Shell and Bone Artifacts from Two Middle Holocene Red Abalone Middens on San Miguel Island

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Abstract

Channel Islands archaeologists have documented a diverse array of technologies and subsistence strategies utilized by maritime peoples of the Middle Holocene. Largely missing, however, is a record of shell and bone technologies employed by the occupants of Middle Holocene red abalone middens. Excavations at two heavily eroding red abalone middens on the south coast of San Miguel Island produced several types of formal shell and bone artifacts that help document a trans-Holocene elaboration of bone and shell technologies on California's Channel Islands. Among the ornaments recovered were two unusual Giant Rock Scallop (*Hinnites multirugosus*) beads dated to approximately 6100 cal BP that extend the range and antiquity of *Hinnites* artifacts in coastal California. The bone tools, one decorated with a punctate design pattern, support King's (1990) chronology for certain bone artifact types, including a relatively early development of decorated bone objects.

Introduction

At the time of European contact, the Chumash and their California Indian neighbors made and used a diverse array of shell and bone artifacts. During the Early Holocene (10,000-7500 cal BP), in contrast, archaeologists have documented a relatively small number of shell and bone artifact types, including spire-removed *Olivella biplicata* shell beads and bone gorges (Erlandson 1994). The diversity of bone and shell artifacts utilized during the Middle Holocene (7500-3500 cal BP) appears to increase (King 1990), but the nature and causes of this diversification remain poorly understood. Channel Islands archaeologists have argued that the number and size of archaeological sites generally increases through time, a pattern that seems to be associated with growing human populations, greater sedentism, and the development of intensified subsistence and exchange networks (Braje et al. 2007; Kennett 2005; Rick et al. 2005). Middle Holocene cultural developments coincide with a roughly 3000-year period of higher than average temperatures in western North America (the Altitherrmal) and a stabilization of postglacial sea levels, but there is no clear linkage between such environmental and cultural changes.

Because of the stratigraphic integrity and faunal preservation found in many Channel Island sites, island assemblages have played a key role in identifying cultural changes along the southern California Coast. General patterns aside, there is still much to be learned about the range of utilitarian and ornamental artifacts used at various times in the region, including shell beads and decorated bone tools. This is particularly true of the Middle Holocene, a period Glassow (1997:73) described as "still shrouded in mysteries produced by an imperfect archaeological record and limited archaeological research." Although

utilitarian artifacts (e.g., expedient stone tools, bifaces, bone gorges) dominate most Middle Holocene assemblages, the density and diversity of ornamental and other shell and bone artifacts seems to increase through time (King 1990; Rick et al. 2005), followed by an even more dramatic acceleration of technological and cultural changes in the Late Holocene (Erlandson 1989). Much more is known about Late Holocene cultural developments, however, partly because sample sizes are much larger due to the historical focus of early archaeologists on the large and comparatively rich sites dating to this time period.

On the Channel Islands, much of what we know of Middle Holocene technologies comes from early excavations of cemeteries and villages on Santa Cruz, Santa Rosa, and San Miguel (e.g., King 1990:30; Orr 1968). On the southern islands, more recent excavations have contributed valuable information on the nature of Middle Holocene technologies, including unique ornaments such as *Olivella* grooved rectangle beads (Howard and Raab 1993; Vellanoweth 2001a). On the northern islands, in contrast, little information is available on the full range of formal artifacts present at Middle Holocene sites. Recent excavations at Daisy Cave, Cave of the Chimneys, Otter Cave, and Otter Point on San Miguel Island (Erlandson et al. 2001; Vellanoweth 2001b; Vellanoweth et al. 2006), the Punta Arena site on Santa Cruz Island (Glassow, Paige, and Perry 2008), and a handful of other sites (Rick, Erlandson, and Wolff 2008) have helped fill this gap. Relatively little published information is available on the specific technologies associated with the many Middle Holocene red abalone middens studied on the Channel Islands, however, a gap we help fill in this paper.

