THE POLITICAL ECONOMY OF ANCIENT SAMOA: BASALT ADZE PRODUCTION AND LINKAGES TO SOCIAL STATUS

by

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Title: THE POLITICAL ECONOMY OF ANCIENT SAMOA: BASALT ADZE PRODUCTION AND LINKAGES TO SOCIAL STATUS

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This dissertation examines the role of stone tool production as a strategic resource in the development of chiefly authority in prehistoric Samoa. The evolution of Polynesia's complex chiefly systems is a long standing issue in anthropology, and prior archaeological research has identified that specialized goods were a significant factor in the elevation of elite status in many Polynesian contexts. Before Western contact, Samoa was a stratified chiefdom with leaders claiming exclusive privileges and participating in an extensive trade network within the Fiji-West Polynesian region during the Traditional Samoan period (c. A.D. 300-1700). However, Samoa's political structure was quite different in the earlier Polynesian Plainware period (c. 500 B.C.-A.D. 300). Archaeologists, with the aid of historical linguistics, have documented a simple hereditary system operating among small horticultural communities. To address this political transformation, I investigate coeval changes occurring in stone adze production recovered on Tutuila Island.

Based firmly in the theoretical perspective of political economy, I ask three inter-related questions in my dissertation: were adze specialists present in ancient Samoa; if so, what was their connection to chiefly prerogatives; and what further relationship did these adze producers have with Samoa's emerging elite? To answer these questions, I utilize mass flake analysis and typological classifications to document technological and spatial changes in stone tool production. I also employ settlement studies and geochemical characterization to chart how leaders managed and controlled raw materials, as well as the distribution of basalt adzes in exchange networks.

From my research, I record numerous nucleated workshops of adze specialization on Tutuila dating as far back as 800 years ago. As a new form of economic organization, these adze specialists acted as catalysts for increased political complexity and stratified authority. In addition, I trace how Samoan elites used their bourgeoning authority in restricting access to basalt sources and the distribution of the finished products during this same time period. In the larger Samoan political economy, I conclude that Tutuilan chiefs, located in an otherwise economically-impoverished island, utilized these newly-developed adze specialists and high-quality basalt as strategic resources for accumulating material surplus in prestige competition.

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To: Tiffany Brannon
a most persistent advocate

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CHAPTER I

INTRODUCTION

> *In Polynesia, authority was already inherent in the Ancestral Polynesian status category... as Polynesian Chiefdoms became larger and more hierarchical in structure, mere ties of kinship were not a sufficient basis on which to build the power relations necessary to command labor and tribute...*
>
> Patrick Kirch (2000:250)

As a key archipelago where Ancestral Polynesian culture formed, Samoa's early political and economic structure is important for understanding Polynesia in general. It has been suggested that Samoa's early political structure was based on a simple hereditary system operating among predominantly small horticultural communities (Kirch 2000:218). However, by the time of Western contact in the eighteenth century A.D., Samoa had developed into a complex chiefdom with a highly specialized economy and marked differences in social stratification (Sahlins 1958; Goldman 1970; Buck 1930). This dissertation delves into how stone tool studies can offer insights into this political transformation by articulating how Samoan leaders harnessed increased benefits through controlling raw material acquisition, adze production and distribution.

Stone tools, specifically basalt adzes, are integral to investigating cultural changes within Polynesian societies because of their archaeological durability and the vital roles they held in subsistence-based and wealth-generating practices (Earle 1997; Figure 1.1). Basalt adzes were a ubiquitous artifact class across Polynesia. Quarried from fine grained volcanic rock available on high islands, the finished adzes were wood-working tools utilized for a variety of subsistence and craftsman activities. At the local level, archaeologists have documented over a dozen large manufacturing sites within the Samoa archipelago, particularly on Tutuila Island, which provide behavioral information on craft production (Ayres and Eisler 1987; Ayres et al. 2001; Clark 1993; Green 1974; Leach and Witter 1990; Winterhoff and Rigtrup 2006). At the regional level, Samoan adzes have been recovered from distant island groups such as the southern Cook Islands, Fiji, Tonga, Tokelau, Phoenix and Santa Cruz (Allen and Johnson 1997; Best et al. 1992; Di Piazza and Pearthree 2001; Walter and Sheppard 1996; Weisler et al. 1994; Winterhoff et al. 2007). The broad geographic distribution of Tutuila's adzes highlights the importance that technological productions systems and Samoan exchange politics have for understanding how large prehistoric exchange networks operated.

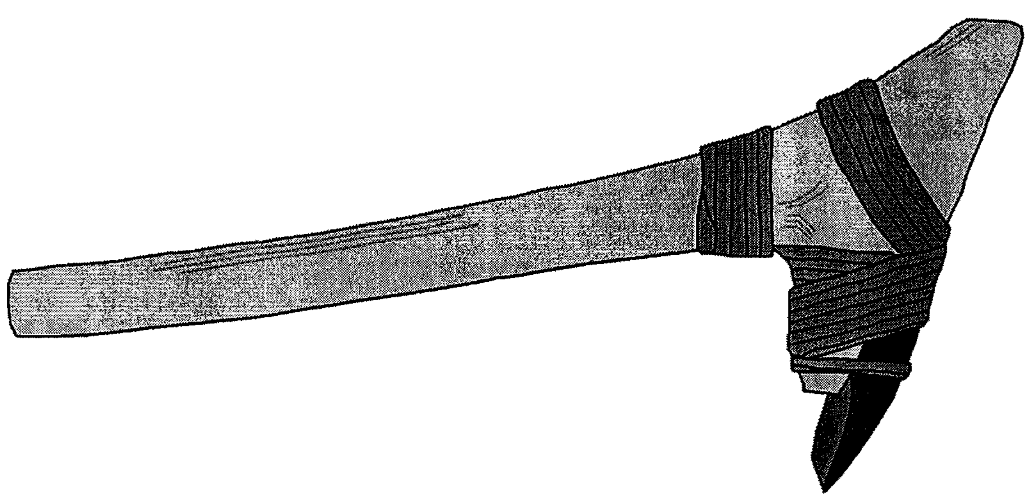

Figure 1.1. A Samoan hafted adze (adapted from Buck 1930:357-359).

Patrick Kirch calls attention to the important question of how Polynesian chiefdoms became more hierarchical in their insular settings. The political transition from a ranked to a stratified chiefdom occurred in Samoa, and encompassed a changing societal view towards status differentiation and privileges of rank (Sahlins 1958). Samoa's earlier political organization can be classified as a Traditional Chiefdom (Goldman 1970:3-28), where status differentiation occurred through birth-ordered descent, status was divided among extended families, and rank had only limited privileges. Samoa's later political organization, or Stratified Chiefdom (Goldman 1970:243-278), had elites participating in intense status rivalry, leading lineages of multiple extended families, holding titles to land and labor, and consolidating power in economic, social political and ceremonial realms (Sahlins 1958:2-10; Tcherkezoff 2000:156-162). Archaeologists have recorded changes in Samoan material culture during the Traditional Period, 300 - 1700 A.D., and have determined that this time period is the temporal setting for the socio-political shift (Davidson 1979). Two such changes in this period were a marked increase in the scale of adze production recorded on Tutuila Island (Leach and Witter 1990) and a geographic expansion in the distribution of these adzes into the larger South Pacific region (Best et al. 1992). As these increases fall into the same critical period as Samoa's political transformation, fundamental questions are raised. How can we document the expanded economic scale in relation to socio-political changes and then identify what cultural or other mechanisms were responsible – significant questions indeed for understanding Samoan and Polynesian prehistory.

Under the rubric of political economy, I propose that the dominant mechanism for this intensification was prestige competition. Elsewhere in Polynesia, anthropologists have linked chiefly competition and its material manifestations to the growing political control exercised by leaders used to finance other forms of social stratification (Bayman and Moniz-Nakamura 2001; Kirch 1984, 1991; Lass 1998). This change in Samoan political structure is significant for the study of Polynesian societies, because the actual transformation between ranked and stratified chiefdoms is poorly understood (Arnold 1996; Earle 1978; Feinman 1995; Kirch and Green 1987; Schortman and Urban 2004). Based on linguistic and archaeological reconstructions, the earlier form of Samoan chiefdom has been characterized by simple rank leadership (Kirch 2000; Kirch and Green 2001; Sahlins 1965). This form of social organization derives from the habitual reciprocal interaction among kin, where leaders command labor drawn along familial lines (Godelier 1978; Wolf 1982). However, Samoa's later lineage-based chiefdom is defined by a stratified leadership that drew upon a network of codified obligations. In the newer form, a Samoan leader constituted a managerial position allowing for substantial claims on exclusive privileges and resources from kin and non-kin alike. My research examines Samoa's political transformation by studying the different leadership strategies enabling Samoan chiefs to begin controlling economic production during the Traditional Samoan period (Bayman and Moniz-Nakamura 2001; Earle 1996, 1997; Godelier 1978; Nelson 1991; Torrence 1986).

Economic systems are composed of the circular interplay among production, exchange and consumption of goods and services within a society (Torrance 1985:4-7;

Figure 1.2). Production entails the entirety of efforts in which to manufacture a product from the acquisition of its raw materials to its successful creation. Exchange is the social process of distribution of a particular product from the producer to the consumer. Consumption involves the commodity's use by the consumer for a designated task. The driving force of this system lies in the process of supply and demand; where the consumption need powers the production required to satisfy it. In chiefdom-level societies, changes to this naïve economic system reflect the amount of control a chief exerts for his or her own wealth accumulation.

Figure 1.2. A diagram of a generalized economic system.

Ethnographically, Samoa was participating in a redistributive economic system. Redistribution describes the pooling of products around a central figure. During the Historic period, Samoan communities pooled limited surplus produced at the household level, but craft specialists produced the greater surplus required to finance elite competition. In Samoa, the redistributive economic system materially mimicked the social order, where chiefs, for purposes of wealth accumulation, controlled the economic interaction with outside polities by usurping or limiting the forces of supply and demand. In Polynesian chiefdoms, material wealth was accumulated in order to obtain social power.

> Everywhere in Polynesia, the chief is the agent of general, tribal-wide distribution. The chief derives prestige from his generosity. In turn, his prestige permits him to exercise control over social processes, such as production, upon which his functions of distribution rest, Consequently the greater the productivity, the greater the distributive activities of the chief, and the greater his powers. [Marshall Sahlins 1958:*xi*]

But in Samoa, there was no single paramount chief, but a heterogeneous community of chiefs with varying levels of prestige (Buck 1930, Krämer 1902; Mead 1928). In this arena, competition among chiefs for greater social powers led to the accumulation of material surplus to continually finance their participation. To examine the amount of elite participation in ancient Samoan economics, the ethnohistoric record creates a launching point to delve further into prehistory. Historic Samoan leadership, or *fa'amatai*, had a number of hierarchical and heterogeneous status positions vying for prestige at both the island and archipelago level (Tcherkezoff 2000). Samoan chiefly structure was divided between two styles of lineage-titles -- the *ali'i*, high chiefs, and *tulafale*, orator chiefs. This dual lineage-title system divided and diluted the ultimate authority an individual chief could obtain, but status differentiation among the titled heads was still hierarchical, so although the Samoa Islands were never a consolidated paramount chiefdom like the neighboring Tonga ones (Aswani and Graves 1998; Burley 1993), some chiefs enjoyed greater benefits than others. The titled individuals in communities held overwhelming sway in the organization of daily activities at the village level as well as acted as the central figure in larger regional interactions. In addition to the *ali'i* and *tulafale* positions, Samoan society included *tufuga* or craft specialists. These specialists were organized into 'guilds' dependent on their skill types (Krämer 1902), and due to the diversity of skills, these craft guilds were integrated into a wide array of Samoan life. For example, an early missionary, Reverend John Stair, documented an extensive set of guilds including house builder, canoe maker, tattooist, and maker of stone hatchets (Goldman 1970; Stair 1897). Although many of these guild forms were substantiated by later ethnographers (Krämer 1902; Buck 1930; Mead 1928), Reverend Stair's note on 'stone tool guilds' is the only documentation linking adze manufacture and specialists in the early historic period. The lack of corroborating historic observations could reflect that Reverend Stair was simply incorrect in recording the existence of such specialization or that there *had been* adze specialists who were rapidly replaced along with their stone tools by metal tools and Western traders (Green 1974). The uncertainty about such an important element of early Samoan technology raises three questions that will frame this study: 1) were there prehistoric specialists in stone tool manufacturing, 2) what type of specialists were present, and 3) what further relationship did these adze producers have with Samoa's ancient *fa'amatai*?

Specialization is defined as craft production where producers dedicate substantial portions of their time to the manufacture of a sole commodity or service in efforts to obtain part of their overall subsistence (Costin 1991:4). Craft specialization would have been a means in which ancient leadership accumulated material wealth for greater political competition (Johnson 1996). Costin (1991:12-13) concludes that as societies become more stratified, craft specialization becomes an increasingly important strategy for leaders to gain control over the economy. To create the surplus needed to finance emerging elites, craft specialization has the ability to increase production levels by either developing more efficient techniques or by monopolizing the skills needed in the manufacture of products. Stone tools and their associated production debris provide excellent datasets for testing the material manifestations of Polynesian leaders' control in such an economic system. Because the type of tools present as well as the composition of the waste flakes recovered at production sites provide vital information on the different strategies of employed by producers, which in turn, reflect the organization of their economic system. To address this, basalt adze research can provide multiple points of investigative departure in how this particular commodity was produced, utilized and discarded within a prehistoric Polynesian society. To accomplish this, I examine how communities interacted with their natural environment by tracing availability of tool-quality basalt sources (Best et al. 1992; Clark et al. 1997; Weisler 1993a) and the social strategies employed to acquire said material (Binford 1983; Ericson 1984; Sahlins 1965). Additionally, I focus on documenting variation in stone tool production as a means to investigate shifts in the spatial and technical divisions of adze manufacture to trace the development of craft specialization (Costin 1991; Torrence 1986). Then, I use extensive provenance data on both known and newly-characterized basalt sources and finished tools, so I can first more accurately chart the prehistoric circulation of basalt adzes in exchange networks and second, investigate the amount of influence chiefs had in their distribution (Best et al. 1992; Pollard and Heron 1996; Weisler 1993a, 1997).

Organization of this Dissertation

This dissertation is separated into three main sections. The first section provides a summary of the cultural context, theoretical perspective, and research questions. Chapter II summarizes the environmental characteristics and cultural background of the Samoan Archipelago. Also in this chapter, a history of basalt adze studies provides a basis for showing the implications of my research within a larger scientific approach towards understanding prehistoric Samoa and greater Polynesia. Chapter III discusses how I use concepts from political economy to chart and interpret the intersection of emerging leadership as well as craft specialization. This chapter reviews prior research and contributions on our understanding of societal development within chiefdoms, and in the end, presents three testable hypotheses for archaeological data.

The second section of the dissertation shifts to documenting the analyzed archaeological sites, the analytical methods and subsequent results. Chapter IV summarizes survey and excavation data from 17 archaeological sites on Tutuila Island. These sites are discussed in detail to provide spatial and temporal context for their individual lithic assemblages. In the first half of Chapter V, I discuss the typological, debitage and statistical analyses conducted on lithic assemblages and the subsequent results. Then in the second half of Chapter V, I record Tutuilan adze distribution through geochemical and statistical analyses.

The final section of the dissertation utilizes the settlement, production and distribution data to test the hypotheses outlined in Chapter III. In Chapter VI, I evaluate my research hypotheses with test expectations. Finally, I discuss the implications of these results for our understanding of Samoan society, craft specialization and the development of social inequality are discussed in the concluding chapter.

CHAPTER II

THE SAMOAN CONTEXT FOR STUDYING PREHISTORIC PRODUCTION

The Samoan Archipelago is located in the South Pacific between 13° 26' and 14° 32' degrees south longitude, and 168° 11' and 170° 48' degrees west latitude (Figure 2.1). Located in West Polynesia, Samoa lies in the warm waters of the South Equatorial currents, powered by the strong Southeast Trade Winds, that run counter-clockwise from the coast of South America to Australia. As a result, Samoa has a tropical marine climate. The islands' annual average temperature is 27° Celsius with a relative humidity averaging 80 percent. Samoa's seasons are mild shifts between the rainy season lasting from November to April, and the dry season persisting from May to October. Little temperature variation occurs between the two seasons, because of the moderating effects of the surrounding ocean. While seasonal variation in rainfall occurs across the archipelago, ranging from 100 to 500 mm per month, Samoa averages 2400 mm per year (Whistler 2002).

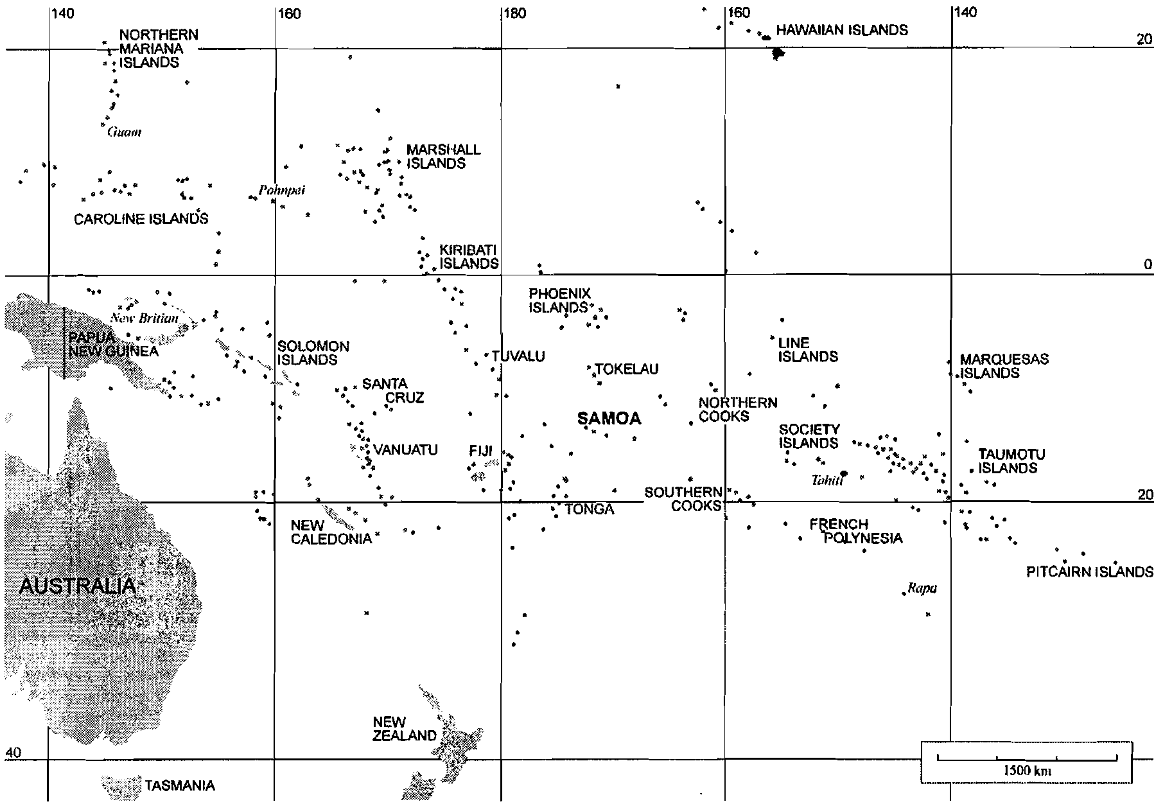

Figure 2.1. Map of the Pacific Ocean showing the location of the Samoan archipelago.

Although unified prior to the nineteenth century A.D., the archipelago now consists of two contemporary political units -- the independent nation of Samoa and the unincorporated and unorganized United States territory of American Samoa (Figure 2.2). Independent Samoa encompasses the two large volcanic high islands of Upolu and Savai'i as well as several smaller islands – Apolima, Manono, Nu'utele and Nu'ulua. This collection of islands has a total land area of 2934 km^2. American Samoa has a smaller total land area of 199 km^2, and is composed of the volcanic high islands of Tutuila, Aunu'u and the Manu'a Group – Ofu, Olosega and Ta'u. In addition, the territory incorporates two small coral atolls, Swains and Rose Islands (not pictured).

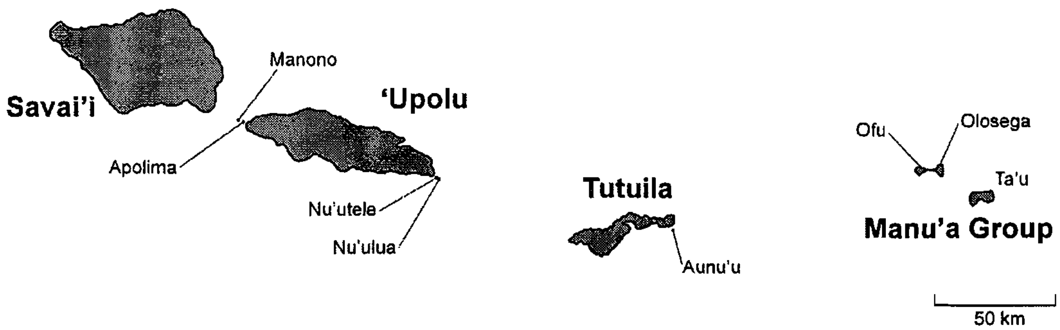

Figure 2.2. Map of the Samoan archipelago.

The Samoan Islands contain dissected valleys with deep alluvial soils and mountainous interiors. The rugged terrain and high rainfalls accumulate an abundance of fresh water in the ground table and streams. Dense vegetation envelopes the islands, but after 3000 years of human occupation not much is still native. Arthur Whistler categorizes six contemporary vegetation types that range from littoral vegetation to rainforest to disturbed vegetation (2002:10). As populations grew and fluctuated, pristine land was cleared for horticultural plots of bananas, breadfruit, and taro (Kirch 1997). The Samoa fauna represents the same situation, where native species were quickly replaced by transported domesticates such as pig, chicken, dog and rat (Anderson 2002).

Samoa's dynamic geologic nature starts 5,000 m below sea level on the Pacific Plate from eruptions of mantle plumes from a seafloor fracture (Natland 1980). These mantle plumes were derived from the superheating of the continental Indo-Australian plate being submerged along the Tongan Trench, 150 km to the south, under the Pacific Plate. The Samoan Archipelago was built mostly during the Pliocene Epoch (5.3 to 1.8 million years ago) upon steep shield volcanoes of alkalic olivine basalt originating in the west and ending in the east of the island group (Stearns 1944). Also during the Holocene, significant contributions to Samoa's geologic mass came from post-erosional eruptions along a rift system, which added nephelinite-series lava to Upolu, Savai'i and Tutuila (McDougall 1985; Natland 2004). The focus of this current archaeological research, Tutuila has five discrete eruptive periods (Figure 2.3). These shield volcanoes formed through multiple eruptions during the Pliocene producing basaltic masses that are internally distinct and highly variable with numerous dikes, plugs and extra caldera lavas (MacDonald 1944, 1968; Stearns 1944). These episodes formed the Pago, Alofau, Olomoana and Taputapu volcanics. The remaining episodes occurred during the Holocene and include the Leone volcanic events located on the Tafuna plain, the A'unuu tuff cone and over 600 dikes of younger lavas transecting the older four volcanics.

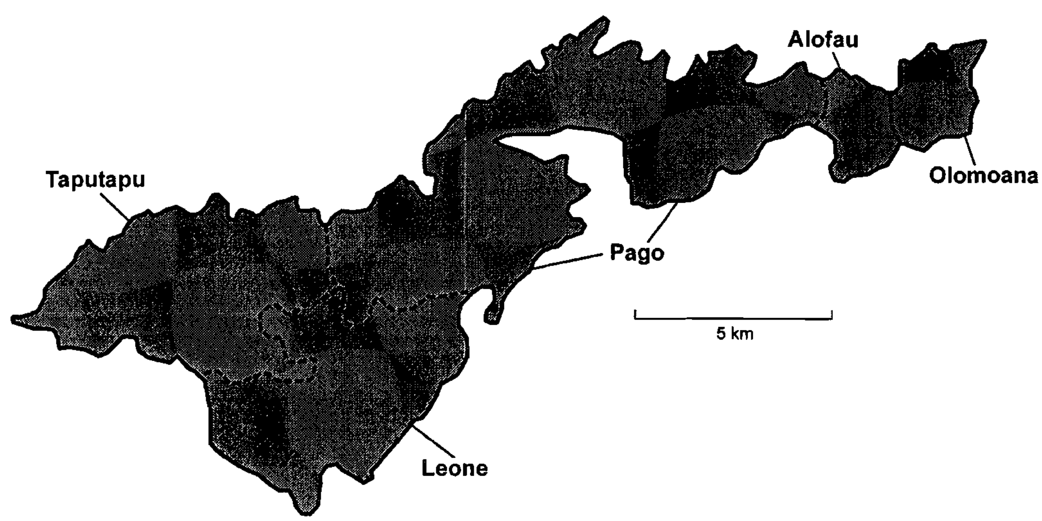

Figure 2.3. Map of Tutuila showing its volcanic formations.

