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Intensified Middle Period Ground Stone Production on San Miguel Island

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Specialized shell bead manufacture is a defining characteristic of Late Period (A.D. 1300 to 1782) Chumash society. While bead manufacturing has been well studied, other items of economic importance have received less attention by archaeologists. This report is a discussion of a quarry and associated habitation site (CA-SMI-503/504) on San Miguel Island, where mortar and pestle manu-

facture took place. The data show that production was centered at the quarry site while 16 other sites in the region show some evidence of manufacture. Radiocarbon dates place intensified production to the later part of the Middle Period (A.D. 580 to 980). It is suggested that the manufacture of mortars and pestles at this time was conducted by part-time, community-based specialists.

CRAFT specialization and economic interaction were prominent features of Chumash society during late prehistory. Centered in the Santa Barbara Channel region, Chumash territory included the northern Channel Islands of Anacapa, Santa Cruz, and Santa Rosa, as well as the westernmost island, San Miguel (Fig. 1). Specialization and trade were particularly important in linking the Island Chumash with people on the mainland. During the Late Period (A.D. 1300 to 1782), people on the islands specialized in the manufacture of shell beads, lived in fairly large and settled villages, and leaders were selected through inherited status (King 1969; Blackburn 1975; Martz 1984; Arnold 1987, 1992). Prior to the Late Period, during the Middle to Late period transition (beginning ca. A.D. 1150), craft specialization is thought to have fully developed and intensified in the region (Arnold 1987, 1990, 1992). At this time, shell bead production changed from a widely practiced, unspecialized endeavor to intensified, specialized manufacture at a few sites on Santa Cruz and Santa Rosa islands (Arnold 1987, 1991; Arnold and Munns 1994).

While specialized bead manufacture during the Late Period has been identified and well studied, other activities of economic importance (especially those from earlier time periods) have received less attention. The lack of information on production activities and specialization in earlier time periods instigated this research into ground stone production on San Miguel Island. A ground stone quarry and manufacturing site was identified previously on the island (Rozaire 1983; Walker and Snethkamp 1984) and there were indications that mortar and pestle production was concentrated during the Middle Period (490 B.C. to A.D. 1150). This suggested that specialization in some industries occurred earlier than the Middle to Late period transition in the Santa Barbara Channel region.

The goal of this project was to investigate the type of ground stone production on San Miguel Island, establish when production occurred and intensified, and develop models about how ground stone production fit into the broader context of the development of Chumash trade and regional integration. This goal was achieved by visiting the quarry site and compiling all of the site records for San Miguel Island in order to determine patterns of ground stone use and production on the island. In addition, the manufacturing debitage from the prior column samples was reanalyzed and the earlier radiocarbon dates were calibrated.

GROUND STONE USE IN THE SANTA BARBARA CHANNEL REGION

Changes in ground stone forms through prehistory are thought to correlate with changes in subsistence strategies. In the Santa Barbara Channel region, ground stone tools followed a general evolutionary trend from roughly made grinding slabs to finely shaped mortars (Glassow 1996a). The first types of ground stone used in the area were the metate (or grinding slab) and the mano. These tools were prominent elements of the mainland tool assemblage during the Early Period from 8,000 to 6,500 B.P. and were presumably used for milling seeds (Erlandson 1994; Glassow 1996a). During this period, there is good evidence of occupation on the Channel Islands (Erlandson 1994); however, manos and metates are relatively rare at sites on the islands, probably because there were fewer seed-bearing plants. Instead of milling implements, weights for digging sticks are a dominant artifact found on the islands during the Early Period, which

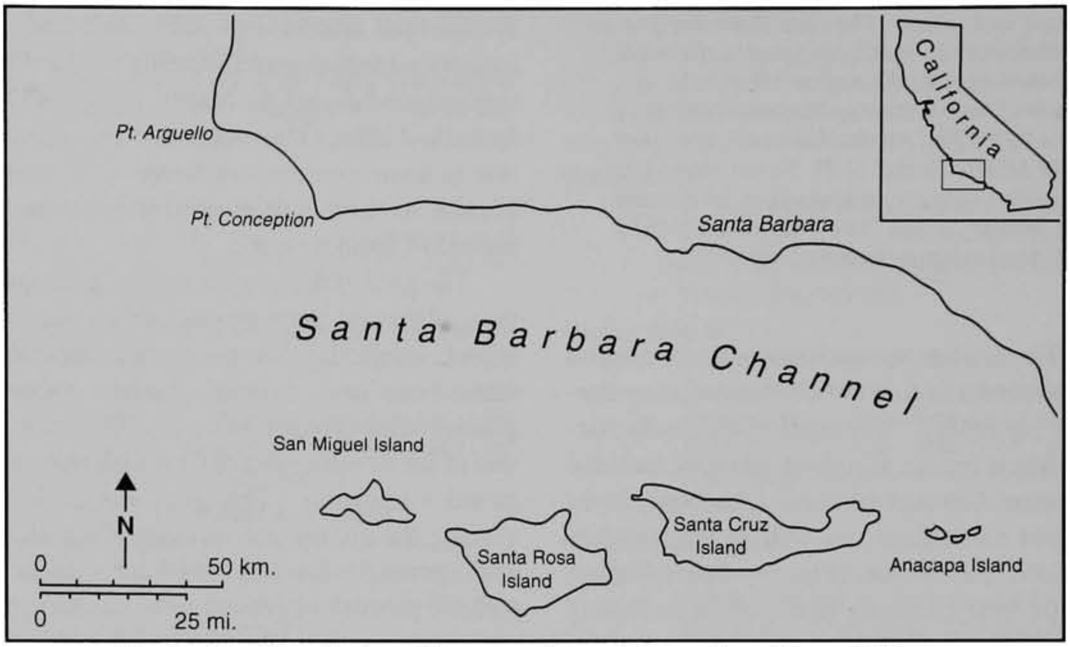

Fig. 1. The Santa Barbara Channel region and the northern Channel Islands.

were presumably used for digging bulbs and tubers (Glassow 1996a).

