifically because the method employed in creating the mortar cup is not the only way a mortar can be created. Time expended during the creation, therefore, may decrease or increase due to changes in material, experimental procedure, or skill level of the replicator.

Another pioneer in the experimental archeology of stone milling features is Jenny L. Adams (1989, 1999). Adams conducted a series of experiments on various groundstone tools to determine use-wear patterns as a basis of comparison for analyzing prehistoric assemblages. Adams (1989) recreated sandstone manos, sandstone abraders, and sheep femur game pieces. Sandstone manos created by Adams took anywhere from fifteen minutes to over two hours to create (1989:263). The manos were then used to grind corn against a metate. “As the manos and metates became dull, grinding took longer and then a decision was made to peck surfaces to resharpen them,” (Adams 1989:264). Adams makes no other reference to altering or modifying the metates. Similarly, Adams (1999) processed various types of corn on a trough metate, a basin metate, and a flat/concave metate to determine the diagnostic differences between use-wear patterns found on different metate types. Adams does not explain whether the metates used in her experiment were worked prior to the processing of corn or not, nor does she explain where the metates may have come from.

Adams’s (1989, 1999) experimental replication of use-wear patterns on groundstone metates utilized metates that were already complete; data was collected only during the food preparation process and no information exists as to how the metates were initially procured or created. By contrast, Osborne's (1998) goal was to time the creation of a bedrock mortar without the addition of actual food processing in the process. Neither Osborne (1998) nor Adams (1989, 1999) addressed the creation of slick milling surfaces. Data collected from the current experimental replication of a grinding slick on granite will therefore serve as a starting point for future study. The data will also provide archaeologists with a baseline for quantifying the effort that goes into the creation of slick milling surfaces.

MATERIALS AND METHODS

For the experimental replication of a grinding slick on granite, a portable slab of granite was procured from the southern Sierra Nevada north of Kernville, California. The granite slab measures 32 cm x 25.5 cm x 8.5 cm (Table 1). Selection of the slab of granite was decided based on two factors: the author's ability to carry the rock, and the flatness of at least one side of the granite slab. From the same general area, three quartzite cobbles were collected to serve as manos, or hand stones. Quartzite was chosen for the hand stones because Osborne (1998) did not have any success using basalt pestles upon granite; Osborne eventually had to switch to quartzite. A fourth quartzite mano was obtained from the author's backyard in Bakersfield, California. The hand stones were carefully chosen based on shape, size, and intent of use. Sizes of the quartzite stones varied from 9 cm long to 15.5 cm long (see Table 1) (Figure 1). Three of the manos were intended to grind upon the granite, while the fourth was intended to sharpen the grinder manos as needed (Adams 1989, 1999). While Adams (1989, 1999) intended to measure use-wear patterns, the goal of the current experiment is to create a slick purely with rock-on-rock contact. Therefore, the milling slick surface would not be re-sharpened.

The flattest surface of the granite slab was chosen to be the location of the slick surface. A total area of 313.5 cm^2 was laid out with a permanent marker (Figure 2). All interactions with the granite slab and manos were timed with a stopwatch and the process from beginning to end was photographed. Timed activities included grinding, brushing debris, sharpening the mano, and break times. An approximate value for the total number of strokes across the surface of the granite was recorded by counting the movement from one edge of the milling surface to the other as one stroke. Every ten minutes during the grinding process the number of strokes per minute (SPM) were counted for one minute. Results from the SPM data were averaged and the mean value for the completed milling surface is 206 strokes per minute.

The smoothness of granite surface was judged based on a scale of zero to five. A smoothness of zero would mean that the rock surface is very rough and jagged, while a smoothness of five would mean that the rock surface felt and resembled a milling slick that might be found in the field (Table 2). The goal of the current experiment was to abrade the granite surface until the marked section became a value of 4-5 smoothness. A visible means of tracking the wear upon the milling surface was the permanent marker cross-section drawn on at the beginning of the experiment. As the surface of the granite was ground away the black cross-section eroded away as well, displaying the amount of wear (Figure 3). The granite slab was not perfectly flat to begin with and had many pockmarks upon the surface. Many pockmarks were too deep to be ground away in the time available for the current experiment, consequently those areas have black marks still within them.