Most of our current knowledge of Tutuila's geology comes from Stearns' extensive geological survey of Samoa (1944). Summarizing his research, the five volcanics are distinct and stratigraphically overlain upon themselves (see Fig. 2.3). Starting with the last episode, Leone Volcanics are a thin deposit of Olivine *pahoehoe* with a number of tuff layers from smaller, later eruptions. The next youngest, Taputapu Volcanics are andesitic basalts interbedded with cinders and tuffs, and compose the northwest corner of Tutuila. Pago Volcanics lie underneath Taputapu and form the central portion of the island. In addition, Pago is composed of two separate episodes which are both thick flows of interbedded basalts -- the Extra- and the Intra-Caldera. The two remaining volcanics, Alofau and Olomoana, are composed of mainly olivine basalts and form the east end of Tutuila. Based on later archaeological and geochemical research (Best et al. 1992; Clark et al. 1997; Johnson et al. 2007; Winterhoff et al. 2007), tool quality basalt has been tied to erosion deposits from the Pleistocene inter-bedded lavas by the production debris of very fine-grained, homogenous basalt constitutes almost the entirety of Tutuila's lithic assemblages.

The Cultural Background

Over the last fifty years, numerous archaeologists have conducted research in Samoa (Addison et al. 2006; Ayres and Eisler 1987; Ayres et al. 2001; Barnes and Hunt 2005; Best et al. 1992; Best 1993; Brophy 1986; Clark 1993, 1996; Clark and Michlovic 1996; Davidson 1979; Green and Davidson 1969, 1974; Frost 1978; Herdrich 1989; Hunt and Kirch 1988; Jennings and Holmer 1980; Johnson et al. 2007; Kikuchi 1963; Kirch and Hunt 1993; Leach and Witter 1990; Pearl 2004, 2006; Suafo'a 1994; Winterhoff et al. 2007). Based on this prior research, Samoan culture history has been divided into four general periods (Table 2.1). First, the Lapita period encompasses the initial successful human settlement of the archipelago. Second, the Polynesian Plainware period represents the cultural transformation from an external colonizing population into a new regional-based society that is considered the cultural origin of greater Polynesia. Third, the Traditional Samoan period describes the development of a single cultural entity, Samoa, separate from neighboring island groups. Finally, the Historic Samoan period depicts the last three hundred years as Samoans navigated the influence of earlier Western colonialism and then the later global economy. The following section reviews each of these four periods, while calling attention to major changes over time in Samoan stone tool technologies and important archaeological sites.

Table 2.1. Chronology of past Samoan periods (adapted from Ayres and Eisler 1987:14).

Period	Timeline
Eastern Lapita	1000 - 500 B.C.
Polynesian Plainware	500 B.C. - 300 A.D.
Traditional Samoa	300 - 1722 A.D.
Historic Samoa	1722 A.D. - present

The Lapita Period

In Samoa, the Lapita period dates from 3000 to 2500 years ago, and signals the human colonization and settlement of the archipelago and surrounding region (Green 1997; Leach and Green 1989). The Lapita Cultural Complex represents the original settlers of Remote Oceania, and is archaeologically defined by their highly stylized dentate-stamped pottery (Anson 1986). The Lapita originated from the melding of voyaging groups of Austronesian speakers, thought to derive ultimately from Taiwan (Rolett et al. 2002), with native groups of Papuan speakers in Island Melanesia at 4000 years ago, before later dispersing farther into Remote Oceania (Anderson 2001; Green 1991; Figure 2.4).

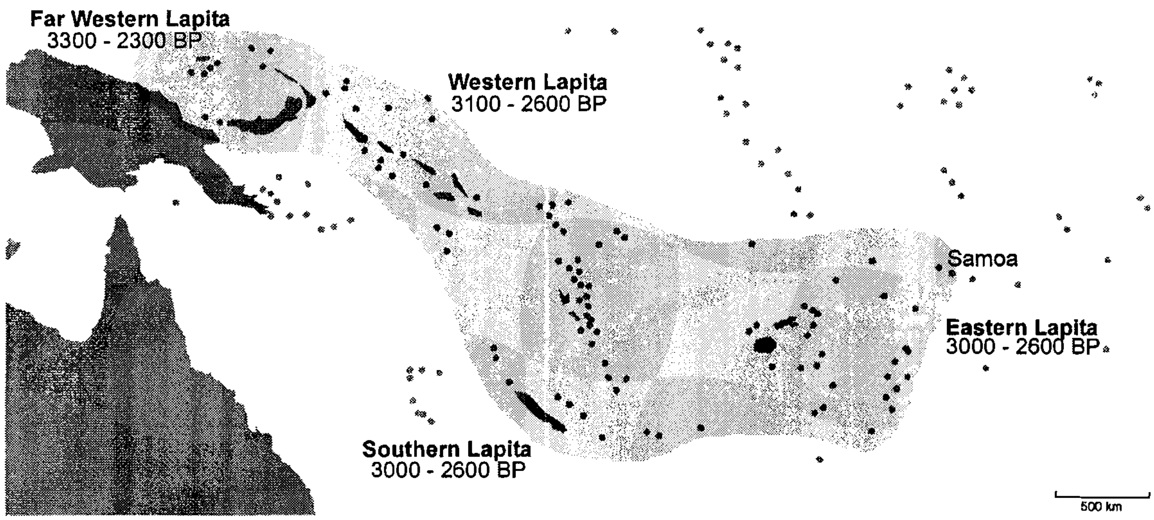

Figure 2.4. The dispersal of the Lapita Cultural Complex into Remote Oceania (adapted from Anderson 2001).

The Lapita brought with them the cultural and biological template as the founding population for Samoa and the region. Based on linguistic reconstructions, archaeologist Patrick Kirch states that the Lapita were not only the *founding* society, but were the original *ranked* society in Remote Oceania (2000:115). A material inventory of the Lapita includes stone and shell adzes, obsidian flakes, shell fishhooks and shell valuables (Gosden 1991; Spriggs 1984); as well as a settlement preference of different sized hamlets located near the coast. In addition, the Lapita transported a subsistence economy based on a horticultural practice including two dozen non-native plant species; for example taro, breadfruit, bananas and coconuts. Also, the settlers brought domesticated animals such as chickens, dogs and pigs to supplement the carbohydrate-rich plant diet. This horticultural complex was augmented by foraging food sources found on the land, the lagoon, the reef and the open ocean.

In 1973, Lapita dentate-stamped pottery was accidentally discovered near Mulifanua, Upolu (Green 1974). The Ferry Berth Site, located immediately off the northwest coast of Upolu under 2.6 m of lagoon water and cemented coral, represents the only Lapita site recovered in Samoa to date (Leach and Green 1989); however, the two stone adzes recovered at the site provide important information on early lithic production within the archipelago. From geological and stylistic examination, it was determined that one with a curvilinear cross-section had come from Tonga and the plano-convex adze was manufactured in Samoa (Leach and Green 1989). The results suggest that basic technical knowledge on adze manufacturing arrived with initial human colonization. The Tongan adze shows limited but early transportation of stone tools between island groups or may even represent a possible colonization effort from the south (Leach and Green 1989).

The Polynesian Plainware Period

The Polynesian Plainware period in Samoa dates from 2500 to 1700 years ago, and marks a major cultural shift recorded in the region's ceramic technology, subsistence practices and settlement patterns. During this period, Tonga, 'Uvea, Futuna and Samoa culturally separated from their western neighbor, Fiji, and became archaeologically distinct (Kirch and Hunt 1993). The period's significance to our understanding of Polynesia's past is derived from the baseline data it provides for the later socio-political and technological diversification documented throughout the greater region (Kirch and Hunt 1993:236).

Although the Polynesian Plainware period is archaeologically characterized by the simplification in ceramic technology of the earlier Lapita period (Clark and Michlovic 1996); this period marks innovations in food processing and storage, such as earth ovens and food pits which begin to appear at approximately 2000 years ago (Davidson 1979:94). The changes in cooking technology denote a similar shift in subsistence practices, where there was a greater reliance on domesticated foodstuff compared to the earlier Lapita period (Kirch and Hunt 1993). Also, settlement patterns changed as more sites began to appear inland as well as on the coast (Green and Davidson 1974) suggesting an increase in the overall population made possible by stabilization in food production (Davidson 1979). Related to this population increase, new groups from Samoa and Tonga began colonizing into East Polynesia spreading the new 'Ancestral Polynesian' developments farther (Anderson 2001; Bellwood 1987; Figure 2.5).

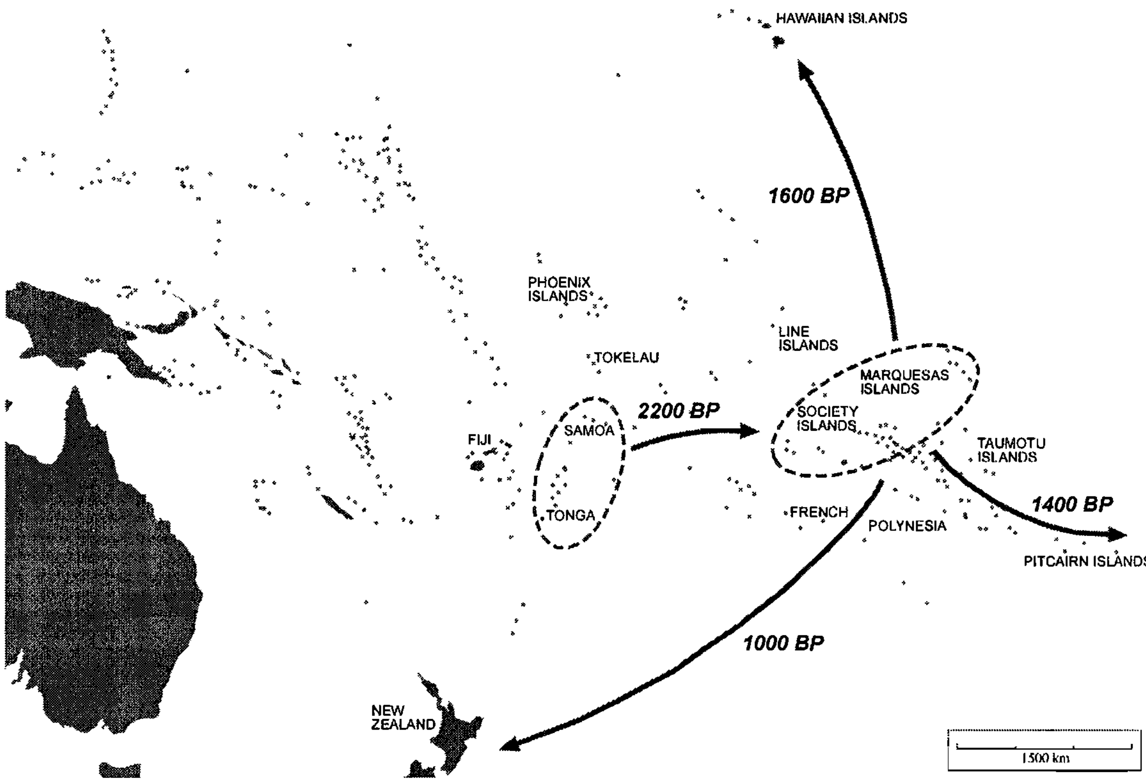

Figure 2.5. Dispersal from the Ancestral Polynesian Homeland (adapted from Kirch 1984).

The period marks two important changes in the Samoan tool kit. First, the triangular-section adze form was invented (Bellwood 1987:54). The invention of this new adze form (Types VI and VII) probably reflects production changes related to wood-working. The presence of this new tool type could be a product of specialization, better raw material availability or new wood products for consumption; however, further research is required to more fully understand its significance. Second, the plano-convex Types IV and V adzes, typical of this period, decreased in frequency towards the end of the period, while quadrangular adze forms increased (Green and Davidson 1969:32; Kirch 1993:158). This shift highlights a preference for labor intensive adze forms like

Type V earlier in cultural sequence, and a preference in less ground adze forms like Type I that required less final modification before use.

Additional evidence relating to adze production in this period, except for minute amounts of debitage recovered at To'aga and Su-Va-1 sites, has been recovered primarily at AS-34-34-F17 in the Maloata Valley (Ayres and Eisler 1987) and to lesser extent at AS-21-5 in 'Aoa Valley on Tutuila (Clark and Michlovic 1996). As these sites' production scale - albeit minor - was not mirrored elsewhere in the archipelago, their presence may suggest the beginnings of technical specialization occurring on Tutuila; however, more research is needed.

The Traditional Samoan Period

From 1700 to 300 years ago, the Traditional Samoan period documents the cultural differentiation of ancient Samoans from the rest of the West Polynesian region. The period starts with the general cessation of ceramic manufacture in Samoa (Clark and Michlovic 1996) perhaps finalizing a rejection of an out-dated cooking technology as earth-ovens became prominent in the archaeological record (Leach 1982). In addition, the islands' population levels increased to proto-historic levels and began to be more evenly distributed throughout the islands (Davidson 1979).

During this period, status differences within the population are witnessed archaeologically by a number of material indicators. Settlements started to reflect a growing elaboration in the socio-political realm. Household structures began to vary in size and function, ranging from small individual house foundations to large chief or guest houses (Davidson 1974). Additional displays of wealth included the construction of large burial and star mounds. Requiring large inputs of labor, their appearance in the archaeological record implies a marked change in status and power within Samoa's ancient polities (Herdrich and Clark 1993). Moreover, large earth-ovens are documented in the western islands denoting the presence of communal feasting (Davidson 1979). Lastly, evidence of ownership and territoriality in the form of stone walls and raised paths, difficult to date precisely, has been assigned to this period.

In the Traditional Samoan period, there is a change in Samoan settlement practices with the introduction of fortifications or more aptly named -- ridge-top settlements (Best 1993; Clark and Herdrich 1993; Pearl 2004). Recent archaeological research confirms that ridge-top locations are a late manifestation (Pearl 2004), and these ridge top sites routinely have defensive trench cuts and extensive terracing (Davidson 1979; Leach and Witter 1990; Best 1993). As these sites are located in non-optimal locations for residential or agricultural purposes, warfare was assumed to play a part in their creation, but poor preservation of burials and wood weapons make it difficult to assign a definitive conflict-related function.

Another new component in the later portion of this period is a well documented system of exchange that connected Fiji, Tonga and Samoa (Kaeppler 1978; Weisler 1997). Adrienne Kaeppler (1978) described the culture contact as a social network of trade partnership for spouses and goods among these three cultural entities beginning in late prehistory and lasting into the historic period. Islanders distributed items such as bark cloth, servants, fine mats, canoes, sandalwood, wooden bowls, red feathers and adzes within the formalized kinship links formed through marriages (Kaeppler 1978; Weisler 1997). From provenance research conducted over the last twenty years, chemical characterization results corroborate the presence of an exchange network, because stone adzes from Tutuila's quarries have been recovered on the islands at sites dating between 900 to 300 years ago (Best et al. 1992; Di Piazza and Pearthree 2001; Winterhoff et al. 2007). At the end of this period, adze production reached its pinnacle (Clark 1993; Clark et al. 1997; Leach and Witter 1990; Winterhoff and Rigtrup 2006).

The Historic Samoan Period

The Historic Samoan period started roughly 300 years ago when the Samoan Islands were visited by Western explorers. In the initial contact phase, Samoa was first sighted and documented by Dutch explorer Jacob Roggeveen, who spotted the archipelago in 1722 (Davidson 1979). But land fall was not made until an ill-fated visit by French explorer LaPerouse in 1787 where due to an unexplained altercation on Tutuila, a dozen of his crew members were killed (see Dunmore 1994). After the incident and subsequent reputation for violence, Samoa was not visited, except for perhaps by whalers and traders, for approximately 50 years.

Then in 1830, John Williams from the London Missionary Society visited the islands and started the religious conversion of the archipelago to Christianity (Williams 1984). The affects of this conversion on Samoan culture, although immediate and widespread across the religious realm, were lessened by strongly in-grained cultural practices in other realms, such as the *fa'amatai*, kinship and high-yield subsistence practices. During an active colonial period, dating from A.D. 1900 to 1976, European and American governments vied for control over Samoa's copra interests and harbors. After the Tripartite Convention in 1899, the United States took control of Tutuila and the Manu'a Islands, and Germany took possession of Upolu and Savai'i. After Germany's loss in World War I, New Zealand took possession of Western Samoa until 1976, when the island nation received its independence and became simply – Samoa. This early twentieth century political division between Samoa and American Samoa still exists and affects how archaeological work is conducted; however, the archipelago is still firmly united culturally.

As for basalt adze production during the Historic Samoan period, the stone adze and its production knowledge was quickly replaced by more efficient metal blades brought by Western and indigenous traders. This rapid replacement occurred during the 100 year period preceding the arrival of missionaries, so direct written accounts on technology do not exist. Although Peter Buck (1930) admirably described components of adze technology from informants' memories of earlier generations; his review was based on indirect accounts and after generations of Samoan interaction with metal tools.

In sum, this culture historical discussion highlights pertinent and coeval economic and material changes that influenced the development of Samoan adze technologies over 3000 years. Adzes contain vital information about Samoa's past, because stone tools represent an excellent proxy for behavioral choices, are archaeologically recoverable and were utilized throughout the archipelago's history. The next section reviews the history of adze studies in Samoa, and shows how data collected from finished tools and their production debris can help address issues ranging from subsistence developments to economic techniques to even politics.

Previous Samoan Adze Research

Adze research in Polynesia has gone through numerous changes over the last hundred years as a result of its addressing new anthropological questions (Cleghorn 1984). During the early 1900s, researchers attempted to create meaningful adze typologies from descriptive attributes of finished tools, such as overall tool shape, cross-section and the presence of polishing (Buck 1930; Emory 1943). Early research primarily utilized these classification data to address questions of migrations of ancient Polynesians but little more. Starting in the 1950s, archaeologists re-evaluated Polynesian typologies using formal measurements and statistical analyses as part of a larger systematic attempt to create meaningful cultural chronologies for individual archipelagos (Cleghorn 1984; Duff 1959; Emory 1968; Green and Davidson 1969, 1974). As archaeological theory changed during the 1970s and 80s, a larger research investment focused on asking 'processual' questions centered on adze manufacture, use and discard. Here, adze research shifted from a focus on the finished product to examining quarry sites in an effort to investigate elements of resource acquisition and tool production as well as how behaviors recorded at these sites are connected to other social organizations (Ayres 1998; Ayres et al. 2001; Cleghorn 1986; Lass 1994; Leach and Witter 1990; Leach 1993; McCoy 1977). The following section discusses the results of this research history.

A review of adze research in Samoa requires that certain terms be defined. First, an adze is a formalized wood-working tool with minimally a ground cutting edge; otherwise it was still an unfinished tool. Currently, there are 10 recorded adze types recovered at prehistoric Samoan sites (Green and Davidson 1969), but these are generally subdivided into quadrangular (which also includes plano-convex and pentangular forms) or triangular in cross-section. An adze preform is defined as a tool core specific to the reduction stage between a flake blank and a completed tool. The flake blank describes the initial 'core' struck from the acquired raw material, usually a cobble. The category, waste flakes, includes all purposefully created debris from an adze's manufacture. A flake tool is defined as an informal tool class composed of modified waste flakes. In addition, standardized adze terminology aids in the ease of descriptions, and for purposes of this dissertation, the terminology developed by Davidson (1961) provides a complete reference vocabulary (Figure 2.6).

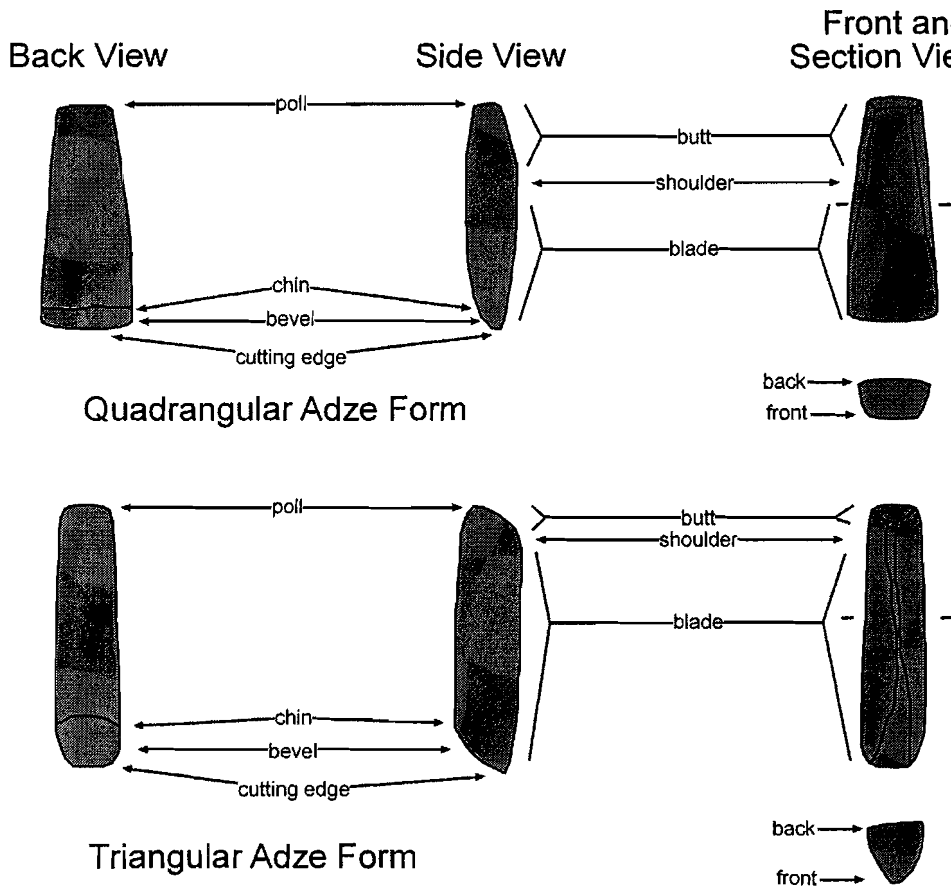

Figure 2.6. Adze terminology for Samoan adze forms (adapted from Davidson 1961).

A tool typology groups an assemblage's diversity along pertinent lines of inquiry, and also highlights the different decisions made in a tool's manufacture. Peter Buck developed the first adze typology for Samoan tools (1930). His typology classified eight different forms based on the adzes' shape, cross-section and the amount of polished surface. Also, Buck remarked on the overall crudeness of adze design compared with Samoa's contemporaries. He noted the dominance of flaking as the means of core reduction, with a complete absence of bruising and pecking reduction techniques which were more typical of Eastern Polynesian forms (1930). In addition, Buck notes that

Samoan adzes were also "crude" due to being tangless. Tangs are the modified adze butts which allow for better hafting of the tool to its handle. Simple tangs as well as elaborated forms are more typical of Central Polynesia and New Zealand (Emory 1968; Turner 2000). Although, much of Buck's critique on the quality of Samoan adzes has been later questioned due to a larger research bias (Leach 1993), Buck's typology has still become the foundation for the West Polynesian region, and has been revised only to account for archaeological collections representing Samoa's longer time depth.

The current typology, created by Roger Green and Janet Davidson (1969), was a revision of Buck's original with the addition of statistical analysis and the incorporation of archaeologically recovered samples. This typology, widely used today, divides the Samoan adze assemblage into 10 types which share statistically similar measurements, morphological features and final grinding patterns (Figure 2.7). There is some temporal information connected to this typology; but overall, the typology does not reflect temporally discrete changes only broad ones. The triangular adze form began to appear during the Plainware period as a unique Samoan invention (Bellwood 1987). Types IV, V and VII were predominately made during the Plainware period, while Type I and VI increased in frequency in the Traditional period. There is some behavioral information attached to the adze typology based on Buck's interviews with informants (1930), but not specifically tested. Triangular adzes were used more for gouges, especially Type VII (Green and Davidson 1969). Large adze forms, like Type I and II, were employed for early stages of wood-working projects, while smaller adze forms, Type III, IX and X, were for more detail oriented work (Buck 1930).

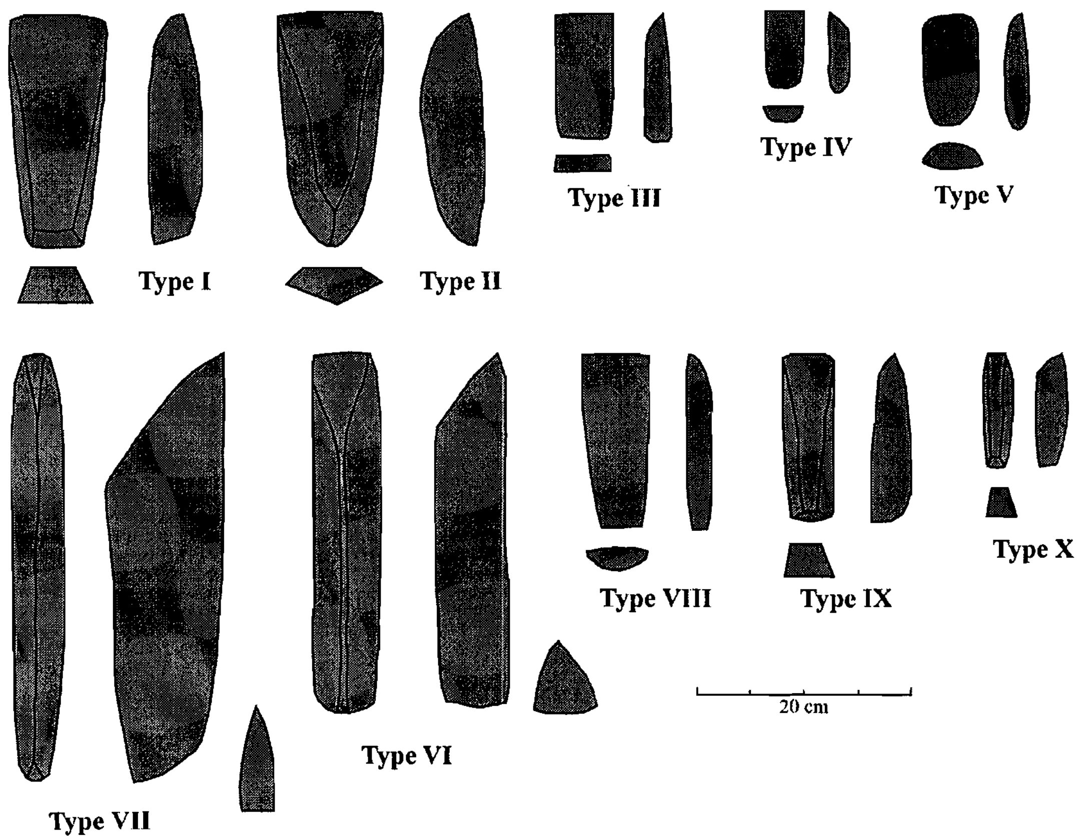

Figure 2.7. The Green and Davidson (1969) adze typology for Samoa.

