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– ARTICLE –

Archaeological Investigation of Caves and Rock Shelters on Guam and Tinian: a synthesis of their use through time

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ABSTRACT

Archaeological investigations in the Micronesian archipelago of the Mariana Islands have generally focused on habitation sites occupied from the Pre-Latte through Latte Period, with more recent attention to palaeoenvironmental studies such as wetland sediment cores, residue analysis of ceramics and tools, agricultural soil analyses, and climate change modeling. One site type recognized as having an early and repeated record of human use over the 3500 year history of the islands is the cave and/or rock shelter. This paper examines their use through time on Guam and Tinian, not as an ancillary feature to habitation sites, but as an independent measure of social and ecological processes in the Western Pacific.

Keywords: rock shelter, cave, Guam, Tinian, Mariana Islands

INTRODUCTION

The history of archaeological investigations in the Micronesian archipelago of the Mariana Islands (Figure 1) has generally highlighted habitation sites; beachside subsurface deposits from the Pre-Latte Period circa 1500 BC to AD 800 (Carson 2010; Hung *et al*. 2012) and the iconic *latte* sets of stone columns in the Latte Period from AD 800 to 1668 (Kurashina *et al*. 1999; Thompson 1932). Issues concerning architectural permanency, kinship residency, social status, gender activities, and domestic versus communal function are still debated for both periods today (Carson 2012; Cordy 1983; Craib 1986; Graves 1986; Russell 1998).

More recently, archaeological attention has been devoted to palaeoenvironmental studies such as wetland sediment cores (Athens *et al*. 2004; Hunter-Anderson 2009), residue analysis of ceramics and tools (Hunter-Anderson *et al*. 2001; Dixon, Bartow *et al*. 2011), agricultural soil analyses (Dixon, Walker *et al*. 2011; Moore 2005), and climate change modeling (Carson and Peterson 2011, 2012; Dickinson 2001). Issues here seem to revolve around the degree to which human impacts on the environment can be differentiated from natural trends over time, although a consensus has yet to evolve.

One archaeological site type recognized as having an early and repeated record of human use over the 3500 year history of the islands is the cave and/or rock shelter (Welch *et al*. 2001), generally part of the same geological formation in this largely karst landscape (Lobban and Schefter 1997). The geographical distribution of the cave and/or rock shelter from coastal to inland settings and their association with fresh water (Taborosi 2004), rock art (Russell 1998), natural shelter (Olmo *et al*. 2001), and refuge in times of stress (Dixon, Gilda *et al*. 2012) make them an ideal window for reexamining land use changes through time. Changes in use of marine resources are included here too.

With that premise in mind, caves and rock shelters are not treated in this study as an ancillary feature to long-term habitation sites, although they sometimes are, but as an independent measure of social and ecological processes of broader interest in the Western Pacific. The data set used here is based upon cultural resource management studies for the Department of the U.S. Navy conducted or aided by the senior author on Guam (Allen *et al*. 2001; Hunter-Anderson *et al*. 2001; Dixon *et al*. 2004) and Tinian (Allen *et al*. 2002; Dixon *et al*. 2000).

Other caves and rock shelters have been excavated on the two islands, but are not the primary focus of this study. Site locations are not presented for their protection.

THE KARST LANDSCAPE OF GUAM

Guam, the largest of the Mariana Islands and a U.S. Territory, is situated over 2000 kilometers (km) east of the Philippine Islands (see Figure 1) with a total land mass

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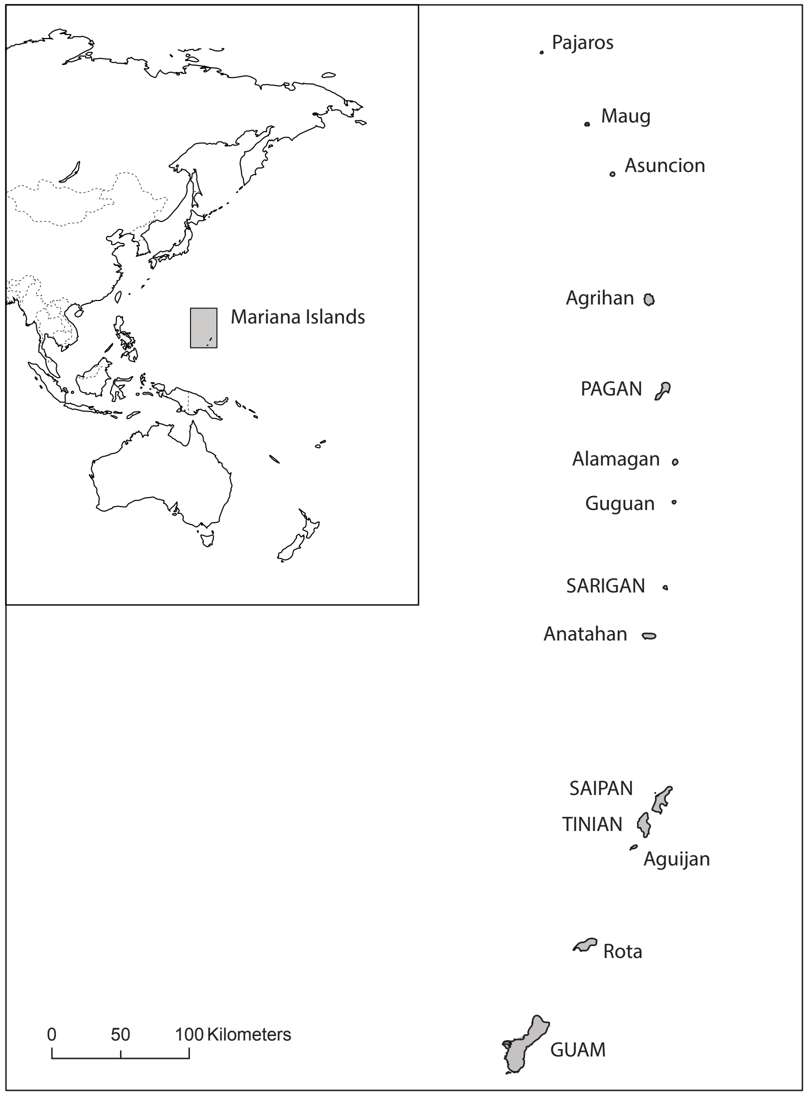


Figure 1. Location of Guam and Tinian in the Mariana Islands (after Carson 2010)

of 539 square (sq) km. Northern Guam consists of a series of former reefs uplifted to an elevation of 180 meters (m) resulting in a limestone plateau of Miocene, Pliocene, and Pleistocene origin (Randall and Seigrist 1996), with very few sources of fresh water, mostly situated in caves or seeps along the shoreline (Taborosi 2004). Much of the epikarst above the escarpment is heavily eroded at the surface, with karren fields of solution pits, sharp points, and irregular holes making human access close to impossible. Algal growth on coastal karst can also result in near impassable landscapes.

Volcanic deposits predating the reef formation are exposed at Mount Santa Rosa and Mount Mataguac (Young 1988), but the majority of the northern plateau is a relatively flat jungle landscape pockmarked with faults, fractures, vadose shafts, soil pipes, pit caves, and sinkholes surrounded by steeply eroding cliffs with numerous caves and rock shelters. This porous network of karst features is constantly evolving as rainwater in the vadose zone moves down through the phreatic zone below the water table into the Northern Guam Lens Aquifer, the main source of drinking water for the island.

Southern Guam, located below the Pago-Adelup fault dividing the island geologically, is volcanic in origin and up to 406 m tall, but it also contains a complex record of smaller expanses of karst located along the east coast, around the inland Fena basin, down the hilly backbone in the west, on Orote Peninsula and Cabras Island surrounding Apra Harbor, and on Nimitz Hill overlooking Asan Bay. Sinkholes, caves, and rock shelters are also prevalent in the karst, but many faults contain permanently flowing rivers of varying lengths, a few disappearing underground into swallow holes for some distance as allogenic flow at the juncture between volcanic strata and limestone.

Not surprisingly, the pre-Contact (prior to Magellan's arrival in 1521) pattern of native Chamorro settlement on northern Guam was dictated to a large degree by access to fresh water in this karst landscape. Latte Period inhabitants preferred leeward embayments with sheltered fringing reefs and fresh water in sinks or seeps such as at Tumon, Hila`an, Haputo, Ritidian, Jinapson, Tarague, and Pagat (Bayman *et al*. 2009; Carson and Kurashina 2009; Craib 1986; Graves 1986; Liston 1996), with very few mostly isolated *latte* set habitations on top of the waterless plateau (Reinman 1977).

Topside, an archaeological mosaic of pottery scatters and midden soils appears to reflect shifting exploitation of the shallow soils and native forests which were relatively homogeneous in distribution (Dixon, Walker, *et al*. 2010), also being used as a 'resource reserve' in times of drought and famine from devastating typhoons (Olmo *et al*. 2001). One of these resources was fresh water accessible at spring caves in blind or dry valleys near Mount Santa Rosa and Mount Mataguac (Taborosi 2004), the latter almost a day's walk from much of the coast.

While the effects of drought and typhoons were no less devastating to the south, Latte Period inhabitants there apparently developed a different coping strategy better adapted to the dendritic distribution of alluvial soils and the one resource not readily available to the north – running water. Here, coastal villages appear to have been supplemented by large inland villages overlooking the most dependable drainages and springs (Dye and Cleghorn 1990; Henry *et al*. 1988a and 1988b; Allen *et al*. 2001; Dixon *et al*. 2004), with smaller *latte* habitations dispersed in between.

The timing of this move inland has been debated based largely upon palaeoenvironmental data, some researchers seeing a Pre-Latte surge in upland deforestation (Athens and Ward 1993, 1995, 1999), while others see a late Latte Period inland expansion of agriculture (Hunter-Anderson 2009). Recent dating of the Lost River Village located just above a series of sinkholes north of the Fena reservoir yielded possible evidence of long-term habitation beginning in the earliest Latte Period circa AD 800–1000 and remaining well after first Contact (Dixon and Gilda 2012), suggesting the sustained importance of this particular karst landscape over time.

THE KARST LANDSCAPE OF TINIAN

Tinian, in the Commonwealth of the Northern Mariana Islands (see Figure 1), is situated approximately 200 km north of Guam and has a total land area of 102 sq km. The island is composed of a series of five limestone terraces that formed as reefs around extinct volcanic peaks and slopes (Doan *et al*. 1960; Young 1989) that protrude through the limestone in a few small areas. The terraces rise in steps from the coastline to a maximum height of 169 m and form level to undulating plains bounded by steep escarpments, which generally occur along fault lines. Elevations of these escarpments range from 50 m to 75 m.

Tinian's geological core is made of Eocene volcanic tuffs and breccias with some submarine deposits occurring as conglomerates, tuffaceous sandstones, and calcareous tuffs (Doan *et al*. 1960; Young 1989). Since its original formation, tectonic uplift, extensive faulting and folding, erosion, deposition, marine transgressions and planation, and new reef building and uplift have collectively shaped the present landscape. The island is divided into five major physiographic zones that reflect these various processes.

The North Central Highlands including Mount Lasu and the Southeastern Ridge of the Carolinas ridge are the highest areas on the island, comprised of the oldest, most uplifted limestone terraces, with exposures of volcanic tuff. The Central Plateau is the largest region and is comprised of more recent, uplifted terraces formed during a long eustatic stand of the sea. The Median Valley is a fault zone between the Central Plateau and Southeastern Ridge which contains the majority of urban and agricultural development today. The Northern Lowlands region was a broad reef flat that emerged very recently in Tinian's geological history.