Ethnographic accounts indicate that manos and metates were used for processing small, hard seeds, while mortars and pestles were used for more pulpy foods like acorns (Kroeber 1925; Gifford 1936; Driver and Massey 1957; Baumhoff 1963; Basgall 1987; Glassow 1996a). At the time of Spanish contact, the Chumash, like many other groups, used mortars and pestles primarily to mill acorns into flour. However, mortars and pestles can be used to process a variety of materials, including seeds, nuts, roots, grasses, fruit, rodents, fish, shellfish, and pigment (King 1967; Yohe et al. 1991; Schneider 1993a; Glassow 1996b; Schroth 1996). Nevertheless, mortars and pestles are most closely associated with acorns, and large quantities of these tools at a site are used as an indication that acorns were an important food source (Basgall 1987).

At ca. 5,000 B.P., unshaped mortars and pestles first appeared on the mainland, perhaps signaling a change in subsistence patterns. Possibly it was at this time that acorns became part of the diet, or it may be that mortars and pestles were used to process something else, such as roots (Glassow 1996b). At about 4,000 B.P., globular-shaped mortars were being manufactured, after which time metates and manos became rare at coastal sites. Also around this time, the basket hopper mortar—a form that is often associated with acorn milling—came into use (Glassow 1996b). The last distinct type of ground stone that has been observed in the archaeological record of the Santa Barbara Channel is the flowerpot mortar that was first used around 1,500 B.P. in the Middle Period and continued to be used until the historical period. However, as this ground stone chronology is based on mainland data, there are undoubtedly differences in the development and use of ground stone on the islands, especially since the plant and animal resources there were significantly different.

Ground stone tools were important utilitarian goods to the people of the Santa Barbara Channel region, but their role in exchange in less well known. By the historical period, trade was frequent and well developed in the Chumash region.

In general, people on the islands exported manufactured goods to individuals on the mainland in exchange for food supplies (King 1976; Glassow 1980; Arnold 1987, 1990). Islanders exported beads, digging-stick weights, and otter skins in exchange for acorns, seeds, roots, chia, bows and arrows, and large baskets (Schumacher 1879; Heizer 1955; Brown 1967; King 1976). Despite the evidence for frequent and intensive trade between the islands and the mainland, ground stone is not something that is easily transported. However, there are historical reports of ollas, presumably of steatite, being brought in large loads from the Santa Barbara Channel islands to the mainland (Schumacher 1878). Although ground stone is not specifically mentioned in the ethnohistoric accounts as a trade item, mortars (*alcaputsh*) and pestles (*chuniec*) are listed as items that people owned, and items that were owned were also commonly traded (King 1976:298). This may indicate that ground stone was part of the exchange system prehistorically. Ground stone vessels have been found in the ocean off Anacapa, Santa Rosa, and San Miguel islands, as well as along the mainland coast (Hudson 1976). Many of these underwater finds may be the result of capsized boats that were transporting ground stone to other areas to use in exchange.

Despite the large quantities and varieties of these tools, much remains unknown about ground stone in the Santa Barbara Channel region. Areas that still need to be explored include the locations and types of quarries, stages of production, modes of production, differential mainland and island uses, and trade patterns. This study of ground stone manufacture and use on San Miguel Island addresses some of these issues, and suggests avenues to future research.

GROUND STONE PRODUCTION ON SAN MIGUEL ISLAND

The environment, geography, and resources found on San Miguel Island are quite different from the mainland. San Miguel Island is relatively low and flat and is only 14 square miles in area. The vegetation on the island has been severely impacted by overgrazing, and strong northwesterly winds have created active sand dunes that have impacted vegetation as well as archaeological sites. Prehistoric plant distributions are unknown, although they likely included grasslands and coastal sage scrub (Glassow 1977; Walker and Snethkamp 1984). In general, potable water is limited on the island, but small streams flow during the wet season and perennial springs are concentrated on the northern coast of the island. On the west end of the island, at Point Bennett, there is an extensive sea mammal rookery that is unique in the region today. Terrestrial mammals are limited to the island fox (*Urocyon littoralis*) and deer mouse (*Peromyscus* sp.).

The earliest researchers on San Miguel Island noted the manufacture of ground stone by the native inhabitants. Its extent and importance, however, were often overlooked. Paul Schumacher (1877:38) was the first to note the production of ground stone on the island, observing that "Of the small surface collection made here, I consider an unfinished mortar the most interesting article, showing in its partially rough and incomplete state the mode of manufacturing of such a utensil by the aborigines." In 1878, Leon de Cessac noted "an extremely interesting series of mortars ranging from the first rough draft to the perfect achievement" (Heizer 1951:8). However, George Heye (1921:41) concluded that the sandstone on the island was of poor quality, that no quarries existed, that there were "practically no unfinished objects," and that all of the large stone artifacts on San Miguel were acquired by trade (although he did comment that one of the few unfinished artifacts discovered was a mortar). David Rogers, who studied the northern Channel Islands during the 1920s, made two interesting points regarding artifacts found on San Miguel Island; that they were similar to those found on the mainland and that there were "large numbers of mortars and pestles though there are now no acorns to grind in them" (Rogers 1929:268).

