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Lithic Technologies from Late Holocene Anacapa Island, California: Local Reliance on *Anayapax* Chert

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Lithic technologies have been an important part of Native American lifeways on California's Channel Islands for more than 12,000 years. However, little is known about stone tool technologies on Anacapa, the second smallest and closest island to California's mainland. To broaden our understanding of stone tool technologies on the Channel Islands and assess the availability of toolstone on Anacapa, we classified 859 lithic artifacts recovered from three ~3,000-year-old shell middens. Each artifact was classified by material, artifact type, and visually inspected for thermal damage. One hundred and forty three of the larger artifacts were examined using a glossmeter. Our results suggest that prehistoric Anacapa Islanders were heat-treating and using local Anayapax polychromatic green cherts and chalcedony to manufacture a variety of core and flake tools. Some of these cherts may overlap in color and quality with polychromatic cherts documented on eastern Santa Cruz Island, but the polychromatic green cherts appear to have been of local Anacapa origin. Our study sheds light on lithic resource use on Anacapa Island, demonstrates that cherts were available and procured on all the Northern Channel Islands, and adds to the growing challenges of identifying specific sources of chipped stone artifacts.

California's Northern Channel Islands (hereafter NCI: Anacapa, Santa Cruz, Santa Rosa, and San Miguel) have been occupied by humans for at least 13,000 calendar years and have been studied by archaeologists for more than 140 years. A wealth of information has been generated on prehistoric lifeways, environments, ecology, technologies, social complexity, settlement, and resource use on the islands (see Arnold 1987; Braje 2009; Glassow et al. 2010; Kennett 2005; Rick et al. 2005; and others). Throughout the long history of occupation, lithic sources were an important resource used for manufacturing a variety of chipped stone tools. During the Terminal Pleistocene and Early Holocene, Paleocoastal peoples on Santa Rosa and San Miguel islands heat-treated Tuqan, Monterey, Cico, and Wima cherts to manufacture Channel Island Barbed (CIB) and serrated Channel Island Amol (CIA) points, crescents, and expedient chipped stone tools (see Erlandson 2013; Erlandson et al. 1997, 2008, 2011, 2012; Jew and Erlandson 2013; Jew et al. 2013). The importance of formal lithic technologies persisted until the Middle/Late Holocene transition between ~3,500–1,500 cal B.P., after which there is an overall increase in expedient chipped stone tools, partly as a result of increased bone and shell technologies and a diversification in subsistence practices such as fishing (see Rick et al. 2005). After about 1,500 cal B.P., people on the NCI developed a massive microlithic industry with chipped stone microdrills used to perforate shell beads (Arnold 1987; Perry and Jazwa 2010).

The largest chert sources on the NCI are located on Santa Cruz Island (SCRI) and are found primarily on the eastern end along the west slope of El Montañon and at various locations east of the crest (Arnold 1987; Kennett 2005:207–209). At least 26 chert quarries have been identified on Santa Cruz (see Arnold 1987; Perry and Jazwa 2010). SCRI chert is generally translucent and predominantly blonde to light brown in color, but is also found in shades of white and gray (Arnold 1987:97). Because of their relatively high quality, many of these outcrops were quarried to produce Late Holocene microblades (Arnold 1987, 1990). Lower quality cherts have also been identified on eastern SCRI in shades of black, dark and light gray, reddish brown, yellowish brown, yellow, and white that also appear polychromatic or mottled (Perry and Jazwa 2010; Perry, personal communication 2014).

Although Anacapa has seen limited research compared to the other NCI (see Rozaire 1978), recent work has helped build a 5,000-year radiocarbon sequence for the island, provided preliminary subsistence data, and demonstrated that some sites were occupied during all seasons of the year (see Jew and Rick 2014; Reeder and Rick 2009; Rick 2006; Rick et al. 2005). Anacapa is situated ~6 km. east of SCRI and ~20 km. southwest of the California mainland at Port Hueneme. Consequently, many researchers argue that the island's sites may reflect 'stopovers' between Santa Cruz Island and the mainland:

> Seeking shelter from bad weather conditions, obtaining fresh water from low-lying seeps, asphaltum globules washed onto beaches, and fishing may have motivated these voyagers to visit the island. Also, inhabitants of Santa Cruz Island, especially of its eastern end due to proximity, and/or mainlanders may have utilized Anacapa Island for seasonally abundant resources. Territorial rights may have pertained to Anacapa Island, perhaps by people living in the eastern sector of Santa Cruz simply given the proximity. The substantial amounts of chert presumably transported to Anacapa from eastern Santa Cruz supports this possibility [Glassow et al. 2010:2.23].

While some of the sites on Anacapa may represent short trips or seasonal occupations for the later part of the Late Holocene, Anacapa has been occupied for at least 5,200 years (see Rick 2006) and preliminary analyses suggest that the island's sites contain a diverse array of faunal and artifactual constituents. Several sites on Anacapa have produced substantial amounts of chert thought to have originated from Santa Cruz Island (Greenwood 1978; Rozaire 1993), but there have been few studies of Anacapa lithic assemblages to assess the range of lithic materials present or types of technologies. Although Schoenherr et al. (1999) and Rick (2006) noted the presence of chalcedony near Frenchy's Cove on West Anacapa, the island was generally thought to lack siliceous materials suitable for chipped stone tool manufacture.

In this paper, we summarize our analyses of stone tool assemblages from three middens (CA-ANI-2, CA-ANI-3, and CA-ANI-4) located on eastern Anacapa Island that are dated to around 3,000 ± 500 cal B.P. We classified 859 lithic specimens by material and artifact type, visually inspecting each artifact for thermal damage and use-wear. Additionally, 143 cores, expedient tools, and flake debitage were measured using a glossmeter to record maximum gloss values for each artifact. Our analyses of chipped stone tools recovered from the CA-ANI-2, CA-ANI-3, and CA-ANI-4 assemblages help characterize stone tool use on Anacapa and the broader NCI during the Late Holocene. In the process, we provide additional detail on the nature of local polychromatic green chert, which further complicates the identification of chert sources and chipped stone artifacts from the NCI.