The two major limestone formations on Tinian are the Miocene Tagpochau Limestone Formation which is exposed on the North Central Highland and on the Southeastern Ridge, and the PliocenePleistocene Mariana Limestone Formation which predominates in the Central Plateau, Median Valley, and Northern Lowlands as well as restricted areas of the Southeastern Ridge (Doan *et al*. 1960). The Tagpochau Formation contains a wide array of facies, many influenced heavily by volcanic material, while the Mariana Formation is primarily a coral reef complex (Young 1989).

Sinks are not as common on Tinian as Guam, but caves and rock shelters occur in the older karst especially where it is exposed to surface rain runoff, even though there is no running water on the island. Shoreline seeps at low tide provide limited access to fresh water as do a few caves and faults through percolation. Lake Hagoi, a former branch of the sea in the Northern Lowlands (Athens 1998), and Makpo springs situated between Pina and Kastiyu plateaus to the south also provided water historically.

Historic and prehistoric Chamorro land use on Tinian, as in northern Guam, was defined by its karst landscape and limited access to fresh water, coastal reefs, and arable soil. Some of the earliest evidence for human settlement in the Mariana Islands circa 1500 BC is found in back dune coastal settings at Unai Chulu on the northwest coast (Craib 1993; Haun *et al*. 1999) and Taga beach overlooking Tinian harbor to the south (Spoehr 1957). The latter setting then became the largest locus of population during the Latte Period with the tallest standing *latte* set in the archipelago at Taga House (Thompson 1932), while other smaller beaches such as Dumpcoke, Chulu, Dankulo, and Masalog also contained native villages at Spanish contact (Dixon *et al*. 2006), as did the Makpo springs vicinity (Farrell 1992). Isolated *latte* sets and pottery scatters recorded on the higher plateaus (O'Day and Vernon 2011) suggest a similar pattern of inland exploitation to northern Guam, although much of the landscape was radically altered by historic agriculture.

While the island was deliberately depopulated by roughly AD 1700 after the Spanish *reduccion* (Farrell 2011), its relatively flat landscape became the target of Japanese agricultural development after Japan purchased the Northern Mariana Islands from Germany at the end of WWI (Russell 1999). By the late 1930s practically 95% of the island's arable land was under sugarcane production (Higuchi 2008) including the importation and housing of laborers dependent upon rooftop cisterns for fresh water (Dixon 2004). A complex system of roads and railroads navigated the limestone plateaus and brought the harvest to a sugar mill in Tinian Town near the former location of Taga House. The same transportation system was then used to employ the agricultural workers as laborers building an island fortress in anticipation of WWII, with runways in the Northern Lowlands and on the Central Plateau (Denfield 1997, 2002).

This infrastructure was immediately capitalized upon during the U.S. invasion in 1944, and the island soon became home to over 150,000 American military personnel until after the two atomic bombs were flown from Tinian to Japan in 1945 (Russell 1995). The island became the home of newly repatriated Chamorro residents after the war (Tuggle 2008), and then reverted to the sleepy agricultural community it remains today, once again dependent on its limited resources provided sparingly by its' karst landscape.

ARCHAEOLOGICAL CAVE AND ROCK SHELTER SITES ON GUAM AND TINIAN

For this comparative study of radiocarbon dated caves and rock shelters in two topographical settings from two Mariana Islands, a total of 19 sites on Guam and 5 sites on Tinian were examined; several sites contained multiple surface or subsurface features (Table 1). Other caves and rock shelters have been excavated on the two islands for the U.S Department of the Navy, local governments, and in the private sector, but they are not the primary focus of this study. Trends here detected may therefore not reflect the totality of 3500 years of human occupancy in the archipelago.

The sites presented here are situated at the inland Naval Munitions Site or NMS (Allen *et al.* 2001) and the coastal Naval Base Guam (Dixon *et al.* 2004) in southern Guam and were examined by Ogden Environmental and Energy Services Co., Inc. and in Finegayan on coastal northern Guam by International Archaeological Research Institute, Inc. (Hunter-Anderson *et al.* 2001). Sites in the Lease Back Area (LBA) of inland Tinian were examined by Ogden Environmental and Energy Services Co., Inc. (Allen *et al.* 2002) and in the former Voice of America (VOA) now the International Broadcasting Bureau near coastal Tinian by International Archaeological Research Institute, Inc. (Dixon *et al.* 2000).

The identification of cave versus rock shelter or boulder overhang was made in the field with a set of morphological criteria by experienced field technicians and the principal investigators, but in some cases one site type graded into another as boulder overhangs were found in front of rock shelters with larger caves or cavern systems deeper within the limestone outcrop. Generally speaking, rock shelters and overhangs were protected from direct rainfall but contained well over 50% exposure to sunlight, while caves contained well under 50% exposure to sunlight and sometimes had stalactites, stalagmites, and other speleothems such as flowstone banks, rimstone pools, soda straws, cave pearls, and columns from prolonged water saturation (Randall and Siegrist 1996; Taborosi 2004). The depth of cultural soil deposition in rock shelters sometimes exceeded one meter, while most caves rarely exceeded half that depth of deposition.

The size and shape of caves and rock shelters on Guam and Tinian varied with the geological formation. Sinkholes with exposed limestone sometimes contained multiple but relatively shallow shelters, while limestone cliffs sometimes contained multiple boulder overhangs and deeper caves within fissures or fault lines. In the NMS of inland Guam for instance, caves varied from 20 to 120 sq m in size, the smaller ones being located near the face of the limestone outcrop. The largest caves were sometimes only 4 m in width and linear in orientation, with multiple chambers or rooftop access points penetrating as deeply as 30 m into the bedrock.

Rock shelters could also be as small as 20 sq m, but sometimes occurred in multiple chambers spanning over 130 m around the base of large sinkholes. In most cases the limited floor space of these sites only enabled the excavation of one or two test units measuring 0.5 to 1.0 sq m and most units were excavated well inside the exterior drip line, but not too close to the interior back wall of the shelter since few exceeded 1.5 m in height. Excavation of one rock shelter in Finegayan on coastal Guam yielded nine stratified Pre-Contact shallow hearths in one test unit, implying both sustained and repetitive use of this site for local resource collection and cooking over time. In contrast, the depth of most inland cave deposits rarely exceeded one m before encountering bedrock or consolidated roof fall.

Pre-Contact modifications to these sites were often challenging to detect because of later use, but low terracing, rough alignments, and crude flooring in the absence of historic artifacts were sometimes found to contain subsurface cooking hearths with Latte Period artifacts and midden materials. The presence of painted pictographs and pecked petroglyphs of anthropomorphic or animistic figures on a few cave walls in Tinian and Guam also denoted pan-archipelago Chamorro ritual use of these settings before Contact (Russell 1998).

Table 1. *Cave and Rock Shelter Site Data from Guam and Tinian*

Project Area	Site Type and (#)	Feature Type and (#)	Surface Artifacts	Test Unit (#) and Results
Guam Finegayan	Site 1672 Rock shelter (1)	Subsurface hearth (3)	Fire cracked rock, Latte Period pottery	(TU1) Metate, fire cracked rock, marine shell, shell fishhook, shell awl, terrestrial mollusk shell, Latte Period pottery, fish bone, fruit bat bone, dated carbon [II/3,II/4, II/7, III/8]
Guam Finegayan	Site 1674 Rock shelter (1)	Subsurface hearth (5)	Latte Period pottery	(TU1) Calcite bead, marine shell, Pre-Latte and Latte Period pottery, faunal bone, fruit bat bone, dated carbon [II/5, III/8]
Guam Finegayan	Site 1676 Rock shelter (4)	Subsurface hearth (1)	None	(TU2) Shell button, shell fishhook, bottle glass, Latte Period pottery, fish scales, fish bone, dated carbon [I/5]
Guam Finegayan	Site 1677 Rock shelter (1)	Subsurface hearth (9)	Latte Period pottery	(TU1) Glass, metal, marine shell, shell adze blank, Latte Period pottery, fish bone, faunal bone, human bone, dated carbon [IV, VII/10, VIII/12]
Guam Naval Magazine	Site T-8 Rock shelter (3), Cave (1)	Rock terrace (1)	None	(TU1) Marine shell, Latte Period pottery, dated carbon [II/1]
Guam Naval Magazine	Site T-16 Rock shelter (1)	Rock alignment (1)	None	(TU1) Marine shell, Latte Period pottery, lithic debitage, dated carbon [II/1]
Guam Naval Magazine	Site T-17 Cave (1)	None	Marine shell, Latte Period pottery,	(TU1) Marine shell, Latte Period pottery, dated carbon [I/2]
Guam Naval Magazine	Site T-19 Rock shelter (2)	Bedrock mortar (1)	Marine shell, Latte Period pottery, ground stone tool fragment, sling stone, glass, faunal bone	(TU1) Marine shell, Latte Period pottery, faunal bone, dated carbon [I/3]
Guam Waterfront Annex	Site T-42 Rock shelter (1)	Cobble hearth (1)	None	(TU1) Marine shell, Latte Period pottery, lithic debitage, dated carbon [I/2]
Guam Naval Magazine	Site T-51 Rock shelter (2), Cave (2)	None	Marine shell, Latte Period pottery	(TU1) Marine shell, Latte Period pottery, fire cracked rock, dated carbon [II/2]
Guam Naval Magazine	Site 1660 Rock shelter (1)	Graveled surface (1)	Marine shell, Latte Period pottery	(TU2) Marine shell, Latte Period pottery, lithic debitage, faunal bone, dated carbon [II, III, IV]
Guam Naval Magazine	Site 1670 Cave (1)	Cobble concentration (1)	Marine shell, Latte Period pottery	(TU1) Marine shell, Latte Period pottery, shell scraper, limestone cobble, faunal bone, dated carbon [I/2]
Guam Naval Magazine	Site 1671 Rock shelter (1)	Niche (1), wall (1), stepped floor (1)	None	(TU2) Marine shell, Latte Period pottery, lithic debitage, faunal bone, dated carbon [III/1]
Guam Naval Magazine	Site 1672 Rock shelter (1)	Walls (2), piles (2), terraces (2), subsurface hearths (2)	Marine shell, Latte Period pottery, copper screen, brass button, metal tube top, basalt adze, hammer stone	(TU1) Marine shell, Latte Period pottery, faunal bone, dated carbon [Feature B, Feature C]
Guam Naval Magazine	Site 1674 Cave (1)	Wall (1)	Marine shell, Latte Period pottery	(TU1) Marine shell, Latte Period pottery, faunal bone, fish bone, dated carbon [I/2]
Guam Naval Magazine	Site 1677 Cave (1)	Walls (2), piles (2), red anthropomorphic pictograph (1)	Marine shell, Latte Period pottery, wire, ordnance canister, saw blade, rubber tire fragments, baling wire, glass jar, sheet metal, Japanese paper	(TU2) Marine shell, Latte Period pottery, lithic debitage, faunal bone, fire cracked rock, dated carbon [Feature H I/2] (TU3) Marine shell, Latte Period pottery, faunal bone, human bone, glass, nail, human bone, dated carbon [Feature A IV/1, IV/4]