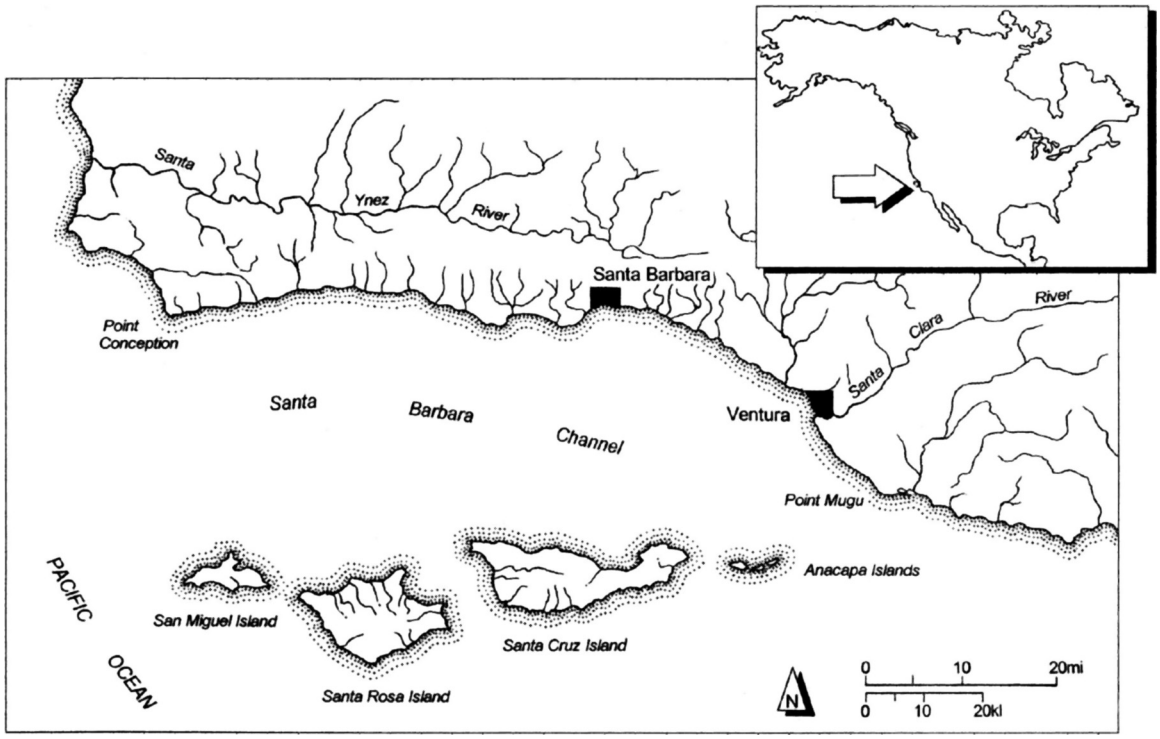

Fig. 1. Map of the Santa Barbara Channel region, showing the location of San Miguel Island.

Background

Channel Islands archaeologists long have been interested in a distinctive class of Middle Holocene sites known as red abalone middens. These sites date between roughly 7500 and 3000 cal BP and are often characterized by thin shell middens, visually dominated by large and mostly whole red abalone shells, or multi-component middens containing discrete lenses of densely concentrated red abalone shells. There is a great deal of temporal and spatial variation in the abundance of red abalone shell in these sites (Braje et al. 2008; Rick, Robbins, and Ferguson 2006), however, and explanations for their appearance on the Channel Islands have been vigorously debated for over fifty years.

Hubbs (1955) argued that the appearance of red abalone middens was tied to episodes of sea-surface temperature (SST) cooling that allowed red abalones to replace black abalones as the dominant abalone species in the intertidal. Glassow (1993; Glassow, Wilcoxon, and Erlandson 1988; Glassow et al. 1994) provided support for Hubbs' hypothesis by drawing on Ault's (1985) abalone distribution studies, Pisias' (1978, 1979) paleoceanographic data, and preliminary isotopic data for mussel and abalone shells found in a midden. Recent data from excavations on San Miguel Island (Braje et al. 2008) and a new marine climate sequence by Kennett (2005) show no clear correlation with cold SST periods and the appearance of red abalone middens. While some red abalone middens date to times of moderately cool SST (Kennett 2005:68, 128-153; Rick, Robbins, and Ferguson 2006), others appear to date to warm intervals of the Middle Holocene.

These inconsistencies have spurred alternative explanations. Sharp (2000) suggested that the use of new collection strategies (diving) allowed for greater access to subtidal abalones. Erlandson et al. (2005) hypothesized that red abalones were larger and more abundant beginning about 7500 years ago due to heavy human hunting of sea otters, a keystone abalone predator. Recently, Braje et al. (2008) proposed a synthetic model, suggesting that spatial and temporal variation in SST in Channel Island waters led to fluctuations in the distribution and abundance of red abalone populations, fluctuations that resulted in the highly variable patterns evident in the archaeological record. Debates concerning red abalone middens have also centered on the degree of subsistence specialization (Braje and Erlandson 2007). Glassow (1993; Glassow et al. 1994) suggested that these sites represent specialized foraging or processing camps, for example, a view also favored by Kennett (2005; Kennett et al. 2007).