A typology calls attention to the different behavioral choices made in tool production. These choices are reflected in the different reduction strategies used to manufacture each adze type. Buck briefly described the Samoan adze production process with indigenous terms for each stage (1930:330). In review, the first stage *foa* describes the act of breaking rock from the quarry. The second stage, *tanga*, refers to the chipping of stone into a preform or *matau*. The last stage, *olonga*, is grinding of the *matau* into a *to'i* – the general term for a finished adze. However insightful, his description lacks the level of detail needed to accommodate the different manufacture practices required to account for the variation in adze types. In response, Helen Leach and Dan Witter (1987, 1990) attempted a more thorough study of production stages based on careful flake scar examination on preforms from museum collections and in-field replicative experiments. From their research of the famous Tataga Matau quarry on Tutuila, Leach and Witter outlined an additional step as well as further sub-divisions in the Samoan adze production sequence (1987). First, the raw material is acquired from the natural environment. In Samoa, raw material can be acquired either as cobbles from both streams and the soil matrix or as cleaved blocks from rock outcrops (Clark et al. 1997). Each micro-environment created different forms of cortex. Cortex is the exterior rind of basalt that interacts with oxygen in the air and iron in the basalt. Cortex is routinely removed early in the manufacturing process, because it represents a weakened portion of the core. Cobbles collected from the soil matrix have the thickest rind with a wider variety of textures, stream cobbles have a thinner water-worn cortex, and outcrops tend to have the thinnest rind or no rind depending where the flake blank was struck.

Samoan cores are large flakes struck off cobbles for further reduction (Figure 2.8). There are three main blank shapes (Leach and Witter 1987). Type A blanks are relatively small flakes. Type A blanks are typically reduced to Type III adzes. Type B blanks are large flakes with thick bulbs of percussion that compose the majority of the blank's mass. Type B blanks were utilized in manufacturing Type I, II, IV, V, IX and X adzes. Type C blanks are long and triangular in cross-section, and are the origins for Type VI, VII and VIII adzes.

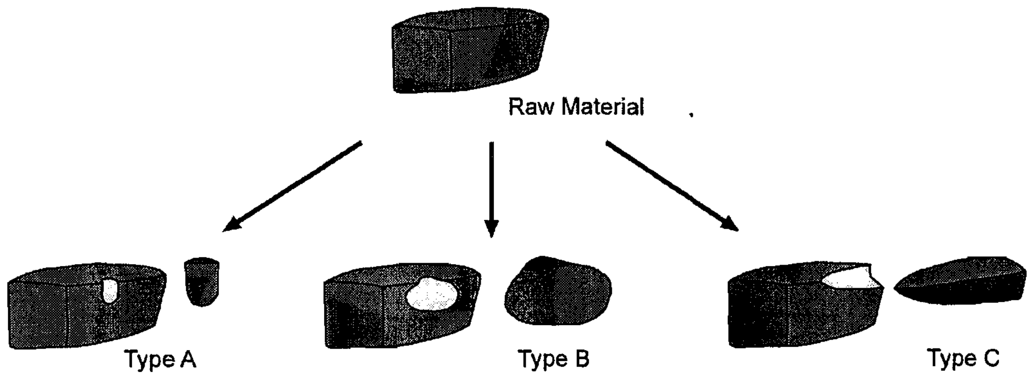

Figure 2.8. Flake blank types for Samoan adzes (adapted from Leach and Witter 1987: Figure 7).

Next, the flake blank is reduced to an adze preform until the finished preform is roughly the desired size and shape of the intended adze. There are four different types of flaking patterns observed on preforms; bifacial, bimarginal, bidirectional and bevel flaking (Leach and Witter 1987, 1990; Figure 2.9). Flake scars produced by bifacial reduction are categorized by the alternating ridge produced in flake removal along the preform edge. Bimarginal reduction is the narrowing of both sides of the preform mass. Bimarginal flaking can be determined by the remaining exterior platform angle of approximately 90° on quadrangular preform edges. Bidirectional reduction is the process of "thinning, shaping and trimming to achieve maximum cross-sectional symmetry" (Leach and Witter 1990). These flakes are struck from near the platform edge, and leave relatively shallow flake scars. Bevel reduction, including small finish flakes prior to grinding, creates an adequate bevel angle and edge for an adze preform, and represents the last stage of flaking.

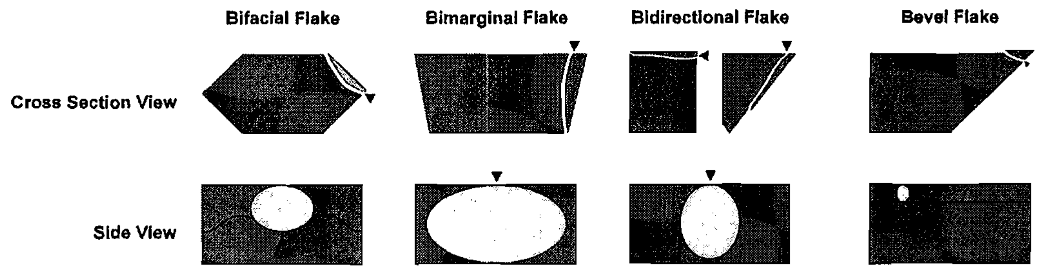

Figure 2.9. Four main flaking patterns in Samoan adze production.

In the final stage of adze production, the adze preform is ground and polished for utilization. This activity was the most labor intensive portion of adze manufacture. Adze grinding entails working the preform across a stone surface, termed a *foaga*, while adding a bit of sand and water to the contact surface. Then, with forceful repetition, a person would grind the preform edge against the slab until the desired amount of polish was achieved. The amount of grinding determined the type of adze being produced as Type III, IV, V and X adzes are routinely ground on all surfaces, while the remaining types are more variable. Combining all the above data, the below figure is a schematic summary on Samoan reduction sequences for common adze types (Figure 2.10).

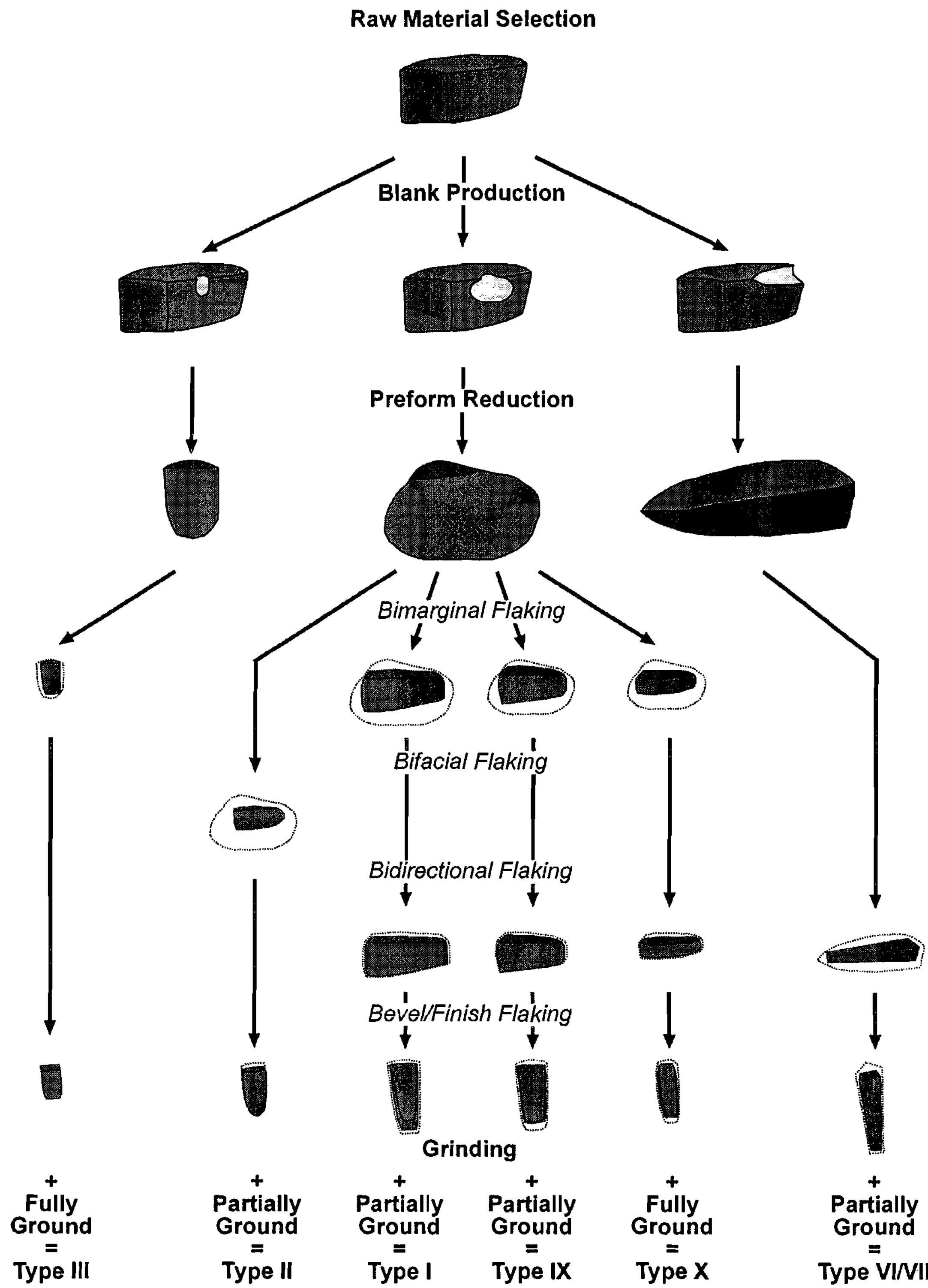

Figure 2.10. A graphical representation of Samoan reduction stages.

This chapter has been a discussion of Samoa's environmental setting, cultural history and adze research that provides the categories of data available for archaeological investigations. The next chapter introduces the theoretical lens -- political economy. As the perspective utilized for this study, the following chapter will define and review the important debates that have led to its modern conception in Anthropology. In addition, Chapter III will examine how political economy can contribute to the study of socio-political developments in chiefdom-level societies, as well as define my specific research questions.

CHAPTER III

POLITICAL ECONOMY: PERSPECTIVES ON STATUS AND STONE TOOLS IN ANCIENT SAMOA

Catch a man a fish, and you can sell it to him. Teach a man to fish, and you ruin a wonderful business opportunity.

Karl Marx (1818-83)

In the above statement, Marx whimsically described the underlying motivation for an individual to *control* economic transactions. Strategically, an individual can gain power in social and economic realms by controlling the access of a consumer to a desired commodity. The study of the how and why a society organizes and codifies these strategies of control is called political economy. Political economy is the theoretical perspective which examines the "imperfect, negotiated, dynamic [social] relations that exist among processes of production, consumption, and distribution… and the organization and use of power" (Schortman and Urban 2004:187). As a product of a long history within social sciences, political economy provides a sophisticated and mature avenue in which to examine the politics embedded in Samoa's stone tool industry. In this chapter, I review how political economy has contributed to the archaeological investigations of chiefdom-level societies by tracing its theoretical usage in the history of anthropological thought. In addition, I construct a set of hypotheses that will test how technological changes in adze manufacture can provide insights into changes, first, in

Samoan craft production and, second, in the transformation of Samoan political complexity during the Traditional Period.

Early Political Economy

The beginnings of political economy as an important theoretical perspective came in the eighteenth century A.D. with the publication of Adam Smith's popular treatise "Wealth of Nations." Smith defines this earlier political economy "as a branch of science of statesman or legislator" (1976 [1776]:325), that government officials utilized to 'enable' the populace (civil society) to provide a living for themselves and a surplus for the state's services and needs (political society) where – in theory – both are benefited. Publication of his book marked a scientific turning point in investigating a social order previously held to theological and governmental realms. Smith championed unchecked capitalism as the mechanism for human prosperity, because it maximizes the achievement of self-interest, which underlies all economic transactions. Additionally, he cites the division of labor developed as an advantage and an obvious consequence of human nature, because individual differences in talent cause this division (Smith 1976 [1776]:21).

The German philosopher G.W.F. Hegel expounded on Smith's distinction between *civil* and *political* societies under an 'idealist' perspective in his book "Philosophy of Right" (1991 [1821]). In his study of economic systems, Hegel argued that ethically the nation should control the larger economy. As the nation's leaders are busy managing this feat, individuals are liberated from their material constraints allowing them to pursue more meaningful goals. In a historical approach designed to buttress his views, Hegel maintained that human evolutionary stages have and continue to progress towards higher degrees of rational thought over the environment and mental enlightenment (Hughes et al. 1995:28). In his analysis, Smith views the variations in available natural resources and the amount of human input as arbitrary, because the idea of want beyond a person's need is simply subjective. Hegel even jokingly points to the cultural differences between what he believes as the excessive 'needs' of Englishman compared to that of Germans. Encapsulated within his humorous reflection, Hegel astutely states his case that an individual want is subjective and culturally sensitive; thus, satisfaction of one's luxury becomes a social act entangled among others' attempts toward satisfaction. Perhaps as a product of his own cultural context, Hegel takes this idea further to validate that social 'wants' can only be achieved under the administration of the state. Here, Hegel's philosophical stance pushes another Utopian dream in the investigation of wealth and surplus -- the benevolent politic. In his attempt to provide political applications for his theory, the German philosopher opens his work for critique. Although his stance on political economy is naïve by today's standards, Hegel did contribute greatly to the overall debate with the introduction of his dialectic approach. The Hegelian dialectic, as a method, examines an argument by contrasting its polar opposites until a dynamic synthesis is derived from the process. By delving into the thesis and antithesis of an argument, a researcher can tease out greater nuances of reality versus the simple rigidity of ideals. The approach has roots in early Greek philosophy such as Aristotle's 'Golden Mean' which states that the obvious truth of an argument lies somewhere in the middle of two extremes. Now, the Hegelian dialectic permeates the social sciences as an integral method that creates an enriched understanding of the human condition (Wax 1997).

In the development of political economy as a critical tool for investigating human societies, another German philosopher with a Utopian dream created the underpinnings for our modern understanding of the politic and the civil. Karl Marx criticized Hegel and Smith on their misplaced idealism in his "A Contribution to the Critique of Political Economy" (1970 [1859]). Marx takes a more bottom-up approach in examining the differences in the distribution of wealth. Ultimately, he cites power as the difference. Power, he argued, is based in the economic vacuum between a product's use-value and its exchange-value. Use-value is the manufactured cost of a product; whereas, exchange-value is the cost the consumer pays for the product. For Marx, all value is created in who is in control over the production process, and human labor fills the discrepancies between the two value types. The control of production and labor allows for the accumulation of wealth by the leaders and middle-men, which set the exchange-value at the expense of the producers and consumers.

Marx explicitly connected societal patterns of economic production to forms of social organization and termed it a Mode of Production (Hughes et al. 1995:42). A general summation of his views is eloquently stated in the preface of his 1859 work.

> In the social production of their existence, men inevitably enter into definite relations, which are independent of their will, namely relations of production appropriate to a given stage in the development of their material forces of production. The totality of these relations of

> production constitutes the economic structure of society, the real foundation, on which arises a legal and political superstructure and to which correspond definite forms of social consciousness. The mode of production of material life conditions the general process of social, political and intellectual life. It is not the consciousness of men that determines their existence, but their social existence that determines their consciousness. At a certain stage of development, the material productive forces of a society come into conflict with the existing relations of production or – this merely expresses the same thing in legal terms – with the property relations within the framework of which they have operated hitherto. From forms of development of the productive forces these relations turn into their fetters. Then begins an era of social revolution. The changes in the economic foundation lead sooner or later to the transformation of the whole immense superstructure. [Karl Marx 1859]

In this brief paragraph, Marx outlined the theoretical underpinnings of his style of political economy (Hughes et al. 1995:42-48). For Marx, the idea of 'production' encapsulated a tripariate idea. First, production consists of the changing relations of human societies to nature. Second, Marxian production entails the social relations of these societies affecting their interaction with nature. Third, production involves the symbolic transformations that substantiate a society's social relations (Wolf 1982:21). In addition to defining a unit of study, Marx called attention to the analytical importance of cultural and historical context in his materialist study of society. Next, he opposed Hegel's concept of idealism and emphasized that human events and actions were occurring and reacting to an external and natural world. Within these external interactions, Marx stressed the supremacy of economic production at the expense of technology as influencing the types of social organization present within a culture. In another contrast to Hegel's 'idealist' perspective, Marx took the idea of economic conditioning to the next level. He argued that a society's ideology creates a set of limits on the range of ideas held by an individual – a form of constrained free will. This influential and pervasive ideology sanctified by institutions in what he coined the 'opiates of the masses' with religion being his most famous example. But perhaps his greatest legacy to social sciences was his view that *no* society is or was static. In dealing with societal transformations, Marx defined an endogamous agent of change – conflict – at the center of his analysis. Marx noted a constant build up of social pressure from leaders' accumulating wealth at the expense of producers, which created a growing conflict between the different 'classes' in the society. At a certain breaking point, these classes clash, and it is this internal reason that creates social change. This focus on an endogamous power struggle has made his work ultimately attractive to later generations of social scientists.

Investigating Modes of Production

Political economy is a theoretical perspective that centers on the human condition by examining a societies' historical interplay with economic, socio-politic and ideological structures. Political economy's major analytical unit is the *Mode of Production.* The Mode of Production consists of "a specific, historically occurring set of social relations through which labor is deployed to wrest energy from nature by means of tools, skills, organization, and knowledge" (Wolf 1982:75). The study of political economy charts, classifies and explains these social organizations and their changes over time. The significance of a Mode of Production accrues not in classification, but in explaining why changes occur across different ones. Here, the Mode of Production can be broken down into a tripartite system similar to Marx's original: the environmental condition, the productive forces and the relations of production (Godelier 1978). The environmental condition represents the material conditions of nature in which a society exists and draws its energy. The productive forces are defined as the materials and knowledge in which societal members utilize to gain that energy, such as tools, technology, skills and human labor. The relations of production have three separate functions (Wolf 1982). The first function entails the social access to resources and thus identifying those in control over the means of production. The second constitutes the organization and allocation of a labor force. The third function determines the social form the circulation or non-circulation of material distribution takes. As a society's environmental conditions are determined by the geographic location of a society, the pertinent components for study in societal change are the relationships between the productive forces and social relations of production (Terray 1972).

Political economy theory and its earlier practitioners have had a major impact within the discipline of anthropology. Eric Wolf goes as far as to state "the social sciences constitute one long dialogue with the ghost of Marx" (1982:20). Because of Marx, political economy has become a general theory of inequality and culture, where styles of control in economic production are the prime movers of change. As an attractive meta-narrative, political economy theory has also been the origin or major feature for a number of theoretical offshoots in anthropology (Robotham 2005; Sidky 2004).

Political Economy and Anthropological Theory

Although not exhaustive (i.e. Feminism and Conflict Theory), the following three perspectives are reviewed for their theoretical origin in earlier political economy and their impact on my study. The first is Cultural Ecology which investigated 'universals' expressed in the form of economic interactions (Steward 1955; Sahlins and Service 1960; Sahlins 1965; Service 1958, 1962). Next, French Structural Marxism broadly focused on the articulation of different modes of production in non-capitalist societies (Althusser and Balibar 1970; Godelier 1978; Terray 1975). Lastly, World-Systems Theory centered on studying the spread of capitalism and the far-reaching linkages of the global economic system (Chase-Dunn and Hall 1997; Shannon 1989; Wallerstein 1974, 2000; Wolf 1982).

Cultural Ecology

Cultural Ecology is a multi-linear evolutionary perspective based on the early work of Julian Steward (1955) and Elmer Service (1958), and is famous for its band-tribe-chiefdom-state classification scheme of societies (Ortner 1984). The school of thought emphasizes a two-fold evolutionary approach, where *general* evolution defines a culture by its placement in the four-stage scheme, and *specific* evolution is the movement between those classificatory stages by a particular society (Service 1962). Thus, cultural ecology research focuses on how specific societies adapted to their environment in order to explain the inception and preservation of cultural norms or how a society changes from one stage to another. As a new development of evolutionary theory in anthropology during the 1950s, Cultural Ecology traces its roots to Franz Boas' Historical

Particularism (Harris 1968) and nineteenth century ethnologically-based syntheses such as Unilinear Evolution (Morgan 1877). Cultural Ecology developed from the unstable anthropological truce between Boas' emphasis on each culture's uniqueness and Morgan's focus on progress through similar evolutionary stages (Barnard 2000:29). But Cultural Ecology reconciled those differences by focusing on historical contexts for change as well as external, rather than internal, factors for the change. In addition to Cultural Ecology's more sophisticated stance on social evolution compared to earlier unilinear versions, it also emphasizes more the predominance of the natural environment in its practitioners' analysis of culture change. Steward states that specific cultures are created by adapting to surrounding environmental conditions and those similarities among societies are a result of comparable natural environments (1953). Here, the divergence from Marxian political economy lies in Cultural Ecology's focus on technological interactions with the natural environment as responsible for a society's particular stage.

"A material transaction is usually a momentary episode in a continuous social relation… the flow of goods is constrained by, is part of, a status etiquette" (Sahlins 1965:139). In non-state societies, the social interaction creates the political process, which Sahlins terms the Domestic Mode of Production (DMP). The DMP consists of a household-driven production unit with direct access to necessities, with limited privileges, and with a structure defined by kinship. The DMP exists in subsistence-based economies based on primarily human input with little division of labor. In these societies, two main forms of economic transactions occur and each has differing organizational principles. The first, reciprocity, refers to the material flow between two groups; whereas, the second, redistribution, describes the flow *within* a population as 'pooling' around a central figure. As an economy codifies a social structure, the different forms have different purposes within a society. Redistribution creates a material form of social solidarity, while the different reciprocities attach the strength of social relationships between two people to a material transaction. Reciprocities comprise three major types – Generalized, Balanced and Negative – forming a two fold continuum, where one line runs laterally along kinship distances between participants and vertically within a group along kinship rank. The type of reciprocity can then be traditionally measured by the immediacy of the return, the equivalence of the return and the mechanical dimensions of the exchange.

French Structural Marxism

Based on the re-reading of Marx's work during the 1960s (Lewis 2005), French Structural Marxism was heavily influenced by Levi-Strauss's Structuralism and by fieldwork centered in French Colonial Africa. French Marxism's aim was to make fieldwork the necessary departure point for theory (Robotham 2005). Due to the internally diverse interests of its practitioners, the school has become largely defunct as a cohesive entity. However, French Marxism's focus on ethnographic empiricism over ethnological theory unified the theorists and makes their work still pertinent to contemporary anthropology (Sidky 2004). French Marxism attempted to overcome a key component to earlier Marxist theory – a focus on only state-level societies – by constructing theory from collected data in societies without ascribed classes. In essence, French Marxism created avenues to examine concepts of power and value in non-capitalist societies by examining issues of articulation of structural relationships against the infrastructure and superstructure of that society.

Godelier's article "Infrastructures, Societies and History" (1978) outlines the major departure of French Marxism from Marx. Godelier calls attention to Marx's view that the infrastructure determines the superstructure. In his view, the two are simply functions of a single entity in kin-based societies. "It is only in certain societies, and particularly in capitalist society, that this distinction between functions happens to coincides with a distinction between institutions" (Godelier 1978:765). He cites the egalitarian Australian Aborigines as a case example of how the economic form and social form can be connected by the structuring principles of kinship in non-capitalist societies, where access to needed resources is determined by one's consanguineal or affinal relationships. As such, Godelier re-addresses Marx's "class struggles", the ultimate mechanism for social change in earlier Marx, to examine the origins of power and its social twin – conflict. In his examination, Godelier describes the control over the means of production as a combination of violence from the dominant and consent from the dominated. This situation exists in all societies to varying degrees, even in egalitarian societies where systematic sharing deflects most of the conflict (Mauss 1954).