Table 1 *continued*

Project Area	Site Type and (#)	Feature Type and (#)	Surface Artifacts	Test Unit (#) and Results
Guam Naval Magazine	Site 1678 Cave (1)	Pile (1), subsurface hearths (2)	Marine shell, Latte Period pottery, sling stone	(TU1) Marine shell, Latte Period pottery, faunal bone, dated carbon [Feature II/3] (TU2) Dated carbon [III/1]
Guam Naval Magazine	Site 1682 Cave (1)	None	Marine shell, Latte Period pottery, mortar and pestle, rebar in concrete, plastic, metal, soft drink cans	(TU1) Marine shell, Latte Period pottery, faunal bone, dated carbon [II, III/1, IV]
Tinian VOA	Site 655 Rock Shelter (3)	None	Japanese bottles, Japanese ceramics, metal cup, Latte Period pottery	(TU1) Lithic debitage, marine shell, coral, Latte Period pottery, human bone, dated carbon [I/4]
Tinian VOA	Site 658 Rock Shelter (1)	Subsurface hearth (1)	Latte Period pottery	(TU1) Burned metal, fire cracked rock, marine shell, Pre-Latte and Latte Period pottery, faunal and human bone, dated carbon [I/4, III/1, IV/1, V/1]
Tinian LBA	Site 1121 Cave (3)	Rock mounds and walls (31), pavements, steps, and detonation scars	Glass fragments, bottles, Japanese coins, bullets, metal buttons, buckles, cans, cooking equipment, leather shoes, wood, gas mask, fuse cord, electric drill, tools, a crucifix, ordnance, human and cow bone, earthenware, U.S. batteries and equipment, Latte Period pottery	(TU1) Glass and metal fragments, shell button, lithic debitage, marine shell, urchin spines, faunal bone, Latte Period pottery, dated carbon [I/6] (TU3) Glass and metal fragments, lithic debitage, marine shell, urchin spines, faunal bone, Latte Period pottery, dated carbon [I/4]
Tinian LBA	Site 1049 Cave (8), Overhang (22)	Rock walls and piles (105) and petroglyph, subsurface hearth (2)	Japanese bottles, glass candle holder, whetstone, milled lumber, chopstick, metal buckle and tools, leather shoe, metal cooking equipment, shrapnel, Latte Period pottery	(TU1, Feature 2) Glass and metal fragments, metal buckle, lithic debitage, marine shell, crab shell, shell beads, faunal bone, Pre-Latte and Latte Period pottery, dated carbon [I/2, I/3, III/1, III/2, III/3, subfeature 2.2, IV/1, IV/3, IV/4, IV/6] (TU2, Feature 6) Glass and metal fragments, lithic debitage, marine shell, crab shell, faunal bone, Latte Period pottery, dated carbon [I/3] (TU5, Feature 30) Glass and metal fragments, lithic debitage, marine shell, crab shell, faunal bone, Latte Period pottery, dated carbon [II/1] (TU9, Feature 61) Porcelain, metal objects, lithic debitage, marine shell, fish bone, faunal bone, Latte Period pottery, dated carbon [III/1, V/1] (TU10, Feature 68) Porcelain, ginger jar, metal objects, lithic debitage, marine shell, shell adze, shell bead, fish bone, faunal bone, Latte Period pottery, dated carbon [III/1, IV/1] (TU11, Feature 71) Bottle, metal objects, lithic debitage, basalt pestle, marine shell, faunal bone, Latte Period pottery, dated carbon [II/1] (TU13, Feature 78) Soy bottle, glass medicine dropper top, straight razor, hairpin, metal objects, lithic debitage, sling stone, marine shell, faunal bone, Latte Period pottery, dated carbon [II/1]
Tinian LBA	Site 1189 Overhang (2)	Rock walls and piles (3) and terrace	Latte Period pottery	(TU2, Burial) Glass and metal fragments, lithic debitage, marine shell, crab shell, faunal bone, Latte Period pottery, dated carbon [II/1], dated human bone [II/1]

Complicating many of these settings was surface evidence of modifications attributed to WWII-era refuge activities by either civilians and/or Japanese military (see Table 1), and several appeared to have been used by stragglers after the war (Dixon, Gilda, *et al.* 2012). Surface modifications included cobble or fallen rock walls to seal off or obscure entrances for emergency defense, piles of raw materials for future use, and candle niches, hearths, low steps, pavements, and terraces for daily use inside the living area.

LAND USE DATA FROM CAVES AND ROCK SHELTERS ON GUAM AND TINIAN

Radiocarbon dating of the 19 sites on Guam (with 34 dated contexts) and 5 sites on Tinian (with 31 dated contexts) suggests some interesting trends in pre-Contact Chamorro land use not always detected by excavation of coastal Pre-Latte and inland Latte Period habitation sites alone (Table 2). Identification of the radiocarbon dated charcoal, analyses of plant phytoliths and pollen in dated soils, and

Table 2. *Radiocarbon Data from Cave and Rock Shelter Sites on Guam and Tinian.*

Lab. No.	Provenience	Dated Material	δ13C ‰	Conventional 14C age	Calibrated Age	Probability Distribution
Guam Waterfront Annex						
Beta-143791**	3-1722, TU 1	*Intsia bijuga*	–25.8	730±50	AD 1206–1318 AD 1352–1390	0.877 0.123
Beta-143790**	3-1722, TU 2	*Casuarina equisetifolia*	–25.0	1270±60	AD 655–886	1.000
Beta-169068**	T-42, TU 1, I/2	*Cocos nucifera* nutshell	–23.6	870±40	AD 1043–1104 AD 1118–1254	0.243 0.757
Guam Finegayan						
Beta-143782**	8-1672, TU 1, II/3	*Cocos nucifera* nutshell	–22.6	1090±40	AD 781–787 AD 876–1023	0.005 0.995
Beta-143783**	8-1672, TU 1, II/4	*Intisia bijuga*	–24.6	890±100	AD 970–1288	1.000
Beta-143784**	8-1672, TU 1, III/7	UnID wood	–26.2	1270±40	AD 662–778 AD 790–832 AD 836–867	0.858 0.082 0.060
Beta-143785**	8-1672, TU 1, III/8	Cf. *Maytenus thompsonii*	–24.7	160±50	AD 1662–1891 AD 1908–1950	0.834 0.166
Beta-143779**	8-1674, TU 1, II/5, Subfeature C	*Casuarina equisetifolia*	–29.0	2160±40	360–92 BC	1.000
Beta-143781**	8-1674, TU 1, III/8	*Casuarina equisetifolia*	–27.1	2560±40	809–731 BC 691–660 BC 650–544 BC	0.538 0.109 0.353
Beta-143778**	8-1676, TU 2, I/5	*Cocos nucifera* nutshell	–23.2	180±30	AD 1653–1695 AD 1726–1814 AD 1836–1844 AD 1851–1869 AD 1872–1876 AD 1917–1950	0.207 0.569 0.009 0.024 0.005 0.186
Beta-143786**	8-1677, TU 1, VI/9	UnID wood	–24.2	2190±40	379–162 BC 129–120 BC	0.992 0.008
Beta-143787**	8-1677, TU 1, VII/10	Cf. *Syzygium* sp.	–26.4	2190±40	379–162 BC 129–120 BC	0.992 0.008
Beta-143788**	8-1677, TU 1, VIII/12	Cf. *Maytenus thompsonii*	–28.3	2560±40	809–731 BC 691–660 BC 650–544 BC	0.538 0.109 0.353
Guam Naval Magazine						
Beta-169064**	T-8, TU 1, II/1	*Cocos nucifera* nutshell	–23.4	610±40	AD 1291–1408	1.000
Beta-169065*	T-16, TU 1, II/1	*Cocos nucifera* nutshell	–25.7	1150±60	AD 718–742 AD 766–1015	0.032 0.968
Beta-169066**	T-17, TU 1, I/2	*Cocos nucifera* nutshell	–24.4	620±40	AD 1288–1405	1.000
Beta-169067**	T-19, TU 1, I/3	*Cocos nucifera* nutshell	–24.0	820±40	AD 1058–1064 AD 1068–1072 AD 1154–1277	0.006 0.003 0.990
Beta-169069*	T-51, TU 1, II/1	*Cocos nucifera* nutshell	–24.1	490±60	AD 1301–1367 AD1382–1516 AD 1595–1618	0.185 0.786 0.029
Beta-134273**	02-1660, TU 2, II Feature B	Bulk soil	–21.8	660±40	AD 1273–1330 AD 1339–1397	0.497 0.503
1Beta-34274*	02-1660, TU 2, III Feature B	*Cocos nucifera* nutshell	–26.2	1150±60	AD 718–742 AD 766–1015	0.032 0.968

Table 2 *continued*

Lab. No.	Provenience	Dated Material	δ^{13}C ‰	Conventional ^{14}C age	Calibrated Age	Probability Distribution
Beta-134275**	02-1660, TU 2, IV Feature B	Bulk soil	–18.9	2430±50	756–679 BC 671–605 BC 599–403 BC	0.221 0.143 0.636
Beta-134285**	09-1670, TU 1, I/2	*Cocos nucifera* nutshell	–26.8	420±40	AD 1420–1523 AD 1572–1630	0.823 0.177
Beta-134288**	09-1671, TU 2, III/1	*Cocos nucifera* nutshell	–25.3	670±40	AD 1268–1327 AD 1342–1395	0.543 0.457
Beta-134279**	09-1672, TU 1, II/1, Feature C	*Cocos nucifera* nutshell	–25.0	830±40	AD 1052–1080 AD1152–1274	0.043 0.957
Beta-134280*	09-1672, TU 1, II/1, Feature E	*Cocos nucifera* nutshell	–24.7	450±80	AD 1316–1355 AD1389–1642	0.067 0.933
Beta-134284**	09-1674, TU 1, I/2	*Cocos nucifera* nutshell	–25.2	610±40	AD 1291–1408	1.000
Beta-134281**	09-1677, TU 2, I/2, Feature A	*Cocos nucifera* nutshell	–24.3	1050±40	AD 892–1035	1.000
Beta-134282**	09-1677, TU 3, IV/1, Feature A	*Cocos nucifera* nutshell	–29.0	980±40	AD 992–1155	1.000
Beta-134283**	09-1677, TU 3, IV/4, Feature A	*Cocos nucifera* nutshell	–24.6	710±40	AD 1224–1235 AD 1241–1315 AD 1356–1388	0.020 0.794 0.185
Beta-134286*	09-1678, TU 1, 2, Subfeature 2	UnID wood	–26.0	180±80	AD 1522–1574 AD 1627–1950	0.048 0.952
Beta-134287**	09-1678, TU 2, III/1	*Cocos nucifera* nutshell	–23.3	850±40	AD 1046–1091 AD 1121–1140 AD 1147–1265	0.119 0.035 0.845
Beta-134289*	09-1682, TU 1, II /1	*Cocos nucifera* nutshell	–23.8	980±150	AD 712–744 AD 765–1285	0.017 0.983
Beta-134290*	09-1682, TU 1, III/1	*Cocos nucifera* nutshell	–24.5	890±120	AD 893–933 AD 936–1300 AD 1368–1381	0.025 0.969 0.006
Beta-134291*	09-1682, TU 1, IV	*Cocos nucifera* nutshell	–25.1	460±80	AD 1311–1359 AD 1387–1638	0.098 0.902
Tinian VOA						
Wk-7274**	TN-1-655, TU 1, I/4	*Cocos nucifera* nutshell	–24.7	1948±67	105 BC–AD 232	1.000
Wk-7269**	TN-1-658, TU 1, III/1	*Cocos nucifera* nutshell	–24.9	606±56	AD 1284–1419	1.000
Wk-7270*	TN-1-658, TU 1, Subfeature A	*Tournefortia argentea*	–26.9	2048±69	350–310 BC 209 BC–AD 86 AD 107–119	0.030 0.965 0.006
Wk-7271*	TN-1-658, TU 1, IV/1	*Hibiscus tiliaceus*	–26.0	1654±56	AD 253–304 AD 313–539	0.114 0.886
Wk-7272*	TN-1-658, TU 1, V/1	*Cocos nucifera* nutshell	–23.5	2145±64	374–40 BC	1.000
Tinian LBA						
Beta-146170***	1049, TU 1, I/2, Subfeature 2.1 (8–28 cmbs)	UnID wood	–25.7	640±40	AD 1282–1399	1.000
Beta-139953*	1049, TU 1, I/2, Subfeature 2.1 (25-29 cmbs)	Cf. *Morinda citrifolia*	–27.4	640±40	AD 1282–1399	1.000
Beta-146171*	1049, TU 1, I/3, Subfeature 2.1 (28–32 cmbs)	UnID wood	–24.9	760±70	AD 1050–1083 AD 1126–1135 AD 1151–1322 AD 1347–1392	0.029 0.006 0.883 0.082
Beta-139954**	1049, TU 1, III/1 Feature 2	*Hybiscus tiliaceus*	–25.9	630±40	AD 1285–1401	1.000