The dearth of formal artifacts recovered from red abalone middens has contributed to interpretations that they served as logistical or short-term campsites, but such conclusions are often based on the excavation and analysis of small column (25 by 25 centimeters) or bulk (~100 L) samples (Braje et al. 2007; Glassow 2005; Kennett 2005; Vellanoweth et al. 2006) in which formal artifacts are unlikely to be present. During our recent excavations at a 6100-year-old red abalone midden (CA-SMI-657) on the south coast of San Miguel Island, we combined small-scale bulk sampling with the excavation of larger samples (a 1 by 2 meter wide test unit) to recover a broader range of artifacts and faunal remains. One of our goals was to recover a wider range of artifacts to help determine the degree of specialization represented by the red abalone midden deposits at CA-SMI-657 (Braje and Erlandson 2007).

In this paper, we describe and discuss ten formal shell and bone artifacts recovered during excavations at CA-SMI-657 and CA-SMI-557, two red abalone middens located in the Crook Point

vicinity (Fig. 2). The recovered artifacts include several unusual ornamental or decorated artifacts that raise questions about the specialized nature of the occupations at these two Middle Holocene sites—and by extension at other red abalone middens on the Channel Islands. Our interpretations were facilitated by the excavation of relatively large sample sizes, which may be crucial to a better understanding of the range of activities represented at red abalone middens.

Site Descriptions, Field Methods, Chronology

CA-SMI-657

CA-SMI-657 was first recorded in 2004 during a systematic survey of the south coast of San Miguel Island, part of Channel Islands National Park's ongoing cultural resource management efforts (Braje 2007b; Braje, Erlandson, and Rick 2005). The site consists of a series of three midden loci exposed for three to six meters in the walls of a large gully and extends from the base of the steep southern escarpment for approximately 100-150 meters south, terminating in a southern locus. Each locus is buried beneath a meter or more of historic sand, probably deposited during the ranching period when sheep grazing destabilized the island's extensive dune fields. At each locus, large red abalone shells and other midden debris are eroding from a paleosol built in light yellowish-brown alluvium (Braje 2007a, b).

While each of the midden loci contains large red abalone shells, the density of the midden and the diversity of shellfish taxa vary. The northern locus is between 10 and 30 centimeters thick and dominated by large, mostly whole red abalone shells of moderate density. The southern locus is about one meter thick, densely packed, and contains the remains of a wider array of shellfish taxa, primarily large red abalone, California mussel, turban snail, and platform mussel shells. We excavated a 100 L bulk sample and a 1 by 2 meter test unit from the east gully wall midden exposure at the northern locus. Sediments from the bulk sample were screened over a combination 1/8 and 1/16-inch mesh and those from the test unit over 1/8-inch mesh.

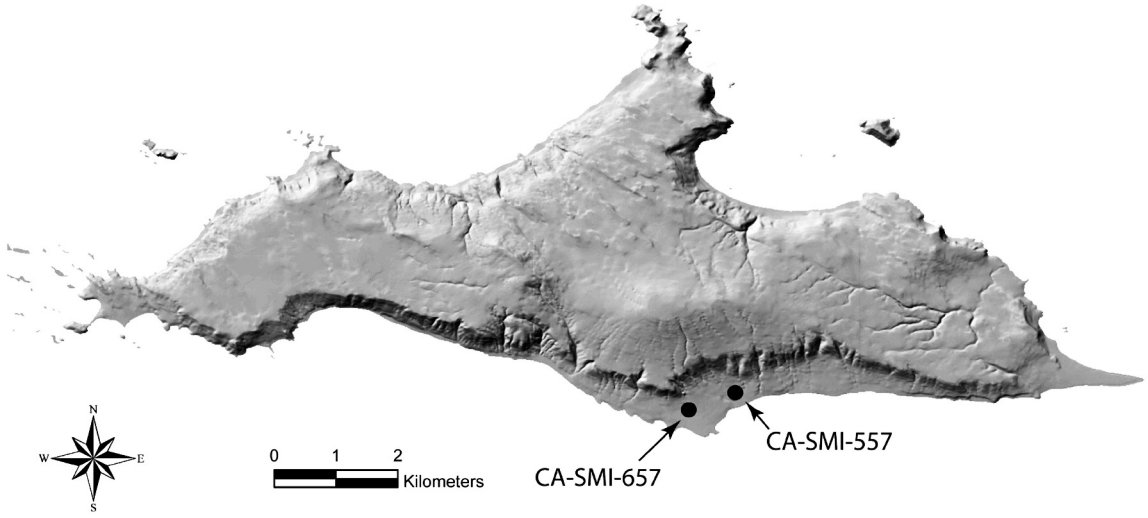

Fig. 2. Map of San Miguel Island showing the location of CA-SMI-657 and CA-SMI-557.

