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Coastal environments, site formation processes, and the *latte* period: Examples from Tinian, Mariana Islands

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Abstract—The paper presents a methodological review of archaeological site formation processes (natural and cultural) at two coastal deposits on the Island of Tinian, Marianas, with the intent of identifying the potential and problems of these sites for understanding the origin and development of the *latte* period on the island. Although each site can contribute to the study of the *latte* period itself, it is concluded that the stratigraphic isolation of the *latte* period deposits is a severe limitation on the potential for the study of the events and processes of *latte* origin, and that for Tinian other approaches must be taken to answer questions about the local evolution of the *latte* period.

Introduction

How do the coastal deposits at the sites of Unai Chulu and Unai Dangkulo on the Marianas island of Tinian (Figure 1) affect our view of the island's pre-Contact history and the development of the *latte* period? That is the question this paper explores from a methodological standpoint.

Archaeologists are interested in history and process, and for a reasonable understanding of the past these have to be studied together, and as part of this we have to measure change. How history and process are studied depends to a great extent on the sources of the data, which may range from stratified deposits to site distribution, from artifacts to architecture, and from datable materials to dimensions of things with temporal patterning.

An archaeologically based cultural sequence for the Marianas effectively began with the work of Spoehr (1957), and has been refined over the following decades predominantly through the work of Butler (1995) and Moore (1983, 2002). This period/phase framework based on the Moore sequence is used for general summaries of Marianas history (e.g., Craib 1997; Russell 1998) and for individual islands, including Tinian (e.g. Welch and Tuggle 2008).

As with most such sequences, each phase/period represents a set of material characteristics (such as pottery types and settlement location) encapsulated as

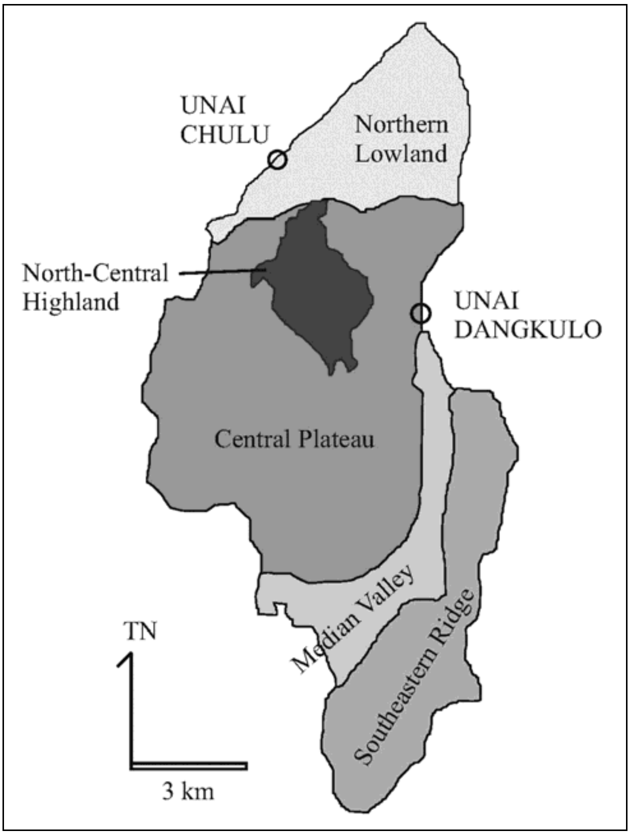

Figure 1. Site locations and the physiographic zones of Tinian.

different from other phases/periods. That is, they denote that change has occurred in chronological succession. But there is an archaeological truism (clearly expressed in Plog 1974), that change itself is often "between" the phases, that is, it is events that occur at the boundaries or divisions. In other words, the process of change or our understanding of the process can be obscured by the nature of the data and by the way in which we categorize the data. Ideally, to understand change, we would identify events and sequences of events, but that this is rare in the archaeological record (commonly best found in archaeological evidence of architectural modification). A more usual approach is the attempt to decrease the time span of phases (as sub-phase or whatever regional term is appropriate). The briefer the periods that we define and the closer we come to identifying events within a periodized framework, the more readily we can understand the nature and processes of change.

For Tinian, interpretation of the cultural sequence (e.g., Allen et al. 2002; Dixon et al., 2000; Welch and Tuggle 2008) depends on application of the Moore phases to two main sets of data for the island. One set is the sites in various locales that can be categorized by phase/period and that have cultural content suitable for comparison (see e.g., Dixon et al. 2000 regarding changes in subsistence and settlement pattern). The other set of data is obtained from stratified sites, primarily beach deposits and cave sites. However, generally the stratified sites have a limited range of interpretive potential for a variety of reasons, with the beach site of Unai Chulu representing the primary exception. From this standpoint several research problems emerge: developing a better understanding of the specifics of the Tinian cultural sequence rather than simply imposing the existing Marianas sequence, increasing the knowledge about the occupation of sites over the entire island, finding additional well-stratified sites, and refining the analysis of the existing stratified sites.

In the long run we want to continue to look carefully at what the independent Tinian data tell us about change and the fundamentally important question of the development of the cultural complex known as *latte*. One of the steps toward this is the present methodological review related to the analysis of Tinian's coastal deposits with attention to Unai Chulu, based on earlier work (Haun et al. 1999) as well as additional investigation in 2008 at both Unai Chulu and Unai Dangkulo (Morrison and Tuggle 2009) The analysis presented here reviews the formation and history of the deposits, including the agents responsible for depositional disturbances.

Under good conditions, stratified deposits provide information about slices of time, and under the best of conditions these deposits represent very brief slices of time, allowing the strongest inferences about change. But complex site formation processes can turn the best of situations to the worst, and coastal deposits are almost always the result of complex site formation processes. As Schiffer (1983: 685) notes: "Many seemingly sophisticated spatial studies in archaeology are badly flawed because, in the analysis, evidence on activity distributions and on formation processes have been conflated." Coastal processes have destroyed remnants of pre-*latte* deposits and created particular biases towards *latte* period research at Unai Chulu, especially regarding the site boundary definition. It is our premise that the development of a more complete understanding of site formation processes will help enhance scientific inferences about past societies on Tinian and in the Mariana Islands in general. However, depositional history and site formation processes may be different across both time and space and therefore must be assessed independently on a case-by-case basis (see Schiffer 1983:676). Assessing depositional history includes an evaluation of the natural and cultural transformational processes that may have occurred since the site was occupied, including the timing and spatial extent (Schiffer 1987:7; Waters 1992:292).

The Marianas and Coastal Site Formation

In the Mariana Islands early archaeological remains are commonly found in stratified deposits in close proximity to active beach areas (Butler 1988; Kurashina and Clayshulte 1983; Moore and Hunter-Anderson 1999). Current evidence from these deposits indicates initial colonization of the Mariana Island archipelago occurred by at least 1500 B.C. (see e.g.,Carson 2008).

Archaeological deposits in coastal settings are subject to depositional disturbances as a result of high-energy wave activity, tidal surges, tsunami events, and sea-level fluctuations, complicating interpretations of temporal patterns and cultural patterns (see Brantingham et al. 2007). Tinian coasts are subject to all of these forces, including sea-level change, given that extensive geologic research has also demonstrated that at the time of Tinian colonization the sea level was approximately 1.8 meters higher than it is today (Dickinson 2000).

In a number of circumstances these changes have affected the integrity of archaeological deposits resulting in stratigraphic mixing and erosion. For example, when discussing the impact of storm events on the stratigraphic integrity of archaeological deposits on Rota Island, Butler (1988:448) notes the "obvious implication is that the prospects for any large areas of intact occupation surfaces in these beach deposits, except near the ground surface, are very poor."

What is particularly problematic is that the original systemic context of the artifacts may retain little relationship to the final depositional contexts from which the archaeological materials are recovered - a result of numerous possible processes including post-depositonal alteration, weathering, transportation, and re-deposition (Hill and Rapp 1998:50). Moreover, when the buried archaeological remains were originally surface deposits, they often underwent primary transformational processes making the association between the recovery context and the behavioral context even further removed (Beck 1994; Schiffer 1972:157). At least two factors that can create discrepancies between modern archaeological surfaces and past archaeological surfaces include 1) modern land modification processes and 2) natural changes in magnitude or direction of geomorphic processes (Lewarch and O'Brien 1981:300). These two circumstances have been particularly severe in the Mariana Islands where human actions have included the drastic World War II beach disturbances, and where coastal processes have often modified both subsurface and surface deposits.

