THE SAN DIEGO ARCHAEOLOGICAL CENTER AND THE FUTURE OF CURATION

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The San Diego Archaeological Center curates archaeological collections and promotes their educational, scientific, and cultural use for a diverse public. Consistent with this mission, the Center has initiated several science-based research projects aimed at demonstrating the value of curated collections. Sponsored projects to date include compositional studies of indigenous ceramics, and experimental and use-wear studies of ground stone artifacts such as milling tools and perforated stones. A pilot study for a proposed large-scale regional project to investigate use of the geochronological technique of detrital zircon provenance analysis for sourcing sedimentary lithic artifacts has recently been completed. GIS-based modeling is being applied to these and other studies. The Center is also encouraging and supporting the efforts of other researchers by making artifacts and collections available for student projects and for technique validation studies, such as the ceramic rehydroxylation (RHX) dating project led by the University of Manchester and University of Edinburgh, U.K. Collaborations with educational and other non-profit organizations are currently under way to increase web-based dissemination and accessibility of archaeological data. All of these research initiatives endeavor to improve interpretations of the archaeological record without the destruction of additional cultural sites. Curation and the full and prudent use of curated collections are key to the preservation of cultural heritage and the future of archaeology.

The San Diego Archaeological Center (the Center) is a private non-profit organization that accepts, curates, and houses archaeological collections on a permanent basis. At the Center, our goal is to utilize curated collections to their fullest research and educational potential, sharing objects and study results with the general public. When collections are brought to the Center, their value to society as an historical and cultural resource has not expired. Rather, these collections continue to be important assets for scientific research and contribute to the advancement of archaeological methods that further our understanding of the past. Over the last several years, a variety of projects carried out at the Center highlight the research value of curated collections. The purpose of this paper is to briefly describe these projects in order to make explicit the considerable research potential of curated collections and thereby promote curation of excavated collections statewide.

HISTORY

For decades, nearly all archaeology in San Diego has been development-driven rather than research-driven. Archaeological collections accumulated and were stored in ad hoc fashion by cultural resource management (CRM) firms and development agencies, with no centralized system for tracking their physical location or condition. In response to concerns about the potential loss of cultural heritage, a group of San Diego's foremost archaeologists, historians, and CRM professionals worked together to create the Center to serve as a repository for the millions of local archaeological artifacts that were neglected after excavation. The Center was founded in 1993. Today, the Center is located in the San Pasqual Valley in northern San Diego County, California on a state park historic property, and it houses

Figure 1: The San Diego Archaeological Center is a private non-profit organization that accepts, curates, and houses archaeological collections. (SDAC Archive Photo by A. Muniz)

approximately 900 collections in an 11,000-ft.^{2} facility (Figure 1). As a nationally recognized leader in the curation of archaeological collections, the Center meets the requirements set forth in Federal Regulation 36 CFR Part 79 (Curation of Federally Owned and Administered Archaeological Collections) and State of California Guidelines for the Curation of Archaeological Collections (1993). The Center curates collections for federal, state, and local governments as well as for private agencies, and works closely with local Native American groups to meet and exceed NAGPRA standards.

MISSION

The Center's mission is to curate archaeological collections and promote their educational, scientific, and cultural use for a diverse public. Our mission is achieved through operation of a museum and library (Figure 2), educational programs, cultural events, and curation and research activities. Over the last year, the Center hosted more than 3,000 local, national, and international visitors and 72 interns, volunteers, and researchers who invested close to 6,000 hours in the Center's educational programs, collections rehabilitation and research, and special events. Overall, statistics indicate that Center programs and outreach activities impacted close to a quarter of a million people over the last fiscal year, demonstrating our success in returning archaeological collections to the public as a cultural and scientific resource. Through exhibits, educational programs, and volunteer opportunities, the Center strives to increase the public's knowledge and appreciation of California history in particular. This is especially vital in a region with little public awareness of the thousands of years of human presence prior to Spanish arrival.