Table 2 *continued*

Lab. No.	Provenience	Dated Material	$\delta^{13}C$ ‰	Conventional ^{14}C age	Calibrated Age	Probability Distribution
Beta-146172*	1049, TU 1, III/2 Feature 2	UnID wood	–25.5	530±100	AD 1274–1524 AD 1558–1631	0.924 0.076
Beta-146173**	1049, TU 1, III/3 Feature 2	UnID wood	–21.3	700±50	AD 1223–1325 AD 1344–1394	0.701 0.299
Beta-146169**	1049, TU 1, Subfeature 2.2 (29-44 cmbs)	UnID wood	–26.9	880±50	AD 1035–1248	1.000
Beta-146177*	1049, TU 1, Subfeature 2.2 (39 cmbs)	UnID wood	–27.6	670±60	AD 1254–1410	1.000
Beta-146174**	1049, TU 1, IV/1 Feature 2	UnID wood	–25.7	1070±50	AD 778–790 AD 808–816 AD 826–841 AD 862–1041 AD 1107–1116	0.010 0.004 0.009 0.972 0.005
Beta-139955**	1049, TU 1, IV/3 Feature 2	*Hybiscus tiliaceus, Psychotira* sp.	–26.6	740±40	AD 1215–1301 AD 1368–1381	0.970 0.030
Beta-146178*	1049, TU 1, IV/3 Feature 2	UnID wood	–26.1	2290±50	453–446 BC 430–200 BC	0.003 0.997
Beta-146179*	1049, TU 1, IV/4 Feature 2	UnID wood	–27.7	2510±40	796–509 BC	1.000
Beta-146175**	1049, TU 1, IV/6 Feature 2	UnID wood	–26.2	690±50	AD 1228–1231 1246–1332 1337–1398	0.003 0.628 0.369
Beta-146176**	1049, TU 1, IV/6 Feature 2	UnID wood	–26.4	1010±50	AD 900–921 AD 950–1156	0.039 0.961
Beta-146181**	1049, TU 2, I/3 Feature 6	UnID wood	–26.6	1010±50	AD 900–921 AD 950–1156	0.039 0.961
Beta-146180*	1049, TU 5, II/1 Feature 30	UnID wood	–25.9	590±60	AD 1287–1428	1.000
Beta-146182**	1049, TU 9, III/2 Feature 61	UnID wood	–25.2	1130±50	AD 773–997 AD 1006–1011	0.992 0.008
Beta-146183***	1049, TU 9, V/1 Feature 61	*Cocos nucifera* nutshell	–13.6	2290±80	744–686 BC 665–644 BC 551–153 BC 137–114 BC	0.032 0.010 0.949 0.009
Beta-139956**	1049, TU 10, III/3 Feature 68	*Cocos nucifera* nutshell	–25.8	1740±30	AD 237–384	1.000
Beta-146185**	1049, TU 10, IV/1 Feature 68	*Cocos nucifera* nutshell	–26.3	1830±50	AD 72–262 AD 276–329	0.895 0.105
Beta-146184**	1049, TU 11, II/1 Feature 71	UnID wood	–19.1	1270±50	AD 660–781 AD 787–877	0.766 0.234
Beta-146188**	1049, TU 13, II/1 Feature 78	*Cocos nucifera* nutshell	–27.4	350±50	AD 1452–1642	1.000
Beta-150512**	1121, TU 1, I/6, Feature 2	*Cocos nucifera* nutshell	–25.2	1300±40	AD 648–776 AD 793–801 AD 848–851	0.993 0.005 0.002
Beta-150513*	1121, TU 3, I/4, Feature 6i	UnID wood	–26.4	340±80	AD 1422–1677 AD 1765–1772 AD 1776–1800 AD 1940–1950	0.963 0.004 0.026 0.008
Beta-146024**	1189, TU 2, II/1, Burial	Bone collagen	–16.6	2280±40	404–349 BC 316–208 BC	0.506 0.494
Beta-150514**	1189, TU 2, II/1, Burial	UnID wood	–22.4	1710±40	AD 242–409	1.000

* Standard radiocarbon age with extended counting, calibrated at 2 σ, 95.4% probability using Calib 7.0 (Stuiver and Reimer 1993, 2005).

** Standard accelerated mass spectrometry (AMS) radiocarbon age with extended counting, calibrated at 2 σ, 95.4% probability using Calib 7.0 (Stuiver and Reimer 1993, 2005).

*** Standard radiocarbon age, calibrated at 2 σ, 95.4% probability using Calib 7.0 (Stuiver and Reimer 1993, 2005) the identification of starch residues adhering to temporally diagnostic ceramics provide important mileposts for these trends.

FINEGAYAN GUAM

Rock shelters at Finegayan appear to have been among the first to be used in northern Guam by the end of the Early Pre-Latte Period *ca.* 809–544 BC at sites 1674 and 1677 (see Table 2), although their setting on the rocky coast line could hardly be optimal (Hunter-Anderson *et al.* 2001), especially since nearby Ague Cove was too narrow and steep to entice earlier settlers with better options up the coast at Ritidian (Carson and Peterson 2011, 2012). Especially noteworthy were ceramic sherds excavated from Level III/8 in TU1 at site 1674 (Figure 2) which contained linear impressed designs joined by zig zags and filled with lime, diagnostic of the terminal Early Pre-Latte Period. Mat impressed sherds found at a higher elevation in Subfeature C of Level II/5 in TU1 date to 360–92 BC, stylistically diagnostic of the Intermediate Pre-Latte Period (Moore in Hunter-Anderson *et al.* 2001).

Perhaps more significant for understanding regional trends of settlement in the Marianas archipelago is the observation that this period likely signifies the first time at which the modern coast and reef of Guam became exposed from the last sea level high stand approximately 1.8 m higher than today (Dickinson 2001), before which these rock shelters at 3 m above mean sea level would have been battered by high surf after their formation by wave action. Deeper water marine resources would also have differed from those available after exposure of the lagoon environment favored by modern fishermen and collectors (Amesbury 2012), as the small shell fishhooks and fish bones found in Pre-Latte contexts attest (see Table 1).

Later use of these same two rock shelters during the last few centuries BC suggests that they continued to be favored locales for processing and cooking collected reef fish and shellfish during the Intermediate Pre-Latte Period. Carbon analysis in advance of radiocarbon dating identified *Casuarina equisetifolia* (Polynesian ironwood), Cf. *Syzygium* sp. (the myrtle family), and Cf. *Maytenus thompsonii* (the Rhamnaceae family) indicating a preference for nearby coastal strand trees and shrubs as firewood rather than the *Cocos nucifera* (coconut) shell preferred by occupants of the other rock shelters closer to the Ague Cove.

Analysis of plant phytoliths excavated from the Pre-Latte soils in these four coastal rock shelters also revealed the presence of *Musa* sp. (banana) at site 1677, perhaps transported to the site from above or beyond the cove. Analysis of residues adhering to ceramics recovered from these sites yielded the remains of fish scales and cooked *Colocasia esculenta* (taro) leaf at site 1674, the latter perhaps used as a cooking lid for ceramics or wrapping of baked goods. *Isognomon* shell fishhooks at sites 1672 and 1677 (Figure 3) suggest what reef resources may have been baked.

In contrast to sites 1674 and 1677 with dated evidence of Early to Intermediate Pre-Latte occupation, rock shelter sites 1672 (Figure 4) and 1676 yielded radiocarbon dated *Cocos nucifera* shell (see Table 2) and ceramics of the Transitional Pre-Latte and Latte Period, signifying a shift from earlier sites which may have become unsuitable as fishing camps. In the uppermost level of TU1 at site 1672 (Figures 5 and 6), aragonite fragments from the cooking of whole shellfish suggest a shift in culinary preference, or more likely the increased access to shallow beach settings as sea levels stabilized (Hunter-Anderson *et al.* 2001).

Also significant to note in this general setting is the presence of shallow bedrock grinding stations and probable Latte Period pictographs at nearby rock shelter site

Figure 2. Lime-filled Ceramics, Site 1674 (after Hunter-Anderson *et al.* 2001: 149)

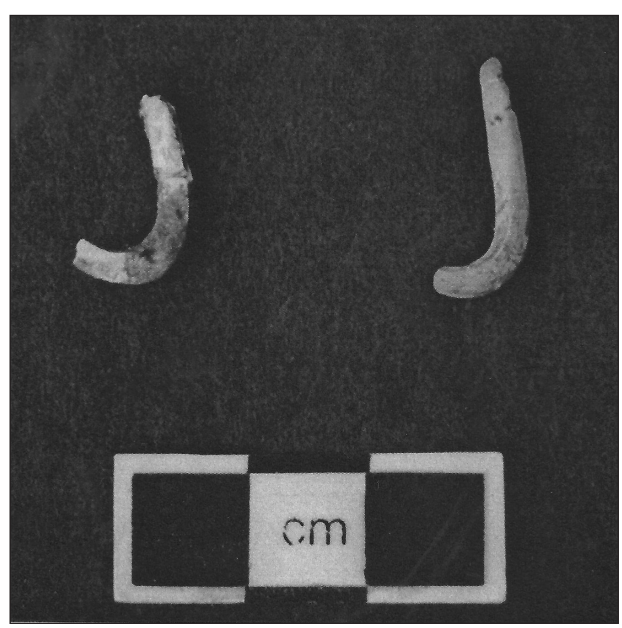


Figure 3. *Isognomon* Shell Fishhooks, Sites 1672and 1677 (after Hunter-Anderson *et al.* 2001: 171)