Although substantial research has been conducted on a variety of characteristics of the *latte* period in the Mariana Islands (e.g., Graves 1986; Graves et al. 1990), there is comparatively less knowledge regarding the cultural sequences, characteristics of the pre-*latte* period, and transition to the *latte* period. While research by Moore (1983), Moore and Hunter-Anderson (1999) and Hunter-Anderson and Butler (1995), among other, have greatly improved our understanding of the pre-*latte* ceramic sequence, there is still a relative paucity of sites that contain undisturbed multi-component deposits spanning the time from initial colonization of the archipelago into the *latte* period. Recent research at Unai Bapot on the Island of Saipan (Carson 2008) has the potential to resolve some of these issues.

Continuing research at coastal sites on Tinian will contribute to these questions--and this research includes attention to site formation and how it structures the evidence related to cultural change as discussed here, but in addition research on inland sites of all time periods will be necessary to understand the overall evolution of island culture.

Unai Chulu

The Unai Chulu coastal plain is located along the northwestern coast of Tinian Island (see Figure 1**)**. The elevation of the Chulu beach terrace rises from sea level to around 11 m approximately 200 m inland (Haun et al. 1999: 6). The current beach berm is located around 30 m from the shoreline. Soils found in the vicinity of Unai Chulu include Shioya loamy sand and Chinen clay loam (Young 1989:Map 2; see also Haun et al 1999:6). Shioya loamy sand consists of coral and coralline derived sands which have been deposited by water activity, while Chinen clay loam is a shallow soil generally encountered about 200 m inland of the water level and at elevations greater than 7 m above sea level.

Unai Chulu Archaeological Investigations

The *latte* component at Unai Chulu (Site TN-0073) was recorded in 1984 (Moore et al. 1986:90), and subsequent disturbance and testing indicated the presence of cultural material at least 1.5 m in depth (Ward and Pickering 1985; Moore et al., 1986; Craib 1993). In 1994 and 1995, excavations were carried out to collect data from the center of the site, with the conclusion that there were six pre-Contact components, plus the historic period, all spanning approximately 3500 years (Haun et al. 1999). A historic component represented Japanese agricultural activity during the first half of the 20th Century and WWII beach invasion (Haun et al. 1999).

In sum, these excavations have demonstrated that Unai Chulu has the evidence for the earliest human settlement on the island, and has the most nearly complete stratified pre-Contact sequence of any of site known on Tinian (Welch and Tuggle 2008:37–88).

In July 2008, additional site inventory fieldwork at Unai Chulu was carried out (Morrison and Tuggle 2009). The purpose of this investigation was to complete the inventory recording of the site for long-term management, that is to more clearly identify the horizontal extent of the cultural strata, the character of

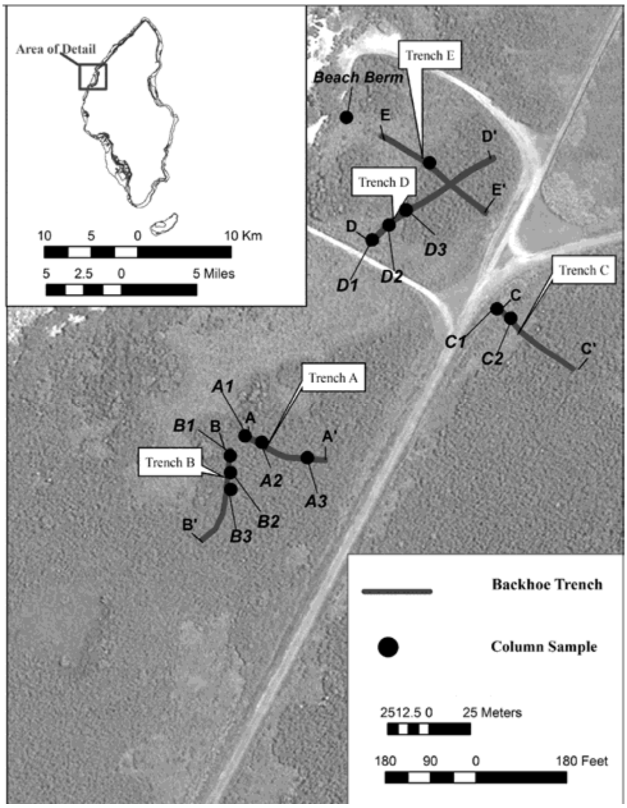

Figure 2. The location of excavated trenches and column samples at Unai Chulu.

Figure 3. Photograph of backhoe trench at Unai Chulu.

the natural deposition and degrees of disturbance of the cultural deposits, and the overall pattern and result of site formation processes. Unlike previous investigation, which depended on shovel testing and one localized excavation, the 2008 fieldwork excavated long backhoe trenches to provide the large view of depositional units critical for determining deposit boundaries and extent of horizontal disturbances. Five trenches were excavated, varying in length from 50 m to 98 m, and all were excavated to the limestone substrate where possible (Figures 2 and 3). Trenches were profiled, sediment samples of all stratigraphic units were collected, in situ features recorded, and material for radiocarbon dating was collected. Column samples were taken from each trench for further laboratory analysis. In addition, elevations of trench surfaces, stratigraphic units, and basal limestone were recorded using an automated laser line level and survey-grade GPS unit. Elevation datum points were established across the Unai Chulu coastal plain, and elevation measurements were adjusted to mean sea level and further corrected to MLLW using National Oceanic and Atmospheric Administration tide charts for Tinian. A geomorphic model was developed using the 2008 extensive horizontal deposit boundary data along with the detailed local stratigraphic data recorded by Haun et al. (1999).

Unai Chulu Site Formation Summary

Based on review of previous research at Unai Chulu (primarily Haun et al, 1999), the 2008 excavations, and subsequent landscape modeling, a model of site formation and archaeological integrity is presented here (Figure 4). This summary does not include details of stratification, cultural content (such as artifact and midden descriptions), or provenience specific radiocarbon dates, all of which are provided in the other reports (Haun et al. 1999 ; Morrison and Tuggle 2009; Welch and Tuggle 2008). Details of the trench and column sample strata are presented in Table 1.

The model that is presented here differs from previous formulations of Unai Chulu stratification, which focus on strata as descriptive archaeological units, which of course included unit dating and conclusions about change (particularly in the "component" review, see Haun et al., 1999:124 and Welch and Tuggle 2008:37). The present model considers stratification from the standpoint of site formation, which may be summarized as event analysis, referring to specific events of natural actions and cultural behavior. This emphasizes not only what is present at a site, but what is absent, that is what may have been destroyed as well as what behavioral or occupation episodes did not occur. The purpose of this, as indicated at the beginning of the paper, is ultimately to assess the site for its potential to contribute to our understanding of cultural change, with particular emphasis on the origin and development of the *latte* period.

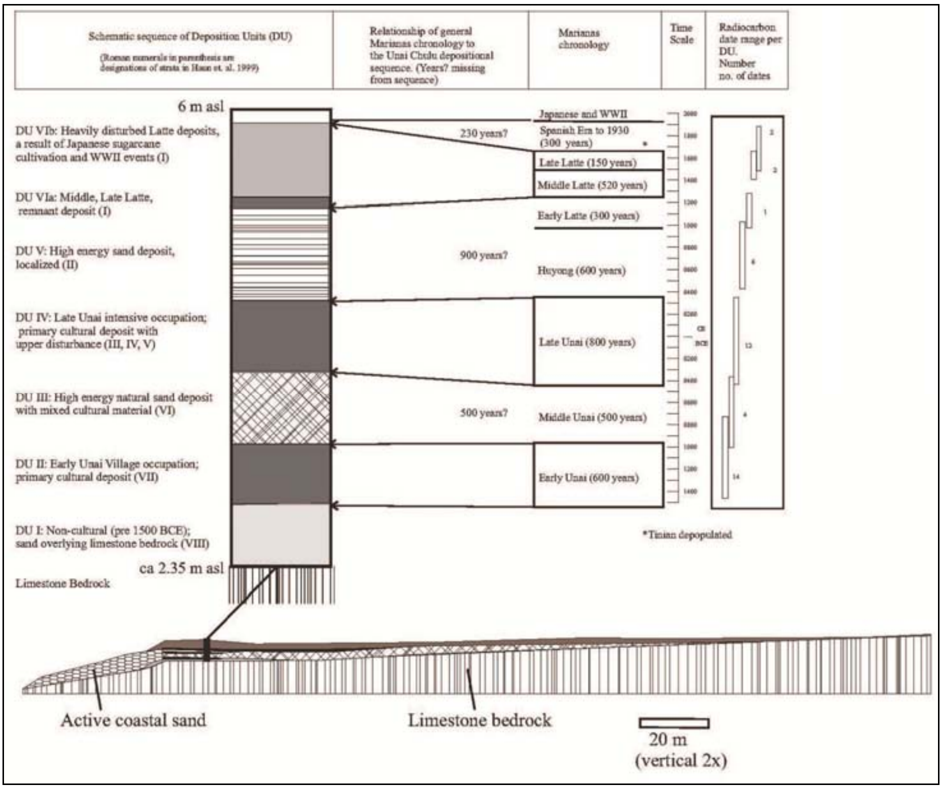

Figure 4. Schematic profile of Unai Chulu.