Figure 2: The Center's curation vaults and museum area; GIS Intern Liz Ferguson. (SDAC Archive photos by A. Muniz)

SPONSORED PROJECTS

Consistent with its mission, the Center has initiated several science-based research projects aimed at demonstrating the value of curated collections for advancing the development of archaeological methods and our understanding of human history. These research activities and projects are being carried out by Center staff in collaboration with researchers and students from local and nonlocal universities, colleges, and CRM firms. Sponsored projects to date include compositional studies of indigenous ceramics and experimental and use-wear studies of ground stone artifacts such as milling tools and perforated stones. By beginning to identify the choices and behaviors of indigenous tool makers and tool users through time, we hope to establish frameworks within which to evaluate the different environmental, social, and cultural influences that underlie particular styles and traditions in this region.

Compositional Studies of Hunter-Gatherer Ceramics

The appearance of ceramics at ca. A.D. 700 is used as a chronological marker for the Late Prehistoric period in San Diego County. Although pottery manufacture and use is often generally presumed to be indicative of a sedentary agricultural lifestyle, archaeological and ethnohistorical evidence suggests that precontact societies of the San Diego region had a mobile hunting and gathering subsistence economy—exploiting plants, animals, and other resources seasonally across environmental zones. Thus,

indigenous ceramics provide an anthropologically significant example of technological adaptation and dissemination. Unfortunately, the rarity and limited scope of systematically detailed comparative compositional studies has hindered advances in recognizing regional variability in ceramic production techniques and associated social groups and cultural boundaries. The result has been that indigenous skills, knowledge of the natural environment, and technological choices reflecting cultural microtraditions have been under-investigated and underappreciated.

Since 2006, several compositional studies of Late Prehistoric hunter-gatherer ceramics and related raw materials have been carried out by Patrick Quinn of the University of Sheffield, U.K. and Margie Burton, Center Research Director, with funding by the Begole Archaeological Research Grant program (Quinn and Burton 2009). These projects examine pottery technology and distribution within and across the desert region of eastern San Diego County by using thin-section petrography and bulk chemical analysis (INAA). The petrographic method originated in the American Southwest with the work of Anna Shepard (1936) and has since been applied and adapted by researchers in many parts of the world, including the U.K. (Arnold 1988; Freestone 1995; Quinn 2009; Vince 2001a, 2001b; Whitbread 2001). Research by Quinn and Burton builds on previous San Diego area studies (e.g., Gallucci 2004; Griset 1996; Guerrero 2004; Hildebrand et al. 2002; Pymale-Schneeberger 1993) to enhance our understanding of ceramic technology, people, and agency in this region.

In studies by Quinn and Burton (2009), samples of ceramic sherds were selected from previously excavated, curated assemblages from sites in the Anza-Borrego desert. Detailed thin-section ceramic petrography of the mostly plain, undecorated artifacts revealed 18 distinct fabric groups characterized by specific combinations of raw materials and technology. The compositional diversity and its correlation with geological field samples suggested that indigenous potters had an intimate knowledge of the geodiversity of the region and utilized a wide range of different naturally occurring raw materials. The researchers concluded that much of the pottery found at the tested sites was probably nonlocal in origin, having been made elsewhere in southern California and transported over significant distances in various directions through seasonal movements or trade among hunter-gatherer social groups. This project contributed to documenting the different recipes or styles of southern California pottery and indicated variation in cultural identities and traditions of hunter-gatherer groups that produced, used, and discarded them.