ARCHAEOLOGICAL AND ENVIRONMENTAL BACKGROUND

Anacapa is the smallest and eastern-most of the four NCI. The island is comprised of western, central, and eastern segments covering a total area of 2.9 km.[2] (Fig. 1). Anacapa has rugged terrain with steep sea cliffs, cobble beaches, and contains limited terrestrial resources and freshwater when compared to the adjacent mainland and the other Channel Islands (Glassow et al. 2010:2.2–2.3; Rick 2006). Anacapa's geology involves gray basaltic and andesitic rocks, wave-cut terraces and alluvium, and beaches of coarse sand, cobbles, and boulders (see Dibblee and Ehrenspeck 2001). Quartz and basalt are found in elevated and dissected alluvial sediments along the north coast of West Anacapa, central inland Anacapa, and throughout East Anacapa (Dibblee and Ehrenspeck 2001). On Western Anacapa near Frenchy's Cove, green chert and chalcedony sources have been reported exposed in silt and sandstone deposits (see Greenwood 1978; Rick 2006). These toolstone sources are ~5 km. west from the study sites, and because of steep island topography between segments of Anacapa, islanders likely traveled to these sources by watercraft.

There are at least 27 recorded archaeological sites on Anacapa—most are shell middens, lithic scatters, and cave sites. Most of the shell middens are relatively small and shallow, fueling the assertion that Anacapa was only occupied intermittently or seasonally, perhaps by people traveling between the larger islands and the mainland. There are a few larger middens, however, which may represent more permanent or sustained occupations (Greenwood 1978; McKusick 1959; Rick 2006; Rozaire 1978).

From 2003–2006, Rick visited sites on East, Middle, and West Anacapa to collect radiocarbon samples and test three middens on East Anacapa (CA-ANI-2, -3, and

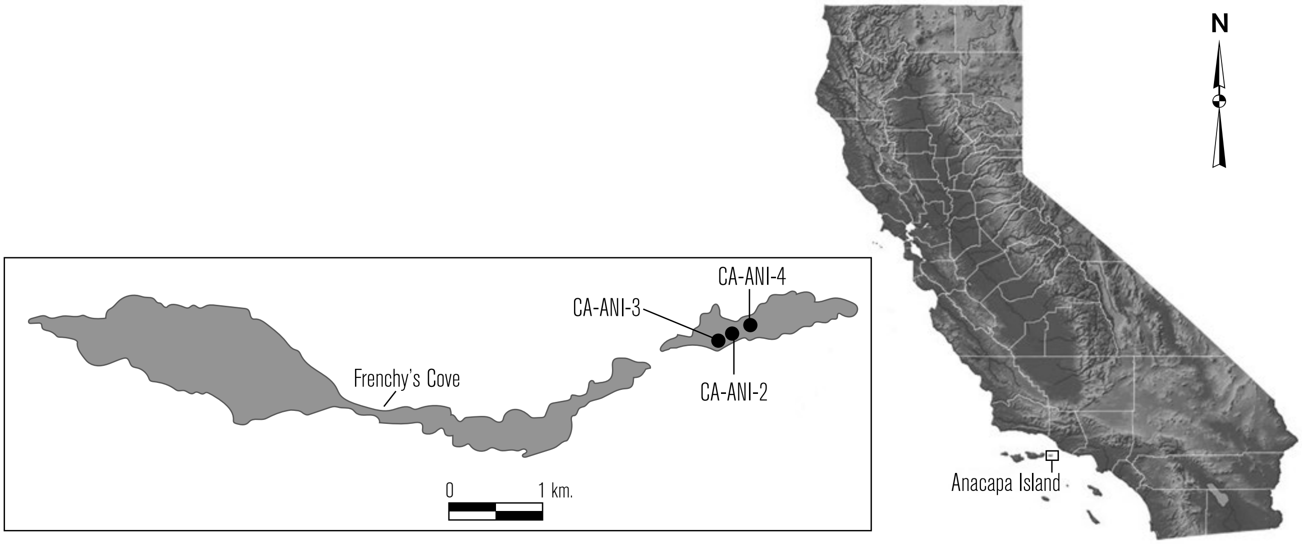

Figure 1. Map of California and Channel Islands including an inset of Anacapa Island and approximate locations of CA-ANI-2, CA-ANI-3, and CA-ANI-4.

Table 1

RADIOCARBON DATES FROM FOUR SITES ON EAST ANACAPA ISLAND, CALIFORNIA

Site	Provenience	Lab Number[a]	Materials	$^{13}C/^{12}C$ Adjusted	Calibrated Age B.P. (1 Sigma)[b]
CA-ANI-1	Probe: ~18 cm. below surface	OS-48488	*M. californianus*	3,820 ± 30	3,495–3,390
CA-ANI-2	Unit 2, ~34 cm. below surface, bottom of unit	OS-63565	*M. californianus*	3,280 ± 35	2,825–2,740
CA-ANI-2	Probe: 38–40 cm. below surface	OS-48508	*M. californianus*	3,310 ± 35	2,850–2,760
CA-ANI-2	Unit 1, 2–5 cm. below surface, top of unit	OS-60407	*H. cracherodii*	3,330 ± 25	2,870–2,780
CA-ANI-2	Unit 1, 52–53 cm. below surface, bottom of unit	OS-60632	*M. californianus*	3,560 ± 30	3,195–3,075
CA-ANI-3	Bulk sample, bottom	DAMS-3996	Marine shell	3,575 ± 34	3,225–3,090
CA-ANI-3	Sea cliff, bulk sample 1, 15–20 cm. below surface of ~20 cm. thick midden	OS-63566	*M. californianus*	3,580 ± 30	3,225–3,105
CA-ANI-4	Unit 1 top	DAMS-3994	Marine shell	3,103 ± 37	2,690–2,540
CA-ANI-4	Unit 1 bottom	DAMS-3995	Marine shell	3,948 ± 27	3,650–3,550
CA-ANI-4	Probe: 25–28 cm. below surface	OS-48509	*M. californianus*	3,530 ± 30	3,160–3,035

[a]OS=Woods Hole National Ocean Sciences AMS Facility; D-AMS=Direct AMS.