When considering the entire suite radiocarbon dates reported here (Table 2) it is noteworthy that 11 of the original dates reported by Haun et al. (1999) and one reported by Craib (1993) are derived from bulk sediment samples, and that there was no taxon identification of wood charcoal. A complete re-evaluation and analysis of the radiocarbon dates and ceramic-based chronology of Unai Chulu should be undertaken with these methodological problems in mind. This analysis should also incorporate an independent probability model, such as the Bayesian (see e.g., Dye 2004).

Figure 4 presents a generalized profile of Unai Chulu near the central portion of the coastal plain. Based on the sedimentary characteristics, artifactual material recovered, and re-analysis of the full suite of radiocarbon dates available for Unai Chulu (Table 1), the following sequence of site formation is proposed, using the designation "Depositional Unit" (DU).

Table 1. Sample strata descriptions from subsurface testing at Unai Chulu.

Trench	Column Sample	Layer	Description	Interpretation
B	B1, B2, B3	I	7.5YR 2.5/1, wavy and clear boundary. Abundant coral and gravel inclusions. Abundant roots present. Structure: moderate ped development. Coarse to very coarse; granular. Consistence: dry: soft, weakly coherent; moist: friable; wet: slightly sticky, slightly plastic.	Layer I is disturbed A horizon.
B	B1, B2, B3	II	7.5YR 2.5/1; wavy and clear boundary. Abundant coral and gravel inclusions. Abundant roots present. Structure: moderate ped development. Coarse to very coarse; granular. Consistence: dry: soft, weakly coherent; moist: friable; wet: slightly sticky, slightly plastic. Interpreted as the same deposit as Layer I, but without activity disturbance.	Layer II is an intact portion of the *latte* period deposit.
B	B1, B2, B3	III	10YR 3/2, dark brown; loose, wavy clear boundary, fine sized particles. Predominately silt with less than 10 % sand inclusions, peds are poorly developed. Consistence: dry: loose; moist: loose; wet: not sticky, non-plastic.	Layer III is a silty sandy loam. This layer does not appear to be associated with the storm deposit directly below it.
B	B1, B2, B3	IV	10YR 4/4, dark yellowish brown. Wavy boundary. Medium to coarse sand, gravel inclusions including shell and coral fragments. Structureless. Consistence: dry: loose, moist: loose, wet: non-sticky, non-plastic.	Layer IV appears to be an interface between Layers III and V. The deposit consists mostly of medium to coarse calcareous sand with a minor inclusion of silt. The silt inclusions have likely percolated into the stratum from the overlying Layer III deposit.
B	B1, B2, B3	V	10YR 6/4, brownish yellow; loose sand, medium to coarse sand; wavy boundary. Medium to coarse sand, gravel inclusions including shell and coral fragments. Structureless. Consistence: dry: loose; moist: loose; wet: non-sticky, non-plastic.	Layer V is interpreted as a storm deposit consisting entirely of medium to coarse calcareous sand and coral cobbles and boulders.
B	B1, B2, B3	VI	5YR 3/4, dark reddish brown; lower boundary on limestone bedrock. Silty clay with less than 10% sand inclusions in matrix. Consistence: dry: slightly hard; moist: friable; wet: sticky, plastic.	Layer VI is a C soil horizon consisting of the weathering limestone substrate.
C	C1	I	10YR 3/2, very dark grayish brown. Ped structure is well developed, wavy clear boundary. Gravel size limestone inclusions; minor root disturbance; fine to very fine silty loam; very few sand inclusions. Appears to be an extensively disturbed A horizon. Consistence: dry: hard; moist: firm; wet: non-sticky, non-plastic.	Layer I is disturbed A horizon present across the entirety of the Unai Chulu coastal plain. It bears evidence of extensive disturbance.
C	C1	II	. 10YR 3/2, very dark grayish brown. Poorly developed ped structure, few gravel inclusions. Minor contribution of cobble sized limestone fragments, fine to very fine silty loam with very few sand inclusions. Consistence: dry: weak; moist: friable; wet: non-sticky, non-plastic.	Layer II is consistent with the undisturbed portion of the Latte Period deposit present in both Trenches A and B. It is similar in sedimentary characteristics to Layer I but does not show signs of extensive

Table 2. Radiocarbon dates from Unai Chulu.

Lab No.	Unit	Layer	Depth (cm)	Conventional Age BP	Calibrated Age B.C./ A. D.	Source
Beta 81946	466, 992	VII	210--220 bd	3120 ± 50	1496 B.C. (93.5%) 1288 B.C., 1282 B.C. (1.9%) 1269 B.C.	Haun et al. 1999
Beta 81952	464, 992	VII	244-250 bd	3110 ± 60	1508 B.C. (93.0%) 1252 B.C., 1241 B.C. (2.4%) 1213 B.C.	Haun et al. 1999
Beta 81948	466, 992	VII	227-249 bd	3100 ± 60	1500 B.C. (95.4%) 1211 B.C.	Haun et al. 1999
Beta 83213	464, 994	VII	240-250 bd	3080 ± 40	1434 B.C. (94.9%) 1260 B.C., 1227 B.C. (0.5%) 1222 B.C.	Haun et al. 1999
Beta 81951	464, 994	VII	244 bd	3070 ± 60	1488 B.C. (0.4%) 1482 B.C., 1454 B.C. (91.4%) 1188 B.C., 1181 B.C. (2.1%) 1156 B.C., 1145 B.C. (1.5%) 1130 B.C.	Haun et al. 1999
Beta 81947	466, 992	VII	220 bd	3070 ± 100	1145 B.C. (1.5%) 1130 B.C.	Haun et al. 1999
Beta 81954	464, 994	VII	250-260 bd	3050 ± 60	1436 B.C. (95.4%) 1126 B.C.	Haun et al. 1999
Beta 81955	464, 994	VII	258-273 bd	3040 ± 60	1433 B.C. (95.4%) 1122 B.C.	Haun et al. 1999
Beta 81950	464, 992	VII	230-244 bd	3020 ± 60	1420 B.C. (93.0%) 1111 B.C.,1102 B.C. (1.8%) 1076 B.C.,1065 B.C. (0.6%) 1056 B.C.	Haun et al. 1999
Beta 83214	466, 994	VII	220-230 bd	3000 ± 40	1386 B.C. (95.4%) 1123 B.C.	Haun et al. 1999
Beta 81953	464, 994	VII	250-260 bd	2990 ± 50	1387 B.C. (90.8%) 1110 B.C.,1104 B.C. (3.5%) 1072 B.C.,1066 B.C. (1.1%) 1056 B.C.	Haun et al. 1999
Beta 81949	464, 992	VII	217-230 bd	2940 ± 70	1378 B.C. (4.2%) 1336 B.C.,1322 B.C. (89.9%) 974 B.C.,956 B.C. (1.3%) 940 B.C.	Haun et al. 1999