Grinding Tool Experimentation and Use-Wear Analysis

Ground stone tools such as mortars-and-pestles and manos-and-metates are important components of archaeological assemblages worldwide. A major two-year research project supported by the National Science Foundation allowed the Center and a team of Native Americans and U.S. archaeologists to conduct experiments with replicated milling tools. The goal of this project was to (1) develop an experimental baseline of detectable criteria for tool use (through microscopic use-wear analysis) and relative efficiency of different grinding tool designs (varying by shape and lithic material type); and (2) apply these criteria to ground stone assemblages from previously excavated archaeological sites. Data generated by the project were intended to aid in understanding how and why grinding tools changed through time in the San Diego region and elsewhere. Over 140 volunteers, interns, and students (Figure 3) participated in grinding experiments using tools and materials based on the archaeological and ethnohistorical record for the San Diego area. Archaeologists and Native American consultants monitored the experiments. Researchers then compared the experimentally determined efficiency and use-wear criteria to archaeological grinding tool assemblages to evaluate long-term change in tool designs and functions relative to change in spatial settlement patterns across San Diego County. Findings included higher than expected frequencies of non-food processing and multiple-use tools in curated ground stone assemblages and demonstrated the fallacy of common 1:1 form-equals-function assumptions.

Detrital Zircon Provenance Analysis

Grinding tools are rarely the subject of provenience studies due to their perceived lack of

Figure 3: CSU San Marcos Anthropology student, Angie Alvarado participating in a grinding experiment at the San Diego Archaeological Center. (SDAC Archive Photo by Rebecca Nathan)

portability and because suitable raw materials are assumed to be widely available (Rowan and Ebeling 2008:8). However, research on ancient basalt milling tools has demonstrated long-distance transport in sedentary agricultural and emerging agricultural societies (Peacock 1980; Weinstein-Evron et al. 1999; Williams-Thorpe 1988; Williams-Thorpe and Thorpe 1993). Also, ethnoarchaeological studies evidence strong cultural preferences for certain lithic types associated with concepts of efficiency and energy investment in tool procurement among contemporary sedentary and semisedentary agriculturalists (Hayden 1981, 1987; Schneider 1993). Mobile hunter-gatherer societies, on the other hand, would have placed a premium on portability and seem less likely than sedentary societies to have carried bulky food-processing tools or tool raw materials for long distances (e.g., Basgall 2008:196-197). Surprisingly, a recent study at the Center of lithic types in 31 San Diego County Archaic and Late Prehistoric hunter-gatherer ground stone assemblages with geologist Dr. Patrick Abbott revealed quantities of "exotic" sedimentary cobble material comprising up to 23 percent of the hand stones at an Archaic site in Otay Mesa (CA-SDI-8654) (Kyle et al. 1990). Porous quartz arenite cobbles, petrologically and geochronologically distinct from rocks typical of San Diego County, were present as well-shaped and intensively used flat multifacial manos at five sites west of the Peninsular Ranges and restricted to the southern part of the county.

In 2009 the Center initiated a pilot study investigating use of the geochronological technique of detrital zircon provenance analysis (Gehrels et al. 2006, 2008) for sourcing these and other sedimentary rock artifacts in collaboration with the Arizona LaserChron Center (www.geo.arizona.edu/alc). The pilot study has shown that sandstone artifacts are amenable to sourcing using U-Pb (detrital zircon) geochronology by Laser Ablation-Multicollector-Inductively Coupled Plasma-Mass Spectrometry (LA-MC-ICPMS). (Results can be found at https://sites.google.com/a/laserchron.org/laserchron/---burton.) Study results suggest the tested tools found at Otay Mesa originate from areas east of the Peninsular

Ranges. A next phase of this research—currently under way—includes analysis of field geological samples in order to establish a reference database for comparison to the sedimentary rock ground stone artifacts.

The Center's study will help demonstrate whether detrital zircon provenance analysis can become an important means of tracing the movements of people and things. This age-based characterization technique is relatively unknown to archaeologists but holds great potential for sourcing sedimentary lithic raw materials for which chemical sourcing techniques have limited value. By identifying the original find-spots of raw materials used for tools and architectural features, it may be possible to investigate technological choices, economic organization, and even the relative social value of different materials and activities. Using curated collections, the Center is among the first to explore archaeological applications of detrital zircon provenance analysis.

GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

Projects utilizing GIS at the Center continue to expand with the support of ESRI ECP Grants (www.conservationgis.org). Over the last four years, interns, volunteers, and staff have been working diligently to integrate GIS with our curation practices. To date, more than 90 percent of our collections have been assigned spatial information allowing for intersite and intra-site studies. Associated data include site chronology, site types, and artifacts and ecofacts found at the sites. GIS has played an important role in the success of the Center's National Science Foundation project and was used to plot selected assemblage attributes against a variety of resource data sets. For example, lithic material types have been plotted against topographic and geological data sets to examine whether rock for grinding tools was obtained from the immediate site vicinity or transported across greater distances.

Geological and environmental data are being increasingly integrated with cultural site maps to better understand the long-term development of San Diego's landscape. A new Center project utilizes GIS to explore past, present, and future human impact on the environment of San Diego County. Data sets compiled over the last century, including satellite and aerial photography, provide the foundation for investigating the effects of human occupation on the southern California landscape, including its river valleys, plateaus or mesas, and coastline. Recent catastrophic events in different world regions can be directly traced to human interference with natural environmental processes. San Diego County is a prime example, with wildfires and mudslides that have resulted in costs ranging into the millions of dollars and the loss of lives, homes, and habitats. As well, this project investigates the impact of recent development on our cultural resources. Private and public-sector decisions to build homes, roads, and power lines in certain areas directly impact archaeological sites and landscapes that evidence the history and prehistory of the region. Unfortunately, few records exist for many prehistoric sites that were once located throughout the county. Some projects are beginning to address this issue, at least for the ethnohistoric time frame (example: www.kumeyaaymapping.com).

The Center's growing GIS program has been especially attractive to students from local community colleges and universities. Over the past year, six students have successfully completed internships at the Center that help satisfy requirements for their GIS certificate programs. Currently, two interns and one volunteer are working on GIS-related projects at the Center. All of these students have been able to use the Center's archaeological data for their classroom projects and have contributed to populating our spatial information databases. They are also gaining valuable hands-on experience that will benefit them in the workplace.

MAKING COLLECTIONS ACCESSIBLE

At the Center, artifacts and other archaeological materials are not simply stored away and forgotten. Center staff facilitate and encourage continued research by making collections available to academic, professional, and other individuals and groups for research, exhibits, and education outreach.

Notable projects utilizing Center collections include technique validation and interdisciplinary studies promising to be at the forefront of cutting-edge research.

One technique with great potential for improving absolute dating of artifacts and sites is RHX dating. The Center has submitted ceramic samples to the University of Manchester and University of Edinburgh for their RHX dating validation study funded by the U.K.'s Natural Environment Research Council (NERC). The technique was developed by Moira Wilson and Christopher Hall (Savage et al. 2008; Wilson et al. 2003, 2009). In California, Carl Lipo and Hector Neff at California State University, Long Beach (www.iirmes.org) are also working to further test and develop RHX dating for archaeological applications.

RHX is an entirely new approach to directly establishing the age of ceramic artifacts. RHX dating is based on the principle that pottery (or brick or tile) absorbs and chemically binds moisture from its surroundings over time. By first measuring the mass of a sample, then heating it to around 500^{o} C in a kiln to remove the chemically combined water, and then measuring the mass again, the weight of water absorbed since the sample's manufacture can be calculated. Using a time law based on the rate at which the sample material absorbs water, it is possible to precisely estimate the sample's age. Advantages of RHX dating are that it is not destructive (although the procedure resets the sample's "internal clock" and therefore precludes retesting) and that it can be applied to museum collections (unlike thermoluminescence dating). Pottery itself cannot be dated using Carbon-14 because fired ceramic does not contain carbon (though carbon deposits, such as soot, on pottery may be dated by radiometric methods). If validation tests are successful, RHX dating has the potential to revolutionize absolute dating in some areas and time periods, such as late precontact San Diego County, where high-resolution chronological indicators (e.g. pottery seriation, dendrochronology) are not available.