Single fragments of well-preserved marine shell from the northern and southern loci were submitted for radiocarbon dating, yielding age ranges of 6190-5970 cal BP (Beta-217110) and 7060-6820 cal BP (Beta-195745), respectively (Table 1). After our excavations in the northern loci were completed, a tiny sample of powdered shell from a Giant Rock Scallop bead (below) was submitted to the NOSAMS facility at Woods Hole for AMS ^{14}C dating, yielding a calibrated age range of 6180-6020 cal BP (OS-56706), fully consistent with the age of midden shell from the same locus.

CA-SMI-557

Glassow (1982) and a team of archaeologists from the University of California, Santa Barbara, first recorded this site during a systematic survey of two quarter-mile wide transects running from the north to south coasts of San Miguel Island. Glassow (1982) described CA-SMI-557 as a complex of several shell midden loci, extending for ca. 150 meters and eroding from the gully walls of Waters Canyon on the south coast of San Miguel Island. The site center is positioned approximately 325 meters north of the shoreline and each locus is between 10 and 30 centimeters thick, embedded in a yellow-tan alluvium, and dominated by large red abalone shells with lesser amounts of black abalone, turban snail, sea mussel, and limpet shells.

In an effort to better understand the site chronology and constituents, we visited this locality during several field seasons from 2003-2005 and sampled the two densest midden loci. Although these loci are separated by approximately 10 meters, they formed in the same deeply buried soil and appear to be from the same stratigraphic level. The northern locus was composed primarily of large and mostly whole red abalone shells, while the southern locus consisted of a wider variety of shellfish species including red and black abalone, California mussel, black turban snail, and sea urchin.

Bulk samples of 40 and 50 liters were collected from the northern and southern loci, respectively, and screened over a combination of 1/8 and 1/16-inch screen mesh. Single fragments of red abalone shells from each bulk sample were submitted for ^{14}C dating (Table 1). Including Glassow's (1992) date, CA-SMI-557 appears to have been occupied between about 6580 and 5980 cal BP. The similar stratigraphic context, close proximity, and ^{14}C age ranges (one sigma) from Bulk Samples 1 (6580-6440 cal BP; OS-44640) and 2 (6400-6265 cal BP; Beta-213143) suggest that the sampled midden

Table 1. Radiocarbon chronology for CA-SMI-657 and CA-SMI-557.

Site	Provenience	Material	Lab number	Measured ^{14}C age	$^{13}C/^{12}C$ adjusted	Age range (cal BP, 1 sigma)[1]
CA-SMI-657	Southern loci	*Cryptochiton stelleri*	Beta-195745	6240 ± 80	6670 ± 80	7060-6820
CA-SMI-657	Bulk Sample 1	*Haliotis cracherodii*	Beta-217110	5460 ± 90	5900 ± 90	6190-5970
CA-SMI-657	Test Unit 1 (10-20 cm)	*Hinnites multirugosus* bead	OS-56706	N/A	5920 ± 40	6180-6020
CA-SMI-557	Bulk Sample 1	*Haliotis rufescens*	OS-44640	N/A	6310 ± 35	6580-6440
CA-SMI-557	Bulk Sample 2	*Haliotis rufescens*	Beta-213143	5710 ± 60	6140 ± 60	6400-6265

1. Calibrated with CALIB 5.0.1 using a local reservoir correction of -225 ± 35 years (Stuiver and Reimer 2000).

loci are roughly contemporary and may have been occupied simultaneously.

Shell Artifacts

Eight shell artifacts were recovered during excavations at CA-SMI-657 and CA-SMI-557 (Fig. 3). All of these artifacts were shell beads or bead fragments, some of which have been previously identified in the Santa Barbara Channel area and along the broader southern California Coast (Gifford 1947; King 1990).