Beta 83216	466, 994	VII	268-283 bd	2920 ± 40	1261 B.C. (95.4%) 1006 B.C.	Haun et al. 1999
Beta 82229	498.43, 937.87	II	85-91 bs	2730 ± 130	1290 B.C. (0.2%) 1282 B.C.,1270 B.C. (95.2%) 538 B.C.	Haun et al. 1999
Beta 81940	466, 994	IIIa	125-130 bd	2580 ±140	1043 B.C. (95.4%) 390 B.C.	Haun et al. 1999
*GX 20796	466, 992	VII	241-262 bd	2565 ± 70	836 B.C. (91.9%) 484 B.C.,464 B.C. (3.5%) 416 B.C.	Haun et al. 1999
Beta 81827	500, 920	VII	70-80 bs	2550 ± 60	817 B.C. (93.0%) 506 B.C.,462 B.C. (0.7%) 450 B.C.,440 B.C. (1.7%) 418 B.C.	Haun et al. 1999
Beta 82230	498.43, 937.80	II	115-120 bs	2490 ± 60	786 B.C. (85.6%) 480 B.C.,468 B.C. (9.8%) 414 B.C.	Haun et al. 1999
*GX 20833	498.43, 937.80	IIIc	15-120 bs	2265 ± 45	401 B.C. (35.9%) 341 B.C.,327 B.C. (59.5%) 204 B.C.	Haun et al. 1999
*GX 20795	466, 994	VII	220-230 bd	2215 ±135	750 B.C. (3.0%) 687 B.C.,666 B.C. (1.0%) 642 B.C.,592 B.C. (91.4%) 60 A. D.	Haun et al. 1999
*GX 20797	466, 994	VII	268-283 bd	2035 ± 135	386 B.C. (95.4%) 236 A. D.	Haun et al. 1999
Beta 81825	460, 940	III	120-136 bs	1930 ± 70	97 B.C. (95.4%) 244 A. D.	Haun et al. 1999
Beta 81939	466, 998	I-II	129 bd	1930 ± 70	97 B.C. (95.4%) 244 A. D.	Haun et al. 1999
Beta 81941	462, 998	IIIb	147-150 bd	1900 ± 70	50 B.C. (94.1%) 258 A. D.,298 A. D. (1.3%) 320 A. D.	Haun et al. 1999

Beta 81944	466, 994	IIIb	115-127 bd	1870 ± 50	24 A. D. (95.4%) 252 A. D.	Haun et al. 1999
Beta 81826	500, 900	III	38-65 bs	1860 ± 60	20 A. D. (90.9%) 261 A. D.,280 A. D. (4.5%) 325 A. D.	Haun et al. 1999
Beta 81945	464, 992	IIIc	138-158 bd	1850 ± 60	25 A. D. (88.6%) 264 A. D.,276 A. D. (6.8%) 332 A. D.	Haun et al. 1999
Beta 81938	460, 994	IIIa	141	1820 ± 60	65 A. D. (94.9%) 348 A. D.,370 A. D. (0.5%) 377 A. D.	Haun et al. 1999
Beta 81942	460, 996	I-II	140-177 bd	1820 ± 70	54 A. D. (95.4%) 384 A. D.	Haun et al. 1999
Beta 81943	464, 994	IIIb	135-139 bd	1810 ± 50	81 A. D. (95.4%) 338 A. D.	Haun et al. 1999
*GX 20794	464, 992	V	150-165 bd	1495 ± 135	235 A. D. (94.6%) 782 A. D.,789 A. D. (0.7%) 810 A. D.,848 A. D. (0.2%) 854 A. D.	Haun et al. 1999
*Beta 83281	466, 994	V	161-191 bd	1480 ± 80	406 A. D. (95.4%) 676 A. D.	Haun et al. 1999
*Beta 83279	466, 994	IIIc	134-164 bd	1320 ± 70	604 A. D. (95.4%) 879 A. D.	Haun et al. 1999
*GX 20793	466, 994	IIIc	134-164 bd	1150 ± 70	694 A. D. (7.2%) 748 A. D.,765 A. D. (88.2%) 1018 A. D.	Haun et al. 1999
*Beta 83282	466, 994	VI	unknown	1050 ± 80	778 A. D. (1.5%) 794 A. D.,800 A. D. (93.9%) 1160 A. D.	Haun et al. 1999
Beta 81823	500, 860	IV	42-61 bs	1030 ± 80	782 A. D. (0.6%) 790 A. D.,809 A. D. (94.8%) 1185 A. D.	Haun et al. 1999
*Beta 83280	464, 992	VI	157-178 bd	860 ± 90	1014 A. D. (95.4%) 1288 A. D.	Haun et al. 1999
Beta 82231	460, 823	II	30-70 bs	450 ± 60	1324 A. D. (2.6%) 1346 A. D.,1392 A. D. (75.3%) 1528 A. D.,1552 A. D. (17.5%) 1634 A. D.	Haun et al. 1999

Beta 81824	480, 920	II/III	40-60 bs	430 ± 60	1406 A. D. (95.4%) 1635 A. D.	Haun et al. 1999
Beta 82175	500, 1030		60-80 bs	400 ± 50	1428 A. D. (60.2%) 1530 A. D.,1538 A. D. (35.2%) 1634 A. D.	Haun et al. 1999
*Beta 83215	468, 996	I-II	101-135 bd	270 ± 60	1460 A. D. (76.8%) 1684 A. D.,1734 A. D. (14.3%) 1806 A. D.,1930 A. D. (4.3%) 1954 A. D.	Haun et al. 1999
Beta 82232	480, 1020	II	52 bs	260 ± 60	1461 A. D. (70.4%) 1690 A. D.,1728 A. D. (18.9%) 1810 A. D.,1924 A. D. (6.0%) 1954 A. D.	Haun et al. 1999
^Beta 62603	Test Unit 2	III	40-50 bs	3690 ± 100	1585 B.C. (95.4%) 935 B.C.	Craib 1993
^Beta 62604	Test Unit 3	III	45-55 bs	3190 ± 50	862 B.C. (95.4%) 396 B.C.	Craib 1993
^Beta 62605	Test Unit 3	III	55-65 bs	3290 ± 50	1027 B.C. (95.4%) 511 B.C.	Craib 1993
^Beta 62606	Test Unit 3	III	70-80 bs	3400 ± 70	1240 B.C. (95.4%) 711 B.C.	Craib 1993
*Beta 62607	Test Unit 3	III	55-67 bs	2530 ± 60	804 B.C. (91.4%) 486 B.C., 462 B.C. (1.4%) 448 B.C., 442 B.C. (2.7%) 416 B.C.	Craib 1993
^Beta 62608	Test Unit 3	IV	90-100 bs	4060 ± 50	1966 B.C. (95.4%) 1480 B.C.	Craib 1993
Beta 246655	Trench E BU	IV	135 bs		266 A. D. (0.6%) 272 A. D.,335 A. D. (94.8%) 540 A. D.	Morrison and Tuggle 2009
Beta 246653	Trench D fea. 2.3	IV	105 bs		1426 A. D. (72.0%) 1524 A. D.,1558 A. D. (23.4%) 1632E	Morrison and Tuggle 2009
Beta 246654	Trench E fea. 2.1	I	50 bs		1426 A. D. (72.0%) 1524 A. D.,1558 A. D. (23.4%) 1632 A. D.	Morrison and Tuggle 2009

* indicates bulk sediment sample
^ indicates marine sample calibrated with Marine 09 Curve, Delta R value = 320 ± 80
OxCal v4.1.3 Bronk Ramsey (2009); Intcal09 atmospheric data from Reimer et al (2009); Marine 09 marine data from Reimer et al. (2009)

DU I: Natural. A pre-human coastal coralline sand deposit 50 to 75 cm in depth overlay a limestone bedrock unit, the surface of which is 4-4.5 m above the present mean sea level.

DU II. Cultural, truncated and capped as a result of natural events. A deposit resulting from initial human settlement and natural sand accumulation developed on the coastal plain. It is a surviving portion of an "early *unai* phase" village, with artifacts, midden, firepits and postholes, dating in the 1600-1000 B.C. range (see Table 1; the full set of dates include a range to about 730 B.C.). The remnant of the occupation is in a localized area inland of the beach berm and approximately 40-45 meters from the current high tide line. The total area of this deposit is probably between 750-1000 sq m., with a maximum thickness of about 70 cm.

This stratigraphic unit is truncated and capped by a natural ocean-derived deposit (DU III), either from one or more storm deposits or tsunami that almost certainly also removed portions of it.