Providing access to research materials for students is a primary Center objective. Center collections and equipment have played an important role in a number of graduate and undergraduate research projects. For example, Micah Hale used Center lithic collections to examine adaptive strategies along the southern California coast for his doctoral dissertation at the University of California, Davis (Hale 2009). The importance of petrographic methods has been previously mentioned. A Master's thesis project by University of Sheffield, U.K. student Sophie Van Heymbeeck utilized ceramic sherds from the Center's Pine Valley collection for a thin-section petrographic study aimed at investigating provenience and technology. University of California undergraduates Jamaica Grace-Bishop and Joelle Morgan were able to complete an academic internship and senior honors thesis, respectively, with the benefit of the Center's research microscope and collections. The Center also encourages and supports interdisciplinary studies. Marco Hatch, a doctoral candidate at Scripps Institution of Oceanography, University of California, San Diego is currently conducting paleoenvironmental studies of the California coast using collections of *Chione undatella* curated at the Center.

SHARING INFORMATION

An integral part of the Center's mission is the dissemination of information to the public. This is accomplished in a variety of ways including classroom education, exhibits, outreach, and special events. Coupled with these is the Center's expanding use of the internet and cloud computing. In addition to the Center's own website, www.sandiegoarchaeology.org, the Center is currently publishing archaeological information on Open Context (www.opencontext.org) to help disseminate data globally in an efficient and economical manner. Developed by the Alexandria Archive Institute (AAI) and the School of Information at the University of California, Berkeley, Open Context is a web-based publication tool that allows storing and sharing of the Center's digital content (Kansa et al. 2010). Open Context is unique in its ability to allow dynamic interaction and analysis of pooled data sets from archaeological and historical sites from diverse world regions and time periods. A small subset of the Center's collections is already available on Open Context. As the collaborative project proceeds, Open Context will make archaeological primary data and documentation for important southern California prehistoric and historic sites easily