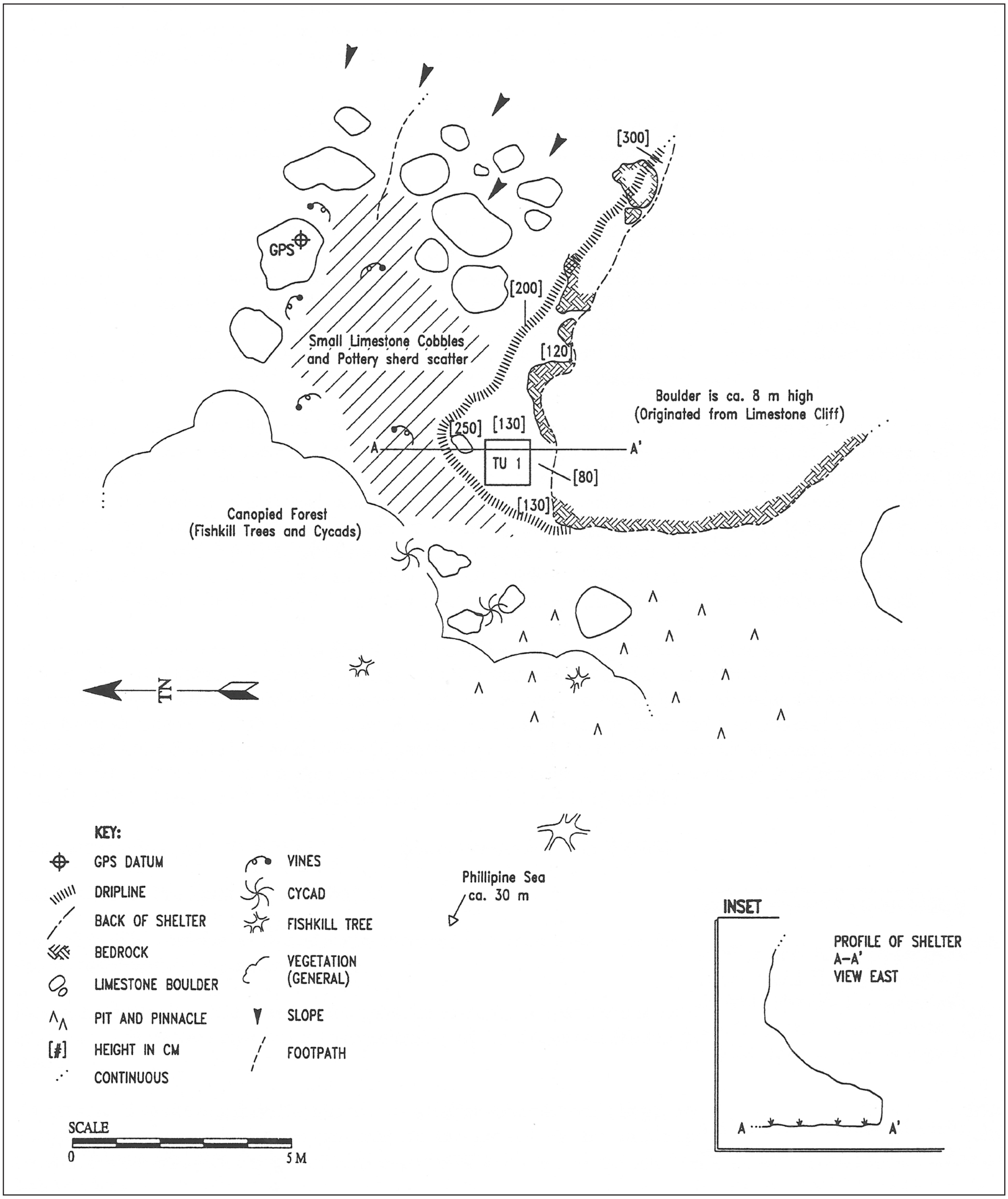


Figure 4. Site 1672 in Finegayan, Guam (after Hunter-Anderson *et al.* 2001:A-12)

1675, including white colored headless anthropomorphic figures and red colored hand prints, plus a possible Contact period dry-stacked cobble wall climbing the slope at open air site 1673. While no *latte* sets were recorded at Ague Cove, the setting is roughly equidistant from Hila'an to the south and Haputo to the north, both substantial embayments with major Latte period villages under a half days walk away.

NAVAL MUNITIONS SITE AND NAVAL BASE GUAM

At the NMS located well inland on south central Guam, 13 caves and rock shelters were excavated during the two projects under examination here (Allen *et al.* 2002; Dixon *et al.* 2004), although many more surely exist in this rugged and sometimes karst terrain. Unlike coastal northern Guam, only one rock shelter site 1660 had evidence of Early to

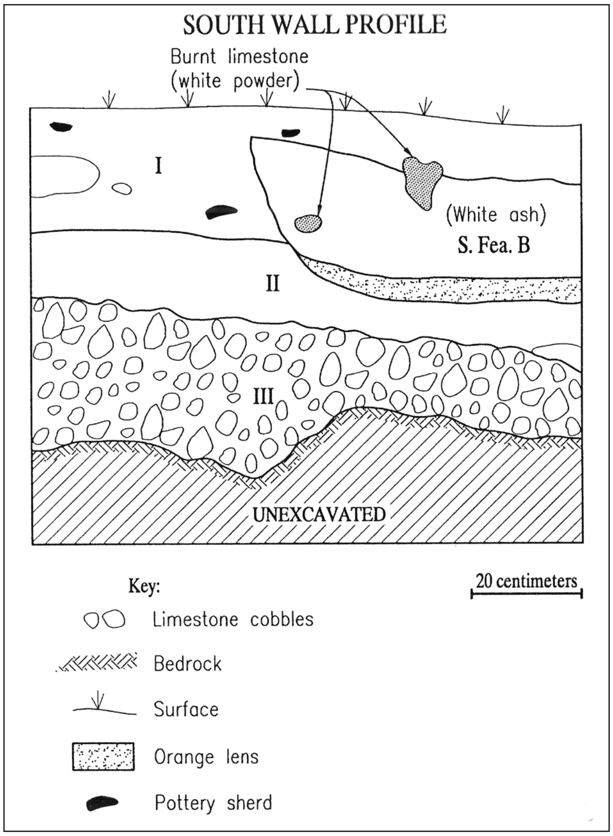


Figure 5. TU1 South Profile, Site 1672 (after Hunter-Anderson *et al.* 2001: 83)

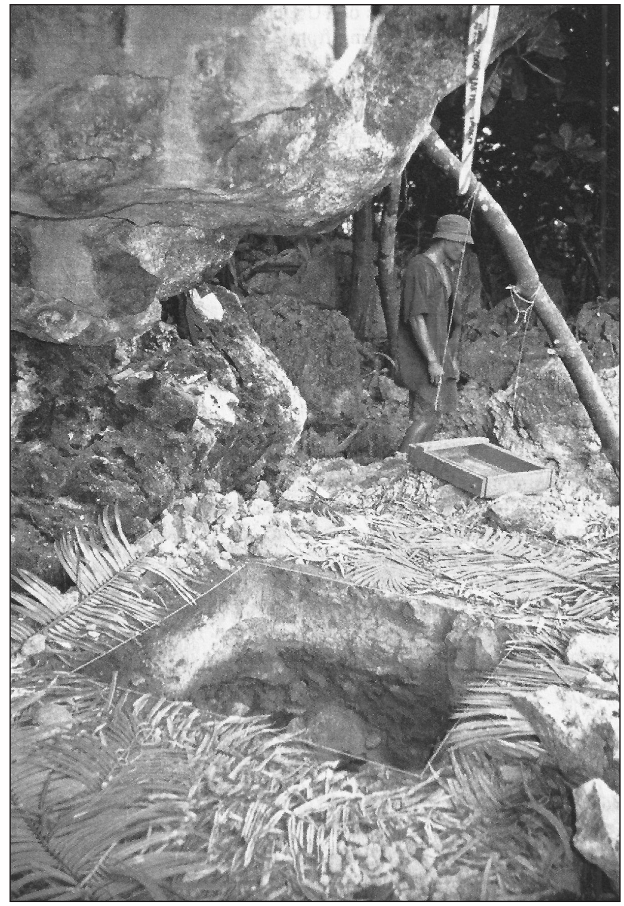


Figure 6. TU1 View to the Southwest, Site 1672 (after Hunter-Anderson *et al.* 2001: 85)

Intermediate Pre-Latte occupation circa 756–403 BC (see Table 2). The dated hearth suggests an overnight visit given the half day walk from the coast, and the site appears to have been attractive enough to be returned to from coastal settlements in the early Latte Period at least twice with two dates of AD 718–1015 and AD 1273–1397. Human bone fragments recovered from cave site 1677 circa AD 992–1155 indicate that the Pre-Latte custom of rock shelter burials noted in coastal settings of Finegayan persisted inland for a while too.

As with all the caves and rock shelters dated to the early Latte Period circa AD 1000 in the NMS (sites T-16, 1660, 1677, and 1682), pottery, marine shell, small faunal bones, and lithic debitage were present (see Table 1), again suggesting well planned and provisioned visits from coastal settlements. This viewpoint should be tempered, however, with recognition that not long after AD 1200 the entire area around what is today Fena reservoir became probably the most densely occupied zone in the Marianas archipelago, judging from the sheer number and size of *latte* settlements recorded since the post-WWII construction of the Naval Magazine. Indeed, excavation at the Lost River Village with 33 *latte* sets located north of the reservoir suggests that permanent inland habitation may have begun at the very beginning of the Latte Period circa AD 800 (Dixon and Gilda 2012). Inland caves and rock shelters in south central Guam would then have shifted from being isolated overnight camps for coastal residents to being a more integral part of permanent settlements and agricultural fields situated on ridge tops overlooking alluvial soils and wetland settings around springs such as Bonya and Almagosa, and along drainages such as the Maulap, Maemong, and Maagas rivers (Dixon, Walker, *et al.* 2011). All 13 sites occupied after AD 1200 (including the four occupied earlier) contain not only pottery, marine shell, small faunal bones of native monitor lizard and birds, and lithic debitage found in early Latte Period sites, but also shell scrapers for processing tubers and corms, basalt adzes, hammer stones, mortars and pestles, fire cracked rock from earth oven use, fish bones perhaps from fresh water catches, and even sling stones suggesting conflict or bird hunting. Marine shell weights measured from these inland sites show a predominance of bivalves over gastropods, as would be expected as both Apra Harbor and Pago Bay experienced increased siltation with sea level stability and stream runoff from agriculture over time (Amesbury 2007).

Analysis of pollen from soil samples excavated every 10 cm in TU2 at rock shelter site 1660 found fern spores, *Alocasia* or wild taro, and *Cocos nucifera* or coconut in Early to Intermediate Pre-Latte Period Layer IV that had charcoal radiocarbon dated to 756–403 BC (see Table 2). The latter two species are probably native to Guam although they could have been propagated by early farmers (Allen *et al*. 2002). At the beginning of the Latte Period from Layer III with charcoal dated to AD 718–1015, grass pollen increased as wild taro and fern spores decreased, suggesting clearing and farming of the nearby wetland sinkhole environment. In the later Latte Period Layer II with charcoal radiocarbon dated to AD 1273–1397, *Alocasia* and most tree pollens are almost non-existent, while undated Layer I contained an increase in *Pandanus* or screw pine and a wider variety of grasses, vine, and fern spores as the nearby wetland may have been abandoned after Contact.

It is perplexing to note that early Spanish chroniclers of late 17th century Guam (Coomans 1997; Garcia 1980) do not mention the densely inhabited interior, and instead spread an interpretation undoubtedly propagated by coastal inhabitants they hoped to convert that inland inhabitants or *mangachanges* were of inferior social status (Russell 1998). Since *latte* sets at inland sites such as Pulantat were even larger than those recorded at coastal village sites such as Tumon (Reinman 1977), it seems more likely this perspective reflected the political agenda of certain coastal families and clans desirous of Spanish influence. Other possible causes for abandoning the interior might have been climatic fluctuations causing serious drought, the effects of infectious diseases introduced after AD 1521, and the attraction of coastal trade with European vessels (Quimby 2011). Indeed, of the 13 cave and rock shelter sites recorded in the NMS, only one (site 1678) has a radiocarbon dated context after AD 1668, while coastal Finegayan has two Contact Period sites (1672 and 1676), one with a *metate*.

After Spanish Colonial settlement of Agana and a few villages around the coast, the NMS then became an area only used for small farms and ranches or *lanchos*, sparsely inhabited as limited wage labor was monopolized by coastal families into the early 20th century when the Americans arrived in 1898. This pattern of land use intensifies during WWII when Chamorro families fled to south central Guam to avoid Japanese occupation demands and later violence, and it is ironically the same area that Japanese military stragglers fled to avoid American and civilian justice after the war (Dixon, Gilda, *et al*. 2012). Many of the surface modifications noted in the caves and rock shelters of the NMS are likely constructed by Japanese soldiers attempting to avoid detection, as the cooking equipment, metal tools, glass bottles, and military clothing lying inside these sites indicate (see Table 1).