The general time span for the early *unai* phase of the pre-*latte* period is about 600 years (1500-900 B.C.) and the radiocarbon dates from Unai Chulu match this well. However, from a site formation standpoint it is highly unlikely that this deposit represents continuous occupation for 600 years, an enormous time span if considered from the standpoint of daily activity. There are intact features (firepits and postholes) in various layers of the deposit, but there was undoubtedly a significant amount of natural and cultural disturbance during occupation, including removal of materials in micro-erosional processes. In addition, some unknown portion of occupation deposit was removed by beach erosion and by the high-energy deposition event of DU III.

DU III. Natural, with mixed cultural materials; cultural sequence gap; a high-energy event or series of events (storm/tsunami; c.f., Tsunami Pilot Study Working Group 2006) produced a extensive, largely homogenous deposit over an area of about two hectares, truncating and capping DU II and removing portions of DU II's coastal component, mixing and re-depositing them. This unit is a highly consistent 40-50 cm thick layer of generally coarse sand, thinning out at the margins that were identified in the backhoe tests, and covers a total area of about 2 hectares. This unit represents a major disruption of occupation, and probably a destruction of large areas of cultural deposition.

In a limited area of this deposit there was some evidence of remnant features, indicating multiple storm events, but this appears to be localized near the ocean, and the major portion of this unit extents far inland with no significant evidence of intact features, indicting that that most of the deposit is from a single event (perhaps a tsunami). There are four radiocarbon dates from this unit, but their context makes their interpretation uncertain. As indicated in Figure 4, this deposit occupies the stratigraphic position of the Middle Unai in the Marianas cultural sequence, and although there are some suggestions from the cultural material that are consistent with this (see Welch and Tuggle 2008:38), this largely natural unit represents a break in the sequence. Whether the break came as a result of limited cultural occupation or is the direct result of destruction of a Middle Unai deposit by the high-energy event is unknown. Whatever the case, this gap in the cultural sequence represents about 500 years.

DU IV. Cultural, with upper disturbance. This unit is a complex set of micro-stratified deposits that contain cultural materials. Associated radiocarbon dates indicate that it derives from events taking place during the Late Unai (400 B.C. to A.D. 400). The unit includes midden, artifacts, and numerous intersecting features including firepits, postholes, burials, and clay floors, all within a unit thickness of about 50 cm. This unit is similar in extent to that of DU II, probably in the range of 750-1000 sq m.

The density of cultural materials and the micro-stratification make this an extremely important locale for the study of cultural change, as indicted in the details of the analysis (Haun et al. 1999). However, cultural period represented here, the late *unai* has a general duration of 800 years, and so the deposition certainly has huge segments of occupation time missing as a result of either destruction (from either natural or cultural events) or breaks in the use of the locale.

DU V. Natural. This is a high-energy sand deposit, probably the result of storm surf. It is much more limited than the deposit of DU III, located only in the near-coastal section of the area. The lower portion of the deposit contains disturbed materials probably a result of damage to the deposits of DU IV when the event of DU V occurred.

Above DU V are remains from the middle to late *latte* phases. This means that there is a vast gap of about 900 years in the stratigraphic sequence, that is, 600 years of the "*huong*" (A.D. 400-1000) and about 300 years of the early *latte* (A.D. 1000-1300). The event of DU V seems to limited to account for the destruction of any significant deposits from this period of time. Further, in the large extent of latter *latte* occupation (DU VI and VII) beyond the limited area of DU V, there is no credible evidence of *huong* or early *latte* settlement.

DU VI. Cultural, variable disturbance. There are standing latte stones at this site and evidence of substantial middle and late *latte* phase village that may have covered an area of more than a hectare. However, a substantial portion of the deposit (perhaps as much 75 cm thick) created by village occupation was destroyed by intensive 20th Century activity of Japanese sugarcane cultivation, Japanese WWII defensive efforts, and the massive US beach landing in 1944. Remarkably, the standing *latte* stones survived the cultivation period because they were located in a corner immediately outside two cultivated fields. During the US beach landing, the main landing tracks and roads were north of the *latte*.

Below the heavily disturbed horizon (DU VIb) of the Latte occupation, there are fragments of deposits and features in undisturbed condition (DU VIa). However, the full extent of the village will probably never be determinable because disturbance to bedrock occurs on the inland side of the site. (Some estimates of site boundary have been made based on ceramics distribution in the disturbed areas, but this is not a valid measure of site definition because of the common distribution of pottery throughout all of the Japanese fields as well as movement of ceramics across the surface of the coastal plain during bulldozing related to World War II era activity.)

Discussion of Unai Chulu Findings

The *latte* period village at Unai Chulu was probably one of the largest settlements in the northern half of Tinian, and some of the village's *latte* stones and associated cultural deposit remain today (Site TN-0073). Without a doubt, the conditions that were attractive for the people of the *latte* period were certainly equally attractive for preceding populations, and intact deposits from those occupations are present on the coastal plain of Unai Chulu, inland of the beach berm.

The nature of coastal settlements at Unai Chulu and the development of the culture of the *latte* period involve two questions concerning site formation. How large were the settlements and what changes took placed over time? The review of the site data indicates that all of the occupations have some degree of disturbance and that site areas have been reduced, in some cases probably considerably. The principal factors that contributed modern configuration of the Unai Chulu coastal plain and its pre-Contact cultural deposits are sea-level change, extreme storm activity, and 20th Century historic events.

The 20th Century disturbance is easy to identify through the disturbance itself as well as by means of review of archival photographs that provide information about areas of destructive events and the mechanisms of disturbance. Unlike the archaeological remains at the village at Unai Dangkulo, much of which was protected from destruction by its topographic location, the site of the Unai Chulu village was effectively destroyed during the period of Japanese sugarcane cultivation, then further damaged by WWII events. The disturbance and absence of Latte Period deposits in many areas of Chulu correlates well with locations known to have been heavily impacted by World War II related activities and modern disturbances associated with bone hunting. The location of disturbance documented with the backhoe trenches in 2008 correlates well with the extent of a road that crosses the central portion of the coastal plain. Extensive bulldozing is also visible in various locations. The standing latte set appears to be in a location with little visible disturbance. The general location where post-war Japanese visitors used machinery to search for human remains is also known. The location of disturbance in backhoe trenches dug around this location are contained within the area, suggesting that searching for the human remains had a significant effect on the integrity of the deposit.

For the lower deposits, the questions have more complex answers. Geologic evidence on Tinian Island indicates that the sea level during the mid to late Holocene was approximately 1.8 m higher than present (Dickinson 2000). Evidence for a higher stand of the sea on Tinian comes solely from the elevation of a wave cut notch recorded by Dickinson (2000) (Figure 5). While Northern Guam and Rota exhibit complex tectonic activity that affects interpretation of sea level history, the elevation of 1.8 meters reported by Dickinson falls within the theoretical height range expected from hydro-isostatic calculations alone (Dickinson 2000:744). Assuming a sea level of at least 1.8 meters higher than present, much of the area below the modern beach berm was under water during the initial settlement of Unai Chulu. The early deposit was located close to the active shoreline. Elevation data acquired from Chulu suggest that the depth of the lower Pre-Latte deposit (DU II) in the inland section is approximately 4.5 m above sea level. The area immediately seaward of the beach berm rapidly decreases in elevation suggesting that much of this portion of the beach formed as a result of beach progradation since the retreat of the mid-to late-Holocene highstand of the sea (*sensu* Mitrovica and Peltier 1991).

Given a 1.8 m higher stand of the sea during the formation of the early pre-*latte* period deposit at Chulu, it is argued that this original deposit was much more extensive than now, with much of it removed and re-deposited during the formation of the poorly sorted calcareous storm deposits that now underlie the *latte* period deposits.

In many locations of the coastal plain, red-slipped and limestone impressed pottery in secondary context was recovered from within the storm deposits up to 7 meters above current sea level. These materials are pre-*latte* in origin and are presumed to have derived from the area near the intensive excavation of Haun et al. (1999) directly shoreward of the current beach berm. Given the stratigraphic context of these artifacts as well as the topographic location, it is clear that the transport agent responsible for their deposition was high-energy wave events.