World-Systems Theory

Popularized in the mid 1970s by the Immanuel Wallerstein, World-Systems analysis began as a call-to-arms for the different branches of social sciences to become more holistic and systematic in their approach (Wallerstein 1974, 2000). Early World-Systems analysis was simply a perspective, not a theory, attempting to combine the three integrated realms of human action – the economic, the political and socio-cultural – to analyze the development of global systems (Wallerstein 2004). The perspective does not associate a complete world-system as an equilibrated whole of the realms, such as in Functionalism (Malinowski 1944), but enables the researcher to pull back and focus on the relationships of seemingly unrelated conflicts occurring across the globe. Its unit of analysis consists of the 'historical system', a substitution for the term society, defining three basic stages that form a continuum of complexities divided by their economic organization (Wallerstein 2004). In its core-semiperipheral-periphery division, World-Systems gave Marx's discourse on internal power in a particular society a 90-degree turn and inter-connected it to the external and horizontal power differentiated among nation-states (Eades 2005).

Similar to Wallerstein's approach, Eric Wolf calls for the recognition of "the world of humankind… [as] a totality of interconnected processes" (1982:1). Also, Wolf stressed that history is not simply a story. Human events do not represent a developmental scheme which historians have concocted in reflectance, but history represents the cumulative decisions of individuals working within a confined and contextual reality. In the end, Wolf rejects the idea of inherent progress within societies, and encourages the investigation of historical context to understand the moment of change.

These three major theoretical schools have contributed greatly to how the past as well as societies are now viewed by researchers. Building on this work and with their own unique material-based data sets, archaeologists have also weighed in on how political complexity has escalated in chiefdom-level societies. This next section reviews how archaeologists have investigated the strategies of emerging leadership and the impact that a society's political organization had on craft production and vice versa.

Political Economy and Archaeological Research

Political economy's usage in current archaeology has focused on answering questions related to the development of social inequality, the emergence of different forms of authority and changes in societal economic organization. Although the effects of these changes are felt in societies around the world, many of these societal modifications occurred in the deep past and prior to the written word (Feinman 1995). So, archaeology and material evidence become important in charting and explaining this stage of cultural development.

Emergence of Social Inequality in Prehistory

Archaeological research has shifted away from the Cultural Ecology's developmental schemes for classifying societies towards examining causes for variability among such societies (Arnold 1996; Earle 1987). Timothy Earle's work in the 1980s exemplifies this change in research focus, where he investigated chiefdom-level societies by the type of leadership strategies employed in creating social inequalities (1989). Similar to Godelier's inclusion of the dominated individual into the equation of power, Earle remarks on how power relationships revolve around a follower's evaluation of cost in compliance relative to the cost in refusal. Earle posits an agent-centered approach for leaders attempting to control the options of his followers, where a leader would actively strategize for control over the economy, military force and/ or ideology. Although dependent on environmental conditions, he states the success of particular strategies hinges on its ability to generate and extract a surplus for a leader to continually finance their control.

Later, Jeanne Arnold's research on organizational transformations focused primarily on how emerging leaders interacted with available labor in societies (1996). Her research differs from that of Earle's, because Arnold's interest is not necessarily in chiefdoms but in what she terms *intermediate* societies. Intermediate societies constitute nonhierarchical, communally-organized societies that range from big-man tribes to simple chiefdoms, and constitute a transitional category between egalitarian and stratified stages (1996). The significance of studying these groups lies in that they predate permanent inequality and stratification, but share some of the same organizational parameters of more complex societies. Her cross-cultural research starts by examining an archaeologically recoverable unit of study -- the household. Arnold has stated that all societies have some form of authority over the household or immediate kin-group, and that complexity involves the layering of new forms of authority over top of this preexisting type. As the transformation towards complexity increases, the actual household organization remains stable for subsistence purposes, but it's the extra-subsistence labor can be pooled and used to create surpluses. It is what these surpluses provided for, no themselves, that would become archaeologically visible during the transformation, and these surpluses are not directly tied to general intensification of labor but specifically to craft specialization (Arnold 1996:70). So, the initial formalization of social inequality may simply be connected to the re-organization of existing and available surplus labor in a community, and the more grandiose strategies of control did not manifest until later and as a result of maintaining and enhancing the status quo. The development of a stratified social organization is founded on the elite control over resources, where status rivalry among elites evolved into an intense competition for dominion of those resources producing a growth-oriented political economy (Earle 1978). Here, a society's leaders were forced to be competitive in these rivalries that required them to maximize their control. To maintain this control, institutional elaboration resulted in increasing scales of complexity, and status and power became more institutionalized and ideologically justified, as did the wealth that marked it.

Documenting Prehistoric Craft Specialization

Cathy Costin's research on craft specialization examines the economic underpinning of wealth generation from a production standpoint. She broadly defines craft specialization as a "differentiated, regularized, permanent and perhaps institutionalized production system in which producers depend on extra-household exchange relationships at least in part for their livelihood…" (1991:4). As specialization is a relative term; her work creates a typology based on ethnographic and archaeological sources (Costin 1986; 1991; Table 3.1). She defines eight types ranging from individual specialization that describe autonomous producers working for local distribution to retainer workshops that have full-time artisans amassed in a single facility working under the patronage of elites.

Table 3.1. Costin's (1991) specialized production typology.

Type	Context	Concentration	Intensity	Scale
Individual Specialization	producer	local	part	household
Dispersed Workshop	producer	local	part	many workshop
Community Specialization	producer	regional	part	household
Nucleated Workshops	producer	regional	part	sole workshop
Dispersed Corvée	elite	elite	part	household
Individual Retainers	elite	elite	full	elite household
Nucleated Corvée	elite	institution	part	facility
Retainer Workshop	elite	institution	full	facility

The significance of Costin's typology is that she abstracts archaeologically-recoverable parameters to chart the degree and type of specialization in production labor. The divisions of Costin's framework consist of the amount of elite's involvement in craft production, the spatial distribution of production across the landscape, the population size or scale of specialists in a society and the work-load a specialist is required to undertake. Based on earlier classification efforts (Earle 1981, 1994, 1997; Sinopoli 1988), Costin's first parameter defines the two poles of elite involvement; where attached specialists operate under the direct influence of elites, while independent specialists are free of that control. Schortman and Urban (2004) further describe the material situation and basic motivations for these two forms of craft specialization. *Wealth Finance* is the products developed from elite control over labor and natural resources. Leaders can accumulate wealth through a number of possible routes such as the distributional control of exotic finished products, the production control of workshop labor, the control of raw material availability and the control of intellectual skills required for manufacture. Schortman and Urban (2004) define, in contrast, *Commoner Craft* as products being produced by independent specialists, because the raw material is easily accessible and widely dispersed, production requiring only simple techniques, and the nearness of raw materials to consumers. Not funded by leaders, commoners attempt to reduce costs and maximize gain, with simple tools designed for maximum function. The archaeological study of these two types of production can provide insights on which forms of institutional elaborations occurred in a particular research context. Identifying the context revolves around the spatial segregation of production in relationship to administrative centers. Attached specialists will be close to features that restriction who is able to produce, such as administrative or defensible positions. Whereas, independent producers will not spend the energies so they may focus on maximizing their own production.

Costin's second parameter involves a society' geographic organization relating to commodity production. The concentration of production relates to the unequal distribution of raw materials and a society's practice of territoriality. Concentration is low and dispersed when resources are evenly scattered across the landscape. But, production concentration becomes nucleated when is unevenly distributed, and producers can exploit resources' unique presence. Documenting production concentration consists of charting the relative frequency of manufacturing sites occurring in a society's settlement pattern. This parameter requires examining a wider scale, because identifying concentration needs to take into account the environmental diversity over an entire region.

The third parameter, production intensity, describes the amount of time a producer spends on their craft. Costin measures this by part-time or full-time workloads. In non-state level societies, the most common form of workload is part-time, because producers tend to have other time commitments and alternate economic responsibilities. But full-time specialists can occur in situations where commodities take a high amount of skill to manufacture, production is a low risk economic endeavor compared to other forms of livelihood and agricultural demands are low. Ultimately, this is the most difficult parameter to quantify because in an archaeological lithic assemblages; a producer's intensity can be low but sustained over a long period of time or high for a short period of time, and the resultant assemblage would look the same.

Finally, production scale documents the number of manufacturers working at an individual production loci. Costin charts the size of a craftsman pool by focusing on the type of production centers located in a particular community. The greater the size of the production center the greater the scale of production. In determining if these centers are households, workshops or facilities, it is necessary to determine how the production center is internally segregated, its overall size and the amount of debris being produced.

Political Economy and the Samoan Chiefdom

A chiefdom is defined as a society with "permanent, ascribed social hierarchy, which in most cases exhibit supra-community political organization and distinctive patterns of labor organization in which some individuals control the disposition of labor of non-kin" (Arnold 1996:2). Chiefdoms, labeling issues aside, are an integral stage in the development of social inequality. Although social inequality was present in egalitarian societies, it was based on achieved forms of status that could shift depending on abilities, but it is in chiefdoms that the first manifestation of ascribed positions gains permanency in social organizations.

To investigate the development of authority and craft specialization in Samoa within the constraints of archaeological inquiry, a pragmatic melding of the above theoretical perspectives is required. First, Wolf's classification of the Kin-Ordered Mode of Production (KMP) as well as Sahlins' DMP form the basic conception of internal organization of early Samoan political economy (Wolf 1982:88-96; Sahlins 1965). Next, Godelier, Earle and Arnold's discussion of power establish a connection to the development of permanent social inequality and how this social change is mirrored in control over the means of production (Godelier 1978; Arnold 1996; Earle 1978). Finally, Sahlins' conception of how material forms of exchange were structured and Costin's work on craft specialization offer the means through which to examine how early leaders' decisions manifested themselves in the archaeological record (Sahlins 1965:130-165; Costin 1991).

Kin-Ordered/Domestic Mode of Production

The KMP/DMP is key to understanding the development of permanent institutions of social power. Here, this particular mode of production differs from more market-based versions in that the nature of the forces of production and its relations are integrated (Godelier 1978). Kinship describes two sides of the same coin -- the familial and the political. Wolf defines that influence "as a way of committing social labor to the transformation of nature through appeals to filiation and marriage" (1982:91), and states social labor is the license of social relationships. Social labor can only be 'mobilized' either through the symbolic construction or the biological enlargement of the kinship license. This license comes from the habitual and reciprocal interaction among kin or by the internal definitions of kin membership. In non-foraging societies, "social labor is distributed in social clusters that expend labor cumulatively and transgenerationally" (Wolf 1982:92). Paradoxically, an increase in the definition of internal social relationship calls for an increase in the exclusion of neighboring social groups. Additionally, the construction of real or fictional lineages enables social groups more control and access to labor. For Wolf, these lineages also created genealogical and mythical charters, which provided a number of functions among the social group: allowing claim on privileges, creating access and control of resources, organizing exchange between social groups, and providing managerial positions within the genealogical pedigree. Here, the construction of lineages supercedes kinship, although it ultimately is based within it, the ideology of kin compose the jurio-political superstructure of lineages, thus positing an ideological extension of parental-esque power relations among leaders and social members. In examining the license of social relationships of Samoa, it is important to understand the variations in status positions and how power is shared in the political system.

Fa'amatai in Post-Contact Samoa

In contemporary Samoa, the kin-based license of social labor is called the *fa'amatai*.

> Each *'aiga* [extended family] normally has one or more *matai*, or titleholders. One of these [titleholders], who ordinarily bears a title name reflecting the name of the extended family itself, is recognized by the family as its paramount authority. This man makes many of the important decisions within the *'aiga* such as those relating to land tenure, work schedules of various members of the kinship group, and serious discipline. [Richard Goodman 1990:138]

This basic description of the *fa'amatai* summarizes its contemporary structure, but re-evaluation of ethnohistorical records hint at a more complex form in earlier times (Tcherkezoff 2000). Because of missionary and western administrative influences during the late 19th and early 20th centuries, there has been a dramatic transformation in the leveling of traditional power and status relations within Samoa. Although *matai* has now come to define simply Samoan "chief" in comparison to lower status, untitled men (*taule'ale'a*), the term *matai* had meant 'the best in his specialized activity'. Additionally, Tcherkezoff, utilizing a comparative approach to ethnohistoric records, noted the internal workings of the Samoan chiefdom were more stratified prior to its historical transformation by describing a more heterogeneous and hierarchical form of status from a reconstruction of the early nineteenth century A.D. socio-political situation (2000:176). First, a '*matai* title' can be one of two types. The title *ali'i* refers to high chiefs and the title *tulafale* refers to orators. The high chief is invested with the decision-making power of the '*aiga*, while the orator 'speaks' on behalf of his *ali'i* to both the public and other chiefs. In addition, *matai* titles included specialists or *tufuga*. A *tufuga* was a master craftsman ordered within a structured guild, who could exact payment for his services and skills. Second, *matai* titles were chosen by the '*aiga* to represent the ancestral landowner and founder. Although, the *matai* title, itself, was one of permanence, the successor was not determined by primogeniture alone. Third, there was a hierarchical division among *matai* titles. The lower form was just a leader of his local families within a village, and the higher form constituted an *ali'i* who as a central figure presided over an extended network of kin groups. Here, the *ali'i* maintained similar control over the lineage network as did local leaders over their own '*aiga*. Thus, these *ali'i* would have been able to draw upon larger amounts of resources and dominate lesser *matai* in prestige competition.

Transformations in Mode of Production

As the previous section summarizes the diversity of leadership in the organization of proto-historic Samoa; next, an understanding of how material exchanges of goods were structured and which goods were exchanged is needed. In Sahlins' discussion of material exchanges among non-market based societies, he notes two basic types –

Reciprocity and Redistribution (1978:141). Reciprocity represents the movement of materials between groups. Redistribution, often conceived as a synonym for chiefdom economies, describes the product movement within a group. Participants pool their surplus around a central figure who then doles out these extra goods for large community projects or in times of need. This process accomplishes two goals. One, redistribution is a material manifestation of kin cooperation, and provides opportunities to celebrate solidarity while drawing concrete social boundaries. And two, it creates an arena of subordination and dominance, as the central figure presides over and determines transactions. Wolf declares this 'pooling' as the ultimate limitation or "Achilles Heel" in the amount of powers a leader can accumulate and centralize within chiefdom economies. The accumulation of enough wealth and power to break the bonds of kinship obligations was foiled by the need to be generous to loosely defined external alliances. However, redistribution, in a general sense, constitutes a system of *reciprocities* governed around a central figure. The fluidity of material exchange is actually the fluidity of social relations, and vise versa. Breaking Wolf's limitation lies in how power is navigated by the central figure, where one leader can shift from generalized to negative reciprocities within redistribution, while still continuing the goals of redistribution. In chiefdoms, the type of reciprocity utilized for a transaction is based on social distance, either by kinship or rank. A leader in a kin-based society can not distance himself easily from the bonds of biology or marriage, but as the ranked institution develops, a leader can manipulate the transactions along increasing status. I found a missing component in Wolf's analysis is the importance of prestige in a society, its social wealth. Here, the leader's aim is to negate material wealth and increase their social wealth, so he does not impinge on obligations. As status increases, the populace invests in their leader's prestige, which places them in social debt to the leader's ambitions. As a consequence, redistribution ideology enforces the vertical separation of society as well as the inclusiveness of the group, which a leader can articulate through the surplus accumulation afforded by redistribution. "Debt is the key to dependence, which, in turn, is the foundation of power and the infrastructure of hierarchy" (Schortman and Urban 2004:192). Thus, leaders navigate past Wolf's economic limitation of material accumulation by utilizing the symbolic ideology of the redistribution institution and by accruing a populace in social debt.

It is at this juncture where Godelier's hypothesis on social transition requires consideration, not into early 'pseudo-classes' like he proposes, but in the degree of internal complexity accruing over time in Samoa. Godelier proposes that when an increasing population becomes more sedentary within circumscribed environments, the relations of power and consent within that population begin to become entrenched in the political maneuverings of their leadership (1978:768). Then, the factors leading to social differentiation are, first, unequal exchange and, second, the reproduction of the unequal nature (Godelier 1978:767-768). He hypothesizes that these relations of the dominant/dominated developed fully during subsistence shifts from more forager to sedentary practices, where populations began to rely on exchange of goods and services due to their agricultural dependence and land tenure. Interesting to note, a similar subsistence shift was documented during the Plainware period in Samoa, perhaps setting the stage for the political transformation recorded in the later Traditional period. This is an essential idea for the development of Samoan political complexity and how the studies of Samoan adzes can allude to its occurrence.

Samoan Adzes: Commoner Crafts and Wealth Finance

Earle addresses an important issue relating to Polynesian adzes, that is, during the proto-historic period; the dual role they had in the Polynesian economic system (1997). Primarily, basalt adzes were common wood-working tools utilized for clearing trees from garden plots, constructing homes, and carving out fishing canoes. Commoner craft and food stuff exchanges were widespread in Polynesia, but due to the abundance of these items locally, households were mainly self-sufficient and these staple goods were not exchanged over large distances. Adzes also held a place in the political realm, because of the political geography of quarries (Krämer 1902), the production of wooden chiefly goods such as guest houses, sculptures and voyaging canoes (Buck 1930), and the possible presence of stone tool guilds (Stair 1897).

Basalt tools were manufactured from geologic sources dispersed intermittently across islands' landscapes. On Polynesian landscapes, societies had divided the environment among different *'aiga* or its linguistic equivalent (Earle 1978). As available high-quality resources were sometimes scarce, leaders benefited by restricting access to basalt and excluded non-members of the *'aiga*. Outside of Samoa, trading for prestige items would have placed leaders in a higher standing due to their control of quarry land or the labor used at a quarry. Secondary connections to chiefly power can be found in the specialized adzes and chisels used in the production of high status items manufactured by guilds (Buck 1930). Within Samoa's ranked society, craftsman guilds also actively participated in the social and ritual space occupied by chiefs, because of the consumption of status items, their control of specialized knowledge, and *tufuga* holding *matai* titles (Tcherkezoff 2000:152-154). Additionally, there is some limited evidence from missionary observations suggesting the presence of actual stone tool *tufuga* and stone tool guilds (Goldman 1970:255; Stair 1897:142).

In the end, archaeology provides the ability to trace societal conditions farther back in time and to test theoretical models where the ethnographic record offers a detailed end point in the process. Although important in model creation, I want to note that the application of synchronic analogs requires caution if applied uncritically to diachronic processes of cultural development. To counteract this, I propose hypotheses to address issues in political economy and the long-term cultural development in Samoa.

Documenting the Prehistoric Production Organization of Samoa

Broadly, my research focuses on determining how the organization of craft production articulated with the political system of prehistoric Samoa. At the time of Western contact, Samoa was a complex Polynesian chiefdom dominated by differential status and a varied hierarchical power structure among its leadership (Krämer 1902; Tcherkezoff 2000). Leaders differentiated themselves in status among their *'aiga* and among other leaders through prestige competition. In Polynesia, many food items were either readily available or perishable, making agriculture a poor alternative for wealth accumulation. So, leaders financed their position by the accumulation of specific status items. In protohistoric Samoa, examples of these status items included tapa cloth, guest houses, chiefly attendants, fine mats, voyaging canoes and large mounds (Goodman 1983; Kaeppler 1978; Krämer 1902). Specifically, my research charts how Samoan leaders utilized different strategies to accumulate material wealth in relation to adze production. The first strategy was to control the labor force that produces desired commodities. The second was to control the access of desired resources found on their land. The third strategy was to control the circulation of desired goods outside of their kin-group. In the following section, I re-state my research questions and propose a set of hypotheses to test against collected archaeological and geochemical data. The first question examines the archaeological documentation of production intensification during the Traditional Period and considers whether it was a product of a bourgeoning stone tool guild or a growing population of independent adze producers. Then, the next two questions delve into the relationship of these specialists or non-specialists have with prehistoric Samoan elite and elite's strategies on maximizing social prestige in the political system.

Research Question One

Was craft specialization present in Samoa's ancient stone tool industry?

Craft Specialization in Ancient Samoa

Documenting the presence of stone tool specialists in Samoa started early on with the observations of an early missionary, John Stair, in 1897. Part of his documentation on Samoan lifeways included a list of *tufuga*, in which he noted "maker of stone hatchets". Regrettably, his historic list is the only direct documentation linking adze manufacture and specialists and later materially-oriented ethnographers, Krämer (1902) and Buck (1930), failed to corroborate his observations. Although, they collected indirect evidence on manufacture practices, usages and indigenous name types (Buck 1930), these early ethnographers neglected to record the presence of an adze guild. This could reflect that Reverend Stair had made a recording mistake *or* he had inadvertently witnessed the tail end of a rapid technical shift towards more efficient metal tools and Western traders.

Over the last three decades, archaeologists have weighed in on whether adze specialists had been present in prehistoric Samoa. Based on the ethnographic work on various *tufuga* guilds, Roger Green took the stance that specialists were present for manufacturing high-quality adzes used by master carpenters based on his review of assemblages recovered from habitation sites in Western Samoa and museum collections (Green 1974). Then in the 1980s, Helen Leach and Dan Witter argued for the presence of specialists based on their systematic research of the famous Tataga Matau quarry (Leach and Witter 1987, 1990). At the quarry, they documented large quantities of debris, finely made adze preforms, and defensive features. Ultimately, they championed the site's uniqueness as the only Samoan export locale for basalt adzes and the only location where specialists were present (1990). However with further survey, William Ayres, Jeffery Clark and David Herdrich contradicted the uniqueness of Tataga Matau's position by providing additional evidence of specialized stone tool manufacture occurring elsewhere on Tutuila by citing extensive debitage assemblages at sites in Alega, Maloata, Fagasa, Tula and Le'aeno Valleys (Ayres and Eisler 1987; Clark 1993; Clark et al. 1997). However astute, this prior research was mainly concerned with only a yes or no answer, and has not addressed the vacuum in our understanding of the organization of adze manufacture and its relationship to larger socio-political processes. In the end, there is a general consensus on the presence of stone tool specialists in Samoan prehistory; however, does this statement continue to hold true in light of more comprehensive archaeological datasets?

Hypothesis

The dramatic increase in Samoan adze production during the Late Traditional Period was a result of tool makers specializing in adze production.

Test Expectation

If specialization manifests itself during the Traditional Period, then there will be a shift in lithic assemblages found at sites dated before and during this period. The difference between determining increases in production debris as a product of simple intensification of non-specialists or as the introduction of specialists is -- *efficiency.* Efficiency can be documented through a number of different attributes. First, there will be a change in the frequency of manufacturing success in making flake blanks into finished adzes, because adze producers would have had more familiarity in production, thus increasing their ease in needed skill sets. Second, the increased time spent manufacturing adzes would lead to other forms of efficiency, such as standardizing of the adze reduction process. This form of efficiency would be recorded in the spatial segregation of specific manufacture activities (Ahler 1989). Next, efficiency can be witnessed in the standardization of the finished product (Costin 1991). Standardization can be defined in different production centers where producers maximized their efficiency by producing only certain types of adzes.

Research Question Two

If specialization was present in ancient Samoa, what type was being conducted?

Stone Tool Specialists: Documenting the Labor Organization

The archaeological study of craft specialization documents the type of affiliation cast between producers and their leaders (Costin 1991; Johnson 1996). The major division in the power continuum is between attached versus independent specialists. Attached specialists produce wealth and luxury items for elite command and desire, and are either partially or fully sponsored. Independent specialists produce subsistence items for a general market, governed by general principles of supply and demand. But as stated earlier, the variation between these two poles of craft specialization present can offer vital clues on the type of political organization characterized in a society.

Hypothesis

Samoan adze production during the Traditional period was conducted by a Samoan *tufuga* guild. This stone tool guild operated in a similar fashion as other ethnographically recorded craftsman, such as the carpenter's guild. This hypothesis states that prehistoric leaders in Samoa controlled or augmented a specialized labor force in stone tool production to increase their personal wealth accumulation. The presence of these adze specialists constitute a form of intensification by maximizing production without significant additions in the labor input through a combination of greater consistency and efficiency in adze production versus earlier periods of non-control (Costin 1991; Earle 1994).

Test Expectation

If elite control was exercised over stone tool makers in the Late Traditional period, then there would be a dramatic change in how production was organized definable by using four variables outlined by Costin; context, concentration, intensity and scale (1991:8-18). Results should mirror the form of *tufuga* documented during the Historic period (Buck 1930): the commodity will be created for the purpose of elite consumption, production will become centralized at a workshop or facility, the intensity of manufacture will be greater than previous time periods, and scale of production will shift from dispersed to nucleated in the society. As the type of specialist present relates directly to an elite's control over available labor, there are still other important avenues or strategies an elite could have employed -- the control over resources and product circulation.

Research Question Three

What other forms of control did Samoan leaders have on adze production?

Samoa's Political Geography: Control of Resources

How do populations acquire their raw materials for production? First, there are a number of environmental variables present in the procurement and selection of raw material – the environmental condition. Archaeologists can chart the environmental condition by locating needed resources across the landscape while documenting their accessibility, its quality, its concentration, its overall abundance and its ease of extraction. Thus, the condition creates a baseline for gauging later human behavior.