Guam Waterfront

Occupation of rock shelters overlooking the Outer Apra Harbor within the Guam Waterfront Annex appears to have begun after Pre-Latte Period sea level stabilization in AD 655–886 from TU1 in site 3–1722 (Hunter-Anderson *et al*. 2001). One rock shelter with hearth charcoal dated to AD 1043–1254 at site T-42 on Orote Peninsula in Naval Base Guam contains a later assemblage at the beginning of the Latte Period (Dixon *et al*. 2004). Even later occupation of TU2 at site 3–1722 dates to AD 1206–1390, indicating continued patterns of land use well into the Latte Period.

Tinian Voice of America

At former VOA Area B situated just above the west coast of Tinian, two rock shelters were excavated within the limestone outcrop located behind a series of small Latte Period habitations at sites 655 and 658 (Dixon *et al*. 1999), both short walking distance from a pocket beach at Dumpcoke Bay, but today only accessible by rope down a steep cliff line. Burned coconut shell from Layer V of TU1 at site 658 (or Feature A of temporary site B42 in Figures 7 and 8) yielded a radiocarbon date of 374–40 BC, while charcoal from native shrub *Hibiscus tiliaceus* in Layer IV yielded a date of AD 253–539, and charcoal of the shrub *Tournefortia argenta* or *Junig* in Chamorro yielded a date of 350 BC–AD 119 from hearth Subfeature A above. TU1 at site 655 also yielded a burned coconut shell radiocarbon dated to 105 BC–AD 232.

Material remains in both Intermediate to Transitional Pre-Latte Period sites included Pre-Latte pottery, marine shell, coral, basalt adzes (Figure 9), scoria abraders and basalt mortars (Figure 10), lithic debitage, fire cracked rock, faunal bone (including two pig tusks presumed to be intrusive at 25 cmbs in site 658), and disarticulated human bone. The human bone in several levels implies early and perhaps repeated burials as has been detected at early caves and rock shelters in coastal and inland Guam, although later disturbances at site 658 are likely since it had surface evidence of WWII refuge activities (see Table 1) and the radiocarbon dates do not form a perfectly vertical chronological sequence (see Table 2).

A Latte Period reoccupation of site 658 is also evident in Layer III of TU1 with a burned coconut shell yielding a radiocarbon date of AD 1284–1419 and Latte Period pottery with more human bone found in stratigraphic association with a small hearth and discarded ash lenses from repeated cooking episodes. Given that this rock shelter is located within 50 m upslope from two *latte* sets, its use as an ancillary cooking feature should not be surprising. Fire cracked rock often found on the ashy surface of rock shelters in the Mariana Islands is taken to imply use of the bedrock face as part of an earth oven, given its heat retention and reflection capacity.

Unlike the pattern observed in southern Guam (Amesbury 1999), the percentage of bivalve weights in the marine shell assemblage of site 658 dropped from the Pre-Latte Period to none in Latte Period deposits, while the percentage of gastropod weights grew over time. Nearby

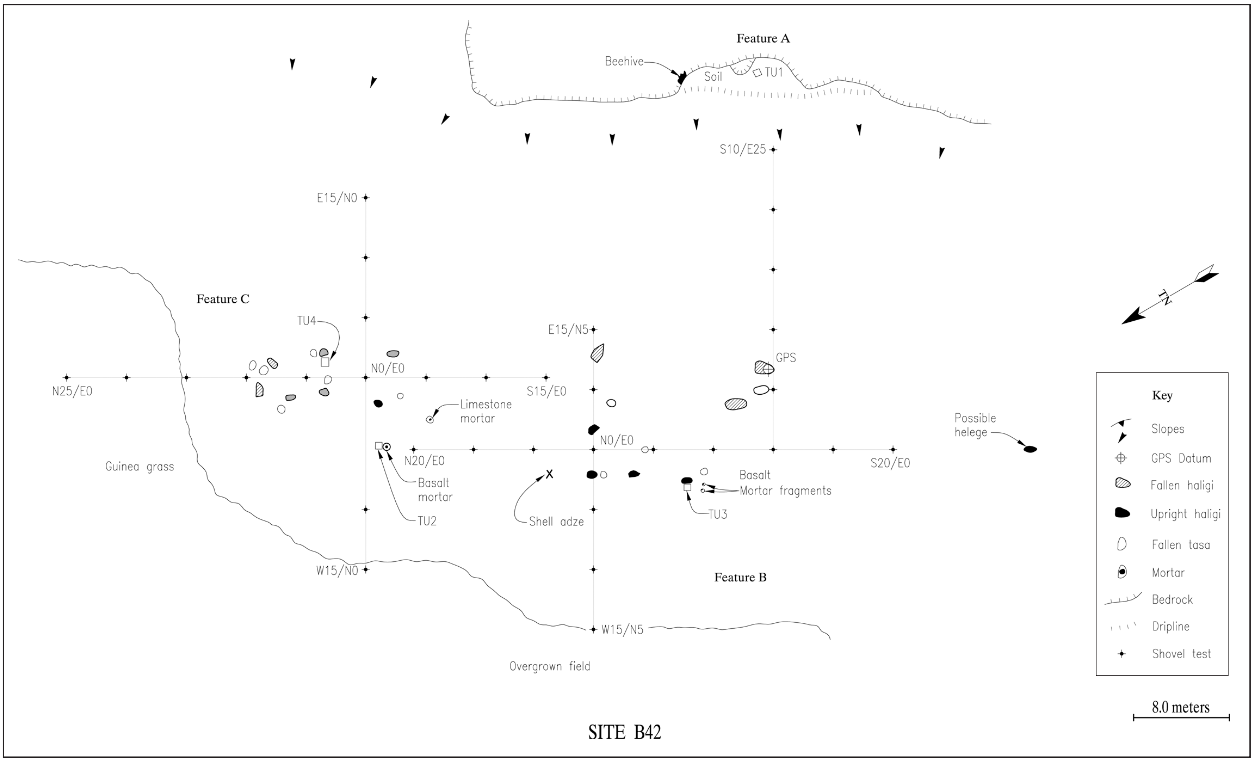


Figure 7. Site 658 in Tinian VOA (after Dixon *et al*. 2000:A-180)

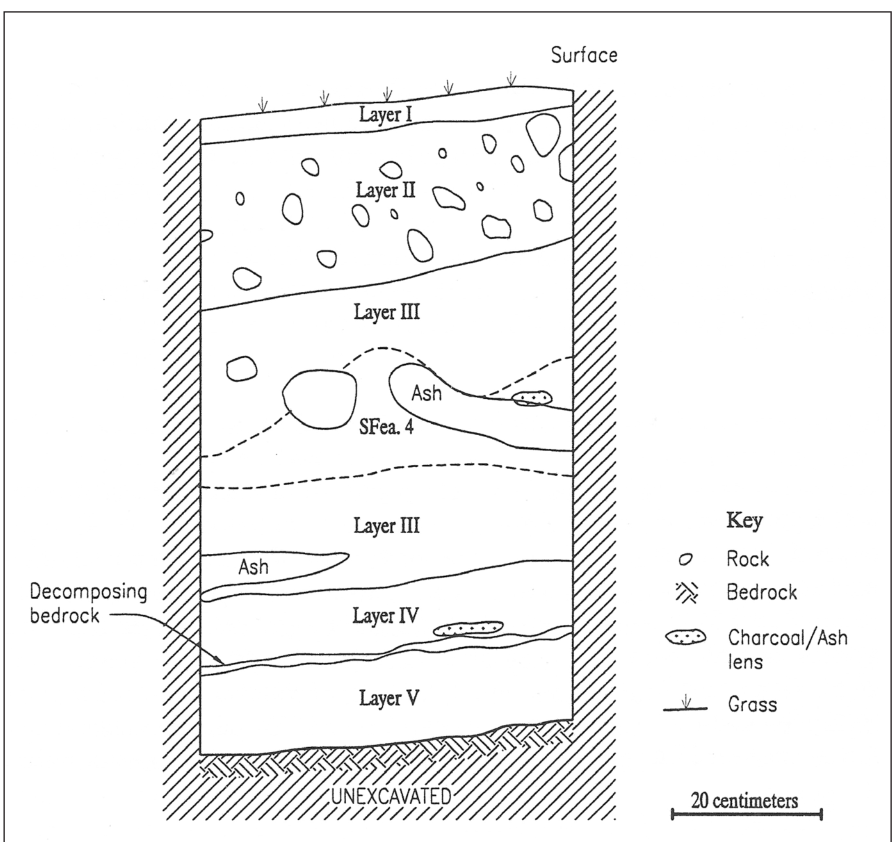


Figure 8. TU1, West Profile, Site 658 (after Dixon *et al*. 2000: 99)

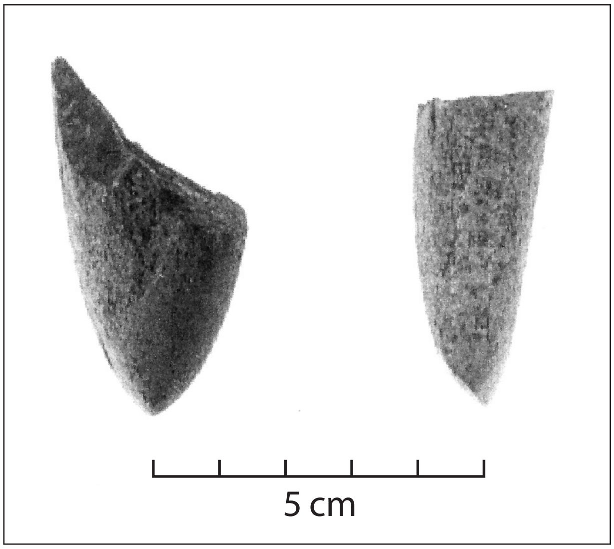


Figure 9. Basalt Adzes, Site 658 (after Dixon *et al.* 2000: 131)

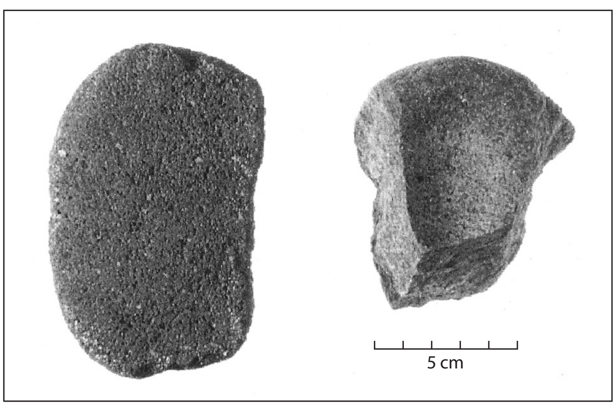


Figure 10. Scoria Abrader and Basalt Mortar, Site 658 (after Dixon *et al.* 2000: 129)

Dumpcoke Bay is quite narrow today and barely supports a reef not far offshore, but very little siltation is evident in the absence of riverine alluviation, so bivalve habitat was likely minimal during the Pre-Latte Period. Several large intact *Tridacna* bivalves on the surface of the site suggest their use as adze raw materials during the Latte Period, so their absence in later food midden may reflect their increased importance as tools over time.

TINIAN LEASE BACK AREA

The Lease Back Area surveyed in central Tinian (Allen *et al.* 2002) is largely inland but spans approximately 10 km from west to east coasts, so cave site 1121 and overhang site 1189 are located in Puntan Diapblo overlooking the southwest coast, while cave site 1049 is located in Laderan Masalog overlooking the northeast coast, all three a relatively easy walk from the rugged shore.

One burial from TU2 Layer II/1 at site 1189 yielded bone collagen with an Intermediate Pre-Latte radiocarbon date of 404–208 BC/410–340 BC (see Table 2) and a $^{13}C/^{12}C$ ratio of –16.6% which is indicative of a diet rich in marine resources and/or C^4 cycle plants. Collagen extraction was approved by the U.S. Navy and CNMI Historic Preservation Office. Unidentified wood charcoal found in the same layer yielded a date of AD 242–409 indicating the wood was a later root or intrusive material not associated with the burial. Caves and rock shelters in both islands are habitats for large terrestrial coconut crabs that often disturb the loose ashy surface during feeding, as do modern crab hunters.