In sum, the ocean has removed substantial portions of the pre-*latte* settlement remains of DU II and DU IV (early and late *unai*), with some amount of re-deposition in the mixed storm/tsunami deposits. The implication for understanding the development of the *latte* period settlement is obvious. Baseline size of pre-*latte* villages (and population size) has to be based on estimate and

Figure 5. Wave-cut notch and emerged reef near Unai Dangkulo, view to south. Photograph by M. T. Carson.

modeling, and even more problematic, the nature of the activities in the destroyed portions of those villages will never be known. The other confounding factor is an even greater difficulty for considering *latte* village development. As important as Unai Chulu is for the evidence regarding segments of pre-*latte* settlements, there is a chronological gap in the cultural sequence of some 900 years.

Unai Dangkulo

Unai Dangkulo is located on the east coast of Tinian (Figure 6; see also Figure 1). The coralline sand beach at Dangkulo is one of the largest coastal plains on Tinian, with the main beach stretching approximately 150 m in length and 80 m wide. Surface survey suggests that the eastern portion of the beach from the mean high tide line to approximately 40 meters (m) inland is regularly inundated by extreme high tides and storm events. At approximately 85 m from the mean high tide line, a limestone terrace covered with thick forest canopy now exists. The limestone terrace has a large, intact latte site (Site TN-0078) and additional areas of ceramics, indicating extensive *latte* period occupation of the area.

Previous archaeological research in the vicinity of Unai Dangkulo was conducted by Moore et al. (1986) and Craib (1999). Moore et al. (1986) focused predominately on the archaeological features of Site TN-0078 found along the limestone bedrock terrace above the Unai Dangkulo coastal plain, a series of *latte* sets varying in number of elements and degree of preservation. Several shovel tests excavations were conducted in the vicinity of the *latte* elements by Craib (1999). No subsurface investigations were carried out by these researchers in the beach of the coastal plain.

The 2008 investigation reported here (Morrison and Tuggle 2009) involved archaeological and geomorphologic research on the Unai Dangkulo coastal plain as a part of subsurface site inventory. The research questions that the excavations were prepared to address if intact cultural deposits were encountered were: 1) age characteristics and the spatial extent of the deposits, 2) site formation processes, and 3) relationship of the deposits to the cultural occupation of the general vicinity.

Although the previous archaeological investigations along the limestone terrace above the coastal plain indicated a *latte* period occupation, it was unclear whether settlement of the limestone terrace area corresponded to the initial use of the area, or if an earlier pre-*latte* component was present in the vicinity of the limestone cliffs and corresponding beach area. Additional attention was placed on understanding site formation processes responsible for the current configuration of subsurface deposits encountered during excavations. The dynamic nature of coastal environments creates a situation in which cultural deposits may be deeply buried underneath calcareous sand or eroded by storm activity and continuous ocean processes (e.g., Allen 1998; Carson 2004).

The presence of wave cut notches at Dangkulo Beach (Dickinson 2000) demonstrates that during the early period of Mariana Islands settlement, the tidal extent would have been much closer to the limestone terrace, drastically limiting the amount of space available for settlement on the beach. According to Dickinson (2000), these wave cut notches provide evidence for a higher stand of the sea during the mid-to late-Holocene. Emergent paleoreef flats on nearby Guam and Rota date between 4750–2750 BP (Dickinson 2000:737, Figure 2). While some degree of tectonic uplift has been documented for Rota and Northern Guam, data from Tinian and Saipan are within the range predicted solely by hydro-isostatic emergence. These data generally suggest that between 4750–2750 BP, sea level was an average of 1.8 m higher than at present. A sea level approximately 1.8 m higher than present during the initial colonization of the Mariana Islands indicates that many low lying coastal areas would not have been available for settlement (Amesbury et al., 1996; Moore and Hunter-Anderson 1999).

During the 2008 fieldwork, emphasis was placed on detailed recording of the mean sea level elevation of the deposits at Dangkulo in order to assess natural processes responsible for eroding cultural deposits and to reconstruct geomorphologic evolution. A high precision survey grade GPS unit was used to establish the

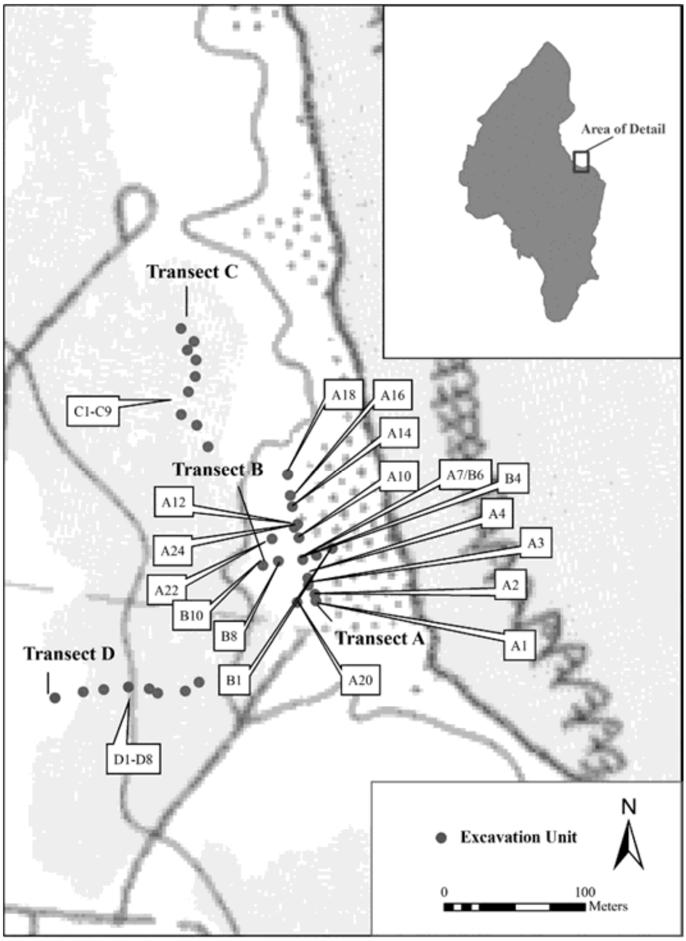

Figure 6. Location of excavation units at Unai Dangkulo.

relationship between stratigraphic units and the present sea level. Tidal measurements were adjusted to mean low low water (MLLW) using tidal charts for Tinian Island. Vertical precision of the GPS readings was established at ± 40 cm. Four transects were laid out for the placement of test excavations (see Figure 6). Transects were labeled A–D with tests conducted at near equal intervals. For comparative purposes, transects A and B were laid out on the coastal plain and transects C and D were placed on the nearby limestone terrace. Sedimentary characteristics were used to develop stratigraphic correlations along both transect lines running parallel and perpendicular to the beach. Attention was also placed on documenting the presence of intact subsurface cultural deposits that could be used to assess the degree of post depositional disturbance.

Unai Dangkulo Stratigraphy

Depositional units at Unai Dangkulo consist predominately of medium to coarse-grained calcareous sediments that were likely deposited during storm events or extreme high tides (Figures 7–9).

Layer I is a recent stratum consisting of calcareous beach sand. This unit represents the present surface of the beach from the high tide line until approximately 80 m inland. Modern debris was consistently encountered within Layer I. In most areas inland of the high tide line, a thin poorly developed organic soil horizon has formed. During excavation and sediment and soil descriptions, the soil horizon was designated Layer Ia.

Layer II is also a medium to coarse-grained calcareous deposit lying directly underneath Layer I. In some areas in the central portion of the coastal plain, a thin poorly developed paleosol separates Layer I and Layer II. In some locations, historic era artifacts were recovered from within this soil horizon. The paleosol is designated as Layer IIa.

Layer III is the primary cultural deposit. The matrix of Layer III is primarily calcareous sand. Terrigenous silt inclusions are also present, likely being deposited by human activity. Abundant artifacts and anthropogenic shell and animal bones were recovered from within this layer. There is no evidence that Layer III material has been re-deposited by post depositional processes and therefore is likely intact in primary context. In the area near the limestone terrace, the modern surface contains a higher percentage of organic material indicating that the surface in this area receives less active deposition from wave activity.