Potentially, social inequality can be created because of physical constraints on mobility in relation to unequal geographic distribution of resources. This inequality, created by the friction of distance, first causes territorial circumscription around needed resources in sedentary societies (Nassaney 1996). In addition to simply distance and territoriality, there are a number of cultural parameters influencing the availability for raw materials. The concept of ownership is deeply rooted in a competitive economy, where accumulation accounts for the basis of the interaction between leaders and producers (Torrence 1986). "When competition is low, accepted rights of ownership may be sufficient means of control, but as it grows stronger, the additional use of boundaries increasingly supported by force will be required to protect exclusive access" (Torrence 1986:40). The presence of restrictive features near resources denotes the degree of energy taken by leaders to insure ownership. Material manifestations of the degree of control exercised by leaders range from the presence of territorial markers, visible symbols of ownership, to domestic debris produced by full-time manufacturers and to defensive features.

Hypothesis 3.1

In the Late Traditional period, archaeologists have documented the development of a new site type -- the ridge-top features (Davidson 1979; Pearl 2004). Their presence near production locales was a result of elite exercising control over desired basalt resources. By claiming ownerships to these resources, these leaders would have increased their standing in the local and regional prestige competitions.

Test Expectation

Hypothesis 3.1 states that Samoan leaders increased their control over access to desired resources in competition with other leaders during the Traditional period. The increased control would be archaeologically evident in the construction of territorial markers, sites in restrictive locations and/ or defensive features, so leaders could better solidify ownership within the larger Samoan political milieu. Depending on how the resource is distributed in the localized environment, Samoan leaders who exercised control over a desired resource would be documented by said material evidence located in association with production sites.

To accurately test Hypothesis 3.1, it is necessary to review the pertinent settlement context by noting the association of defensive features and production centers both temporally and spatially. The temporal association can range from restrictive features and production centers being coeval to no temporal association. The spatial association can range from strong where the two features occur within a single complex to weak where each being recovered separately within a single valley. So the strongest connection of leaders restricting their desired resources would entail both a temporal and spatial inclusiveness, and the weakest would consist of the two features lacking a temporal association but the features occurring in the same valley. In addition to both features' association, the concentration of lithic debris occurring at the production centers also influences an interpretation, where light flake scatters may have been simply incidental or for locally utilized tools and extremely dense concentrations represented a production center for tools being more widely distributed. So if chiefs developed control over resources during the Traditional period, there would be strong temporal and spatial associations at highly productive centers (Ericson 1984; Torrence 1986; Figure 3.1).

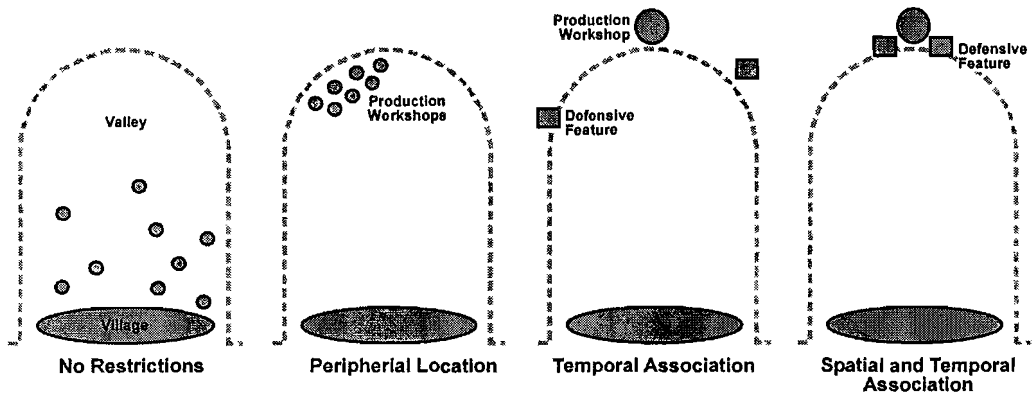

Figure 3.1. A graphic representation of Test Expectation 3.1.

Samoa's Role in Long Distance Exchange: Control of Distribution

As stated previously, product distribution connects the separate and material acts of production and consumption, where the product's value is dependent on who is in control of production, not necessarily the product. As part of the larger economic system, exchange is a widespread phenomenon manifested in sharing, pooling, trade, barter and currency-based transactions; perhaps, even universal in all human societies (Earle 1994). To trace the materials in exchange, archaeologists utilize a variety of methodological techniques such as stylistic, petrographic and geochemical analyses (Earle 1982; Plog 1977; Renfrew 1986). Each has advantages and disadvantages, but none of these methods have an inherent explanatory or interpretive mechanism to describe exchange (Pollard and Heron 1996). As a result, Earle (1982) began to examine distributed artifacts within a contextual approach, which incorporates exchange as only a part of a larger production and consumption processes. The contextual approach, influenced heavily by political economy, does not divorce exchange from the larger economic system and the social relations that govern it.

Just as there a number of ways to restrict access to resources, there is also an array of methods to acquiring them. Direct acquisition refers to an individual's procurement of materials (Binford 1983). This strategy presupposes that the individual's own range encompasses said resource, where time-energies are devoted solely to the material's procurement, and the individual has the related skills to manufacture the finished product. Embedded acquisition consists of one's procurement of raw materials but in the participation of an unrelated activity (Binford 1983). This strategy negates substantial time-energies in resource acquisition by combining the decision to procure additional needed resources in the same trip. If production is linked to direct or embedded acquisition, a greater number of producers travel to manufacture, and thus products will vary and there will be irregular patterns in production (Ericson 1984).

Reciprocal acquisition entails the collection and allocation of materials through immediate social connections, what Marcel Mauss (1954) refers to gift giving, and what Sahlins' refers to as general and balanced reciprocity. "The exchange does not create the relationship, but rather is part of the behavior that gives it content" (Bohannan 1963:232). This strategy utilizes a low level form of exchange, not motivated by materials, but on the process of giving, receiving and returning. The process of obligation among related populations (Sahlins 1965) provides access to subsistence resources located in different micro-environments and the basis of kin-based solidarity.

Indirect acquisition, commonly referred to as trade, encompasses all behaviors associated in procuring a product and accumulating wealth, where strong social ties are absent and negative reciprocity is utilized (Sahlins 1965). Materials are accumulated in a maximizing manner, without concern of social relationships. Accumulation for status and wealth is tied to this method, and acquisition tends to facilitate socio-political necessities, not subsistence ones. If production is linked to regional exchange with high territoriality, products are expected to have greater regularity as local producers solely manufacture products for trade (Ericson 1984). Exchange research needs to investigate the mechanisms responsible for the documented material exchange. Within kin-based societies, Sahlins' classic model incorporating the idea of distance – essential to provenance research – and social relationships as mechanisms provides an excellent opportunity to explore the Samoan condition (Sahlins 1972:196-204; Figure 3.2).

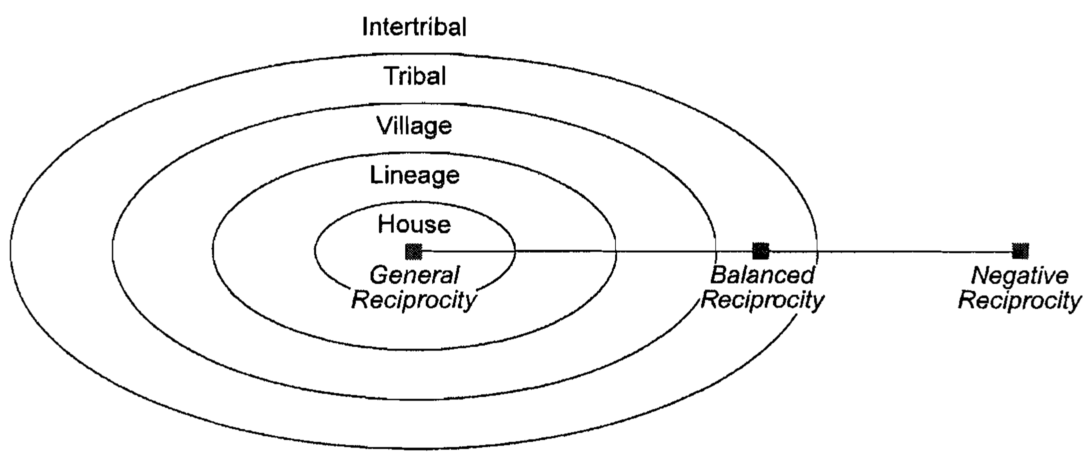

Figure 3.2. Sahlins model of exchange distance and social relationships.

The archaeological ability to geographically chart product distributions has inferential importance on the decreasing social relation between producer and consumer within ranked societies (see Fig. 4.10). In constructing archaeological scales similar to Sahlins model, the organization of chiefdoms allows a means to collapse a number of small scale interactions difficult to examine in the archaeological record. Here, the redistribution of materials around a chief creates a structural form of centricity expressed both at the logistic and social level. Thus Sahlins' household/ local lineage/ village groupings can be consolidated in a single node, one expressed in prehistoric settlement practices – the Intra-Valley Level. The remaining sectors of Sahlins' model correlate more effectively with the archaeological revision; Village Sector with Intra-Island, Tribal Sector with Intra-Archipelago, and Intertribal Sector to the Inter-Archipelago form.

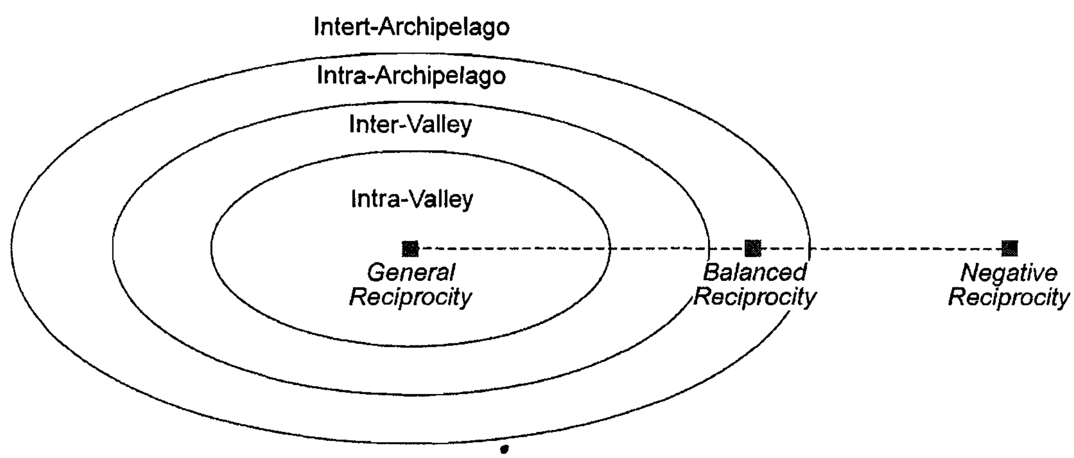

Figure 3.3. Applied model of exchange distance for archaeological investigations.

Hypothesis 3.2

In the Late Traditional period, archaeologists have recorded an expansion in the geographic distribution of Tutuilan adzes (Best et al. 1992; Winterhoff et al. 2007), this expansion is thought to be a result of elite control over adze distribution. By actively participating in regional trade networks, Samoan leaders benefited and advanced in their own internal prestige competition.

Test Expectation

If adze distribution was a product of internal elite competition and adze production was increased for elite demand, then leaders circulated basalt adzes in efforts to accumulate wealth among themselves. If this was the case, internal prestige maneuvering would have benefited only individual Samoan leaders and negative reciprocity of adze distribution would be present within Samoa first before being applied to un-related regional populations. If not part of elite control, then the similar production processes occurring in the Plainware period would be similar to the later Traditional period with only incremental increases in quantity over time because of growing populations.

In this chapter, political economy was discussed in its early history, important contributions to theoretical debates within anthropology, and how the perspective is being used in contemporary archaeology. Key features of political economy were reviewed in relation to documenting changes in Samoa's political organization and its relationship to adze production. Finally, my research questions were outlined in greater detail including research backgrounds, proposed hypotheses and test expectations. The following chapter provides summaries of sites that were investigated for this research, and begins to lay a foundation to answer these questions.

CHAPTER IV

SITE INVESTIGATIONS ON TUTUILA ISLAND

> *At no site* [in Upolu or Savai'i] *were either the numbers of incomplete adzes discarded as rejects, or the quantities of cores and flakes in all sizes, sufficient to suggest adze manufacture as a primary activity.*
>
> Roger Green (1974:266)

Over the last twenty years, archaeologists have since overwhelming documented that adze manufacture has occurred in great quantities on Tutuila Island (Clark 1993; Leach and Witter 1990). In an effort to compile a systematic database for investigating Tutuila's stone tool industry, I mapped, surveyed and excavated at fourteen manufacturing sites and analyzed three additional lithic assemblages from previously investigated sites. The sites were chosen to provide a cross-section of flaking behaviors over Tutuila and different time periods. This chapter reviews the contextual information and lithic assemblages for each of these sites. The sites are located in eight different locations around Tutuila (Figure 4.1); four from western Tutuila, one from the Tafuna Plain, one from central Tutuila, and two from eastern Tutuila. This chapter is divided by these general geographic locations with a discussion of their unique environmental setting. Two sites date to the Polynesian Plainware period, while the remaining sites come from Traditional Period. The type and amount of production at each site encompasses a range of production activities. Each site is summarized based on collection methods, excavation results and general lithic data, so when I discuss the results of adze and debris studies in Chapter V, this information will already be in its context.

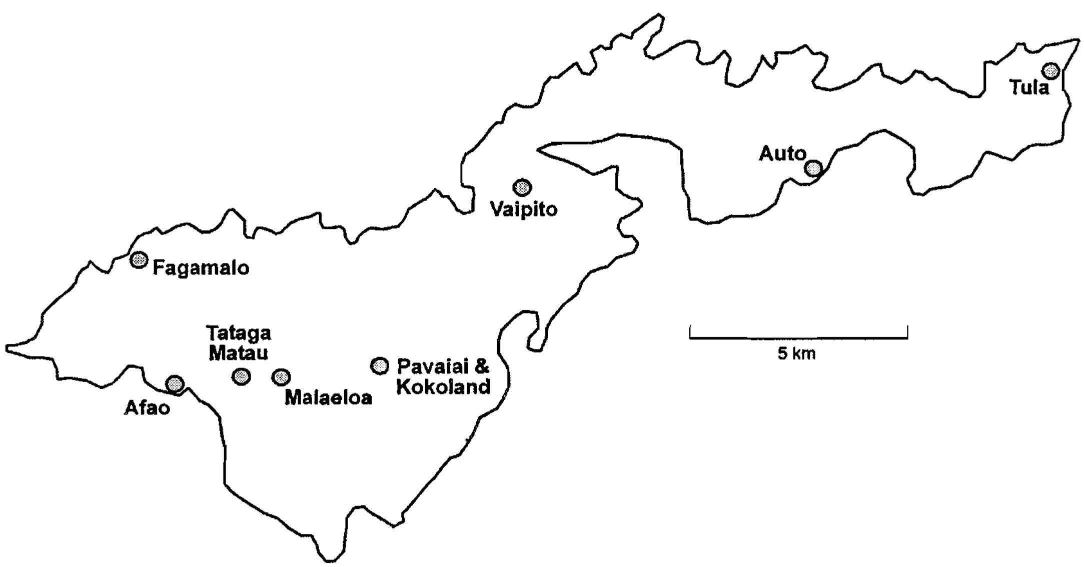

Figure 4.1. Map of Tutuila showing research locations discussed in this chapter.

<u>Fagamalo Valley</u>

The Fagamalo Valley is located on Tutuila's northwest coast. Fagamalo's steep sloped ridges surround a flat, but narrow valley floor, where the Misa and Matavai streams bisect the valley before converging and emptying into the ocean (Figure 4.2). Alkalic olivine basalts from the Taputapu volcanic comprise the local bedrock (Stearns 1944). The valley's soils are composed of Aua very stony silty clay loam and Fagasa family lithic Hapludolls-rock outcrop association (Nakamura 1984). The Aua soil typifies the very deep, well drained soil found in the lower elevations. The Fagasa family is found mostly in mostly steep ridges and mountainsides that in this case surround the Aua soil series except where the Aua series meets the sea. The small Fagamalo Village is the closest modern village to the research locale, and is located near the coastline.

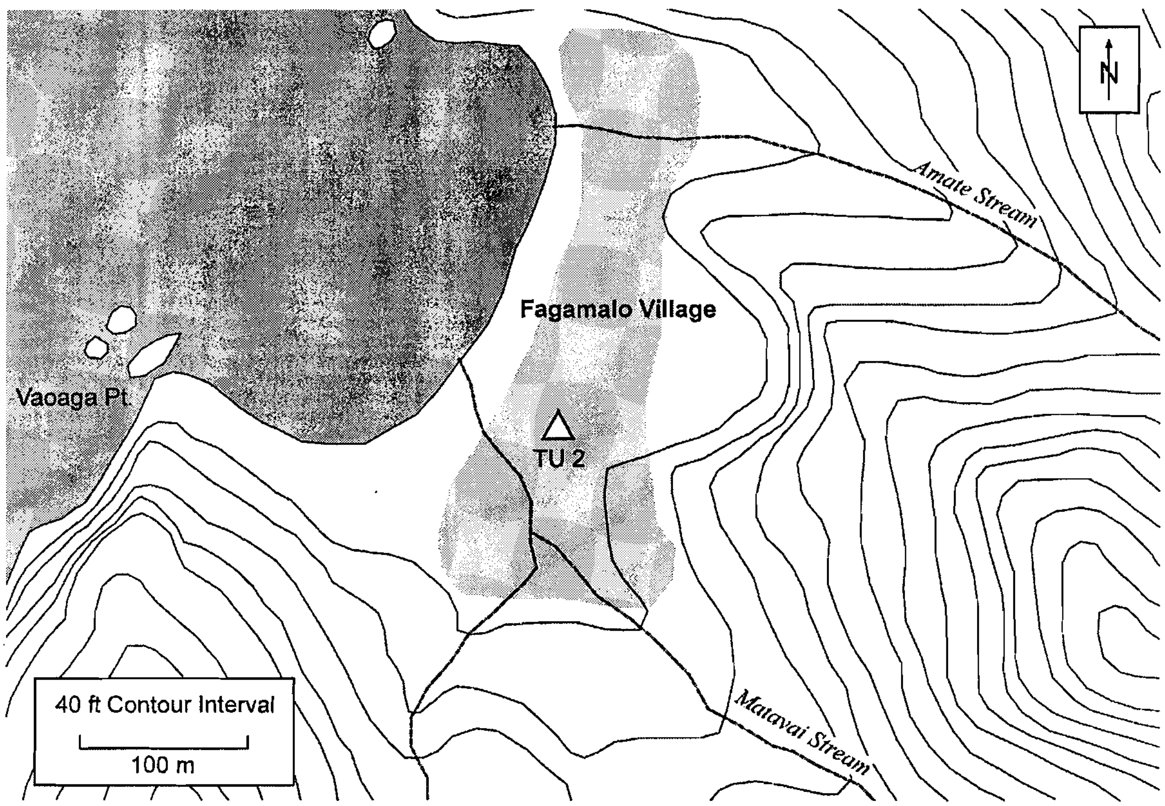

Figure 4.2. Map of Fagamalo valley showing the location of Excavation Unit 2.

From May 8 to 17, 2002, a crew from the Archaeological Division of the American Samoan Power Authority excavated five one by one m excavation units. The archaeological testing was conducted for a future expansion of an underground sewer line, and test unit locations were placed in areas of possible disturbance. Although most of the testing yielded little in the way of adze production, some evidence was located during the excavation of EU 2, which the author subsequently analyzed (see Figure 4.2).

EU 2 was located near the center of the village 10 m east of the main road. The excavation unit was excavated in 20 cm levels, soil removed from the excavation units was screened through 1/4 inch mesh, and a total of roughly 1.2 m^3 soil was excavated. There were three layers documented during the investigation. The top layer was recent fill. Starting at 22 cm below the surface, a concrete pad was encountered and associated basalt cobbles were encountered down to 88 cm. The bottom layer, ranging from 22 to 60 cm in thickness, was an intact cultural layer (Figure 4.3). Artifacts recovered in EU 2 include two adze preforms, three adze flakes, and 431 pieces of debitage. I chose to analyze this assemblage, because of the valley's peripheral location in western Tutuila and the amount of debitage, based off the amount of sampling, is typical of small scale production.

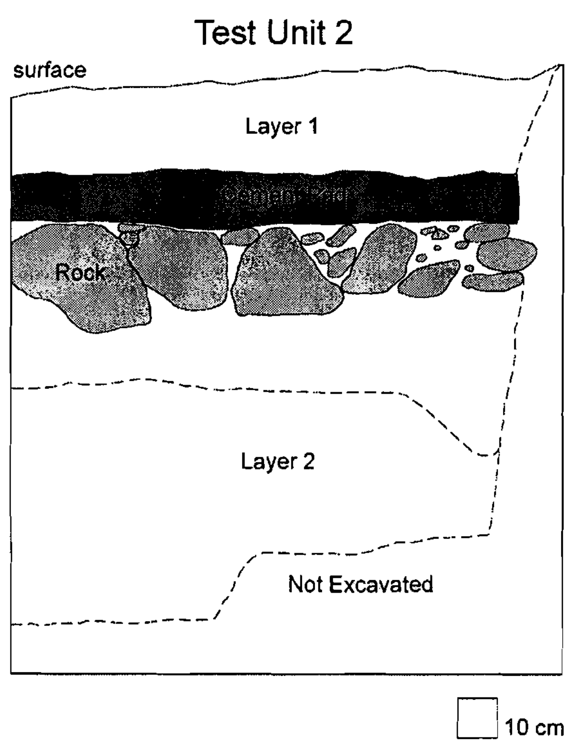

Figure 4.3. Soil profile for TU 2 at Fagamalo valley.

Afao Valley

The Afao Valley is a coastal valley located on the western side of Tutuila (Figure 4.4). Afao village is one km northwest of the village of Leone, and lies at the head of a valley of the same name. The valley floor runs from sea level up to 300 m at the surrounding ridge tops. Afao's underlying bedrock is composed of the Taputapu basalt formation (Daly 1924; Nateland 1980). The initial costal portion of the valley is composed of Urban land-Aua-Leafu complex and represents mainly disturbed surfaces, while the remaining valley and surrounding ridges are split among Aua soils, Fagasa-Ofu soils and steep rock outcrops (Nakamura 1984). Atauloma Stream flows down the center of the valley, and bisects these well drained and deep soils. Vegetation encountered during survey included agricultural fields in the valley and recovering forest on the ridges, and surface visibility varied greatly. I conducted surveys in this valley, because David Herdrich, Territorial Archaeologist at American Samoan Historic Preservation Office, had made mention of grinding slabs -- important in the final stage of adze production -- located in the front of the valley in the Atauloma Stream (David Herdrich, personal communication 2005), and he speculated that a substantial production center would be located in the valley. At start of the survey, I documented 25 individual grinding bowls in a 300 m area of the stream, not including a large boulder that had 12 individual bowls. However after over a week of survey, only two small manufacturing sites were uncovered, because of occurrence of modern disturbance near the coast and dense ground cover in the back of the valley.

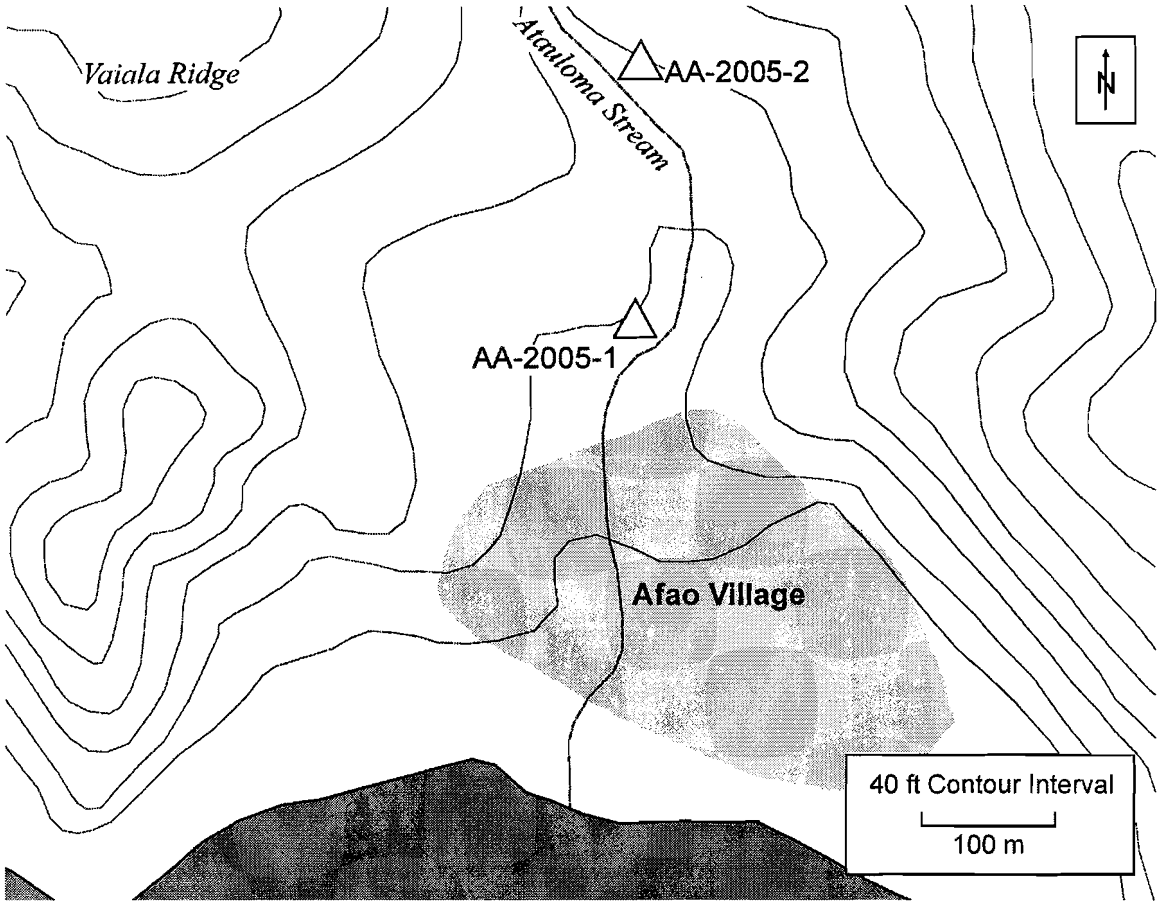

Figure 4.4. Map of Afao valley showing the locations of prehistoric manufacturing sites.