A more securely dated Transitional Pre-Latte deposit was encountered in Layer I/6 of Feature 2, a rocky floor pavement found in TU2 at site 1121 with coconut shell radiocarbon dated to AD 648–851, while a higher floor paving in Feature 6i above yielded unidentified charcoal with a Latte Period radiocarbon date of AD 1422–1950.

The large site 1049 demonstrates some of the challenges to dating multi-component cave and rock shelter sites. TU1, placed inside a walled enclosure Feature 2, was excavated well beneath 1 m in depth and thus yield charcoal suitable for a total of 14 radiocarbon dates in a vertical column (see Table 2). As expected from the Latte Period pottery on the surface, the majority of charcoal including one ash lense Subfeature 2.1 with Cf. *Morinda citrifolia* or the small tree *lada* in Chamorro, yielded dates after AD 800. In situ carbon from a deeper ash lense Subfeature 2.2 situated near the bottom yielded two Early Pre-Latte dates of 453–200 BC and 796–509 BC, plus fragments of Pre-Latte Period pottery. The two Latte Period dates recovered from screened deposits below therefore remain anomalous.

Transitional Pre-Latte features were also dated in site 1049, including two strata in TU9 of the Feature 61 enclosure with the lowest burned coconut shell in Layer V/1 dated to 550–100 BC, two strata in TU10 of the Feature 68 cobble mound with the lowest burned coconut shell in Layer IV/1 dated to AD 70–340, and wood charcoal from Layer II/1 of TU11 of the Feature 71 enclosure dated to AD 660–890.

Six other surface features at site 1049 were also tested in this multi-component site composed of numerous chambers and modifications (see Table 2). TU2 in the Feature 30 overhang yielded wood charcoal in Layer I/3 with an early Latte Period date of AD 900–1156, while TU5 in the Feature 30 overhang yielded wood charcoal in Layer II/1 with a later Latte Period date of AD 1290–1440, as did TU13 in the Feature 78 enclosure with charcoal in Layer II/1 dating to AD 1452–1642.

Artifacts found in the Latte Period deposits at all three sites include pottery, marine shell, urchin spines, crab shell, small faunal bones, and lithic debitage, all indicative of cave and rock shelter use as temporary camps perhaps while collecting from native forests and farming plateau soils as has been recorded nearby (Dixon, Bartow, *et al.* 2011). Gravel flooring and hearths also indicate a degree of preparation in anticipation of reuse over time, while a pecked anthropomorphic petroglyph found on the wall of site 1049 suggests traditional Chamorro ritual use of an inner chamber as well. While much of Tinian was cleared during the pre-WWII Japanese plantation era (Dixon 2004), disturbed *latte* set components and *lusong* or boulder mortars have been noted at Leprosarium bay near sites 1121 and 1189, as well as at Unai Masalog near site 1049.

All three sites show evidence of surface modifications assumed to reflect WWII Japanese civilian or military refuge and perhaps post-WWII straggler use. Artifacts discarded on the surface include items of Japanese manufacture such as coins; beer, liquor, or condiment bottles; porcelain bowls, shallow dishes, or teacups; glazed earthenware storage jars; glass candle holder; whetstone; military clothing and equipment such as metal cooking vessels and gas masks; fuse cord and unused ordnance; hand and power tools; chopsticks; and objects perhaps pilfered from American dumps such as U.S. batteries, canteens, and mess kits. Cow bone on the surface may indicate meals hastily prepared, while human bone fragments and shrapnel indicate the outcome of the conflict.

OVERVIEW AND DISCUSSION

This review of radiocarbon dated cave and rock shelter deposits from two topographical settings on two islands in the Mariana archipelago has revealed several trends in pre-Contact Chamorro land use not always evident from an examination of permanent habitation sites alone.

In terms of chronology, most sites located near the coast (Finegayan in Guam and VOA in Tinian) were occupied earlier than their counterparts inland as expected (Table 3a–c), although there were a couple of notable exceptions (site 1660 in the Guam NMS and site 1189 in the Tinian LBA). This Early Pre-Latte occupation does not predate 800 BC, however, so there are seven centuries of previous occupation on both islands unaccounted for, at least in terms of cave and rock shelter use. Both Finegayan in Guam and the VOA in Tinian are admittedly somewhat marginal settings in comparison to the larger embayments preferred by the earliest Pre-Latte settlers in Ritidian on Guam (Carson 2010) and Unai Chulu on Tinian (Craib 1993). In the case of Finegayan on Guam, the caves and rock shelters here examined would have been subject to tidal surges during the last high sea stand of the Late Holocene prior to 800 BC (Dickinson 2001) so virtually uninhabitable, but the Tinian VOA sites were situated well above tidal action so their early avoidance would appear to be a matter of preference.

Low population densities during the first centuries of the Early Pre-Latte Period might account for a lack in utilization of caves and rock shelters before 500 BC (3 of 34 dated contexts = 9% on Guam; 1 of 31 dated contexts = 3% on Tinian) although it is unlikely inland resources remained unused, especially after periodic typhoons. But after sites on both islands continued to be used sparingly throughout the Intermediate Pre-Latte Period between 500 BC and AD 1 (2 of 34 dated contexts = 6% on Guam; 3 of 31 dated contexts = 9% on Tinian), there seems to be an upswing of inland site use on Tinian (9 of 31 dated contexts = 29%) with little change on Guam (4 of 34 dated contexts = 9%) during the Transitional Pre-Latte Period between 0 and 800 AD. Perhaps the shorter walking distance and lower elevation differential on Tinian when compared to Guam made inland expansion less onerous. If so, the early Latte Period between AD 700 and 1250 that has been called the 'times of plenty' during the Medieval Warm Period in the Pacific Basin (Nunn *et al.* 2007) does see an increased use of mostly inland caves and rock shelters on Guam (12 of 34 dated contexts = 37%), but not on Tinian (6 of 31 dated contexts = 19%).

In the following Little Ice Age from AD 1250–1800, termed the 'times of less' in the Pacific basin (Nunn *et al.* 2007), cave and rock shelter use on Guam remains roughly the same (14 of 34 dated contexts = 40%) while an increase on Tinian (12 of 31 dated contexts = 38%) is evident during the late Latte Period. Given an apparent rise in permanent inland population density on both islands during this time of supposed societal disruption (Dixon *et al.* 2006; Dixon and Gilda 2011), and evidence of an increase in agricultural utilization of inland soils on both islands (Dixon, Bartow, *et al.* 2011; Dixon, Walker, *et al.* 2011), it should not be surprising that use of inland caves and rock shelters steadily increased. That these trends were in fact both punctuational and of variable intensity suggests social factors unique to each island's history over time (Fitzpatrick 2010). The only noticeable societal disruption in their use however, appears to follow the arrival of Ferdinand Magellan in 1521 when cave and rock shelter use plummets on both islands, and all but disappears after the permanent settlement of the Mariana Islands by Spaniards in 1668.

As for changes in pre-Contact land use, wetland sediment cores with radiocarbon dated charcoal particles have been interpreted to indicate anthropogenic burning of native forests circa 2300 BC well before archaeological evidence of the first arrival of Austronesian settlers from Island Southeast Asia (Athens *et al.* 2004), while savannah grasses and fern spores appear circa 1550 BC when the first coastal habitation sites begin to be occupied (Carson and Peterson 2011, 2012). Given the low population density of these earliest groups of maritime-adapted inhabitants and probably for generations, large-scale destruction of inland forests for swidden gardening would appear counter intuitive with ample coastal land available between small communities, as the absence of inland cave and rock shelter use prior to approximately 800 BC suggests. Unfortunately, most caves and rock shelters are not ideal traps for airborne pollen and charcoal particles by virtue of their semi-enclosed morphology and variable humidity, so pollen from primary occupation contexts is limited.

When inland sites are eventually occupied within the NMS on Guam, pollen from wild taro and coconut are found in Early to Intermediate Pre-Latte Period deposits with charcoal radiocarbon dated to 756–403 BC at site 1660 (see Table 2). Both these species could have been present in the Marianas archipelago when the first Austronesian settlers arrived, suggesting only early horticulture and aboriculture pursuits (Allen *et al.* 2002). Much later early Latte Period charcoal dated to AD 718–1015 was found in association with an increase in grass pollen, while wild taro and fern spores decreased, suggesting clearing of the natural wetland sinkhole environment perhaps for farming. In subsequent Latte Period deposits with charcoal radiocarbon dated to AD 1273–1397, wild taro and most tree pollens were almost non-existent as local forests had been cleared for permanent settlement. The final undated deposits near the surface of this rock shelter contained an increase in screw pine and a wider variety of grasses, vine,