In studies conducted by Charles Rozaire and George Kritzman (Rozaire 1965, 1978), Roberta Greenwood (1978, 1982), and Michael Glassow (1982), most of San Miguel Island was surveyed, leading to a better understanding of prehistoric occupation there. Site records from these surveys were incorporated into a spatial geographical database in order to view the distribution of sites and artifact types. A total of 568 prehistoric sites has been identified and recorded on the island. Occupation dates back to at least 10,000 B.P. (Erlandson 1993; Erlandson et al. 1996), extending through the historical period. One of the most striking features of San Miguel Island artifact assemblages is the ubiquitous presence of ground stone, especially given the sparse local plant resources. Of all of the recorded sites, 57% (n = 322) have ground stone artifacts (Fig. 2). If sites where no artifacts were found are excluded, then that percentage increases to 65% of all sites on the island. Furthermore, since these numbers are based on recent survey data, they could be conservative, as earlier pothunting and poorly documented previous excavations may have skewed the archaeological record.

Mortars and pestles are more common at sites on San Miguel Island than manos and metates (Table 1). There is also a difference in the spatial distribution of sites with mortars and pestles compared to sites with manos and metates (Fig. 3). Sites with manos and/or metates are clustered more on the eastern end of the island, while mortars and/or pestles appear to be more evenly distributed across the island. Since there is a temporal difference in the use of mortars and pestles versus manos and metates the presence of these different ground stone types may give some insight into changes in site locations over time. It is also interesting to note that most sites with manos and/or metates also contained mortars and/or pestles, suggesting a long history of habitation in many places or a continuation of milling practices.

Quarry Site at CA-SMI-503/504

Evidence for ground stone manufacture on San Miguel Island comes from two sites (CA-SMI-503 and -504) on the northwest coast of the island (Fig. 4) (Rozaire 1983; Walker and Snethkamp 1984). While CA-SMI-503 contains the greatest concentrations of manufacturing remains, the two sites are virtually continuous and are considered together in this analysis (hereinafter referred to as CA-SMI-503/504). The site is located on a series of sand dunes above a conglomerate formation containing pebble to boulder-sized clasts that provided the raw material for ground stone manufacture. This Eocene-aged deposit, referred to as the "Undifferentiated Pozo-Canada Formation" (Bremner 1933:13; Weaver and Doerner 1969:30), consists of volcanic porphyries, sandstone, quartz, chert, limestone, diorite, and various granitic types. The mortars and pestles were generally manufactured from a pink and gray rhyolite porphyry, while igneous cobbles were used as hammerstones in the manufacturing process. Small boulders were expediently used as preforms for mortars. In addition to evidence of quarrying and manufacturing activities, the site contains a large midden of habitation refuse.

Portions of CA-SMI 503/504 are covered with chipping waste from ground stone manufacture (Fig. 5). The debris includes flakes of rhyolite porphyry, along with large quantities of flakes from hammerstones used in manufacture. Often the assumption is made that ground stone tools were produced primarily through grinding and abrasion. However, recent research has revealed that a great deal of what is called ground stone is actually manufactured primarily by percussion flaking and pecking (Hayden 1987; Wright 1992; Schneider and Osborne 1996; Wilke and Quintero 1996). Other techniques used for making ground stone artifacts include batter-

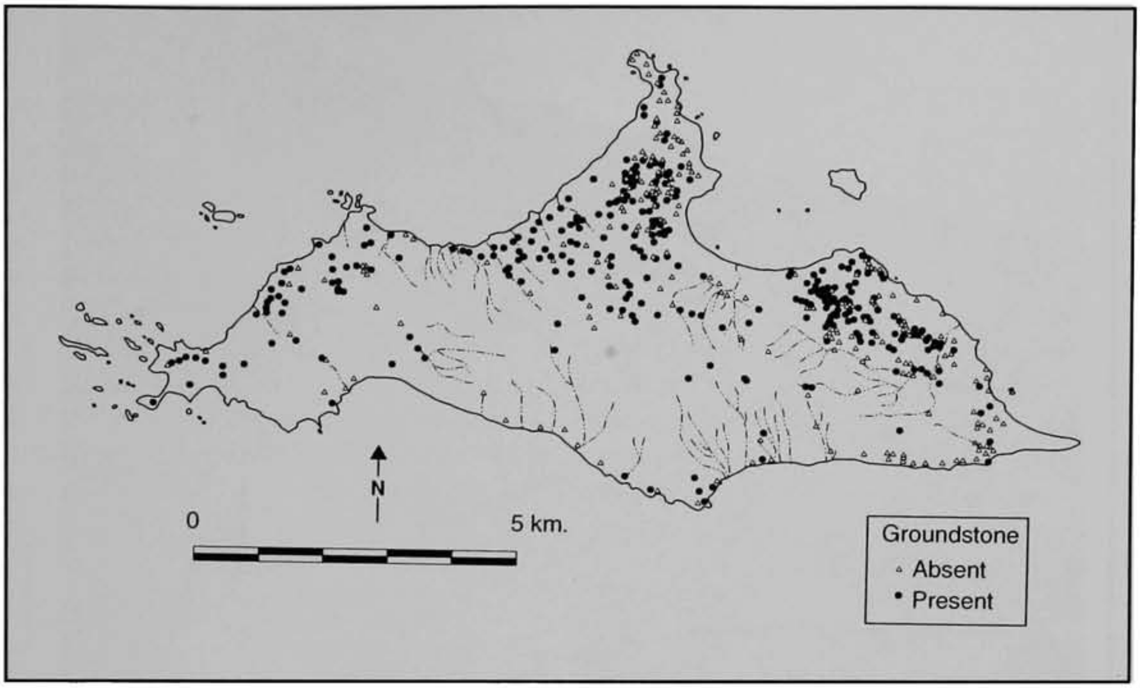

Fig. 2. Presence and absence of ground stone at sites on San Miguel Island.