Afa Terrace (AA-2005-1)

The Afa Terrace is a residential and lithic manufacturing terrace associated with a larger terrace complex, probably the prehistoric site of Afao village (see Fig. 4.4). The 70 by 30 m site rests 25 m above sea level, in a present day plantation with moderate surface visibility (50 to 90 percent). The Afa Terrace contains a three by four m house foundation, a coral fragment scatter and a cobble scatter which all share a slight rise in the west portion of the terrace (Figure 4.5). Two wall alignments are located in the south central portion of the terrace, and two sparse lithic scatters are found on the west and east ends of the terrace. Considerable disturbances were noted at the site. These subsurface disturbances included a dirt driveway, modern house construction and erosional cuts.

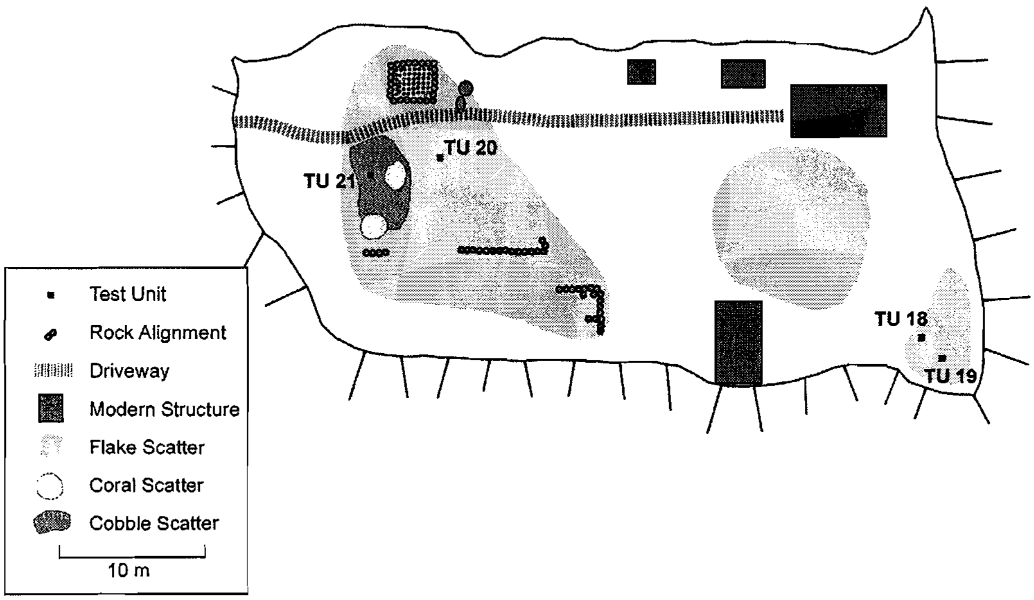

Figure 4.5. Plan view of the Afa Terrace.

After surveying the valley floor and surrounding ridge slopes, I conducted excavations on September 15 to 16, 2005. I excavated four 50 by 50 cm test units, because the surface scatters were the densest encountered during the valley survey (see Figure 4.5). TU 18 was located in the eastern-most portion of the terrace in a light flake scatter. TU 19 was located five m northwest of TU 18 in the same flake scatter. TU 20 was excavated on top of the rise in the western portion of the terrace placed in a large flake scatter. TU 21 was situated on a cobble scatter in between two coral fragment scatters in the western portion of the terrace. Each test unit was excavated in 10 cm levels, soil removed from the test units was screened through 1/4 inch mesh, and a total of .38 m^3 soil was excavated (Figure 4.6). The average depth for the test units was 38 cm. Rock impasse was the reason for all units' termination. The soil was a dark brown clayey loam in the top 15 to 30 cm, below that clay content increased and soil color changed to yellowish brown. Artifacts recovered during test excavations include three adzes, three flake tools, and 343 pieces of debitage.

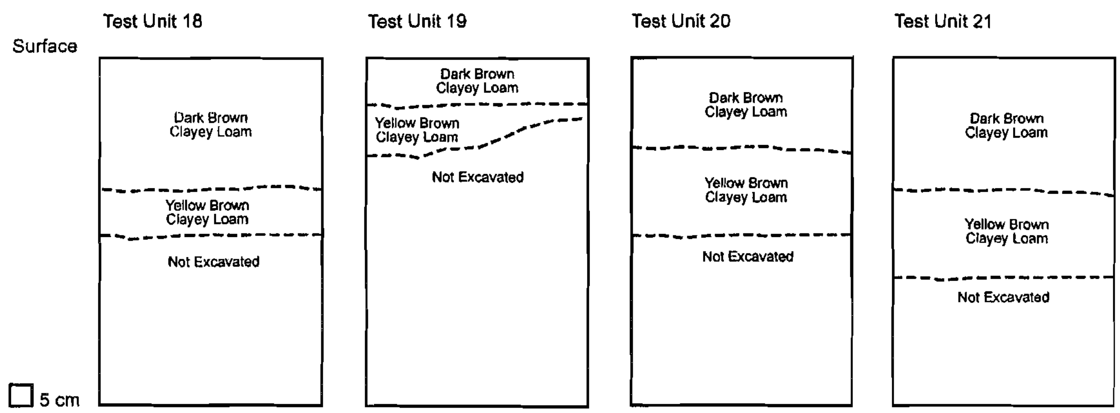

Figure 4.6. Soil profiles for test units from the Afa Terrace.

Manioc Terrace (AA-2005-2)

Site AA-2005-2 is a lithic scatter and a small alignment of stones on a 12 by 15 m terrace (Figure 4.7), and is located at 50 m above sea level in the northern portion of Afao valley, just east of the main stream on garden re-growth. This terrace is just one of a larger terracing complex in the valley; however, there is little to no surface visibility in the immediate area due to dense manioc overgrowth making visual identification of stone features difficult.

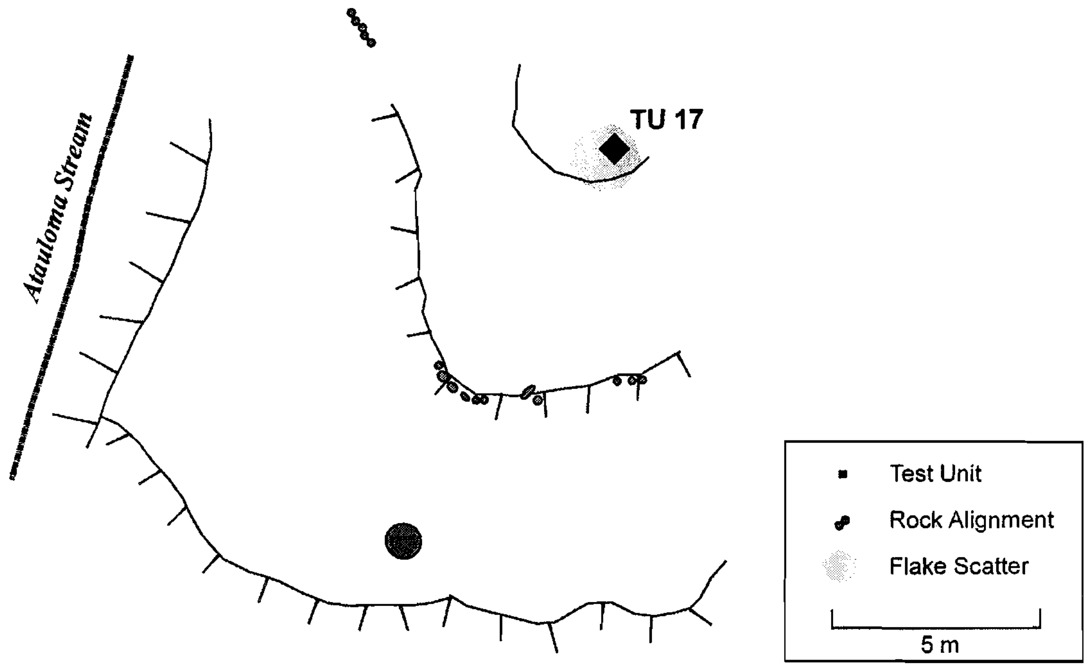

Figure 4.7. Plan view of the Manioc Terrace.

On September 14, 2005, one 50 by 50 cm test unit was excavated at the Manioc Terrace. TU 17 was excavated on top of the only visible surface flakes (Figure 4.8). The test unit was excavated in 10 cm levels, soil removed from the unit was screened through 1/4 inch mesh, and a total of .13 m^3 soil was excavated. The unit was terminated because a rock impasse was encountered. The soil was a dark brown clayey loam in the top 25 cm, below that clay content increased and soil color changed to a dark yellowish brown. Artifacts recovered during test excavations include one preform and 33 pieces of debitage.

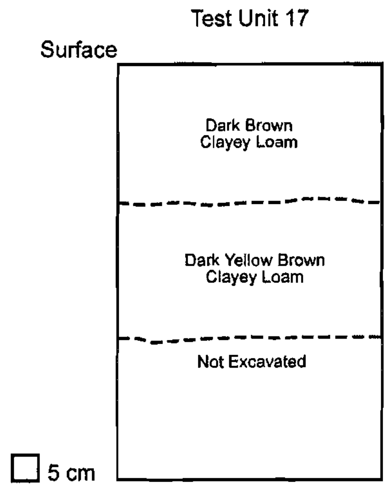

Figure 4.8. Soil profile for TU 17 at the Manioc Terrace.

Tataga Matau

Tataga Matau is located on an inland ridge top in the western part of Tutuila. Leafu Stream and many of its tributaries run down from the ridges in this area into Leone Bay (Figure 4.9). This site is approximately 280 m above sea level. The bedrock consists of Taputapu Volcanics, an alkalic olivine basalt (Stearns 1944). Oloava silty clay loam and Fagasa family lithic Hapludolls-rock outcrop association characterize the soil of Tataga Matau (Nakamura 1984). The Oloava silty clay loam is typified as a deep and well drained soil formed from ash and cinders. Steep ridges and mountainsides make up the Fagasa family lithic outcrop association. The nearest modern village is Leone, about two and half km south of Tataga Matau.

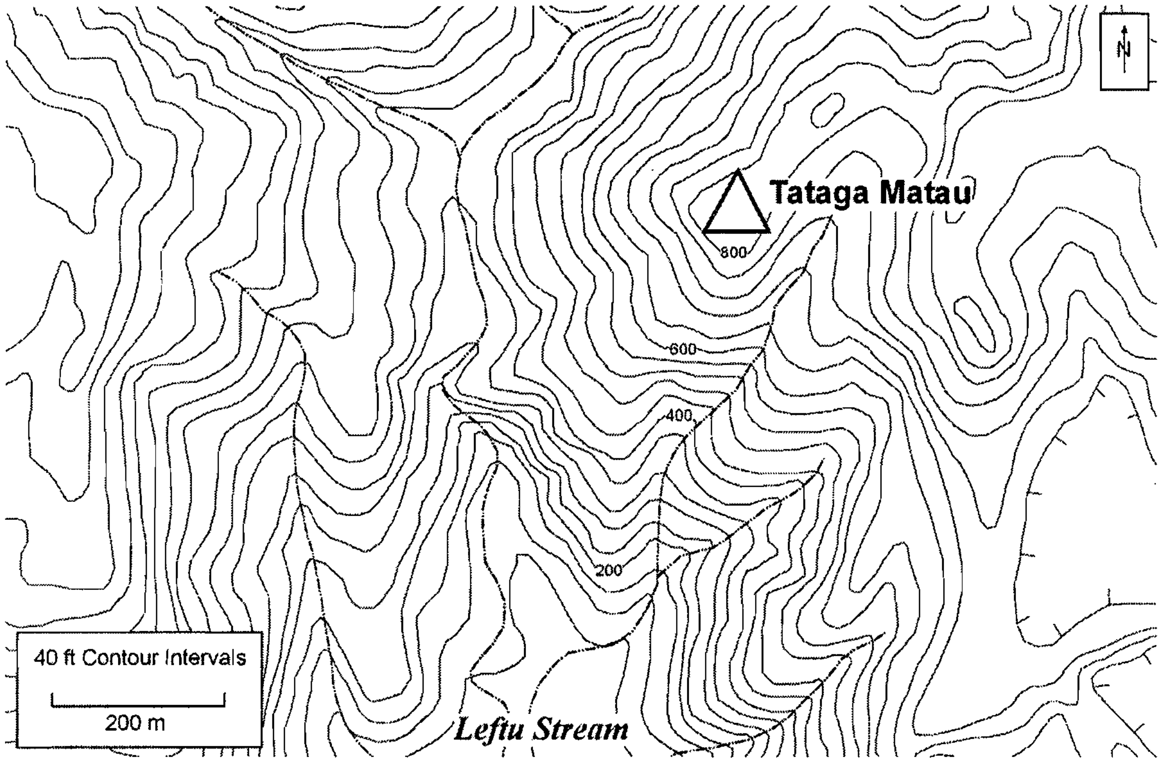

Figure 4.9. Map of Tataga Matau and the surrounding area.

Tataga Matau is a 20 hectare site complex located on a ridge top northeast of Leone Village (Buck 1930; Leach and Witter 1990). Not simply a quarry, this large site complex contains a wide variety of features including star mounds, earthen mounds, ditches, pits, terraces and leveled ridge tops. One particular archaeological feature germane to this study is the Star Mound Terrace excavated in 1988, named for the star mound, or *tia ave,* located in the center of the terrace (Figure 4.10).

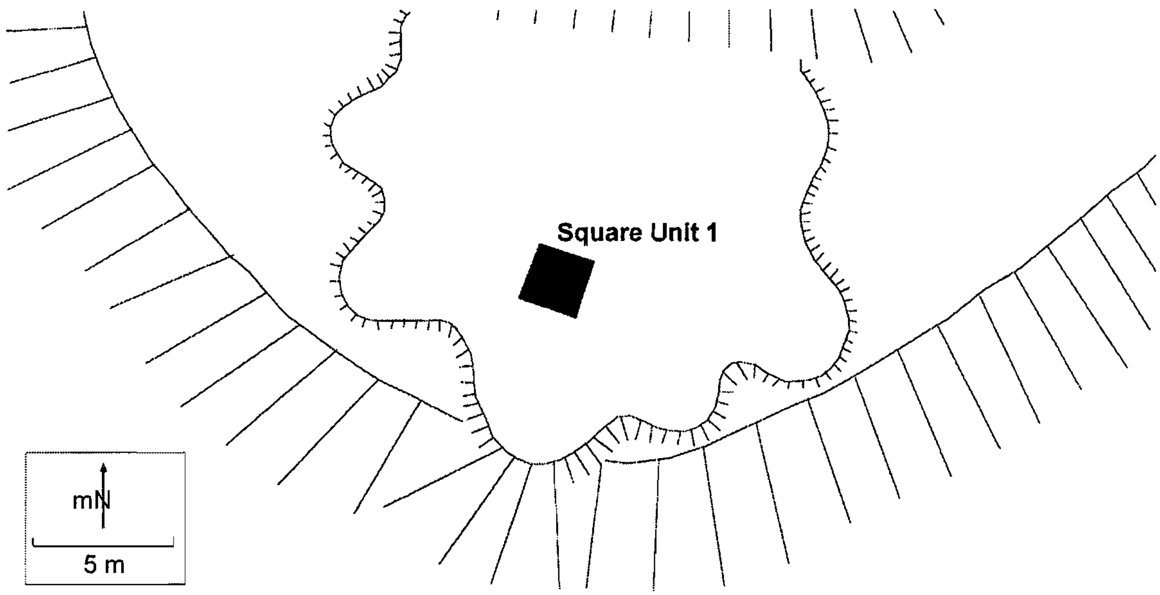

Figure 4.10. Plan view of the Star Mound Terrace at Tataga Matau (adapted from Best et al. 1988).

A one by two m trench unit was excavated by Simon Best to investigate the utilization of non-quarry features at Tataga Matau (Figure 4.11). But based on his excavations, the terrace was found to have had multiple uses over time. Layer B of the trench contained the remains of adze manufacture, and a charcoal sample analyzed from a small charcoal lens in association with the debris (Best et al. 1988). The sample provides a conventional date of 602 +/- 50 BP. Pertinent to this study, all excavated flake debris at the Star Mound Terrace was weighed and measured by the author with the approval of research director Helen Leach; however, comparisons with other flake scatters at the site could not be accomplished because collections were not done systematically at other features within the fortified hilltop quarry (Best et al. 1988). Artifacts recovered during test excavations of Layer B included sixteen preform, two blanks and 601 pieces of debitage.

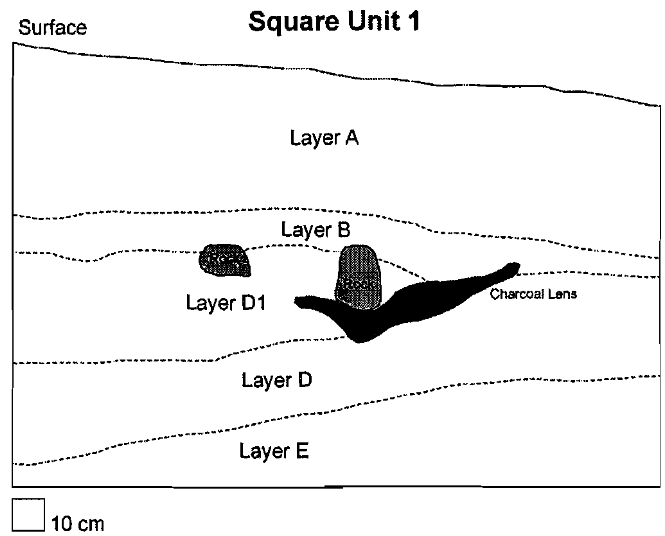

Figure 4.11. Soil profile for Square Unit 1 from the Star Mound Terrace (adapted from Best et al. 1988).

Malaeloa Valley

Malaeloa is a broad, inland valley that is located one km east of the village of Leone (Figure 4.12). The relatively flat valley floor has an area of .7 km^2 and roughly 60 m above sea level. The surround ridges have steep slopes ranging from 30 to 70 percent, and rise up to an elevation of 360 m. Fuafua and Vaitai streams bisect the valley floor before turning west and emptying into the ocean south of Leone village. The bedrock is composed mainly of alkalic olivine basalts from the Taputapu formation (Daly 1924; Nateland 1980). Soil surfaces are dominated by either Leafu silty clay on the valley floor or Oloava clay loam on the surrounding ridges (Nakamura 1984). The Leafu soil series is classified as deep and poorly drained soils composed of decaying igneous rock. The Oloava formation is characterized by deep and well drained soils formed from ash and cinders. Vegetation encountered during survey included agricultural fields in the valley and recovering forest on the ridges; surface visibility varied greatly based on vegetation. The modern village of Malaeloa is located at the southern opening of the valley and comprises the majority of subsurface disturbances, although farming practices have produced limited disturbances in the back of the valley. Extensive evidence of adze production was collected at AS-32-6-F4 during my initial field season in Samoa (Ayres et al. 2001), and when further survey was conducted over the valley by the author found the valley to contain numerous intensive production centers.

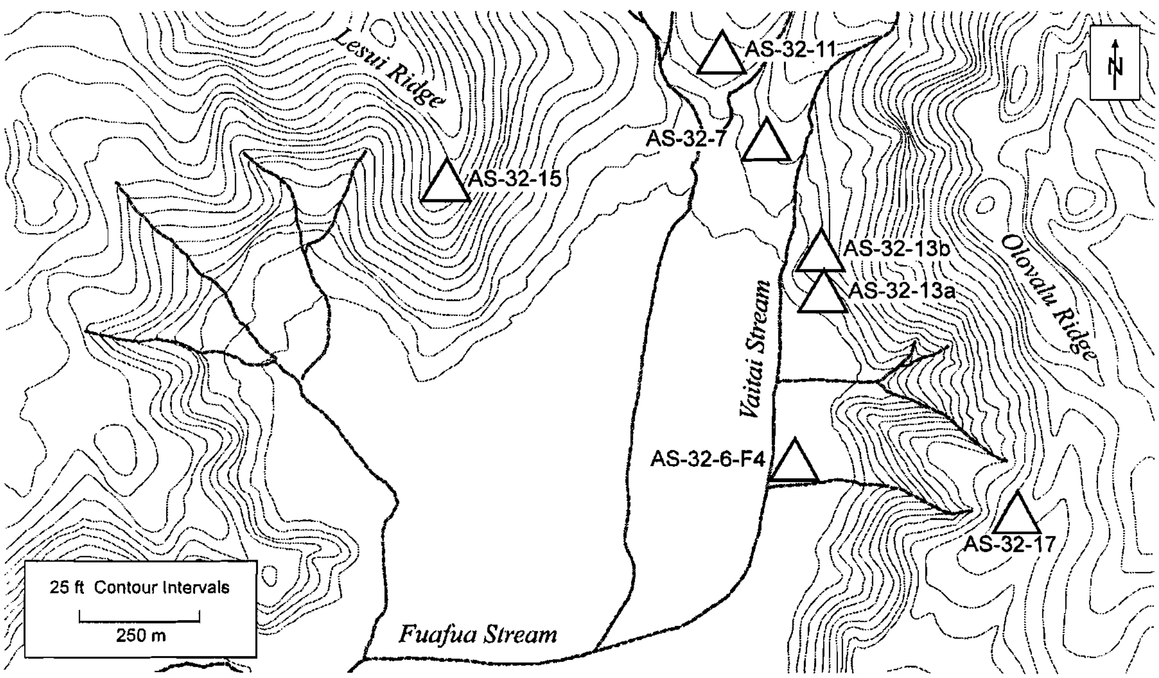

Figure 4.12. Map of Malaeloa valley with the locations of archaeological sites.

Pigtrap Terraces (AS-32-13a)

Pigtrap Terraces covers an area of .24 hectares and is situated on the west facing side slope of the eastern ridge in the northeast portion of Malaeloa Valley (see Fig 4.12).

AS-32-13a consists of three terrace features, stone retaining walls, two house foundations, an earth-oven, and rock several alignments (Figure 4.13). Artifacts documented at the site include adzes, preforms, flake tools, a hammerstone, a grinding stone and flake scatters. Surface visibility ranges from 10 to 80 percent, and there were limited subsurface disturbances including prior horticultural activities, intermittent creek flows and related erosion, and feral pig ruts. The western terrace is approximately 100 by 20 m (Figure 4.13). This terrace has numerous cobble stone alignments; a disturbed house foundation composed of a gravel scatter, a three and half m circular house foundation, and a stone wall running perpendicular to the length of the terrace. Light to medium flake scatters are visible on the surface. The central terrace is approximately 22 by 7 m. There is a boulder retaining wall at its southern lip, and no surface artifacts or features were witnessed. The eastern terrace is 20 by 12 m, with a well preserved retaining wall forming the back of the terrace. Only a two by one m cobble scatter, a possible earth-oven, was located near the terrace's center. Based on these investigations, the Pigtrap Terraces were a prehistoric habitation site with two peripheral special purpose terraces.