Four shell beads were recovered from Unit 1 at CA-SMI-657—one whole *Olivella* bead, one fragmented *Olivella* bead, and two unusual Giant Rock Scallop beads. Both *Olivella* beads are made from beach-rolled wall fragments that appear to have been collected from sandy beaches in the Crook Point area, where similar *Olivella* wall fragments can be found today. While little information can be gleaned from the fragmented bead, the unbroken *Olivella* bead is more or less rectangular and drilled biconically. No evidence of edge grinding or modification was evident under high-powered magnification. Neither Bennyhoff and Hughes (1987) nor King (1990) describe similar beads, possibly because they were a relatively expedient technology where the bead shape depends on the shapes and sizes of the *Olivella* fragments gathered from local beaches. These beads may also represent early, extemporized types that were more common before social and economic institutions more tightly controlled the manufacture and distribution of shell beads. It is also possible that these beads are rectangular *Olivella* preforms lost or discarded before being edge-ground into a formal shape. This idea seems unlikely, however, since neither bead shows evidence of grinding or edge modification despite being completely drilled.

The Giant Rock Scallop beads were constructed from the brightly colored hinge portion of the shell.

Fig. 3. Shell artifacts from CA-SMI-657 (top row: two Olivella *wall beads at left and two* Hinnites *tube beads at right) and CA-SMI-557 (bottom row, four* Olivella *barrel beads). Scale shows centimeters. Photo taken by J. M. Erlandson.*

The tube-shaped beads show remnants of dark red to deep purple coloring at one end where the hinge has been ground into a smooth tube shape. On one side of each tube bead, a C-shaped indentation has been drilled and carved out. Both beads were then drilled from each end of the shell tube until the perforation reached this central indentation. If these were intended to be tube beads, these *Hinnites* tubes may have been drilled so they could be strung horizontally. It is also possible, however, that these unique ornaments were meant to serve as choker-like fasteners for necklaces or draw-strings.

Giant Rock Scallop tube or globular beads have been previously identified by Gifford (1947:45-46), Harrington (1928:160-162), King (1990:192-193), and others on the southern California mainland and offshore islands. Gifford (1947:46) studied an ethnographic collection of Giant Rock Scallop beads and concluded that they usually are found with a variety of other bead types and probably strung together for highly ranked individuals. King (1990:192-193) summarized their temporal and spatial occurrence in southern California and concluded that they were only made during Phases L2 and L3 (ca. AD 1500-AD 1800) and that most were made on the Northern Channel Islands. King (1990:193) also stated that their use "apparently reflects the growth of complexity of the Chumash economy and of the political system."

The recovery of these Giant Rock Scallop beads from a Middle Holocene shell midden, well before the documented appearance of social and political complexity in southern California, is intriguing. These data suggest that this bead type persisted for at least 4500 years as an important ornamental, social, and cultural symbol for the Chumash and their ancestors. Little is known, however, of the antiquity, distribution, and manufacture of *Hinnities* beads in southern California. Giant Rock Scallops inhabit subtidal environments and the dense hinge portions of their shells are difficult to modify, shape, and drill. The energy investment required to produce beads from these shells (especially since black abalone, California mussel, and *Olivella* shells are more widely available and easier to modify) may have prevented widespread production. Ultimately, the most significant aspect of this discovery may be as a cautionary tale of equating artifact rarity with social, political, or economic complexity.

Four *Olivella* barrel beads were recovered from the 50 L bulk sample excavated from the southern locus at CA-SMI-557. Barrel beads are relatively common in Middle Holocene sites in coastal southern California and persist to early Protohistoric times (Bennyhoff and Hughes 1987:122). Bennyhoff and Heizer (1958) and King (1990) suggested that barrel beads represent a trend in southern California of *Olivella* shell base removal (evolving from Early Holocene spire removed beads), a reduction in bead size, and an increase in manufacturing cost. King (1990:108) argued that this is an indication of the increased use of *Olivella biplicata* shells in economic contexts. The recovery of four of these barrel beads from a 50 L bulk sample is a relatively high density of beads for a red abalone midden, especially one that appears to be between 6250 and 6600 years old.

Bone Artifacts

Bone artifacts, unlike shell beads and ornaments, are relatively rare and usually fragmented in Channel Islands archaeological sites. Few focused studies, therefore, have attempted to develop a classification system and trace the evolution of this technology through time. Gifford (1940) provided one of the earliest and most complete bone tool and ornament classification systems for the state of California. His studies were later expanded by Orr (1947), Bennyhoff (1950), King (1990), and

most recently Wake (2001). While these studies provide a baseline for analyzing, classifying, and comparing southern Californian bone tools across time and space, larger samples are necessary to refine our understanding of bone tool innovation and distribution in the Chumash area.