Grinding the granite rock with quartzite manos was a tremendously arduous activity. After a session of grinding the author's forearms and biceps were tired from pushing the mano back and forth. Moreover, the hands sustained the worst of the injuries; knuckles became very sore from holding the mano, and hands scraped against the granite numerous times. The granite rock was held with either of two techniques: placed on the floor with the replicator bending over the top, or with the replicator sitting and the rock placed in the lap (Figure 4). Both techniques yielded similar values of SPM, and the shifting of position was necessary to avoid back pain.

Figure 1. From left to right, mano numbers one through four used for experiment.

Table 1. Measurements of the milling tools used.

Tool	Length (cm)	Width (cm)	Height (cm)
Granite Slab	32	25.5	8.5
Mano #1	15.5	9.5	6.5
Mano #2	11	10	6
Mano #3	12	8	6.3
Mano #4	9	6.6	5

Table 2. Smoothness rating chart.

Smoothness Rating	Explanation
0	Rough and jagged surface of rock.
1	Rough surface, but no jagged points.
2	At least 85% of surface is rough, 15% is smooth.
3	At least 70% of surface is rough, 30% is smooth.
4	Surface is 50% rough and 50% smooth.
5	95% of surface is smooth.

Figure 2. Cross-section drawn on granite surface.

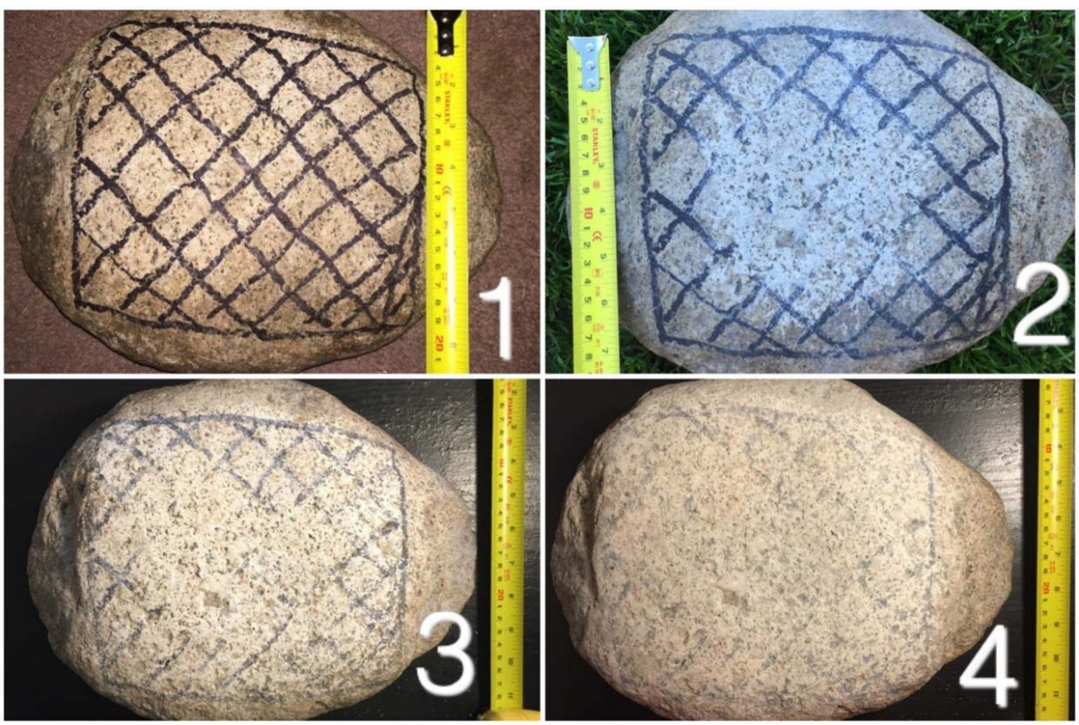

Figure 3. Progression of wear on granite surface.

Figure 4. Techniques used for grinding the granite surface.

Overall, the total amount of time spent grinding the milling without slick until at least 95% of the surface became smooth was five hours and six minutes, with an approximate total of strokes of 49,852 (Table 3). The completed milling slick is flat and therefore has no volume to be measured (Figure 5).