[b]All dates were calibrated using Calib 7.0 (Stuiver and Reimer 1993; Stuiver et al. 2005) and applying a ΔR of 261±21, see Jazwa et al. 2012. $^{13}C/^{12}C$ ratios were determined by the radiocarbon labs.

-4, Table 1). Prior to this research, the last formal survey of the island was conducted in the 1970s by Greenwood (1978). Relatively little has been published on the archaeology of Anacapa (Glassow et al. 2010; Jew and Rick 2014; McKusick 1959; Reeder and Rick 2009; Rick 2006, 2011; Rozaire 1993) and there is still a great deal that we do not know about Anacapa's prehistoric peoples. Here we focus on lithic assemblages from the three sites on East Anacapa excavated by Rick.

CA-ANI-2 is situated on a knoll on East Anacapa and contains a dense midden covering an area of approximately 24 × 30 m. (Greenwood 1978; Rick 2006). In 2006, Rick excavated two 1.0 × 1.0 m. test units and two 25 × 25 cm. column samples in midden deposits ~50 cm. thick, which produced a diverse faunal and lithic assemblage. Four calibrated AMS ^{14}C dates on well-preserved marine shells from the midden suggest that it was occupied between about 3,200 and 2,750 cal

B.P. Faunal remains include California mussel (*Mytilus californianus*), black abalone (*Haliotis cracherodii*), owl limpet (*Lottia gigantea*), and other rocky shore shellfish, fish, marine mammals, and birds (Reeder and Rick 2009). Based on a preliminary assessment of 201 chipped stone artifacts recovered from Unit 1, it was hypothesized that lithic materials were most likely procured locally from deposits exposed on the island's sea cliffs (Reeder and Rick 2009:121). Over 400 additional lithic artifacts have been recovered from a recent excavation of a second unit at the site and are included in this study, along with a more detailed analysis of the materials from units 1 and 2.

CA-ANI-3 is located west of CA-ANI-2 and is a small 15 × 10 m. shell midden. The site is well vegetated, but the recovery of a bullet casing during excavations suggests that the site has been disturbed, though portions of the deposit may be intact. In 2006, two 50-liter bulk samples were recovered from the densest portion of midden. Two ^{14}C dates on marine shells produced nearly identical calibrated age ranges of ~3,200–3,100 cal B.P. (Table 1).

CA-ANI-4 is located on a small knoll near the midpoint of East Anacapa and contains a lithic component and shell midden approximately 14 × 17 m. wide and 46 cm. deep (Greenwood 1978; Rick 2006). Greenwood (1978) identified several lithic artifacts, including a possible quartzite knife and a sandstone pebble tool. The site has been badly disturbed by historical land use, with bricks and other historic materials reincorporated in the shell midden. In 2006, Rick excavated a 0.5 × 1.0 m. unit from a greater than 30 cm. thick midden deposit. Despite disturbances, radiocarbon dates (Table 1) suggest a range of occupation spanning ~1,100 years between about 3,650 and 2,550 cal B.P. Preliminary assessment of the faunal remains suggests that California mussels dominated the assemblage, with evidence of black abalone, owl limpets, and fish and bird bones (Rick 2006:68).

ANALYTICAL METHODS

For this study, 859 chipped stone artifacts from three assemblages were classified by material and artifact type. We examined 667 chipped stone artifacts from CA-ANI-2 units 1 and 2 and column samples, 43 artifacts from two 50-liter bulk samples from CA-ANI-3, and 144 artifacts from Unit 1 at CA-ANI-4. Because the assemblages only produced a single microblade fragment and no other diagnostic tools, artifacts were assigned to four major categories: cores/core tools, hammerstones, expedient tools, and debitage. Cores and core fragments include large stones with cortex and flakes scars, and core tools containing evidence of edge damage, retouch, or battering/smashing. Hammerstones are water-worn cobbles with evidence of battering, crushing, or edge damage. Expedient tools include crude macrodrills or punches, scrapers, and/or flakes that exhibit retouching or edge damage resulting from possible tool use. Debitage consists of waste flakes, shatter, and other chipped stone debris. Except for shatter and debris, all artifacts were inspected under a low-powered (10×) high-resolution microscope to identify evidence of retouch, edge damage, or other signs of possible use-wear.