Two bone tool fragments were found during the excavation of Unit 1, level 2 (Fig. 4) at CA-SMI-657. These bone artifacts are small and fragmented making it difficult to determine a precise function. One of the artifacts is a decorated mammal bone fragment, possibly from a hairpin, "scepter," or "sweatscraper" (King 1990:258-259). Both sides of the bone fragment have a linear series of small, drilled circular depressions, 19 on one side and 11 on the other. Gifford (1940) and King (1990) identified several bone tool types from Santa Barbara Channel sites adorned with punctate designs, making a precise functional assignment for the CA-SMI-657 specimen impossible.

The second bone artifact may be a fragment of a split dolphin or porpoise jaw hairpin. The proximal end of this possible hairpin has been shaped and smoothed and is similar to hairpins from burial assemblages analyzed by King (1990:29-31) from Cemetery A at Tecolote Point (CA-SRI-3) on Santa Rosa Island. King (1990:258) attributed these tools to his phase Ex (ca. 7500-6400 cal BP), somewhat earlier than the ^{14}C dates from the northern locus at CA-SMI-657. Although Orr (1968) concluded that all 79 burials (and associated grave goods) from Cemetery A dated to the Early Holocene, Erlandson (1994:189) concluded that the cemetery included several burials associated with a roughly 4000-year-old midden overlying the cemetery—raising questions about the antiquity of some of the bone tools. Our data demonstrate that these relatively elaborate bone tools were made and used at least 6000 years ago on San Miguel Island, increasing the likelihood that they may also extend back even further in time as King (1990) suggested.

Fig. 4. Bone artifacts from CA-SMI-657 with circular depressions highlighted on specimen at left. Scale shows centimeters. (Photo taken by T. Braje.)

Conclusions

The recovery of ten shell and bone artifacts from two Middle Holocene red abalone middens on San Miguel Island provides evidence for a relatively diverse tool-kit rarely documented at such sites. These include several unusual shell and bone artifacts we did not expect to find in a 6100 year old red abalone midden, a site type often interpreted as serving a relatively specialized function. Our results suggest that faunal remains and subsistence patterns are much better understood for Middle Holocene red abalone middens than the technologies associated with them. Debates about the nature of these sites, their function, and the reasons for their appearance should include greater attention to the recovery and reporting of more representative artifact assemblages, which can provide independent evidence for the function and economic basis of an occupation.

Certain classes of archaeological material—especially those rarer objects (e.g., sea mammal bones, finished artifacts, features, etc.) that tend to be scattered widely or unevenly distributed in shell middens—have probably been underrepresented in most excavations at red abalone middens. Larger excavation samples, exceeding or equal to our 1 by 2 meter unit at CA-SMI-657, may provide a broader view of the activities and technologies of Middle Holocene abalone foragers. Ultimately, this information might help resolve questions concerning the level of subsistence specialization (Braje and Erlandson 2007) and logistical foraging (Kennett et al. 2007) represented by red abalone middens that vary considerably through space and time.

For now, we have shown that some Middle Holocene red abalone middens on the Northern Channel Islands contain relatively unusual shell and bone artifact types, including colorful beads made from the hinge areas of rock scallop (*Hinnites multirugosus*) shells—artifacts once thought to be status markers found only in Late Holocene assemblages along the southern California Coast. These, along with two relatively elaborate bone artifact types at CA-SMI-657, suggest that some red abalone middens on the Northern Channel Islands may not have been specialized foraging or processing camps (Braje and Erlandson 2007). They also help document a relatively early diversification of elaborated shell and bone artifacts during the Middle Holocene along the California Coast and add to our knowledge about the acceleration of cultural change in the Santa Barbara Channel area through time.

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References Cited

Ault, Jerald S.
1985 Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest), Black, Green and Red Abalones. *US Department of the Interior, Fish and Wildlife Service Biol. Rep.* 82(11-32).

Bennyhoff, James A.
1950 California Fish Spears and Harpoons. *University of California Anthropological Records* 9:295-337. Berkeley.

Bennyhoff, James A., and Robert F. Heizer
1958 Cross-dating Great Basin Sites by California Shell Beads. *Reports of the University of California Archaeological Survey* 42:60-92.

Bennyhoff, James A., and Richard E. Hughes
1987 Shell Bead and Ornament Exchange Networks between California and the Western Great Basin. *Anthropological Papers of the American Museum of Natural History* 64(2). New York.