Table 1
FREQUENCIES OF GROUND STONE TYPES AT SITES ON SAN MIGUEL ISLAND

Ground Stone Type	No. of Sites
pestle only	76
mortar only	81
both mortar and pestle	126
Total sites with mortars and/or pestles	283
mano only	21
metate only	74
both mano and metate	33
Total sites with manos and/or metates	128

ing, pounding, chopping, incising, cutting, and drilling (Wright 1992:53). Wilke and Quintero (1996) found that the majority of grinding occurs not in the production but in the use of ground stone.

Also found at CA-SMI-503/504 are dozens of mortars and pestles abandoned in various stages of manufacture, indicating that the entire process of manufacture was carried out at this location. Walker and Snethkamp (1984:59) recorded 42 mortar blanks and rim fragments and 53 pestle blanks at the site and suggested that this sample represented a quarter of the mortars and one-tenth of the pestles. Both globular and flowerpot mortars have been discovered at the site; however, it appears that no manos or metates were produced there. The general steps in the manufacturing process of mortars at CA-SMI-503/504 were: (1) the selection of an appropriate piece of raw material; (2) percussion flaking to produce a blank with a roughly shaped exterior (Fig. 6); (3) pecking the exterior to form the shape; and finally (4) pecking the interior to produce a rim (Walker and Snethkamp 1984). Pestles were made in a similar fashion by removing large flakes to create a rough shape (Fig. 7), followed by pecking to even out the surface (Rozaire 1983).

Hammerstones were used in mortar and pestle manufacture at CA-SMI-503/504 and appear to have been the primary tool used for ground

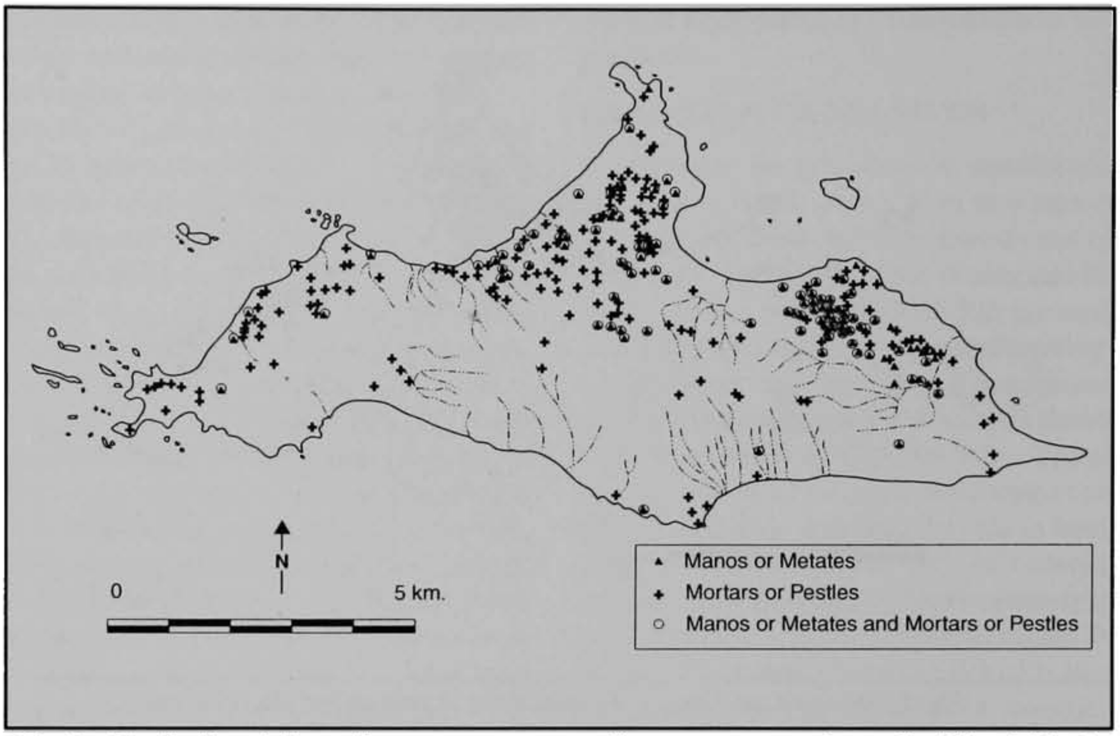

Fig. 3. Distribution of sites with manos or metates and/or mortars or pestles on San Miguel Island.