A preliminary inspection of lithic materials showed that assemblages were dominated by two chert types: (1) a chalcedony (Anacapa Chert), likely obtained from deposits at Frenchy's Cove, and (2) *Anayapax* polychromatic (multicolored) green chert. Anacapa Chert is a translucent microcrystalline chalcedony similar to the Cico cherts found on San Miguel and some SCRI cherts (Erlandson et al. 1997; Rick 2006). Both Anacapa cherts are newly discovered varieties that have only been documented in these assemblages. Based on cores found in Anacapa assemblages containing substantial amounts of cortex, polychromatic chert, particularly the green variant, appears to be common in beach-cobble form. Polychromatic chert is a general classification for low mid-grade quality cherts which are similar in composition and mixed grain sizes (fine/medium), but display multiple colors, including green, tan-brown, black, red, and gray (Table 2). These colors are intermixed, often overlapping and presenting a mottled or swirled appearance (Fig. 2). Polychromatic cherts are found in Anacapa assemblages and outcrops but have a significant overlap in color and quality with cherts on eastern SCRI (Perry, personal communication 2014; Perry and Jazwa 2010), although the green variety has only been documented in Anacapa assemblages. For our study, polychromatic chert artifacts are classified by the dominant color (>60–70%). Some of these colors strongly resemble the reds, greens, and yellows found

Table 2

MUNSELL COLOR DESCRIPTIONS FOR *ANAYAPAX* POLYCHROMATIC CHERT ARTIFACTS FROM CA-ANI-2 AND CA-ANI-4 SHOWING THE DIVERSITY AND RANGE OF COLOR VALUES

	Munsell Color Values		
Artifact ID	Primary	Secondary	Tertiary
CA-ANI-2-49a	7.5YR 3/3 dusky red	*G[a]1 3/1 5G very dark greenish gray*[b]	G1 2.5N black
CA-ANI-2-679	*G2 2.5 10G greenish black*	10YR 7/4 very pale brown	G1 2.5N black
CA-ANI-2-43-1	*G1 5/1 5G greenish gray*	2.5Y 2.5/1 black	10YR 6/6 brownish yellow
CA-ANI-2-43-2	5Y 2.5/1 black	7.5YR 3/3 dusky red	G1 8/1 N white
CA-ANI-2-43-3	7.5R 5/6 red	*G2 2.5/1 5BG greenish black*	G1 2.5N black
CA-ANI-2-669-1	*G1 5/2 5G grayish green*	*G1 3/2 5G very dark grayish green*	*G1 2.5 5GY greenish black*
CA-ANI-2-669-2	*G1 6/2 5G pale green*	*G1 2.5/1 10GY greenish black*	*G1 4/1 5GY dark greenish gray*
CA-ANI-2-669-3	10YR 7/8 yellow	10YR 4/3 brown	*G1 4/2 5G grayish green*
CA-ANI-2-669-4	10YR 6/1 gray	2.5Y 4/1 dark gray	2.5Y 5/6 light olive brown
CA-ANI-2-676	*G1 2.5/1 5G greenish black*	2.5Y 5/6 light olive brown	5Y 7/1 light gray
CA-ANI-2-671a	10YR 5/8 yellowish brown	*G1 4/2 grayish green*	*G2 2.5/1 10G greenish black*
CA-ANI-2-671b	7.5YR 7/1 light gray	*G1 4/1 5GY dark greenish gray*	10YR 7/6 yellow
CA-ANI-4-10-1	*G1 4/2 5G grayish green*	*G1 3/2 5G very dark grayish green*	G1 2.5N black
CA-ANI-4-10-2	10YR 5/2 grayish brown	G1 6/N gray	7.5YR 8/1 white
CA-ANI-4-10-3	10YR 6/6 brownish yellow	*G1 3/2 5G very dark grayish green*	10YR 4/3 brown
CA-ANI-4-10-4	G1 2.5N black	7.5YR 3/3 dusky red	*G1 2.5/1 5GY greenish black*
CA-ANI-4-10-5	G1 2.5N black	10YR 6/4 light yellowish brown	7.5YR 6/1 gray
CA-ANI-4-25	G1 2.5N black	7.5YR 3/3 dusky red	G1 8/1 N white
CA-ANI-4-40	*G2 2.5/1 10G greenish black*	7.5YR 8/1 white	10YR 6/2 light brownish gray
CA-ANI-4-41	7.5YR 4/2 brown	10YR 7/4 very pale brown	*G1 3/2 5G very dark grayish green*
CA-ANI-4-42	G1 2.5N black	*G1 4/2 5G grayish green*	5YR 4/4 reddish brown
CA-ANI-4-43	5Y 2.5/1 black	7.5YR 8/1 white	7.5YR 4/4 brown
CA-ANI-4-44	*G1 4/2 5G grayish green*	*G1 3/2 5G very dark grayish green*	G1 2.5N black

[a]G is abbreviation for gley in the Munsell system.
[b]Italicized colors show the variability in the polychromatic green chert variety.

in Franciscan chert, and (in our opinion) small artifacts lacking the chalcedonic matrix could easily be mistaken for Franciscan chert or possibly cherts from SCRI.

One method used to improve the overall quality and knappability of low mid-grade chert for stone tool manufacture is through heat-treatment, also referred to as thermal alteration or annealing (Crabtree and Butler 1964; Mercieca and Hiscock 2008). To determine whether the Anacapa lithics were heat-treated, each artifact was visually inspected under a low-powered microscope (10×) for thermal damage such as pot-lids, thermal fracturing, or heat crazing, and 143 artifacts (x>15 mm.) were scanned using an ETB-0686 glossmeter to measure maximum gloss values, which are then reported in standard gloss units (GU). In an adaptation from previous studies (e.g., Brown et al. 2009; Jew and Erlandson 2013), maximum gloss values for artifacts were compared to a 2.3 GU value—which is the mean threshold for Monterey and other island cherts that is used to distinguish between potentially heated, unheated, and heated and flaked materials. Jew and Erlandson (2013) conducted experimental thermal treatment of several island cherts and found statistically significant differences between non-heated and heated gloss values. Artifacts selected for glossmeter analysis from CA-ANI-2 included cores (n=29), expedient tools (n=50), and flake debitage (n=21). For CA-ANI-4, 43 artifacts were measured for maximum gloss values including cores (n=9), expedient tools (n=9), and flake debitage (n=25). Artifact gloss values were plotted by site and compared to the mean threshold for heated and unheated island cherts.