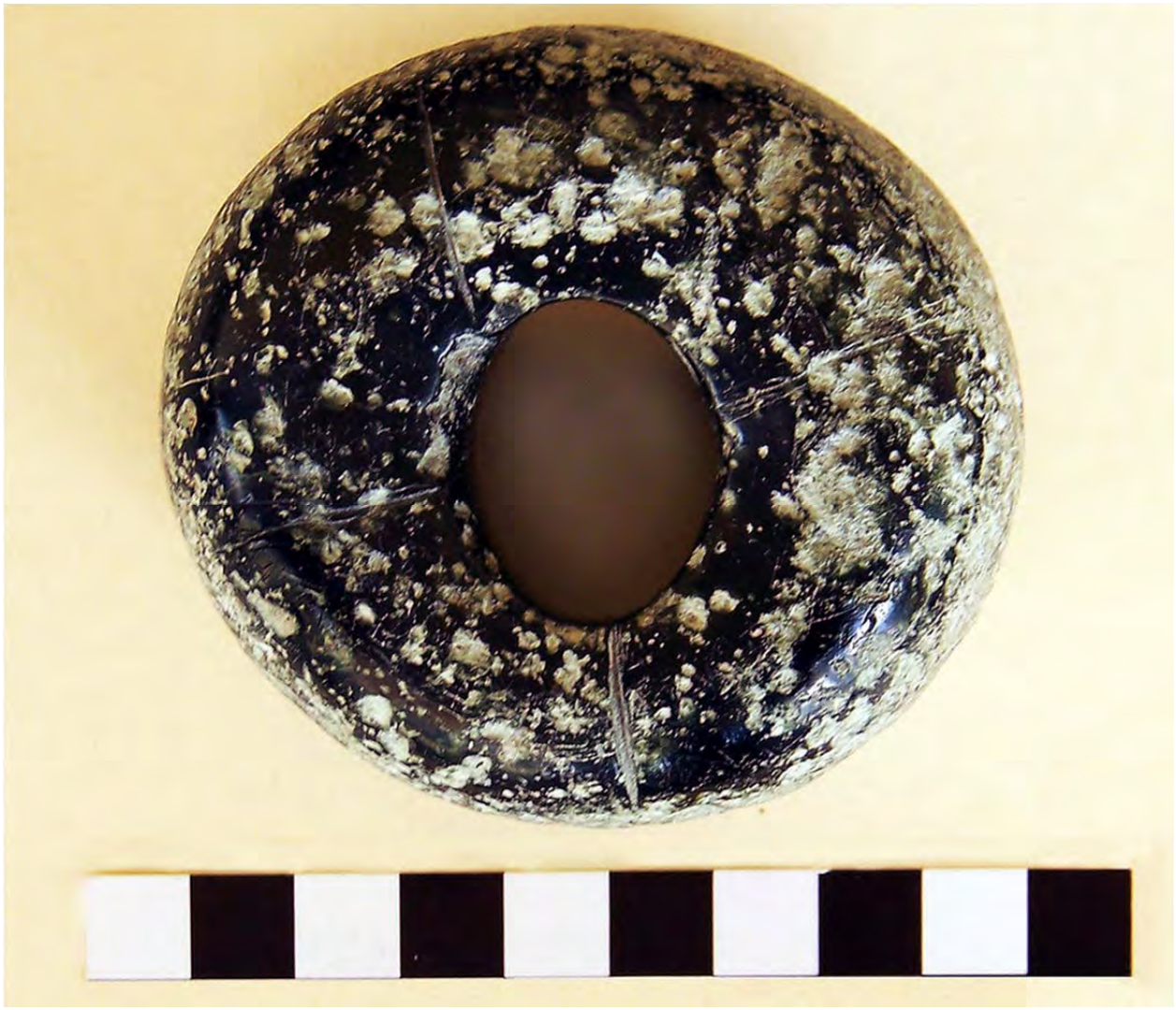

Figure 4: Incised steatite "donut stone" from CA-SCLI-30. (SDAC Archive Photo by Erin Yetts-Teeling)

accessible and useful for teachers, students, researchers, special-interest communities, and the general public. Internet users will be able to search, sort, re-sort, and summarize catalogues and reports from archaeological sites dating from 10,000 years ago to the A.D. 1950s. The overall goal of web publication of primary data is to help people to imagine and interpret global cultural evolution (change over time and across space) that combinations of archaeological data sets and written versions of history represent.

One project scheduled for uploading to Open Context in the next few months is a macro- and microscopic investigation of "donut stones" (Figure 4) conducted by the Center in collaboration with theDepartment of the Navy, Naval Facilities Engineering Command, Southwest Division. Numerous "donut stones" (or perforated stones) have been found on San Clemente Island and other insular and coastal areas of southern California (Koerper 2006; Molitor 2000; Raab et al. 2009). A preliminary inspection of various specimens from collections curated at the Center suggests a reductive technological sequence and functions ranging from the profane to the sacred.

COLLECTIONS FOR THE FUTURE

Curated archaeological collections are an invaluable resource for students, researchers, and the general public. The Center is playing an important role in ensuring that collections are properly curated and that their full educational and research potential is realized. All artifacts, ecofacts, soil samples, excavation reports, photographs, maps and pertinent materials from archaeological projects are organized and prepared for long-term storage. However, curation does not represent the end of the road for our collections, but just the beginning. The Center's research initiatives and collaborative activities described in this paper have improved and continue to improve interpretations of the archaeological record without the destruction of additional cultural sites. Curation and the full and prudent use of curated collections are key to the preservation of cultural heritage and the future of archaeology. It is incumbent on archaeologists and society as a whole to work together to promote curation of the past for the future.

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