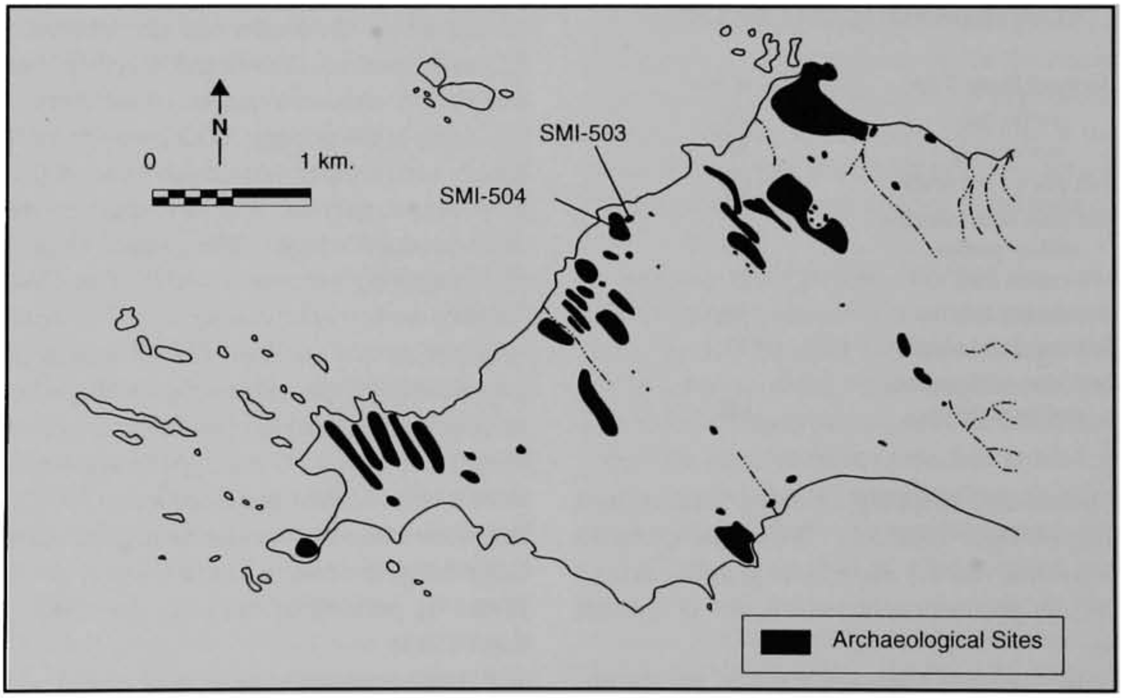

Fig. 4. The northwest coast of San Miguel Island, including sites CA-SMI-503 and -504.

Fig. 5. Chipping waste covering a dune at CA-SMI-503.

Fig. 6. Porphyry mortar blank from CA-SMI-503/504.

Fig. 7. Porphyry pestle in the process of manufacture at CA-SMI-503/504, with large percussion flakes removed.

stone manufacture in the Santa Barbara Channel region (King 1976; Hudson and Blackburn 1987; Erlandson 1994). Hudson and Blackburn (1987) noted the lack of attention by archaeologists in identifying flaking versus pecking implements, suggesting that many of the hammerstones described in archaeological reports were actually for the manufacture of ground stone. Erlandson (1994:83) believed that core hammers, which are intentionally flaked to create obtuse, angular edges, were used to peck and shape ground stone tools. These core hammers were also used to roughen the grinding surface after extended use. Core hammers can take different forms, including unifacial and bifacial flaked choppers, split cobbles, picks, and stone discoidals (Erlandson 1994:83). However, in quarries with an abundance of adequate raw material for tool use, relatively unmodified cobbles were used (Hayden 1987). At CA-SMI-503/504, there are large numbers of both prepared core hammers and unmodified cobble hammers.

Another tool type found at CA-SMI-503/504, as well as many other sites on the island, are picks and gouges (Rozaire 1978, 1983). Both types were manufactured by percussion flaking and have single pointed ends. Gouges are generally smaller, unworked on one side, and have one rounded end; picks are larger and often triangular in shape. Rozaire (1983:141) maintained that these tools were used for finishing the surfaces of ground stone. The examples found on San Miguel Island are commonly made of volcanic material, predominantly rhyolite porphyry but also including quartzite and chert. However, such tools do not show use-wear of the type expected to be found if they were used to peck ground stone. Similar picks were reportedly used to quarry steatite (Schumacher 1878; Heye 1921), suggesting that they were used on other types of ground stone material, despite the fact that steatite is much softer than other types of stone. It has also been suggested that these tools are reamers (Hudson and Blackburn 1987), shellfish pries (Jones 1956), or drills for making doughnut stones (Rogers 1929). While picks and gouges have been found on Santa Cruz and Santa Rosa islands, they have not been identified on the mainland. Despite the lack of use-wear, they do seem to be associated with ground stone on San Miguel Island. Of the 124 sites with picks and gouges, all but 16 also had ground stone tools. It remains possible that these are specialized tools used in the production of ground stone implements.

Middle Period Mortar and Pestle Manufacture

Radiocarbon dates obtained by Walker and Snethkamp (1984) from column samples at the quarry site were recalibrated. The recalibrated dates indicate that ground stone manufacture on San Miguel was concentrated in the Middle Period (490 B.C. to A.D. 1150), especially in Phase 3. The chronology used here is based on calibrated and corrected radiocarbon dates from King's (1990) chronology (see Erlandson and Colten 1991; Kennett 1998). A date obtained from the upper stratum at CA-SMI-503 (15 to 25 cm.), which contained the highest amount of chipping waste, was recalibrated to A.D. 702 (803) 917 during Phase 3 of the Middle Period. The total weight of debitage from this level was 2740.3 g. The lower levels of CA-SMI-503 (184 to 189 cm.) yielded a calibrated date of 1879 (1778) 1710 B.C. (Early Period) and there is no evidence for ground stone manufacture from this level.

Surface artifacts identified by the author corroborate the Middle Period occupation of the site. One small obsidian harpoon point was collected on the surface of CA-SMI-503, associated with mortar and pestle manufacture. This type of point dates to around A.D. 450 or later (Glassow 1996a:20). Also at this site was a larger leaf-shaped point (possibly a dart point) of Monterey chert. Obsidian and Monterey chert both come from mainland sources indicating cross-Channel trade at this time. It is common in the Middle Period for island sites to have obsidian from the eastern Sierra 300 km. away, and mainland chert from up to 60 km. away (Arnold 1991:959). A J-shaped fishhook and *Olivella* saucer beads from the surface also indicate occupation during the Middle Period (King 1990) at CA-SMI-503/504.

In addition to CA-SMI-503/504, 16 other sites on San Miguel Island have evidence of mortar and pestle manufacture (Fig. 8). The majority of these sites is on the western end of the island near CA-SMI-503/504. Seven sites contained single specimens of unfinished mortars, and five sites contained a single unfinished pestle. Six of the sites column sampled by Walker and Snethkamp 1984) had evidence of ground stone manufacturing debitage in one or more levels (Table 2). The debitage from these samples (all of equal volume) was recounted and weighed. Of the levels containing debitage, five were radiocarbon dated. One level dated to Phase 2 of the Middle Period, three to Phase 3 of the Middle Period, and two to Phase 1 of the Late Period. The second largest amount of debitage came from CA-SMI-525 (303.3 g.) in one of the levels dating to Phase 3 (A.D. 670 to 813). This site had unfinished mortars and pestles on the surface, as well as debitage of rhyolite porphyry and other volcanic materials. The third largest quantity of debitage was derived from a level at CA-SMI-492 (219.2 g.) that was just above the level dated to Phase 3 of the Middle Period.