EVALUATION

Replicating a milling slick consumed a total of five hours and six minutes. The time spent specifically on grinding was four hours and three minutes. Times for brushing debris, breaks, sharpening manos, and total time values are available in Table 4. The method for the current experiment was to grind with the mano upon the granite rock with no additional lubricant. A strong possibility exists that adding a lubricant, such as water or food products, may change the rate of wear on the granite during grinding. Adams (1999) notes that adding corn on the metate reduces the rate of wear and increases the time spent grinding because the corn adds a cushion between the metate and mano. Other factors that may change the total amount of time spent grinding and the mean SPM are the manufacturer's skill level at grinding and the amount of pressure and strength put into grinding.

Osborne (1998) mentions the existence of some controversy over whether milling objects are created intentionally prior to use, or are the product of use-wear. Osborne is of the opinion that a correlation

Table 3. Time consumed during grinding and correlating number of strokes across the granite.

Hour	Approximate Total Strokes	Smoothness Rating
0	0	1
1	12,360	2
2	24,720	3
3	37,080	4
4	49,852	5

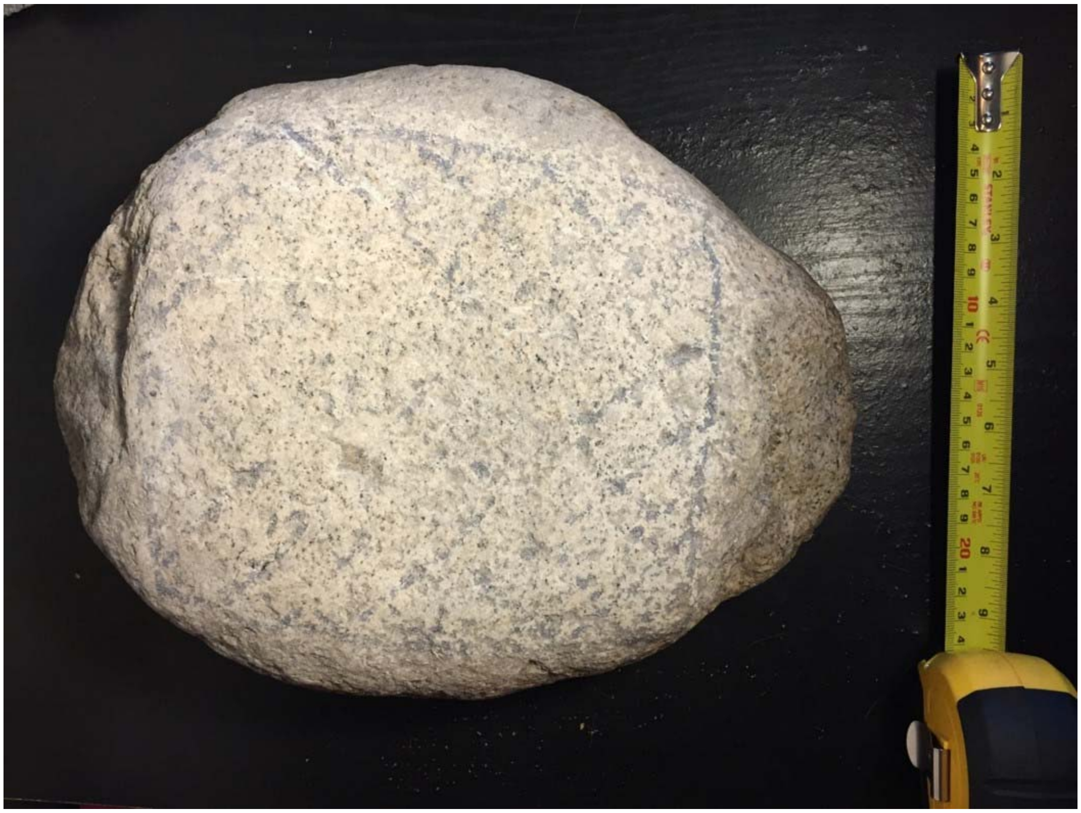

Figure 5. Completed slick on granite slab.

Table 4. Total values of time consumed for replication.