Braje,Todd J.
2007a Geographic and Temporal Variability of Middle Holocene Red Abalone Middens on San Miguel Island, California. *Journal of California and Great Basin Anthropology* 27(2):153-164.
2007b Archaeology, Human Impacts, and Historical Ecology on San Miguel Island, California. Ph.D. dissertation, University of Oregon. University Microfilms International, Ann Arbor.

Braje, Todd J., and Jon M. Erlandson
2007 Measuring Subsistence Specialization: Comparing Historic and Prehistoric Abalone Middens on San Miguel Island, California. *Journal of Anthropological Archaeology* 26:474-485.

Braje, Todd J., Jon M. Erlandson, and Torben C. Rick
2005 Reassessing Human Settlement on the South Coast of San Miguel Island, California: The Use of ^{14}C Dating as a Reconnaissance Tool. *Radiocarbon* 47(1):11-19.

Braje, Todd J., Douglas J. Kennett, Jon M. Erlandson, and Brendan J. Culleton
2007 Human Impacts on Nearshore Shellfish Taxa: A 7,000 Year Record from Santa Rosa Island, California. *American Antiquity* 72:735-756.
Braje, Todd J., Jon M. Erlandson, Torbeen C. Rick, Paul K. Dayton, and Marco B. Hatch
2008 Fishing from Past to Present: Long-term Continuity and Resilence of Red Abalone Fisheries in California's Northern Channel Islands. *Ecological Applications* (in press).

Erlandson, Jon M.
1989 The Evolution of Maritime Economies on the Southern California Coast: Resource Stress and the Rise of Cultural Complexity. In, *Proceedings of the Circum-Pacific Prehistory Conference*. Washington State University, Pullman.
1994 *Early Hunter-Gatherers of the California Coast*. Plenum Press, New York.

Erlandson, Jon M., Torben C. Rick, James A. Estes, Michael H. Graham, Todd J. Braje, and René L. Vellanoweth
2005 Sea Otters, Shellfish, and Humans: A 10,000 Year Record from San Miguel Island, California. In, *Proceedings of the Sixth California Islands Conference*, eds. David K. Garcelon and Catherin A. Schwemm, pp. 9-21. Institute for Wildlife Studies, Arcata, CA.

Erlandson, Jon M., René L. Vellanoweth, Annie C. Caruso, and Melissa R. Reid
2001 *Dentalium* Shell Artifacts from a 6600-Year-Old Occupation of Otter Cave, San Miguel Island. *Pacific Coast*

Archaeological Society Quarterly 37(3):45-55.

Gifford, Edward W.
1940 Californian Bone Artifacts. *University of California Anthropological Records* 3(2):153-237. Berkeley.
1947 Californian Shell Artifacts. *University of California Anthropological Records* 9. Berkeley.

Glassow, Michael A.
1982 Archaeological Investigations on Eastern San Miguel Island, Channel Islands National Park, California. Report on file, Central Coast Information Center, University of California, Santa Barbara.
1993 The Occurrence of Red Abalone Shells in Northern Channel Island Archaeological Middens: Implications for Climatic Reconstruction. In, *Third California Islands Symposium: Recent Advances in Research on the California Islands*, ed. F.G. Hochberg, pp. 567-578. Santa Barbara Museum of Natural History, Santa Barbara.
2005 Variation in Marine Fauna Utilization by Middle Holocene Occupants of Santa Cruz Island. In, *Proceedings of the Sixth California Islands Symposium*, ed. David K. Garcelon and Catherine A. Schwemm, pp. 23-34. Institute for Wildlife Studies, Arcata, California.

Glassow, Michael A., Douglas J. Kennett, James P. Kennett, and Larry R. Wilcoxon
1994 Confirmation of Middle Holocene Ocean Cooling Inferred from Stable Isotopic Analysis of Prehistoric Shells from Santa Cruz Island, California. In, *The Fourth California Islands Symposium: Update on the Status of Resources*, eds. W. Halvorson and G. Maender, pp. 223-232. Santa Barbara Museum of Natural History, Santa Barbara.

Glassow, Michael A., Peter Paige, and Jennifer Perry
2008 *The Punta Arena Site and Early and Middle Holocene Cultural Development on Santa Cruz Island, California.* Santa Barbara Museum of Natural History Contributions in Anthropology (in press).