It appears that the majority of mortar and pestle production took place at CA-SMI-503/504 while more limited manufacturing occurred at other sites in the vicinity of the quarry. The large amount of unfinished and broken ground stone tools found at quarry sites in general indicate a high degree of failure, especially in the

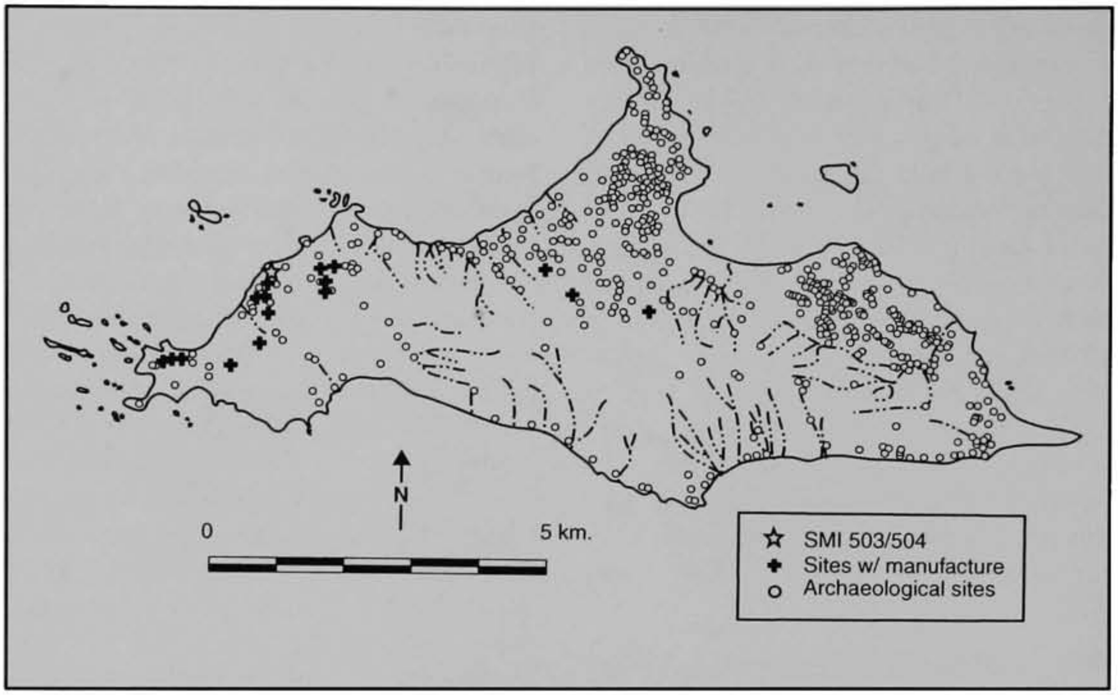

Fig. 8. The 16 sites on San Miguel Island with evidence of ground stone manufacturing.

manufacture of pestles (Schneider 1993b, 1996). Therefore, the preliminary and most risky stages of manufacture were carried out at quarry locations so that if a tool failed, another could be easily started. This would explain, at least in part, the distribution of mortar and pestle manufacturing on San Miguel Island.

DISCUSSION

Several interesting issues arise when considering the ground stone data from San Miguel Island. These include the timing and causes of intensified manufacturing, the uses of mortars and pestles, and the degree of specialization represented. It seems evident that production of mortars and pestles intensified and was concentrated in the Middle Period. The manufacture of ground stone from the source at CA-SMI-503/504, however, does appear to have continued in a limited manner after the Middle Period. From a site at Adam's Cove on the far western end of the island, a flowerpot mortar of pink rhyolite porphyry was found. The deposits at this site date to the Late and Historic periods (D. Kennett, personal communication 1997). In addition, the porphyry debitage from CA-SMI-525 showed that manufacture continued into the Late Period but probably to a lesser degree. There is no evidence that manufacturing continued at CA-SMI-503/504 in the Late and Historic periods. While the raw material sources continued to be used to some extent, there was no longer habitation at this location.

The changes in use of the quarry site between the Middle and Late periods parallel King's (1990) conclusions about ground stone manufacture and trade. King (1990) asserted that throughout Phase 4 of the Middle Period, there was an increase in the use of both shaped stone mortars and steatite bowls from Catalina Island. These vessels commonly occur in burial contexts, suggesting a corresponding increase in their manufacture and trade (King 1990). After this time, at the very end of the Middle Period and into the Late Period, mortars and bowls no longer occur in mortuary contexts. King (1990) attributed this

Table 2
REANALYSIS OF COLUMN SAMPLE DATA COLLECTED BY WALKER AND SNETHKAMP (1984) SHOWING MORTAR AND PESTLE MANUFACTURING DEBITAGE AND CORRESPONDING DATES