Action	Time Consumed
Sharpening Mano	5 minutes
Sweeping Debris	11 minutes
Resting	47 minutes
Grinding	4 hours, 3 minutes
Grand Total	5 hours, 6 minutes

could possibly be found between Native American dentition wear and the intentional creation of milling objects. If the milling tools are created prior to use, then less grit would be present in the meal used for consumption. Adams (1989) does not mention the initial creation of the metates used for grinding, however, the experiment does note that the metates used in her experiment were periodically sharpened as they became dull and less efficient for grinding. If Native Americans were indeed sharpening metates as they milled food, then rock particles could remain in the meal even if the milling tool was created prior to use, unless the tool was washed in between each act of milling and sharpening. The best method for determining whether milling tools are created intentionally prior to food production or as a result of use-wear is to set up a new experiment that evaluates both the time consumed when creating a slick and the results from grinding food products within them.

CONCLUSION

The current project of replicating a milling slick on a granite rock was successful in that a milling slick was produced and the different aspects of producing were recorded. While the replication reported herein may provide a base value for human occupation time at archaeological sites associated with grinding slicks, further research is necessary. A slick with no additional lubricant that is 300 cm^2 takes about five hours and six minutes to complete. The current experiment was relatively concise and more experimentation is required to provide additional significant data about milling slick replication.

A future experiment, to be conducted in the next year, will provide necessary additional information. The new experiment will explore both the amount of time needed to create slicks and the food processing productivity of those slicks. Outlined below are the goals to further investigations for replicating slick milling surfaces.

1. *Create two additional slicks of the same size and shape as in the current experiment, with the same method.*

Replicating additional slicks will give the experimenter more practice in creating milling surfaces as well as amplify the significance of the data being collected. Results from the three slicks will be cross-correlated and will contribute to designing further experimental procedures.

2. *Conduct interviews with Native American tribal members in the Kern River Valley.*

Interviews with Native American Tribal members from the Kern River Valley will provide additional background material concerning the manufacture and use of milling surfaces in the southern Sierra. Ethnographic accounts such as these oral interviews will allow for a better understanding of the cultural material being reproduced and the importance those materials hold for the Kern River Valley Native peoples.

3. *Create two additional slicks using water as a lubricant for one and food material as a lubricant for the other.*

While the materials and size of the milling surface will remain the same, adding water or food as a lubricant may increase or decrease the time spent on producing a slick milling surface. Additionally, the slick created with food products will be analyzed to determine the volume of grit within the meal. The two new slicks will be able to be compared to previous slicks created with purely rock-on-rock contact. An anticipated result of these experiments is insight into the role of experience in creating slick surfaces.

4. *Time the productivity of processing food on each of the milling slicks and compare the different methods of manufacturing that were used.*

Timing the rate of food production upon each of the milling surfaces will determine if creating a slick with lubricant or without is more efficient. Knowledge gained from the experiment coupled with information from Native American tribal members may shed light on the question of whether slicks are created prior to food processing or as a result of use-wear.

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REFERENCES CITED

Adams, Jenny L.

1989 Experimental Replication of the Use of Ground Stone Tools. *KIVA* 54(3):261-270.

1999 Refocusing the Role of Food-Grinding Tools as Correlates for Subsistence Strategies in the US Southwest. *American Antiquity* 64(3):475-498.

Euler, Robert C.

1964 Southern Paiute Archaeology. *American Antiquity* 29(3):379-381.

Garfinkel, Adam P. and Harold Williams

2011 *Handbook of the Kawaiisu: Sourcebook and Guide to the Primary Resources on the Native Peoples of the Far Southern Sierra Nevada, Tehachapi Mountains, and the Southwestern Great Basin* 1st ed. Wa-hi Sina'avi Publications, California.

Kelly, Tim

2016 Personal communication. US Forest Service Archaeologist, Sequoia National Forest, Kern River Ranger District.

Osborne, Richard H.

1998 The Experimental Replication of a Stone Mortar. *Lithic Technology* 23(2):116-123.

Smith, Charles R.

1978 Tubatulabal. In *California*, edited by Robert F. Heizer, pp 437-445. Handbook of North American Indians, Vol. 15, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Spier, Robert F. G.

1978a Foothill Yokuts. In *California*, edited by Robert F. Heizer, pp 471-474. Handbook of North American Indians, Vol. 15, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

1978b Monache. In *California*, edited by Robert F. Heizer, pp 426-432. Handbook of North American Indians, Vol. 15, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Steward, Julian H.

1933 Ethnography of the Owens Valley Paiute. *University of California Publications in American Archaeology and Ethnology* 33(3):233-250.