Glassow, Michael A., Larry R. Wilcoxon, and Jon M. Erlandson
1988 Cultural and Environmental Change during the Early Period of Santa Barbara Channel Prehistory. In, *The Archaeology of Prehistoric Coastlines*, eds. Geoff Bailey and John Parkington, pp. 64-77. Cambridge University Press, Cambridge, UK.

Harrington, J. P.
1928 Exploration of the Burton Mound at Santa Barbara, California. *Forty-fourth Annual Report of the Bureau of American Ethnology 1926-1927*, pp. 23-168. United States Government Printing Office, Washington D.C.

Howard, W. J., and L. Mark Raab
1993 *Olivella* Grooved Rectangle Beads as Evidence of an Early Period Southern Channel Islands Interaction Sphere. *Pacific Coast Archaeological Society Quarterly* 29(3):1-11.

Hubbs, Carl L.
1955 Water, Fish, and Man in Southern California. *Bulletin of the Southern California Academy of Sciences* 54:167-168.

Kennett, Douglas J.
2005 *The Island Chumash: Behavioral Ecology of a Maritime Society*. University of California Press, Berkeley.

Kennett, Douglas J., James P. Kennett, Jon M. Erlandson, and Kevin G. Cannariato
2007 Human Responses to Middle Holocene Climate Change on California's Channel Islands *Quaternary Science Reviews* 26:351-367.

King, Chester D.
1990 *Evolution of Chumash Society: A Comparative Study of Artifacts Used for Social System Maintenance in the Santa Barbara Channel Region Before A.D. 1804*. Garland Publishing, New York.

Orr, Phil C.
1947 Appendix: Additional Bone Artifacts. *Anthropological Records* 9:115-132.
1968 *Prehistory of Santa Rosa Island*. Santa Barbara Museum of Natural History, Santa Barbara.

Pisias, Nicklas G.
1978 Paleoceanography of the Santa Barbara Basin during the Last 8000 Years. *Quaternary Research* 10:366-384.
1979 Model for Paleoceanographic Reconstructions of the California Current during the Last 8,000 Years. *Quaternary Research* 11:373-385.

Rick, Torben C., Jon M. Erlandson, René L. Vellanoweth, and Todd J. Braje
2005 From Pleistocene Mariners to Complex Hunter-Gatherers: The Archaeology of the California Channel Islands. *Journal of World Prehistory* 19:169-228.

Rick, Torben C., John A. Robbins, and Kurt M. Ferguson.
2006 Stable Isotopes from Marine Shells, Ancient Environments, and Human Subsistence on Middle Holocene Santa Rosa Island, California, *U.S.A*. *Journal of Island and Coastal Archaeology* 1(2):233-254.

Rogers, David Banks
1929 *Prehistoric Man of the Santa Barbara Coast*. Santa Barbara Museum of Natural History, Santa Barbara.

Salls, Roy A.
1992 Prehistoric Subsistence Change on California's Channel Islands: Environmental or Cultural. In, *Essays on the Prehistory of Maritime California*, ed. Terry L. Jones, pp. 157-172. Center for Archaeological Research at Davis, California.

Sharp, John T.
2000 Shellfish Analysis from the Punta Arena Site, a Middle Holocene Red Abalone Midden on Santa Cruz Island, California. Master's Thesis, Cultural Resources Management, Sonoma State University, Rohnert Park, California.

Stuiver, M., and P. J. Reimer
2000 Calib 4.3 Radiocarbon Calibration Program 2000. Quaternary Isotope Lab, University of Washington, Seattle.

Vellanoweth, René L.
2001a AMS Radiocarbon Dating and Shell Bead Chronologies: Middle Holocene Exchange and Interaction in Western North America. *Journal of Archaeological Science* 28:941-950.

2001b Coastal Archaeology of Southern California: Accounts from the Holocene. Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.

Vellanoweth, René L., Torben C. Rick, Jon M. Erlandson, and Gnesa Reynolds
2006 A 6,000 Year Old Red Abalone Midden from Otter Point, San Miguel Island, California. *North American Archaeologist* 27(1):69-90.

Wake, Thomas A.
2001 Bone Technology on Santa Cruz Island and Implication for Exchange. In, *Origins of a Pacific Coast Chiefdom*: *The Chumash of the Channel Islands,* edited by J. E. Arnold, pp. 183-197. University of Utah Press, Salt Lake City.

Walker, Phillip L., and Pandora Snethkamp
1984 Archaeological Investigations on San Miguel Island – 1982, Prehistoric Adaptations to the Marine Environment, Vol. 1. Report on file, Central Coast Information Center, University of California, Santa Barbara.