Table 3a. *Radiocarbon dates from cave and rock shelter sites on Guam.*

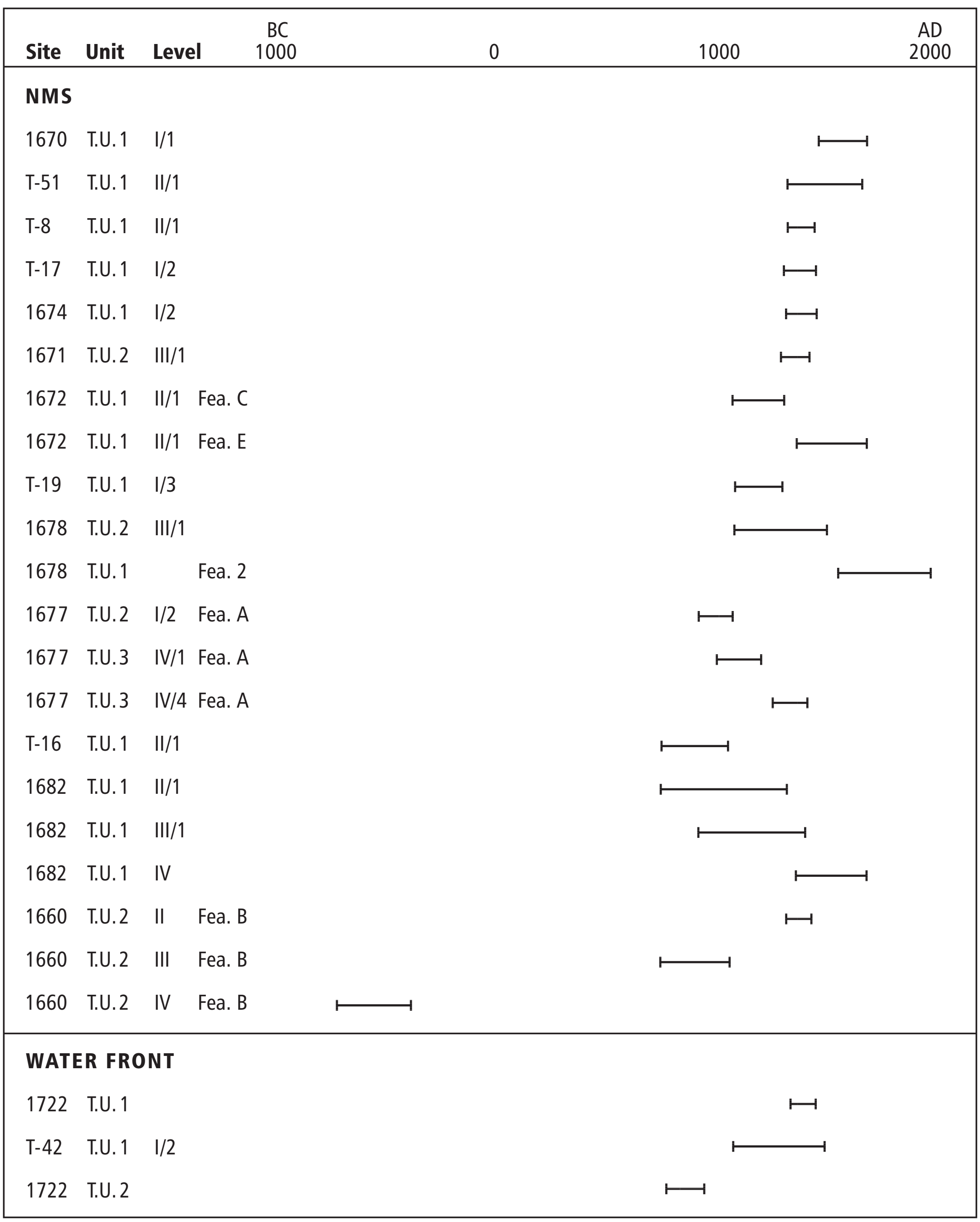
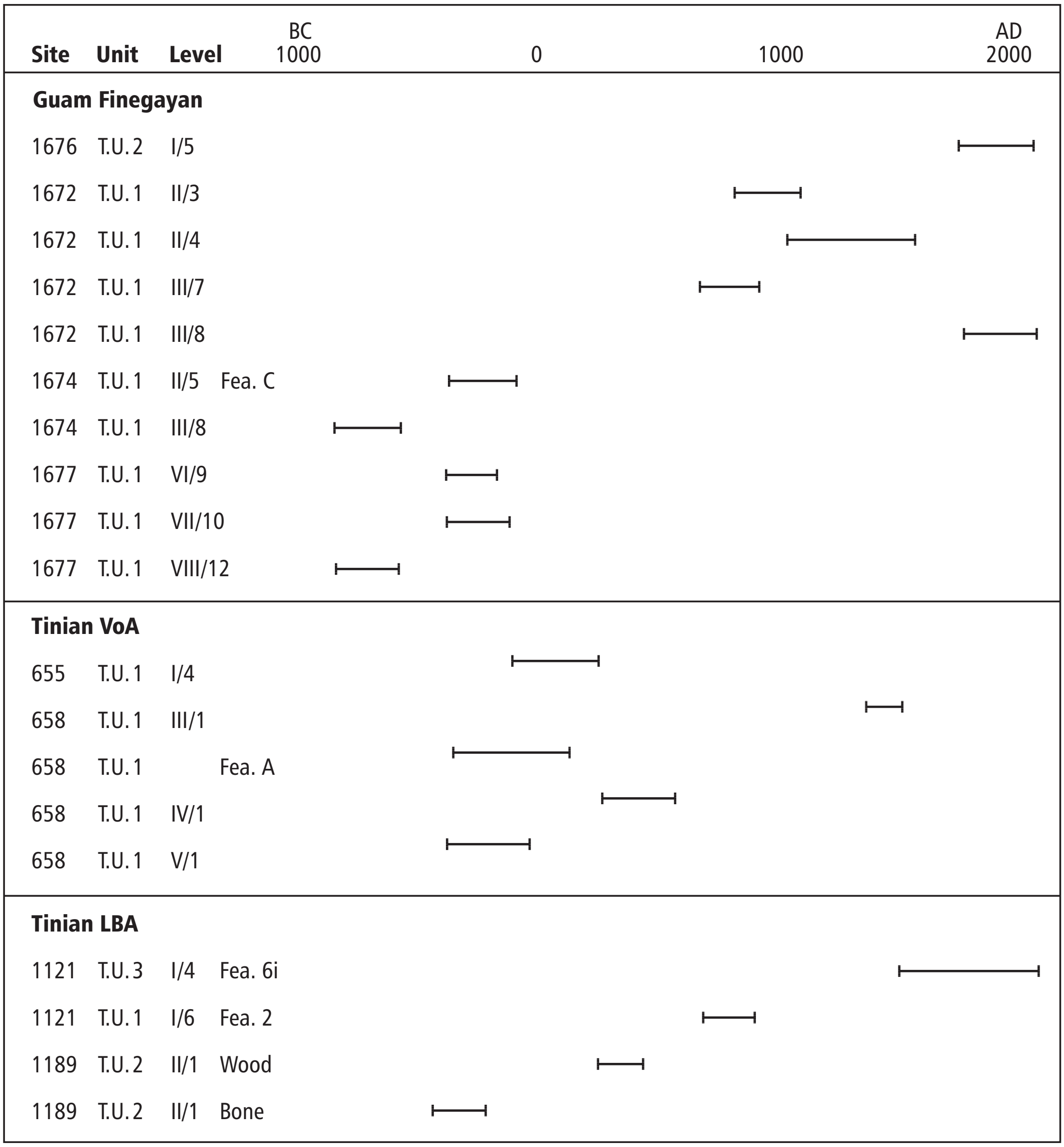


Table 3b. *Radiocarbon dates from cave and rock shelter sites on Guam & Tinian.*



and fern spores as the setting was presumably abandoned after Contact.

What is not evident in any of these deposits is pollen from domesticated taro, yams, arrowroot, or other species presumed to have been the mainstay of the traditional plant food diet by the end of the Latte Period. Subsurface remains found upon excavation of caves and rock shelters on both islands may provide dietary inferences however (see Table 1), since intact strata often contained Latte and occasional Pre-Latte Period earthenware ceramics for cooking and food storage; marine shells for food and tool manufacture; sea urchin spines; crab shells and claws; fish bone and scales; faunal bone of native lizards and fruit bats plus introduced rats; lithic debitage from stone tool manufacture; fish hooks, adzes, and awls of bone and shell; coral; calcite beads; fire cracked rock from earth ovens; and wood carbon or burned coconut shell used as fuel. Also evident at disturbed surface contexts in a few sites were ground stone mortars or pestles for processing traditional foods or medicinal herbs and *metates* indicating Spanish Colonial period use of historically introduced corn.

By the mid-20th century, traditional Chamorro land use was eclipsed in the Tinian LBA and Guam NMS by WWII refuge and defense (see Table 1), with surface artifacts such as Japanese coins; beer, liquor, or condiment bottles; porcelain bowls, shallow dishes, or teacups; and glazed earthenware storage jars of Japanese manufacture indicated the ethnicity of most temporary inhabitants during or after WWII. Military equipment and clothing of Japanese and American manufacture in these two settings likely reflected both wartime stocks and post-invasion

Table 3c. *Radiocarbon dates from cave and rock shelter sites on Tinian.*

Site	Unit	Level		BC 1000 — 0 — 1000 — AD 2000
Tinian LBA				
1049	T.U. 5	II/1	Fea. 30	
1049	T.U. 2	I/3	Fea. 6	
1049	T.U. 11	II/1	Fea. 71	
1049	T.U. 13	II/1	Fea. 78	
1049	T.U. 9	III/2	Fea. 61	
1049	T.U. 9	V/1	Fea. 61	
1049	T.U. 10	III/3	Fea. 68	
1049	T.U. 10	IV/1	Fea. 68	
1049	T.U. 1	I/2	Fea. 2.1	
1049	T.U. 1	I/2	Fea. 2.1	
1049	T.U. 1	I/3	Fea. 2.1	
1049	T.U. 1	III/1	Fea. 2	
1049	T.U. 1	III/2	Fea. 2	
1049	T.U. 1	III/3	Fea. 2	
1049	T.U. 1		Fea. 2.2	
1049	T.U. 1		Fea. 2.2	
1049	T.U. 1	IV/1	Fea. 2	
1049	T.U. 1	IV/3	Fea. 2	
1049	T.U. 1	IV/3	Fea. 2	
1049	T.U. 1	IV/4	Fea. 2	
1049	T.U. 1	IV/6	Fea. 2	
1049	T.U. 1	IV/1	Fea. 2	

raiding of U.S. dumps by stragglers, while domestic refuse of Japanese manufacture in the absence of military equipment in the Tinian VOA may have reflected civilian refuge from nearby immigrant Okinawan laborer farmsteads during the U.S. invasion (Dixon 2004). Both areas have reverted to U.S. military stewardship today, with controlled civilian hunting and medicinal plant collection policies defining the only forms of legal land use.

CONCLUSIONS AND REGIONAL INFERENCES

To extrapolate from the chronological and land use trends here identified with utilized caves and rock shelters on Guam and Tinian to the broader western Pacific is challenging, due to the Marianas' long history of settlement and its unique archaeological record in comparison to its neighbors.

While the Mariana Islands were settled circa 1500 BC, which is somewhat earlier than the Austronesian diaspora to northern Melanesia, southern Micronesia, and Polynesia (Hung *et al.* 2011), their development in terms of socio-political complexity remained more akin to their homeland in the Philippines and Island Southeast Asia than their neighbors to the south. At European contact between 1521 in the Marianas and the early 19th century for parts of southern Micronesia, the high islands of Palau, Pohnpei, Kosrae, and Yap were found to be home to chiefdoms who maintained regular contacts with neighboring islands, sometimes via peaceful trade and sometimes not so peaceful interaction (Parmentier 1987). In contrast, the

Mariana Islands were found to be inhabited by clans and lineages whose interaction also included trade and conflict, but the archipelago did not appear to have a paramount chiefdom nor did individual islands (Russell 1998). During the Latte Period the presence of sling stones and walled entrances in some Guam and Tinian caves and rock shelters suggests they may have upon occasion been used as refuges in times of conflict, much as their counterparts were used in Polynesia (Kennedy and Brady 1997), but permanent defenses were never constructed as in some Micronesian high islands to the south, even after Contact.

Large scale earthen terracing and later stone villages in Palau (Liston 2009), the monumental scale megalithic centers of Nan Madol in Pohnpei (Ayers 1983) and Lelu in Kosrae (Cordy 1982), and the complex network of villages, fish traps (Hunter-Anderson 1981), and stone money in Yap (Fitzpatrick 2001)are not regularly subject to typhoons that ravage the Mariana Islands. While the effects of typhoons when they do occur to the south are sometimes catastrophic, especially to the smaller and lower atolls of the Caroline Islands, their constraint on the social development of the aforementioned higher islands in terms of natural resource depletion was probably limited in comparison to the effects of typhoons and droughts in the Mariana Islands. The archipelago was sporadically visited by Carolinian refugees escaping the effects of typhoons even before European contact (Barratt 1988), but their cultural impact on the developmental trajectory of the Chamorro inhabitants appears to have been minimal. In that regard, caves and rock shelters on Guam and Tinian were an integral part of the civil defense system in 'times of less' and often provided predictable fresh water and temporary shelter in 'times of plenty'. Caves in Palau were also used in the extraction of stone money destined form Yap (Fitzpatrick 2001).

During the 2500 year Pre-Latte Period in which the monumental scale earthen terraces of Palau were constructed and eventually abandoned (Liston 2005), inhabitants of the Marianas remained by choice in coastal villages of relatively small size built of habitations with perishable materials, much as their ancestors constructed when they first arrived. After about AD 800, Latte Period Chamorro began to erect increasingly larger villages with houses supported by pairs of stone columns and capstones locally called *latte* sets, the largest of which reached 4.8 m in height at the Taga House site on the island of Tinian, probably still occupied at the time of initial Spanish contact (Russell 1998). While different in configuration and raw materials from the volcanic island centers of Nan Madol in Pohnpei and Lelu in Kosrae, the net investment in megalithic labor and organization was indeed comparable. That caves and rock shelters remained an important part of the cultural landscape throughout the entire history of Guam and Tinian suggests underlying themes of resilience and survival presumably part of the ancestral heritage of the first Chamorro settlers.

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