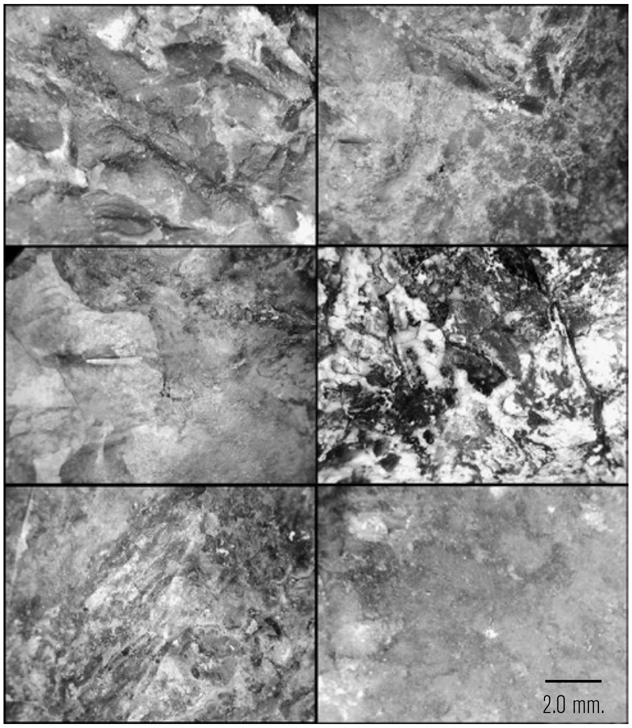

Figure 2. ***Anayapax*** **polychromatic chert cores from CA-ANI-2 illustrating overlap variation in texture qualities (field of view 10×, images by N. Jew).**

RESULTS

Artifact Types

All assemblages contained a high frequency of debitage and to a lesser extent cores and expedient flake tools (Table 3). Except for one SCRI chert microblade, there were no other bifacial or formal tools. The CA-ANI-2 lithic assemblage contained mostly debitage or waste flakes (n=518) with a variety of artifacts, including cores, core fragments, and core tools (n=77), basalt hammerstones (n=4), and expediently flaked chipped stone tools (n=68) such as crudely shaped macrodrills/boring, or macro-punch (n=14), retouched and/or utilized flakes (n=48), and winged flake tools (n=6). Most of the expedient macrodrills and flake scrapers (Fig. 3) are relatively small and retouched, and several of the artifacts have further evidence of edge damage (grinding or serration) along the flake margin. Winged chipped stone tools were initially classified as expedient tools, but their shape suggests that they may have been systematically, if crudely, manufactured (Fig. 4). Winged chipped stone tools are defined here as relatively flat flake tools with a wing-like flaked margin along one side; a few have a small notch right before the base ends in a point. The other side of the flake is relatively straight and terminates in a point. These flake artifacts vary in size from relatively large (50 × 70 mm.) to small (10 × 20 mm.).

Table 3

THE FREQUENCY AND DISTRIBUTION OF ANACAPA LITHIC ARTIFACTS CATEGORIZED BY SITE, MATERIAL,[a] AND ARTIFACT TYPE

Material Type	Debitage	Cores	Flake Tools	Hammerstones	Total Count
CA-ANI-2					
Anacapa chalcedonic	65	6	20	–	91
Gray chert	27	13	2	–	42
Black chert	131	12	10	–	153
Green chert	167	16	16	–	199
Brown/tan chert	53	6	13	–	72
Red chert	66	20	3	–	89
Basalt	–	–	–	4	4
Quartzite	1	4	2	–	7
Misc. materials	8	–	2	–	10
ANI-2 subtotal	**518**	**77**	**68**	**4**	**667**
CA-ANI-3					
Anacapa chalcedonic	14	–	3	–	17
Gray chert	1	–	–	–	1
Black chert	4	1	1	–	6
Green chert	8	–	–	–	8
Brown/tan chert	1	–	–	–	1
Red chert	3	–	1	–	4
SCRI chert		–	1	–	1
Basalt	1	–	–	–	1
Quartzite	2	–	–	–	2
Misc. materials	2	–	–	–	2
ANI-3 subtotal	**36**	**1**	**6**	**–**	**43**
CA-ANI-4					
Anacapa Chalcedonic	22	3	7	–	32
Gray chert	28	–	4	–	32
Black chert	4	–	1	–	7
Green chert	30	2	1	–	33
Brown/tan chert	6	3	4	–	13
Red chert	12	1	3	–	16
Basalt	2	–	–	–	2
Shale	–	–	2	–	2
Obsidian	–	–	1	–	1
Misc. materials	13	–	–	–	13
ANI-4 subtotal	**117**	**9**	**23**	**–**	**149**
Grand total	**671**	**87**	**97**	**4**	**859**

[a]Italicized cherts are included in the polychromatic chert totals and represent the dominant color.

CA-ANI-3 produced a large amount of debitage (n=36) considering the small size of the bulk samples.

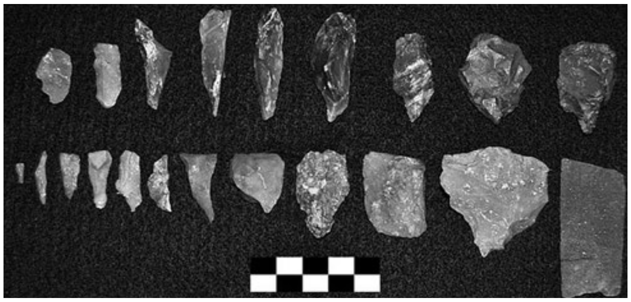

Figure 3. Example of expedient chipped stone tools from CA-ANI-2 (top row) and CA-ANI-4 (bottom row) including flake scrapers, drills, and a microblade fragment from CA-ANI-3 (far left). Scale is in cm. (Photo by N. Jew.)