Unai Dangkulo Radiocarbon Dating and Site Formation

Two charcoal samples were submitted for wood identification but neither sample could be conclusively identified. In the absence of other suitable materials for dating, it was decided to proceed with radiocarbon dating of the samples. While the lack of charcoal identification is a concern in considering the radiocarbon dates, the radiocarbon results are consistent with the results of the ceramic analysis. A ceramic analysis based on body and rim thickness, rim type, rim orientation, surface treatment, and temper type was conducted to investigate the temporal extent of the subsurface deposit (see Morrison and Tuggle 2009 for details). Results suggest that the pottery recovered from excavation units on the beach derive from the pre-*latte* period. Comparison with other assemblages in the Northern Mariana Islands suggests the deposit may date to the late *unai* or early transitional period (Welch and Tuggle 2008). The sample recovered from unit A 10 comes from a hearth (Feature A 10.1) located directly on top of the sterile beach sand layer (Layer IV), and provided a date of A.D. 140-397. A second

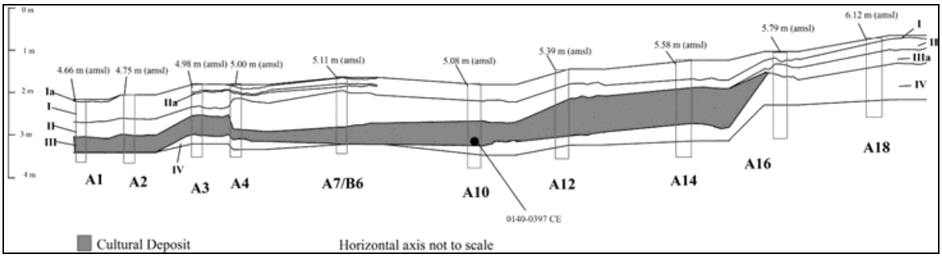

Figure 7. Stratigraphic correlation diagram form Transect A at Unai Dangkulo.

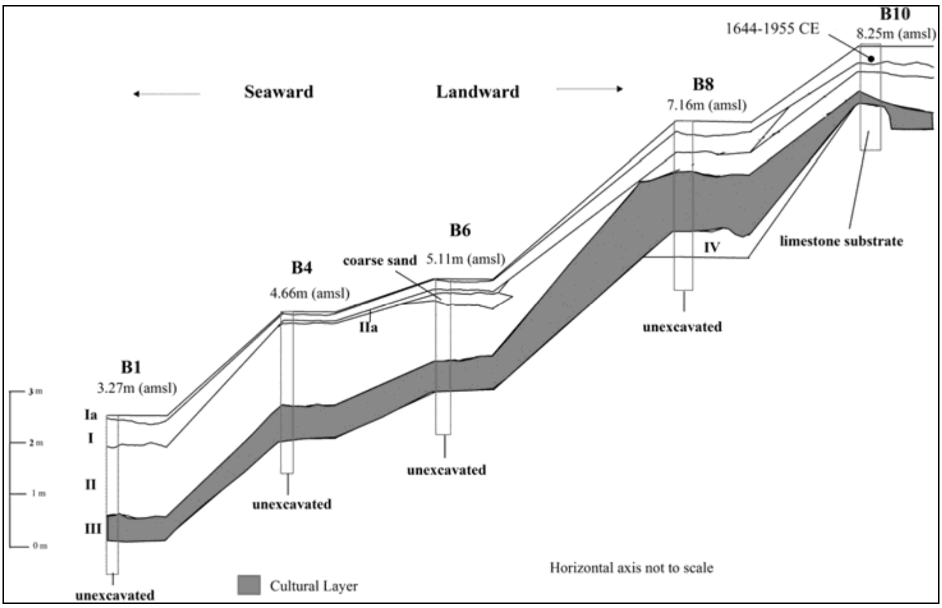

Figure 8. Stratigraphic correlation diagram for Transect B at Unai Dangkulo.

radiocarbon date from a sample collected at 66 cmbs in Layer I of excavation unit B10 in the vicinity of the limestone terrace returned a date of A.D. 1644–1955 (Table 3).

A range of prehistoric cultural material was encountered during the course of subsurface testing at Unai Dangkulo. Modern and historic artifacts were recovered from the uppermost strata, but no historic or modern materials were found within the primary cultural deposit (Layer III). Ceramics make up the bulk of the artifacts (2229 sherds recovered). Other artifacts recovered during excavations at Unai Dangkulo include several formal and informal lithic tools,

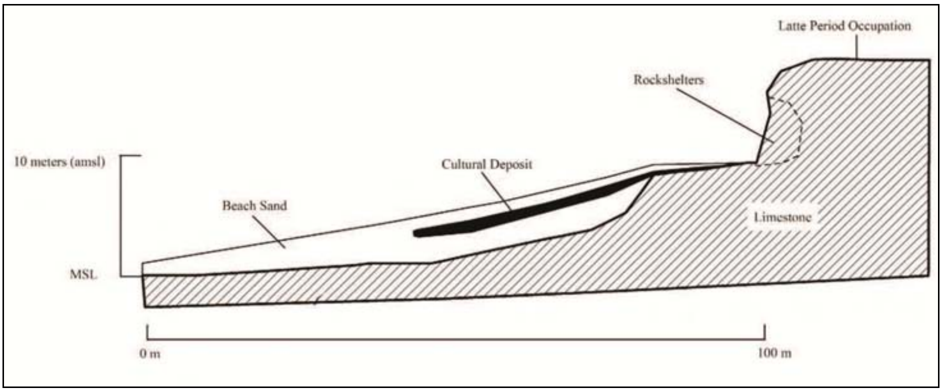

Figure 9. Schematic profile of Unai Dangkulo.

four shell beads, one shell pendant, two bone needles, one fishhook fragment, and three *Tridacna* adzes. The majority of artifacts were recovered from the primary pre-contact cultural deposit (Layer III).

Geomorphologic information acquired through topographic mapping with high-precision GPS and detailed stratigraphic recording of subsurface excavations suggest that the upper stratigraphic layers (Layers I–II) are derived from high-energy wave deposition. The low surface elevation relative to present mean sea level suggests the coastal plain is frequently scoured by high-energy storm events. Consequently, it is likely that the absence of *latte* period cultural materials in the majority of subsurface deposits on the beach is the result of site disturbance from natural processes that have truncated the upper portion of the cultural deposit. Deposits in test excavation unit B10, located further inland approximately 2–4 m from the beginning of the limestone terrace, contained *latte* period pottery mixed with historic and modern artifacts suggesting that wave over-wash may have deposited remnants of the *latte* period deposit further inland. A radiocarbon sample from Layer I in excavation unit B10 returned a date of A.D. 1644–1955.

In order to systematically investigate site formation processes at Unai Dangkulo, elevation data for each test excavation and stratigraphic unit were recorded and adjusted to Mean Low Low Water (MLLW). Inspection of a stratigraphic correlation diagram along Transect B (see Figures 7 and 8) indicates that the thickness of the primary cultural deposit, where present, is least developed in the vicinity of test unit B1. Stratum III was reached at a depth of 1.33 m below the current surface. The current surface of unit B1 stands 3.27 m (±40 cm) above MLLW. Therefore, Stratum III in excavation unit B1 stands only 1.93 m above current sea level. Stratum II is a coarse grained calcareous sand deposit sitting directly on top of Layer III. Given the nature and extent of Layer

Table 3. Radiocarbon dates from the Unai Dangkulo beach excavations.

Cat. No.	Lab. No.*	Provenience	Material	Age BP	$^{13}C/^{12}C$ ‰	Conventional Age BP	Calibrated Age A.D.**
1	Beta-246657	Unit A10, Layer III, 90 cmbs	charcoal ?	1760 ± 40 BP	-25.9	1750 ± 40 BP	140–397
2	Beta-246656	Unit B10, Layer I, 66 cmbs	? charcoal	190 ± 40	-24.7	190 ± 40	1644–1955 1915-1955

* Beta Analytic Lab Number

** Calibration from OxCal v4.05 computer program (Bronk Ramsey 2007); IntCal04 atmospheric curve (Reimer et al. 2004);-all dates have a 2 sigma age range.

II as well and the low elevation relative to sea level of Stratum III, it is highly probable that Layer III has been truncated by natural coastal processes responsible for the deposition of Layer II.

The well developed cultural layer (III) reaches its greatest thickness of approximately 80 cm in the vicinity of units A10 and A12. The radiocarbon date of A.D. 140–397 for an in situ feature at the base of Layer III in unit A10 suggests that the entirety of deposit formed after this time. The proto-historic to historic age for a second radiocarbon date recovered from Layer I in excavation unit B10 as well as the presence of both historic and pre-Contact artifacts supports the idea that Layer I has been significantly re-deposited and disturbed.