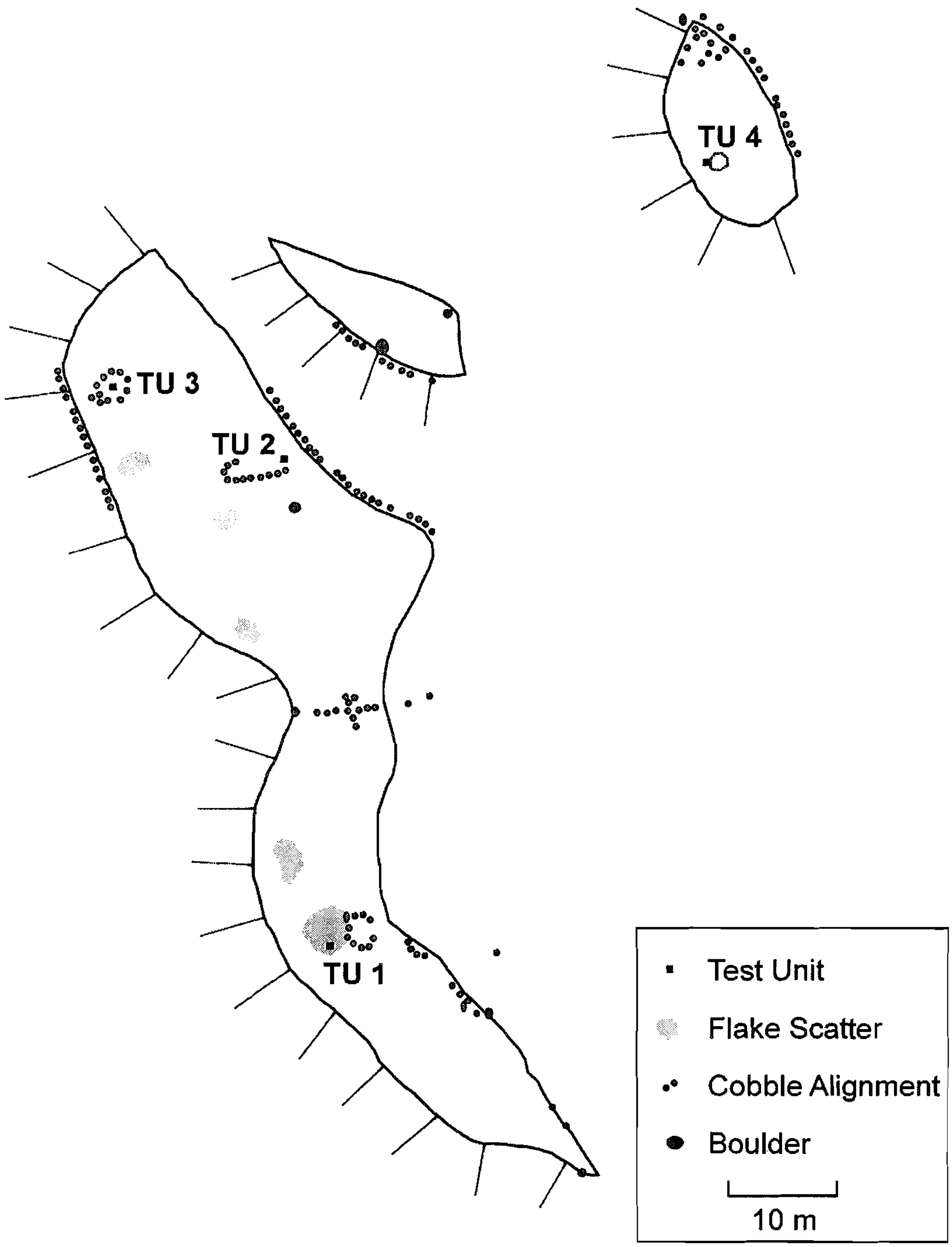

Figure 4.13. Plan view of the Pigtrap Terraces.

On August 13 to 16, 2005, four 50 by 50 cm test units were excavated at the site. TU 1 was located in the north half of a two by three m circular scatter of cobbles and gravels in the south central portion of the western terrace. TU 2 was located in the central portion of the western terrace, and was placed on top of a light flake scatter. TU 3 was excavated in the center of a four by four m circular rock alignment in the north western portion of the western terrace. TU 4 was situated on two by one m earth-oven in the central portion of the eastern terrace. Each test unit was excavated in 10 cm levels, soil removed from the units was screened through 1/4 inch mesh, and a total of .3 m^3 soil was excavated. The average depth for the units was 30 cm (Figure 4.14). Rock impasse was the reason for all units' termination. The soil was a dark brown clayey loam in the top 15 to 30 cm, below that clay content increased and soil color changed to yellowish brown. Artifacts recovered during test excavations include two adzes, two preforms, two flake tools, a hammerstone and 219 pieces of basalt debitage.

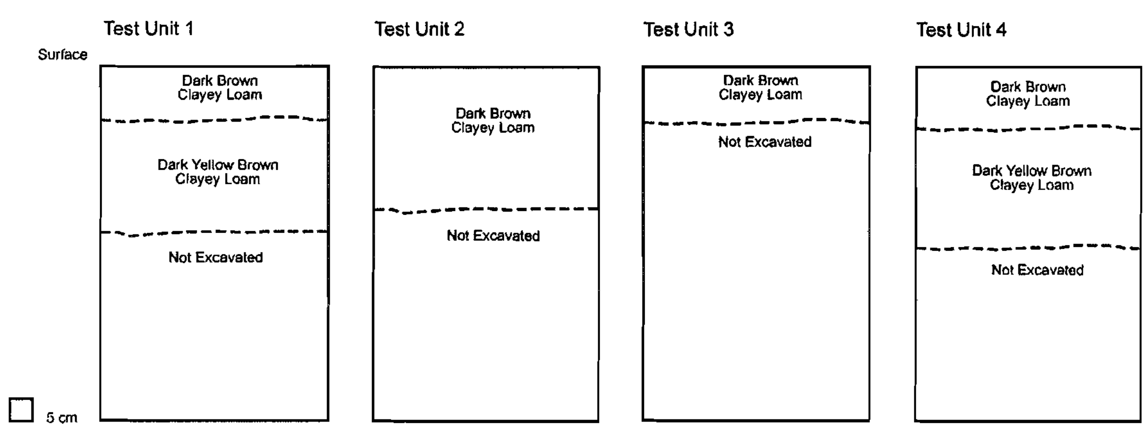

Figure 4.14. Soil profiles for test units from the Pigtrap Terraces.

Frog Terraces (AS-32-13b)

Frog Terraces are situated on the west facing side slope of the eastern ridge in the northeast portion of Malaeloa Valley, and 50 m north of AS-32-13a. AS-32-13b consists of three terrace features, a house foundation and considerable amounts of debitage (Figures 4.15). Only limited subsurface disturbances were noted during investigations, mainly consisting of prior horticultural activities and bioturbation; surface visibility ranged from 20 to 80 percent. The western terrace is 58 by 15 m, and has a good example of a well preserved house foundation in its northern half, which may date to the historic period based on later conversations with villagers. The foundation has three intact walls of curbstones with a cobble fill and a light flake scatter. The central terrace is a 14 by 5 m ovate terrace with a heavy flake scatter. Large concentrations of basalt debitage were discovered among the large basalt boulders between the central and eastern terrace. The eastern terrace is 25 by 7 m in size, and has a retaining wall collapsed along its back side and an eight by six m raised house foundation. A remarkable amount of flake material was witnessed on and between it and the lower terraces. In all, the terraces have an area of .11 hectare, but cultural material was also found on the side slopes between the terraces. The extent of erosional deposition is unknown, but probably significant in the final provenance for most of the material witnessed in between terraces. The western terrace was a habitation terrace, and the remainder of the site is indicative of lithic manufacturing activities. Radiocarbon samples from the lithic industry portion of the site date to the fifteenth and sixteenth century A.D. (433+/-42 to 280+/-38 BP, uncorrected ^{14}C).

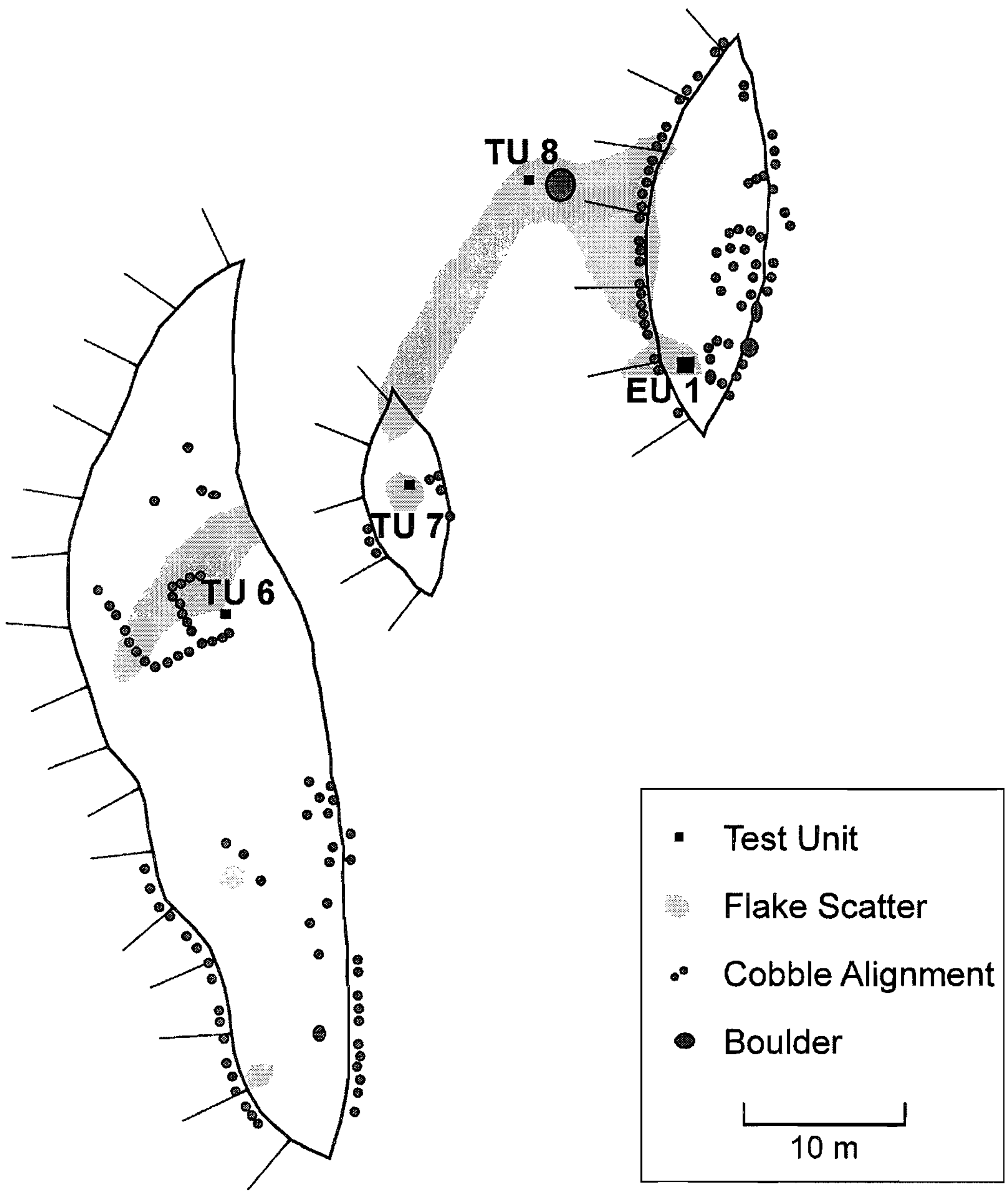

Figure 4.15. Plan view of the Frog Terraces.

On August 19 to 25, 2005, three 50 by 50 cm test units and a single one by one m excavation unit were excavated across the site. EU 1 was located in the southern portion of the eastern terrace, just west of a raised two by three m foundation (Figure 4.16). TU 6 was situated on the eastern edge eight by six m house foundation on the central portion of the western terrace. TU 7 was excavated in the central terrace, near the center over a flake scatter. TU 8 was situated west of a large boulder in between the central and eastern terrace, where a dense layer of waste flakes were encountered. Each unit was excavated in 10 cm levels, soil removed from the units was screened through 1/4 inch mesh, and a total of .78 m^3 soil was excavated. The average depth for the units was 48 cm. Rock impasse, sterile levels and bioturbation were the reason for all the units' termination. The soil was a dark brown clayey loam in the top 10 to 20 cm and dark yellowish brown loamy clay in the bottom. Artifacts recovered during test excavations include twenty-two adze preforms, fourteen flake tools, seven adze flakes -- flakes broken from a finished adze during use and retaining a polished surface -- and 13,223 pieces of debitage.

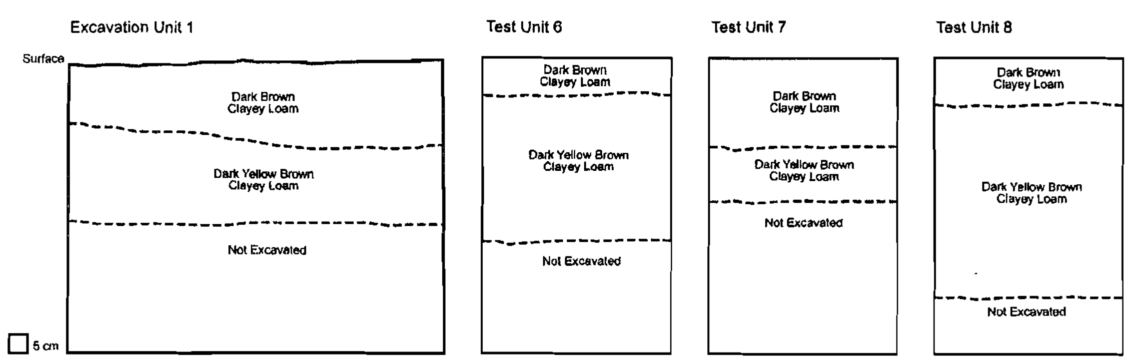

Figure 4.16. Soil profile for the excavation unit and test units from the Frog Terraces.

Toa Terrace (AS-32-11)

Toa Terrace is a lithic manufacture terrace associated with a larger terrace complex located on the majority of the ridge. The 22 by 28 m terrace lies at 90 m above sea level in secondary forest, near an existing plantation (Figure 4.17). The terrace had a 50 to 80 percent surface visibility, and no visible disturbances were noted during investigation. On the terrace, there is a four by six m ovate house foundation and a 15 by 15 m flake scatter that had a tremendous amount of waste flakes and three broken preforms on the surface. Uncorrected ^{14}C sample provide a twelfth century A.D. date (845+/-36 BP) for the terrace construction and start of manufacture activities.

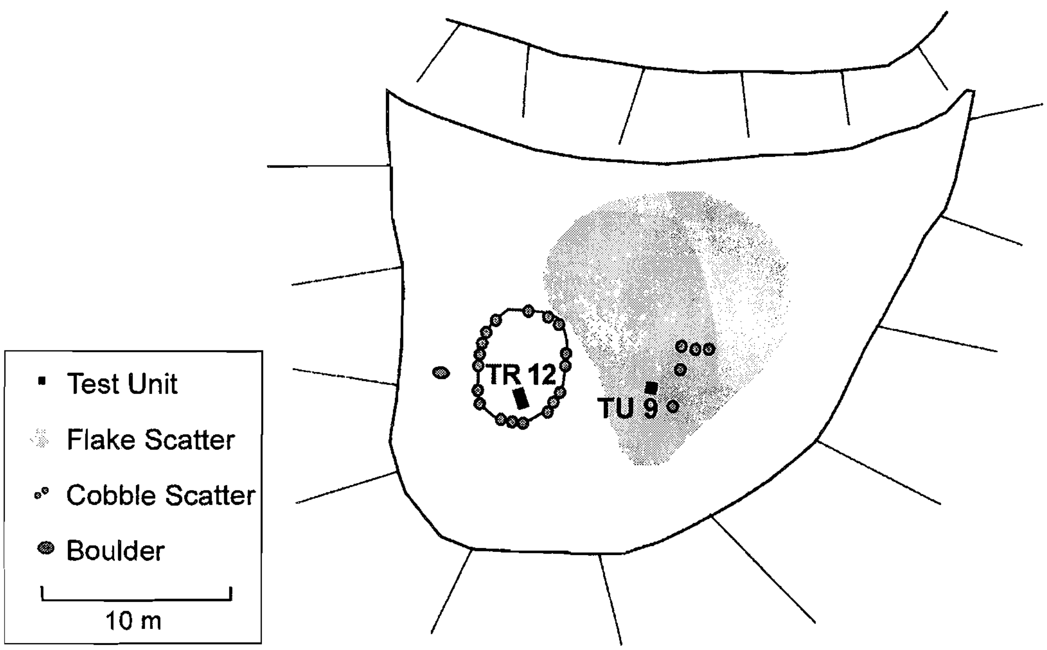

Figure 4.17. Plan view of the Toa Terrace.

On August 25 and 31, 2005, one 50 by 50 cm test unit and a one m by 50 cm excavation trench were excavated. TU 9 was located on a heavy flake scatter in the central portion of the terrace, and TR 12 was located in the southern half of the house foundation situated it the south western portion of the terrace (Figure 4.18). Each test unit was excavated in 10 cm levels, soil removed from the probes was screened through 1/4 inch mesh, and a total of .38 m^3 soil was excavated. The average depth for the test units was 55 cm. Rock impasse and sterile layers were the reason for termination. The soil was a dark brown clayey loam in the top 15 to 18 cm, below that, clay content increased and soil color changed to yellowish brown. Artifacts recovered during test excavations include nine adze preforms, seven flake tools, seventeen adze flakes, one piece of ceramics, seven flaked stone tools and 15,487 pieces of debitage.

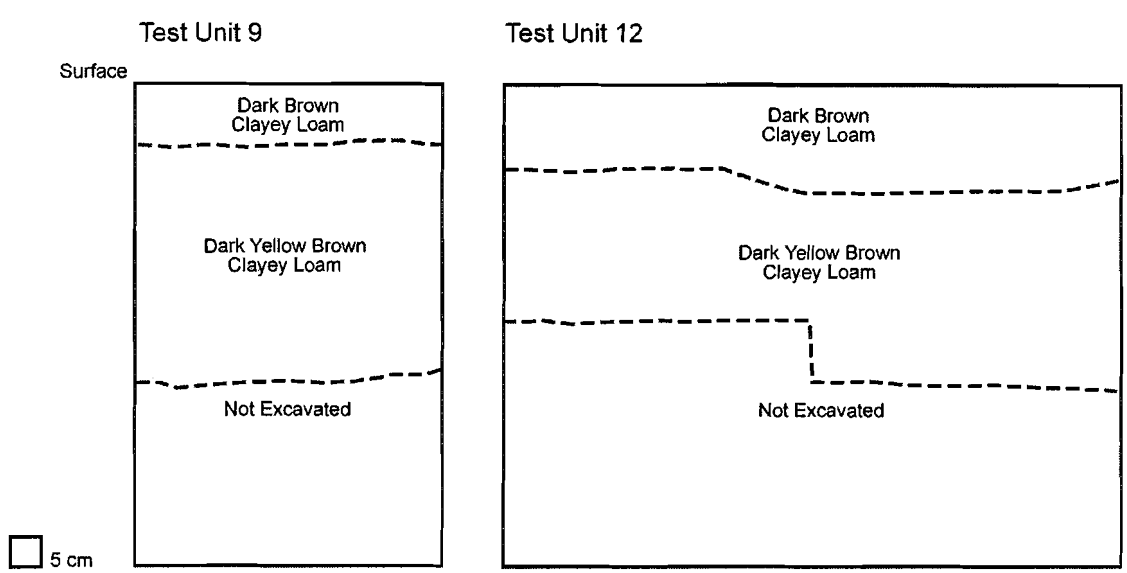

Figure 4.18. Soil profiles for test units from the Toa Terrace.

Gecko Terrace (AS-32-15)

The 30 by 13 m terrace is located 146 m above sea level on the Lesui ridge. Situated in secondary forest, the terrace had a small light flakes scatter in the southern portion of the terrace surface (Figure 4.19). One test unit was excavated on top of the flake scatter. Under the surface, the concentration of flakes increased greatly. The Gecko Terrace was a special activity terrace possibly associated with gardening with adze manufacture being a secondary activity.

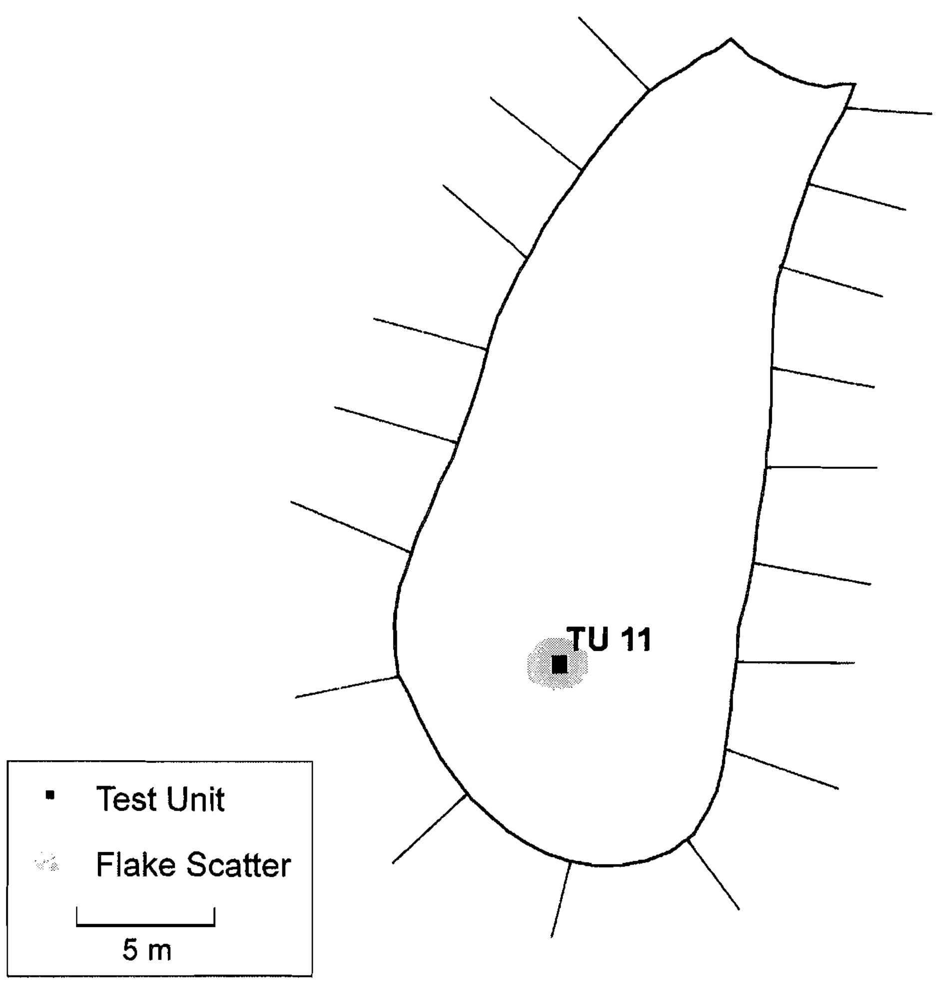

Figure 4.19. Plan view of the Gecko Terrace.

On August 30, 2005, one 50 by 50 cm test unit was excavated. TU 11 was excavated in 10 cm levels, soil removed from the unit was screened through 1/4 inch mesh, and a total of .1 m^3 soil was excavated (Figure 4.20). Culturally sterile soil in the bottom two levels was the reason for the unit's termination. In the test unit, dark brown clayey loam in the top 10 cm overlaid a yellowish brown clayey loam. No tools were recovered during excavation or survey, but a total of 219 pieces of debitage were recovered during excavation.

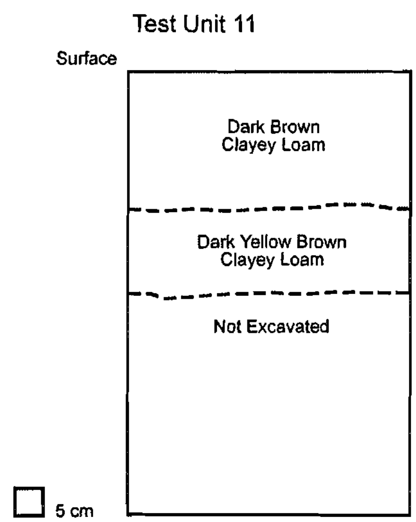

Figure 4.20. Soil profile for TU 11 at the Gecko Terrace.

Tuitasi Terraces (AS-32-7)

Tuitasi Terraces are a complex of man-made terraces located on a ridge slope in the northeastern portion of the Malaeloa Valley (Winterhoff 2003; Figure 4.21). The lower three terraces of AS-32-7 encompass .11 hectare, and contain a substantial amount of lithic debris. An intensive surface survey and excavation of two 50 by 50 cm test units were conducted. During the pedestrian survey, I located one cobble scatter denoting a house foundation, three stone retaining walls, dense lithic scatters, two grinding stones, four ground adze fragments, 14 broken adze performs, 10 flake tools, and two pieces of Polynesian Plainware. In addition to the survey, three ground adze fragments, four preforms, one ceramic sherd, three flake tools, and 5,475 flakes were recovered during excavation. No charcoal samples were recovered from excavation and the ceramics were recovered in disturbed contexts, so no temporal association can be given to the site. Based on the amount of debris and associated tools, the Tuitasi Terraces were an intensive adze production locale.