This included one SCRI chert microblade fragment, four thin retouched flakes with edge damage along the margins, one possible winged flake tool with a small side notch (Fig. 4), and a single core fragment with substantial edge damage along one side. Although this is the smallest of the lithic assemblages, the diagnostic tool recovered from the two small bulk samples suggests that additional excavation would likely produce more formal tools.

Chipped stone tools at CA-ANI-4 include a large amount of debitage (n=117), followed by expedient tools (n=23) and cores, core fragments, and/or core tools (n=9). The expedient tools consist of thin drills (n=6), retouched flakes with evidence of use-wear (n=11), and winged flake tools (n=6) varying in size from 50×30 mm. to 25×20 mm. CA-ANI-4 was the only assemblage that included a small obsidian flake that was retouched and used along multiple margins.

Lithic Material Types

Overall, polychromatic green chert and Anacapa chalcedony are the most common material types found in the assemblages (Table 3). Lithic materials from CA-ANI-2 are dominated by polychromatic chert (n=555, 83%), followed by Anacapa chalcedony (n=91, 14%), and smaller amounts of basalt, quartzite, and miscellaneous stone too small to identify. Polychromatic chert includes all five color varieties, with the majority of artifacts being green (n=199, 30%) and black (n=153, 23%). Several cores (n=67) contain multi-colored combinations of greens, reds, grays, yellows, and browns, while some of the smaller artifacts only had a single color.

The polychromatic chert colors, textures, and overall low mid-grade qualities for CA-ANI-3 and -4 are similar to those described for CA-ANI-2. For CA-ANI-3, polychromatic chert (n=20, 46%) included green variants that made up 40% (n=8) of the polychromatic material, followed by Anacapa chalcedony (n=17, 40%) and lesser amounts of basalt and quartzite. For CA-ANI-3, the polychromatic chert includes color blending of green (n=8, 40%), black (n=6, 30%), and red (n=4, 20%). CA-ANI-4 lithics are also dominated by polychromatic chert (n=99, 66%) including color combinations which contain green (n=33, 33%), gray (n=32, 32%), and red (n=16, 16%). Similar to the other assemblages, Anacapa chalcedony (n=32, 21%) is the next most common material followed by much smaller amounts of miscellaneous types. For all assemblages, exotic lithic materials include one small retouched obsidian flake and a SCRI chert microblade fragment.

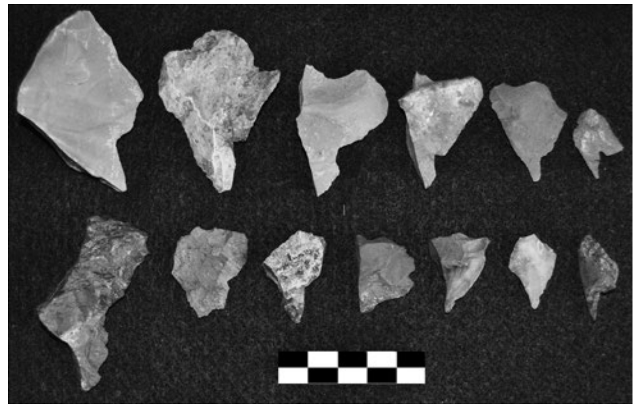

Figure 4. Expedient chipped stone winged flake artifacts and fragments from CA-ANI-2 (top row), CA-ANI-4 (bottom row), and CA-ANI-3 (bottom right artifact). Scale is in cm. (Photo by N. Jew.)

Lithic Heat-Treatment

Almost 50% of all artifacts show evidence of either heat damage (Fig. 5) or contain maximum gloss values typical of heat-treated cherts (Fig. 6; see Jew and Erlandson 2013). The range of gloss values (0.3 to 5.5 GU) above and below the estimated mean threshold of 2.3 GU suggests that artifacts were either heated and flaked or not heat-treated. For CA-ANI-2, 12 (16%) out of 77 cores, core-fragments, and core-tools show evidence of heat fractures, pot-lids and/or crazing. At least 18 (62%) of the 29 measured cores contained gloss values above 2.3 GU, suggesting that a majority of the cores were heated and flaked. Seven (33%) of the 23 pieces of