Coastal Deposits and the Occupation of the Limestone Terrace

To investigate the relationship between deposits encountered on the beach and along the limestone terrace, analysis of materials recovered from subsurface investigations were made. Comparison of sherds from excavation units in the beach deposits to sherds recovered in subsurface contexts on the limestone terrace suggest that a pre-*latte* deposit is prevalent on the beach but may be absent on the limestone terrace. There are several possible reasons for the discrepancy between the two areas. First, it is possible that increased activity on the limestone terrace occurred during the *latte* period (see Moore and Hunter-Anderson 1999 for a similar discussion). The location of numerous *latte* elements in the area today attests to this fact. It is also probable that natural site formation processes associated with storm surges and high energy coastal processes may have eroded evidence of the *latte* period deposit along the beach.

General Discussion

Extensive archaeological fieldwork conducted on the Unai Chulu coastal plain has documented the presence of a multi-component archaeological site dating to the earliest occupation period of the Mariana Islands and spanning into the historic period (Craib 1993; Haun et al. 1999). The results of sub-surface testing conducted in 2008 indicate that extensive surface and subsurface disturbances have occurred across the Unai Chulu coastal plain. Furthermore, the research reported here demonstrates that the early pre-*latte* deposit is likely spatially distinct, deeply buried only in the western extreme of the coastal plain.

The subsurface testing also indicates that natural processes associated with storm events have affected much of the surface and subsurface of the Unai Chulu site. The presence of predominately thin red slipped pre-*latte* period pottery in a coarse calcareous storm deposit indicates that much of the subsurface archaeology is no longer in a primary context but has likely been re-deposited by one or more storm events. World War II era activities on the beach had a significant effect on deposits located approximately 100–150 m from the shoreline. The area around 40 m from the current shoreline is the most likely area to contain evidence of the earliest cultural component at Unai Chulu

Results of subsurface testing at Unai Dangkulo indicate that an intact pre-*latte* deposit exists beneath the surface of the coastal plain. The deposit is thickest with the highest density of remains in the central area of the beach. Subsurface testing in the northeastern area of the beach indicates that the deposit has likely been eroded away from that area due to storm surge. The presence of numerous *latte* elements along the limestone terrace also demonstrate that the terrace was used heavily during the *latte* period. In contrast, very few archaeological remains from the *latte* period were recovered from the beach excavations. It is plausible that remains of a *latte* period occupation have been removed through active coastal processes.

The two cases studies highlighted above suggest that in many instances, archaeological deposits in coastal settings are likely to be disturbed by geomorphic and human induced processes. As a result, many multi-component sites in the Mariana Islands suffer from stratigraphic mixing, deflation, and the absence of cultural material for long periods of prehistory. Unfortunately it may be difficult to recognize depositional disturbances especially in the absence of material suitable for radiocarbon dating. Additionally, because radiocarbon dating requires a clear association between the event being dated and other cultural material contained within a given depositional unit, it is often poorly suited for directly assessing the degree of disturbance within a deposit and for determining modes of cultural change with fine scale temporal resolution (Feathers 1997). This is especially true in circumstances where archaeological material has been vertically displaced but the subsequent radiocarbon sample dated has remained *in situ*. In this situation, a sequence of radiocarbon dates may be in stratigraphic order while the material in the associated deposit bears little temporal relationship to the acquired radiocarbon dates (e.g., Erlandson 1984, Rick et al. 2002).

The use of paired charcoal and shell dates will help to assess problems with vertical and horizontal depositional mixing (Kennett et al. 2002). For example, working in coastal Peru, Kennett et al. (2002) reported charcoal samples dating 100–750 years older than paired shell samples from the same depositional contexts. They attribute these differences to the burning of old wood rather than problems associated with depositional disturbances, however the results indicate that the use of charcoal samples alone would have led to fallacious conclusions.

While marine reservoir corrections have been calculated for several locales in the Mariana Islands (e.g., Athens 1986, Craib 1993), additional methodological work must be conducted before archaeologists can confidently apply shell dates to chronological problems in the region (see Petchey 2009). The calculation and application of a marine reservoir correction requires an in depth understanding of the geographic differences in ocean marine ^{14}C reservoir (e.g., Petchey et al. 2009) which is the result of numerous factors including climate, upwelling, and ocean currents (Stuvier and Braziunas 1993). Additionally, diet and habitat of the species of shell being dated must also be taken into consideration (Dye 1994).

Recognizing post depositional disturbances will also require the use of additional chronometric methods to directly date the artifacts in the deposit and potentially the deposition of the deposit itself. These methods include directly dating artifacts using radiocarbon (e.g., Rick et. al. 2002) and thermo-luminescence dating (e.g., Huntley et al. 1983; Lipo et al. 2005), and assessing the timing of deposition of stratigraphic units through optically stimulated luminescence dating (e.g., Aitken 1998). Huntley et al. (1983) have successfully used thermoluminescence to date pottery sherds from the Loyalty Islands. However they note that the sherds were imported from the largely continental landmass of New Caledonia. Prescott et al. (1982) have reported difficulties using the methods on artifacts from volcanic island arcs containing predominately andesitic rocks with low amounts of uranium and thorium (Prescott et al. 1982:132). While OSL has been used to date cultural deposits at the Sigatoka Dunes, Fiji (Anderson et al. 2006), the method generally requires the presence of feldspar or quartz that other than Saipan, are not readily present in most depositional contexts in the Mariana Islands (Dickinson et al. 2001: 850). Recent advances in the direct dating of fired ceramic artifacts through the rehydroxylation method (Wilson et al. 2009) also has the potential to directly date individual ceramic artifacts and will therefore be useful for refining ceramic chronologies and assessing site formation processes.

Future research on Tinian concerning cultural change and the origin and development of the Latte culture will have to also give a great deal of attention to non-coastal surface sites on all areas of the island. There is potential for a variety of intact cultural deposits in many areas, despite the significant amount of 20th Century surface disturbance, as has been demonstrated in a number of studies (e.g. Allen et al. 2002; Dixon et al. 2000; Dixon and Welch 2002; Tuggle 2009). However, identification of these sites and their investigation will necessarily involve extensive subsurface survey followed by wide-scale areal excavations (see e.g., Tuggle 2009).

Conclusion

At Unai Chulu, although the damage to the *latte* period deposit has been extensive, the site has the potential for the reconstruction of the pattern of the *latte* period village, which was certainly one of the most important in northern Tinian. This can be done with extensive areal excavations, exposing the features that survive at the base of the heavily disturbed deposit. In contrast, the Unai Chulu deposits have little potential to contribute to the understanding of the immediate origin and development of the *latte* culture. There is a chronological gap of as much as 900 years in cultural activity at the site for the period preceding the *latte* and for the early *latte* phase. Stratigraphic-based research into the origin of the *latte* culture on Tinian will depend on investigation at other sites. However, Unai Chulu has significant intact deposits from the early and late *unai* phases, and these deposits have the potential for micro-stratigraphic analysis to allow an understanding of event-based cultural change that gets to a level of behavioral detail that is not possible with reliance on radiocarbon dates, whose wide ranges obscure the reality of the events that constitute site formation. These early deposits are fundamental in providing information for the total picture of culture change on Tinian that culminated in the *latte* period.

Excavations at Unai Dangkulo identified an intact pre-*latte* deposit with a basal radiocarbon date of A.D. 140–397. Analysis of the site geomorphology and a review of regional geologic processes and local geologic features suggest that the upper portion of the primary cultural layer has been truncated. As a consequence, cultural materials dating to the *latte* period are for the most part missing from the coastal plain. However, extensive *latte* period material was found in excavation units inland on the coastal plain near the limestone terrace as well as on the surface and subsurface of the terrace itself. Together these data indicate that site formation processes related to coastal depositional forces have removed much of the *latte* period material from the Unai Dangkulo coastal plain.

Finally, much research is needed on the question of a Tinian chronology, developed by comparison with, but independent of, the general Marianas chronology. This will necessarily involve more investigation of stratified sites (including reanalysis of the radiocarbon dating of the Unai Chulu deposits), but also a focus on extensive areal excavations in numerous pre-Contact localities throughout the island, many of which we can say with confidence are buried beneath upper layers of Japanese sugarcane deposits and WWII military construction.

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