Site CA-SMI-	Unit	Level (cm.)	Strata	PD[a] Count	Grams	OD[b] Count	Grams	Calibrated ^{14}C Date	Phase[c]
485	N	0-10	--	6	--	0	--	--	--
485	N	10-20	--	0	--	1	--	--	--
485	N	40-50	--	0	--	2	--	--	--
485	S	0-10	--	0	--	1	--	A.D. 1376 (1434) 1481	L1
485	S	10-20	--	6	--	1	--	--	--
488	S	0-5	--	3	1.4	2	0.3	--	--
488	S	13-17	--	3	1.5	2	1.7	--	--
488	S	17-31	--	0	0	1	0.2	--	--
488	S	32-41	--	6	14.5	11	9.5	--	--
488	N	0-10	--	0	0	1	7.1	--	--
488	N	40-45	3	0	0	1	0.2	--	--
492	N	15-32	11	0	0	23	26.2	--	--
492	N	32-48	10	6	3.9	58	215.3	--	--
492	N	48-64	9	7	1.9	0	0	A.D. 589 (658) 706	M3
492	N	64-78	8	0	0	1	0.4	--	--
492	S	0-10	--	3	1.4	0	0	--	--
492	S	10-20	--	6	7.9	1	0.2	--	--
492	S	20-30	--	0	0	1	2.8	--	--
503	N	--	2	1	1.0	0	0	--	--
503	N	--	3	2	10.7	5	2.1	--	--
503	N	--	6	1	1.1	0	0	--	--
503	N	30-52	8	2	5.6	2	51.9	730 (544) 420 B.C.	M2
503	C	0-10	1	3	106.6	1	1.6	--	--
503	C	10-18	2	3	1.3	0	0	--	--
503	C	18-25	2	2	139.8	4	1.3	--	--
503	C	25-35	3	0	0	1	0.1	--	--
503	S	15-25	--	56	1689.4	16	1050.9	A.D. 702 (803) 917	M3
503	S	profile	--	109	1338.9	20	581.6	--	--
504	N	26-37	3	1	0.8	0	0	--	--
504	N	241-287	15	0	0	1	1.2	--	--
510	N	--	2	5	3.4	6	22.6	--	--
510	N	--	3	6	3.6	3	14.2	--	--
510	N	--	5	0	0	3	25.4	--	--
510	N	89-97	6	1	0.2	1	0.6	A.D. 691 (768) 843	M3
510	S	25-35	2	4	12.7	4	1.6	--	--
510	S	35-45	3	0	0	6	13.5	--	--
510	S	45-55	4	1	0.7	2	1.5	--	--
510	S	90-95	6	2	0.2	0	0	--	--
525	A	--	9B	1	1.7	0	0	--	--
525	A	--	10	0	0	1	6.9	--	--
525	B	99-104	--	1	40.8	0	0	--	--
525	D	--	1	2	0.6	3	2.1	--	--
525	D	--	2A	0	0	1	2.2	--	--
525	D	--	2B	0	0	2	0.5	--	--
525	D	30-37	3	2	3.3	13	12.2	A.D. 1334 (1406) 1440	L1
525	D	--	4A	2	2.2	8	19.9	--	--
525	D	--	4B	0	0	3	3.3	--	--
525	D	--	5A	0	0	1	0.3	--	--
525	D	--	5B	0	0	2	0.3	--	--
525	D	--	6	7	4.1	7	9.9	--	--
525	D	--	7	1	1.3	13	10.6	--	--
525	D	--	8	17	25.5	8	13.3	--	--
525	D	70-79	9	5	10.6	15	292.7	A.D. 670 (725) 813	M3
525	D	--	11B	1	4.0	0	0	--	--
525	D	--	13	0	0	5	3.7	--	--
525	D	--	19	3	27.6	0	0	--	--
525	D	--	14	0	0	4	6.2	--	--
525	D	--	15	0	0	1	0.2	--	--
525	D	--	21	0	0	1	15.7	--	--
525	D	--	26	0	0	1	22.4	--	--

[a] PD = Porphyry debitage.
[b] OD = Other volcanic or sandstone debitage.
[c] Phases are based on calibrated dates (Erlandson and Colten 1991; Kennett 1998) of King's (1990) cultural phases.

to a decrease in the manufacture of such items, although a decrease in their use as burial goods may be related to changes in ideology.

Evidence for the production of mortar and pestles at 16 sites on San Miguel Island is noteworthy as few locations of manufacture have been identified from the mainland or the other northern Channel Islands. In the collections at the Santa Barbara Museum of Natural History, there are single sandstone mortar blanks from CA-SRI-62 (Historical Period) and CA-SRI-5 (Middle Holocene and Middle Period on Santa Rosa Island, but no other evidence of production has been found. The conglomerate formation that provides the source of raw material for mortars and pestles on San Miguel Island is thought to be similar to the conglomerate in the Domengine formation on Santa Cruz Island (Bremner 1933: 13), although manufacturing has not been reported on this island either. From the southern Channel Islands (just outside the Chumash sphere), there is evidence of ground stone manufacture on San Nicholas Island (Bryan 1961, 1970) and San Clemente Island (Schumacher 1878; L. M. Raab, personal communication 1997, as well as steatite ground stone manufacture on Santa Catalina Island (Wlodarski 1979).

Because the use of mortars and pestles by the Chumash is associated with acorn processing and there is no evidence of oak trees on San Miguel Island during the Middle Period, ground stone production on the island must be explained by other factors. From ethnohistoric sources, it is clear that acorns were traded to the islands from the mainland during the Historic Period. If it is assumed that acorn processing is the primary function of mortars and pestles, then the data from San Miguel Island suggest that interaction increased tremendously during the Middle Period. This could be true if mortars and pestles were used for processing acorns that were traded in and/or if the ground stone itself was exported. Large numbers of finished mortars and pestles have been discovered at sites on the island, indicating the use of such implements there. In addition, mortars made of volcanic porphyry similar to the type found on San Miguel Island have been identified at sites on Santa Rosa and Santa Cruz islands, as well as on the mainland (author's personal observations, 1996), although without chemical compositional or mineralogical/petrographic studies, the origin cannot be determined with certainty.