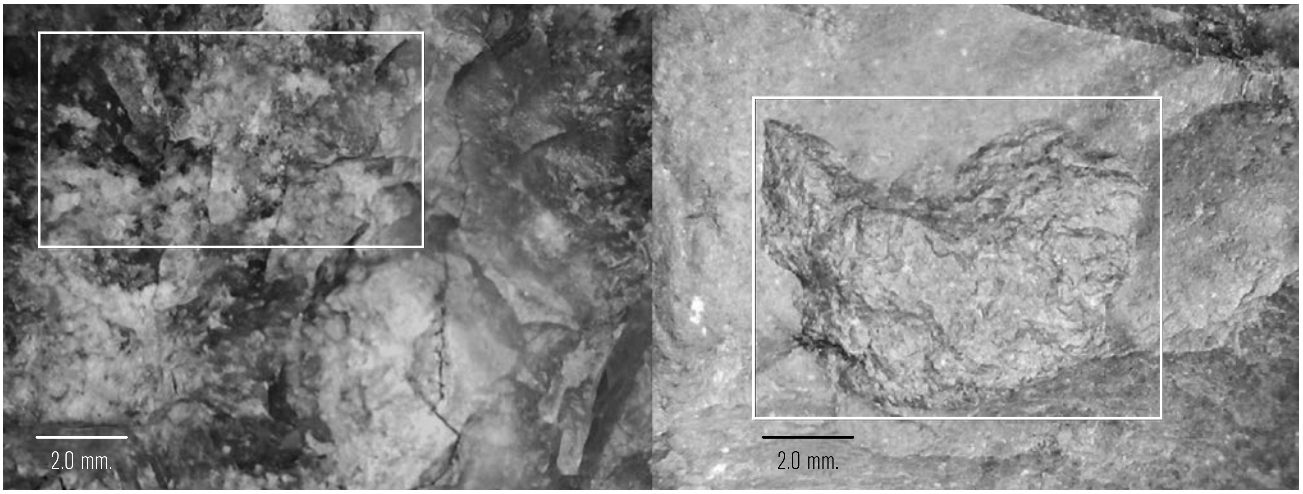

Figure 5. Example of thermal damage (field of view 10×) including heat crazing on artifact CA-ANI-2#667 (Anacapa chert) and a thermal pot-lid on CA-ANI-2#43b (polychromatic black, red, and gray chert). The outlines illustrate areas of thermal damage. (Images by N. Jew.)

measured debitage had high gloss values ($x>2.3$ GU), and 62 (12%) of the 518 pieces of debitage contained thermal fractures, pot-lids, fissures, or heat crazing. For expedient tools, 22 (44%) of the 50 measured artifacts had gloss values above the mean threshold and only six (9%) of the 68 expedient tools contained evidence of thermal damage, usually in the form of pot-lids.

There are relatively high proportions of heat-treated artifacts at CA-ANI-4. One hundred of the larger artifacts were inspected for thermal damage and 24 (24%) possessed pot-lids, thermal fissures, or heat crazing. Gloss analyses for 43 of the larger artifacts produced GU values ranging between 0.8–6.2 GU (Fig. 6). Seven (78%) out of nine cores had gloss values above 2.3 GU and 10 (56%) out of the 18 measured expedient tools had gloss values above the threshold. Ten (63%) out of the 16 measured pieces of debitage had relatively high values, suggesting that most of the debitage was heat-treated.

The variation in gloss values for both assemblages suggests that at least some of the cores and expedient tools were thermally altered, probably to improve knappability of the low mid-grade chert materials. The range of gloss values, including several below 1.0 GU, demonstrates that some lithics were not heat-treated, while others with relatively high values were both heated and flaked. Artifacts recovered from the same strata have physical characteristics of thermal damage (unsuccessful application of annealing) while others show no evidence of heat treatment, suggesting that thermal alteration of these artifacts was probably intentional rather than incidental (i.e., from wildfires). This assessment is further supported by analysis of large quantities of unburned shell recovered from the same strata for CA-ANI-2 (see Reeder and Rick 2009).

DISCUSSION AND CONCLUSIONS

Little is known about lithic technologies on the NCI during the early Late Holocene, due largely to limited research and an abundance of expedient tools in those assemblages (Rick et al. 2005:209). Our study of Anacapa lithic assemblages revealed that most tools are expedient and formal tools are rare, similar to many other early Late Holocene NCI sites. Anacapa assemblages contain core tools, hammerstones, scrapers, and crude punch/boring tools; however, the winged flake tools may have been more systematically (albeit crudely) manufactured. At least twenty-five bone tools, including gorges and barbs, have been recovered from CA-ANI-2, along with shellfish, finfish, and sheephead remains (see Reeder and Rick 2009), raising the possibility that some of the stone artifacts may have been associated with processing fish or shellfish. Because these sites predate the development of the intensive NCI microblade industry (see Arnold 1987), it is not surprising that microblade technologies are rare in these assemblages. Microblades and bladelet drills made from SCRI chert have been identified in later assemblages at ANI-6 and ANI-8 (see Rozaire 1993).