One other explanation for the intensification of mortar and pestle manufacture during the Middle Period is that these tools were being used for processing something besides acorns. Ethnographic information indicates that California groups reportedly processed rodents, fish, insects, and large mammals with ground stone tools (Yohe et al. 1991). While mice were on the island prehistorically, these animals were far less abundant than marine resources such as fish, shellfish, and sea mammals. The Middle Period has been characterized as a time of subsistence change with an increase in both fishing and the hunting of sea mammals (Glassow 1996a). The Pomo, Modoc, and Yuma reportedly used mortars and/or pestles to process fish (see McLendon and Lowy 1978; Schroth 1996), so it is possible that increased fishing during the Middle Period led to the intensification of ground stone manufacture. Masters (1983) proposed that mortars from La Jollan sites south of the Chumash area were used for marine foods such as shellfish. However, there is no apparent reason why a mortar and pestle would be a necessary tool for processing marine foods. The Luiseño were known ethnohistorically to have simply pounded abalone on rocks to make it tender (Schroth 1996).

What were the causes for increased ground stone production during the Middle Pe-riod? Intensification came before the large growth in trade and interaction that began in the Middle to Late period transition and culminated during the Historic Period. One possible explanation is that the development of the plank canoe (*tomol*) had an immense impact on regional interaction during the Middle Period. Some studies have suggested that the *tomol* was first used between A.D. 500 and 800 (Hudson et al. 1978; King 1990; Arnold 1995) and Arnold (1995) believed its final form was developed by about A.D. 1100. This technology allowed for deep-sea fishing and facilitated transportation between the islands and the mainland. At this time, trade may have increased, leading the people on San Miguel Island to increase production of ground stone in order to be part of an expanded regional exchange network. The report of at least one ground stone vessel off the coast near CA-SMI-503/504 and vessels located off the coast near Point Conception and the other Channel Islands (Hudson 1976) suggest the possibility of ocean trade of these objects.

Increased manufacture and exchange of mortars and pestles during the Middle Period does not necessarily indicate that the use of acorns or another food source changed and/or intensified at this time. If interaction between the different islands and between the islands and the mainland increased due to the development of the *tomol*, the people of San Miguel Island would have needed something to exchange in the expanding trade network. Since there was such a good source of raw material for making mortars and pestles, they may have chosen to intensify production of these items for exchange. The exchange of ground stone for other goods could have established or helped solidify social ties with people in other areas. Alternatively, ground stone tools may have been used to produce other goods, such as tenderized and/or dried fish or sea mammal meat that could then be exchanged.

Another significant issue regarding ground stone production on San Miguel Island is the degree and type of craft specialization. It is proposed here that part-time, community-based specialization of mortar and pestle manufacturing occurred at CA-SMI-503/504. Community specialization has been defined as "autonomous individual or household-based production units, aggregated within a single community, producing for unrestricted regional consumption" (Costin 1991:8). The producers in this type of situation are kin-based and their production is not attached to elites.

It does not necessarily follow that the high density of ground stone manufacturing debitage at CA-SMI-503/504 is an indication that mortar and pestle production was very intensive or highly specialized. Huge amounts of debitage are created in the manufacturing process of ground stone tools (Wilke and Quintero 1996), which may lead to overestimates of the amount of production taking place. Schneider (1993a, 1996) reached similar conclusions about the ground stone quarries she studied in the Southwest. For example, at the Antelope Hill quarry, which encompassed 300 acres and included 46,136 workshop areas, Schneider (1996) concluded that despite its extent, this quarry represents the low end of the range of craft specialization. CA-SMI-503/504 is much smaller in size than the quarries Schneider (1996) studied, but it was also used over a shorter period of time. From their work on the southern Channel Islands, Williams and Rosenthal (1993) concluded that although there was significant trade of soapstone bowls that were produced on Catalina Island, there is little evidence for craft specialists. They based this conclusion on the absence of specialized tools and standardized production, as well as the lack of mass blank production, storage, or exclusive access (Williams and Rosenthal 1993:43-44).

There is, however, evidence that production of mortars and pestles on San Miguel was more than just generalized and for family consumption. There are no other comparable material sources on San Miguel Island and the evidence points to mortar and pestle production in the immediate area surrounding CA-SMI-503/504 in this limited region of the island. A large midden area containing habitation debris such as charcoal, faunal remains, and various tools was found at CA-

SMI-503/504. People were living at the site while the quarry was being used and it was not a place used only for the procurement of the raw material. The association of substantial habitation with the quarry suggests that there may have been control over the raw material source (Torrance 1986; Arnold 1987). In addition, the dense habitation refuse indicates that production was probably part-time since people were still heavily involved in subsistence activities. Finished mortars and pestles at CA-SMI-503/504 and a limited zone where tools in the final state of manufacture are found are consistent with some degree of restricted access and suggest community based, organized production focused at the site (Costin 1991).

CONCLUSIONS

The results of this research indicate that there is a large amount of ground stone on San Miguel Island, despite the scarcity of plant resources. This is most apparent at CA-SMI-503/504, a quarry site that is associated with a habitation area where the entire manufacturing process of mortars and pestles took place. In addition, there are 16 other sites in the vicinity of CA-SMI-503/504 where evidence of later stages of production have been found. Finally, the majority of the evidence dates the manufacture of ground stone on San Miguel Island to Phase 3 of the Middle Period.

Overall, the evidence from San Miguel Island suggests that intensification of trade and production of certain items occurred during the Middle Period. This was perhaps related to the development of the *tomol* around the same time. At CA-SMI-503/504, part-time and possibly community-based, specialized production of mortars and pestles developed. This was different than the more standardized, larger scale production of Late Period shell bead manufacture. However, there was intensification of a local resource that could be used by the people of San Miguel, or certain segments of the population, to participate in a larger economic system and which laid the groundwork for the integrated trade systems in the Late and Historic periods.

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