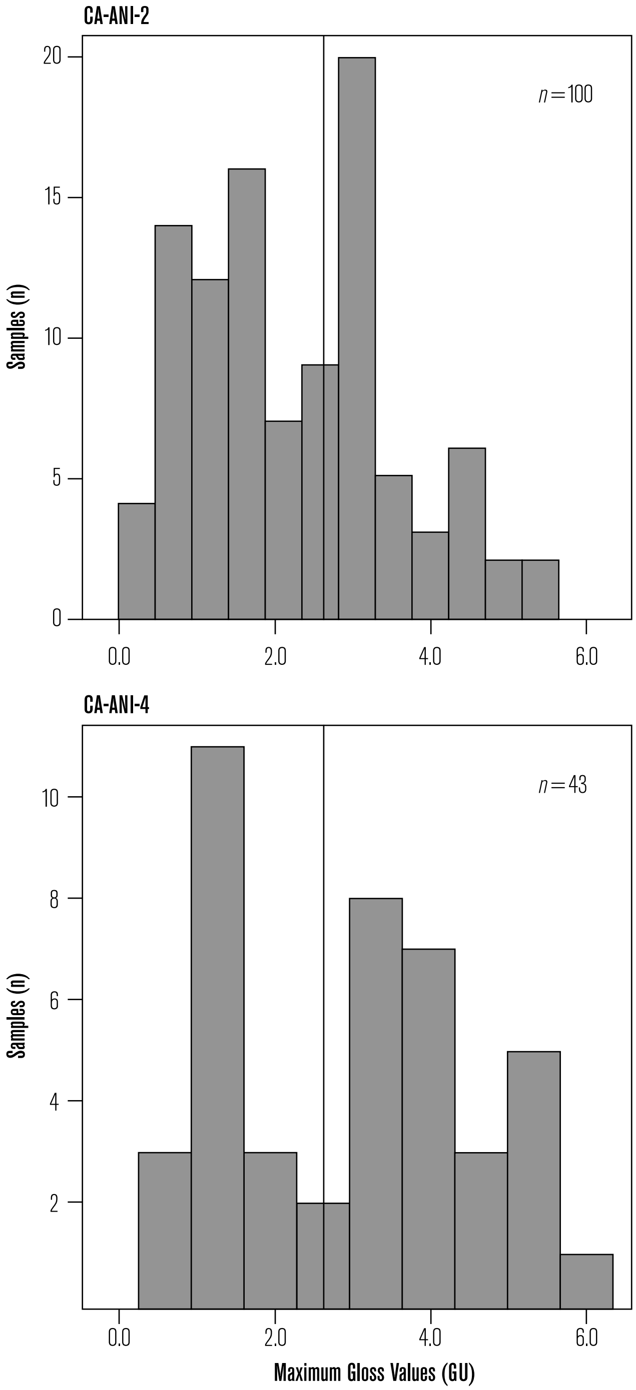

Figure 6. Maximum gloss values (GU) for CA-ANI-2 and CA-ANI-4. The x-axis line represents the maximum gloss value threshold (2.3 GU) for heated (above) and unheated (below) NCI cherts (after Jew and Erlandson 2013).

Our results suggest that people on East Anacapa used a variety of island lithic materials, primarily polychromatic green chert and to a lesser extent Anacapa chalcedony, basalt, and quartzite. Survey in 2013 by Rick identified a ~20 cm. thick vein of green chert located near Frenchy's Cove on West Anacapa that is similar in color and composition to that of some of the artifacts found at CA-ANI-2, -3, and -4. In addition to known Anacapa chalcedonic sources (see Greenwood 1978; Rick 2006) in the same area, the large number of cores and core tools, debitage, and overall lower quality of polychromatic green chert suggests that some chert is locally accessible—most likely in the form of cobbles/nodules from raised and modern beaches, or in veins embedded in volcanic conglomerates. It is possible that these nodules are eroding out of sea cliffs or are found in raised beach deposits on Eastern Anacapa in tuffaceous sandstone/siltstone areas or in the basaltic/andesitic flows which comprise the majority of Eastern Anacapa's coastline (see Dibblee and Ehrenspeck 2001). Polychromatic chert devoid of green may have been locally procured or brought over from eastern SCRI, since polychromatic SCRI cherts (see Perry and Jazwa 2010) seem to overlap with some of the cherts identified in our Anacapa assemblages. Further investigations and systematic survey of Anacapa, SCRI, and other Channel Islands are required to better understand the nature, distribution, and exploitation of polychromatic green chert from Anacapa Island and also from other source locations. On eastern San Miguel Island near Challenge Point, for instance, a variant of Cico chert with distinct feathering inclusions near the cortical margins appears to be a visual marker exclusive to outcrops near Challenge Point (Jew and Erlandson 2014). Depending on the number of sources available, the unique coloration in mottled and swirled patterns may be a visual marker for polychromatic cherts, making sources easier to identify.

Except for one SCRI chert microblade and an obsidian flake tool, the majority of the materials of the chipped stone artifacts examined from these ~3,000-year-old Anacapa Island assemblages (e.g., polychromatic green chert and Anacapa chalcedony) may be of local origin. Other polychromatic cherts devoid of green coloration (i.e., black, gray, reds, and yellow variants) may have been imported from SCRI, but at least 28% of the chipped stone artifacts and 35% of polychromatic cherts contain green as a primary color. We also cannot rule out the possibility that some of the very small red or green flakes may have been obtained from Franciscan chert sources on the mainland. Given the overall low quality of most of the chert identified in the Anacapa assemblages, we suspect that much of it is of island origin (either ANI or SCRI), but further testing and analysis is needed to support this interpretation. For now, we can say with confidence that cherts of toolstone quality were available and utilized on all of the Northern Channel Islands.

In addition to the polychromatic green chert and chalcedony identified in the Anacapa assemblages, the high proportion of artifacts with heat treatment is an important discovery that may help explain the selection of these lower quality materials. Based on the percentage of artifacts with evidence of heat damage or high gloss values, heat-treatment was likely employed to improve the quality and knappability of local cherts for toolstone production. Similar heat-treatment strategies have been documented for Terminal Pleistocene and Early Holocene lithic assemblages on San Miguel and Santa Rosa islands, which were also composed predominantly of local island toolstones (see Jew and Erlandson 2013). While some of the heat damage found in NCI chipped stone assemblages may have been incidental, it is likely that most was the result of intentional annealing.

It remains unclear if Anacapa Island served primarily or exclusively as a stopover for people traveling between the larger Channel Islands and the mainland, or if at times the island contained more sustained occupations. Our data suggest that ~3,000 years ago on eastern Anacapa Island people relied on local polychromatic green chert and Anacapa chalcedony—and perhaps some other polychromatic cherts from SCRI—for stone tool manufacture. Current research suggests that people on Anacapa Island were engaged in a range of activities during the early Late Holocene, including the intensive harvesting of shellfish, seabirds, fishes, and marine mammals, as well as the production of bone and stone tools. Stable oxygen isotope analyses of California mussels demonstrate that shellfish were collected in a variety of water temperatures, suggesting shellfish harvesting at CA-ANI-2 during all seasons of the year (Jew and Rick 2014). Further excavations and examinations of Anacapa assemblages are required to better understand the range of activities, extent of occupations, and intensity of resource use. However, current research is demonstrating that Anacapa contained a more complex history of human occupation than previously believed. Given overlap in assemblages and technologies in early Late Holocene sites on SCRI (see Perry and Delaney-Rivera 2011) and the presence of significant quantities of deer bone (primarily metapodials and other elements for making bone tools) from the mainland at CA-ANI-2, it is reasonable to assume that some Anacapa sites were an extension of the seasonal rounds of people based on Santa Cruz Island or the mainland. To gain a true regional synthesis, all of the islands, including Anacapa, must be thoroughly assessed and investigated before archaeologists can fully understand regional cultural trajectories, change, or complexity on California's Northern Channel Islands.

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