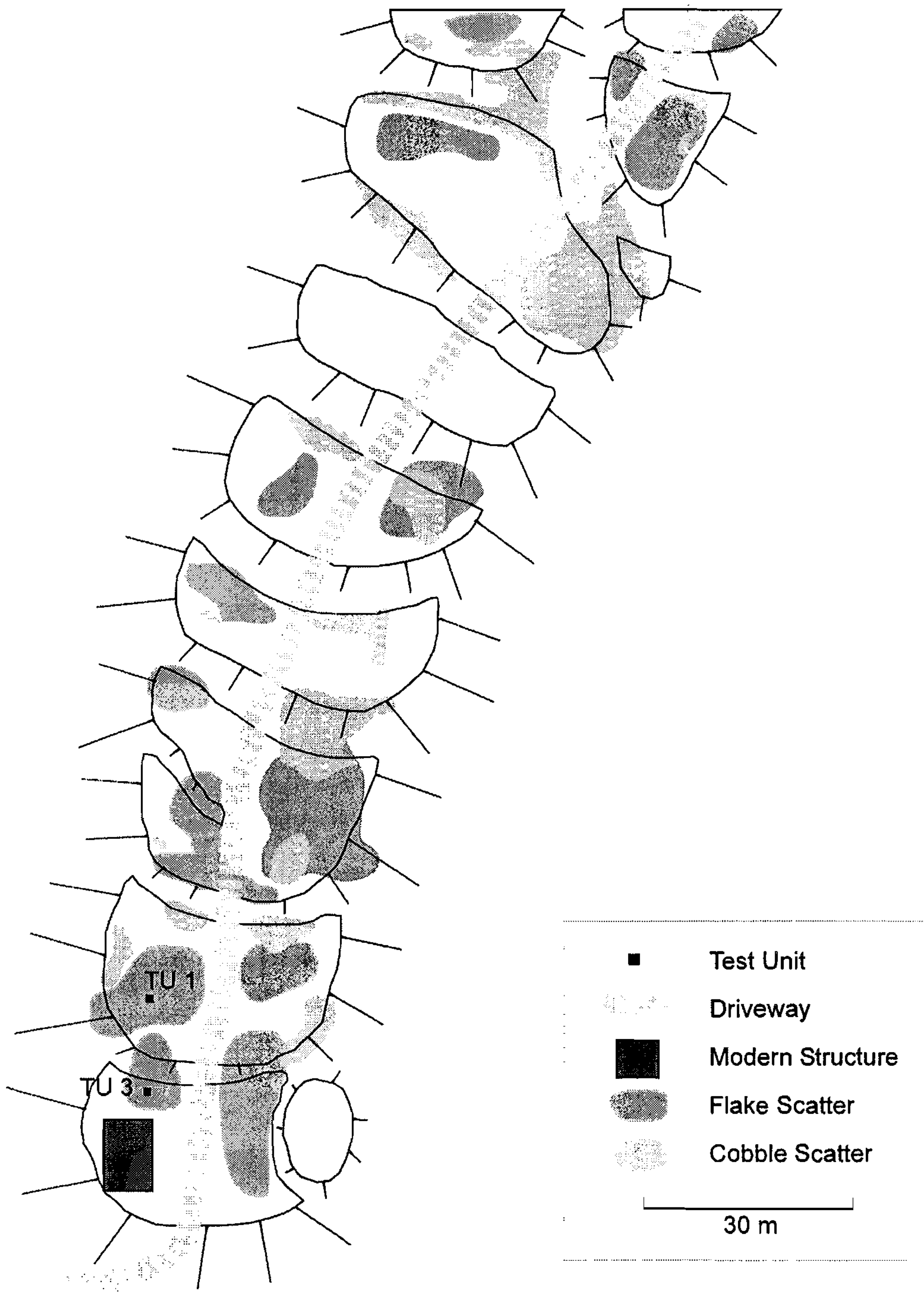

Figure 4.21. Plan view of the Tuitasi Terraces (adapted from Winterhoff 2003).

AS-32-6-F4

Site AS-32-6-F4 is a dense lithic scatter, 75 m^2 in area, situated in the east central part of the Malaeloa Valley (Ayres et al. 2001), and dates to between the fifteenth and eighteenth century A.D. (Figure 4.22). During an earlier investigation, 1,400 flakes and tools were collected during surface survey, and 9,600 debris and artifacts were recovered during the excavation of two 50 by 50 cm test units and one by one m excavation unit at the site. In 2001, the site was revisited by the author and the University of Oregon Archaeological field school. Four one by one m excavation units and eight 50 by 50 cm test units were excavated to further study the size of the site and search for additional subsurface features (Winterhoff 2003). The data retrieved from this second season confirms the initial 1999 season. For my current analysis, I examined 5,515 waste flakes recovered in the excavation of two one by one m test units, TU 2 and 3.

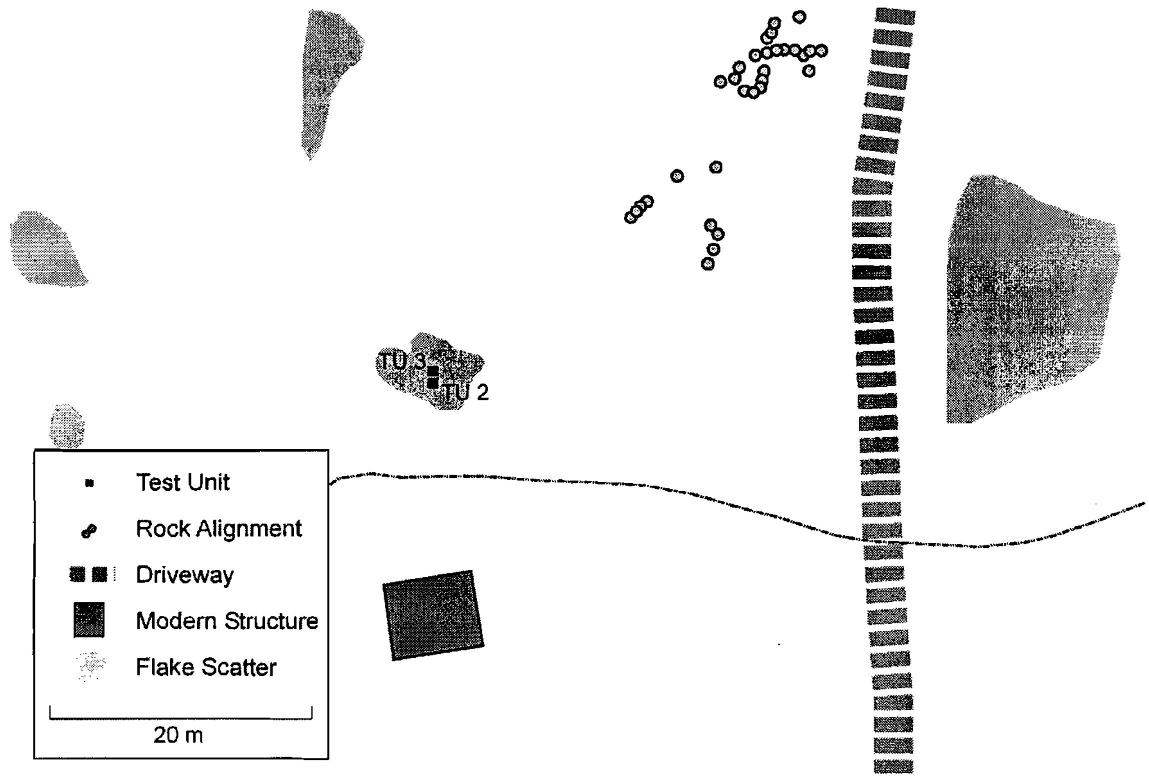

Figure 4.22. Plan view of site AS-32-6-F4.

Banana Plantation Terrace (AS-32-17)

The Banana Plantation Terrace, consisting of a lithic scatter next to a prehistoric house foundation, is located on the east ridge above site AS-32-6-F4 (see Fig. 4.12). The lithic scatter had a low quantity of debitage spread over a 20 by 20 m area in a current garden. A 50 by 50 cm test unit was excavated on the edge of the house foundation. Although there was only limited evidence of adze manufacture at the site – a total of 24 flakes were recovered and left unanalyzed, one adze and three adze preforms were also recovered at this peripheral habitation site.

<u>Pavaiai and Kokoland</u>

Pavaiai and Kokoland are located inland on the relatively flat terrain of the Tafuna Plain (Figure 4.23). Leone Volcanics characterized as *pahoehoe* olivine basalts dominate the bedrock here. Pavaiai soil is composed of Iliili stony mucky clay loam. Kokoland is dominated by two types of soil, Leafu silty clay and Pavaiai stony clay loam. These soil types are distinguished by a well drained soil formed in volcanic ash and underlain by lava. Three sites were excavated in an effort to both investigate the geographic range of manufacturing activities and sample sites dating to the Polynesian Plainware period.

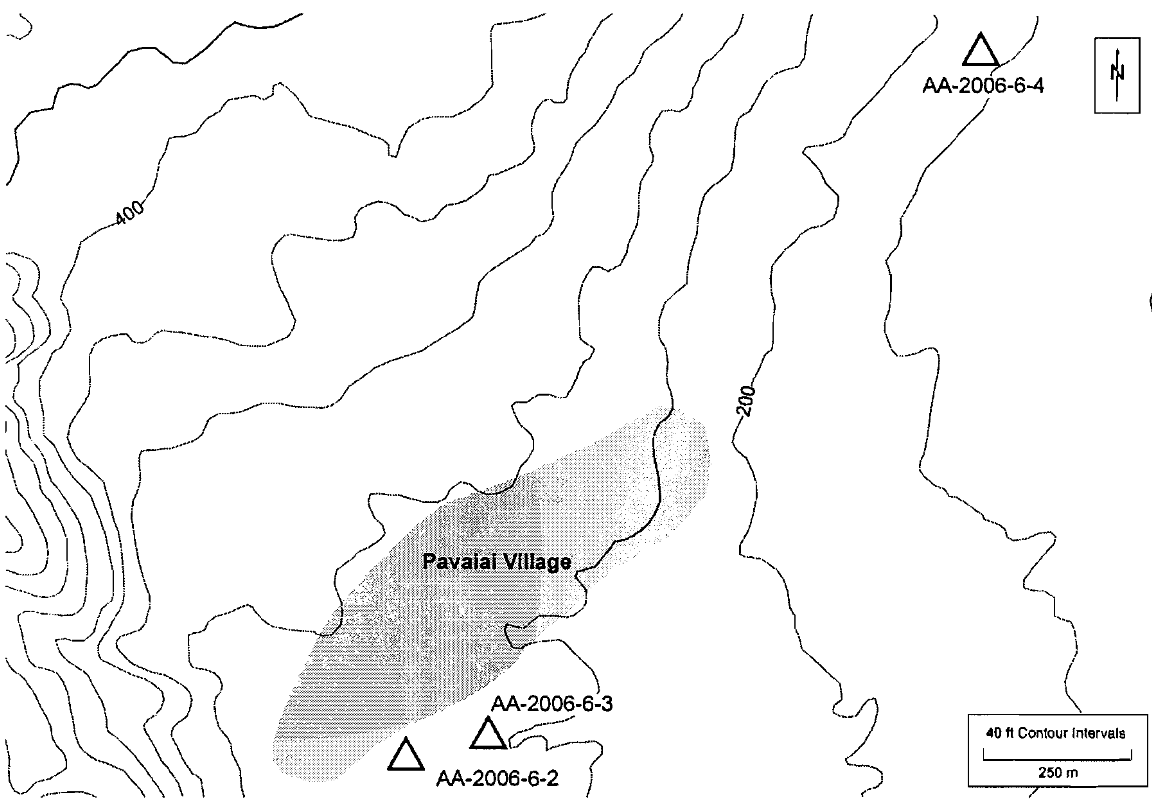

Figure 4.23. Map of Pavaiai and Kokoland showing the locations of archaeological sites.

Pulu Tree Site (AA-2006-6-2)

The Pulu Tree Site is a lithic manufacturing site associated with the larger prehistoric village complex of Pavaiai. The 10 by 10 lithic scatter rests at 68 m above sea level (Figure 4.24), and is located in a present day residential compound that provided low surface visibility (5 to 25 percent). AA-2006-6-2 contains a dense lithic scatter with no associated surface features with only limited disturbances. These subsurface disturbances included a dirt driveway, modern house construction and a nearby underground sewerline, but their overall impact was slight.

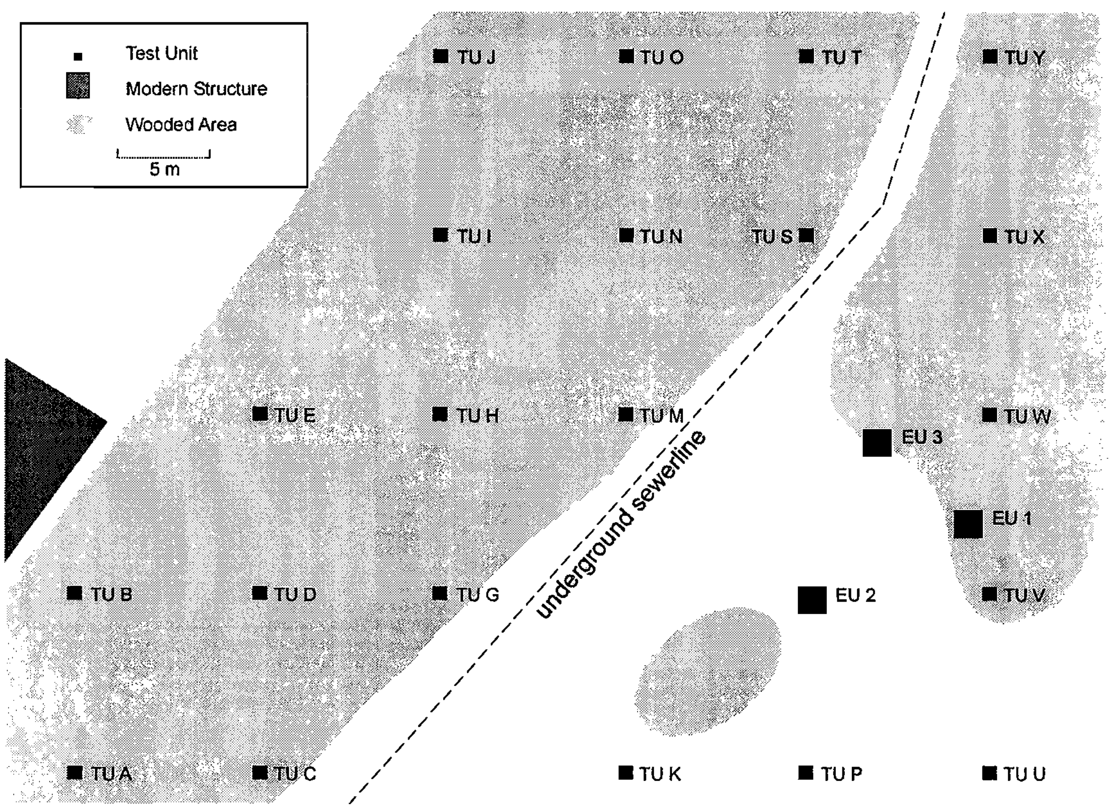

Figure 4.24. Plan view of the Pulu Tree Site.

On July 3 to 9, 2006, three one by one m excavation units and twenty-five 50 by 50 cm test units, in a grid of 10 m increments, were excavated at the site. The test units were utilized to investigate the spatial extent of the site, and showed that the surface scatter of waste flakes was isolated to the area immediately around EU 1, 2 and 3. The recovered materials from these test units were not used for analysis, because the material was found to be unrelated to the Pulu Tree Site. EU 1 was located in the center of the flake scatter. EU 2 was located seven m southwest of EU 1 in the same flake scatter. EU 3 was excavated on western edge of the flake scatter, and was located seven m northwest of EU 1. Each unit was excavated in 10 cm levels, soil removed from the units was screened through 1/4 inch mesh, and a total of .9 m^3 soil was excavated (Figure 4.25). Cemented volcanic ash bedrock was the reason for all units' termination. The soil was a dark brown clayey loam for the top strata, below it became a condensed ash layer. Artifacts recovered during test excavations include one adze, one adze preform and 6,467 pieces of debitage.

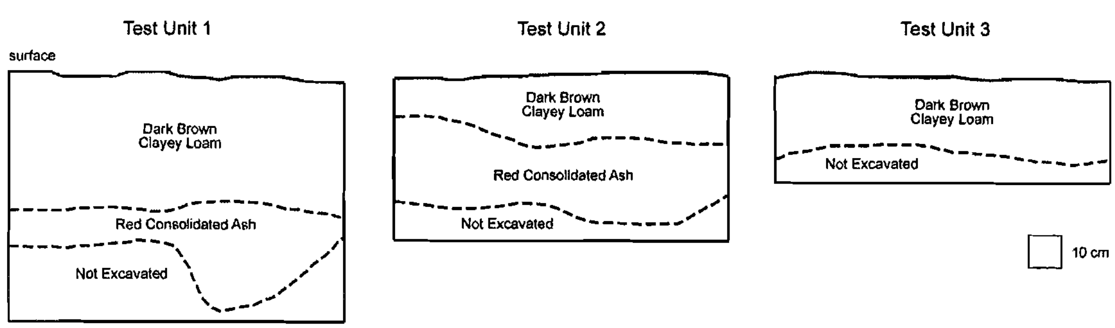

Figure 4.25. Soil profiles for excavation units from the Pulu Tree Site.

Pavaiai P6 Site (AA-2006-6-3)

The Plainware period AA-2006-6-3 is a residential, lithic, and ceramic manufacturing site with a uncalibrated radiocarbon date of 1467 +/- 36 BP (sample no. 19502). The 40 by 40 m site rests 68 m above sea level (Figure 4.26) and stretches across a lawn and wooded plot with low overall surface visibility (0 to 10 percent). The Pavaiai P6 Site contains lithic and ceramic deposits with no associated surface features. The major subsurface impact to the site was an underground sewer line. The site was uncovered during its construction, and based on subsurface sampling, the construction only impacted a small portion of the total site area.

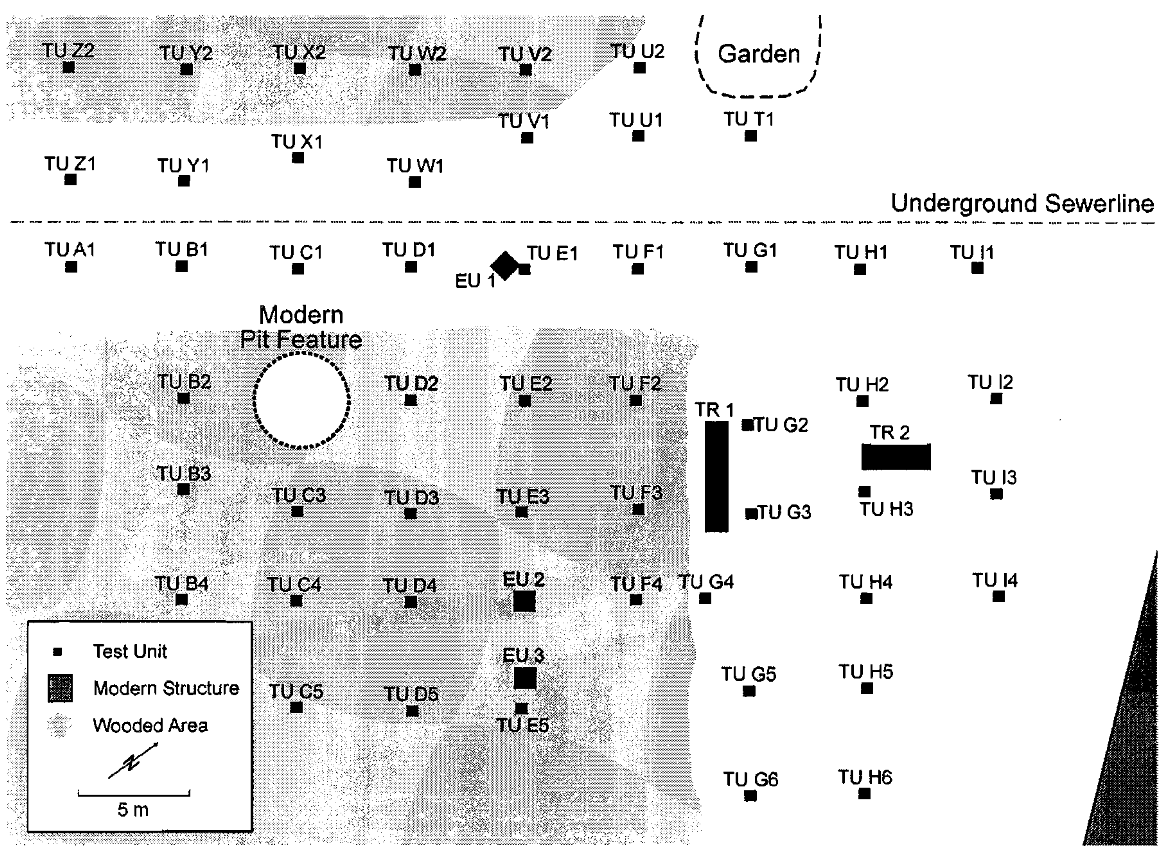

Figure 4.26. Plan view of the Pavaiai P6 Site.

On July 10 to 22, 2006, fifty-two 50 by 50 cm test units, three one by one m excavation units, a five by one m trench, and a three by one m trench were excavated at the Pavaiai P6 Site (see Fig. 4.26). EU 1 was located just west of TU E1, two m south of the sewer line. EU 2 was placed over TU 4E, 17 m south of the sewer line. EU 3 was excavated four m south of EU 2. The northern end of Trench 1 is nine m south of the sewer line, it extends for another five m south and lies between the F and G transects (Figure 4.27). Trench 2 is 10 m south of the sewer line, its western end lies on the H transect and extends east for three m. Each excavation was excavated in 10 cm levels, soil removed from the units was screened through 1/4 inch mesh, and a total of almost 9.8 m^3 soil was excavated. Bedrock impasse was the reason for all units' termination. The soil was a dark brown clayey loam in the top 10 cm, below that soil turned into a dark brown clay loam for another 10 cm. Then, the soil turned into a red ash layer that extended for about 15 cm. After the red ash was the cultural layer, about 20 cm of dark grey brown clay loam. Lithic artifacts recovered during test excavations included four adzes, three adze preforms and only 46 pieces of debitage.

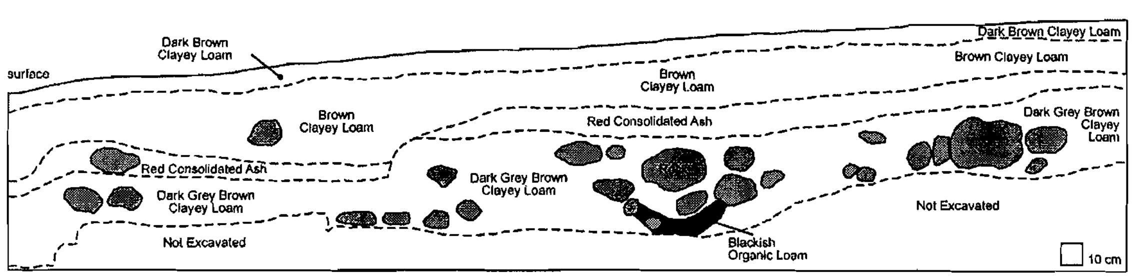

Figure 4.27. Soil profile for Trench 1 from the Pavaiai P6 Site.

Kokoland M2 Site (AA-2006-6-4)

The Kokoland M2 Site is a Polynesian Plainware pottery deposit located immediately north of Kokoland (See Fig. 4.23). The deposit was encountered during construction of the same underground sewer line, and my investigation was an attempt to uncover adze manufacturing activities associated with earlier time period. A three by three m excavation pit was dug down 90 cm to the top of the deposit, so two one by one excavation units could be placed within the cultural stratum. The cultural stratum was dated to 2154 +/- 38 BP, which places the deposit firmly in the Plainware period (^{14}C sample no. 19504). Each excavation unit was excavated in 10 cm levels, soil removed from the units was screened through 1/4 inch mesh, and a total of almost .7 m^3 soil was excavated. The cultural layer was covered by a consolidated ash layer that had capped the site (Figure 4.28). The soil was a medium brown clay in the top 22 cm, below that soil turned into a light brown clay for another 13 cm. The substantial amount of ceramics recovered is currently being analyzed by Dr. David Addison of the American Samoan Community College. For the purposes of my dissertation, the lithic artifacts recovered during test excavations only included two adzes, one flake tool and 71 waste flakes.

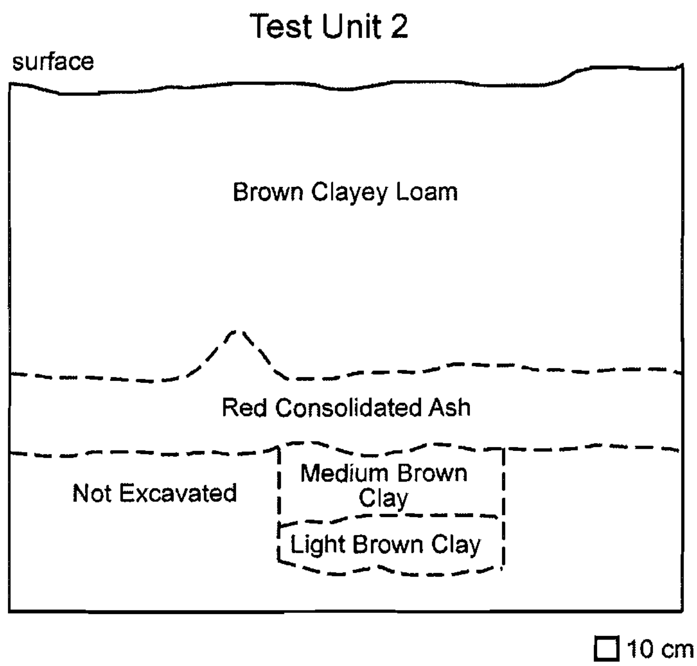

Figure 4.28. Soil profile for the Kokoland M2 Site.

Vaipito Valley

Vaipito is a large coastal valley is found southwest of Pago Pago (Figure 4.29), where the Vaipito Stream, Leau Stream, and Vaima Stream all meet up and runoff into Pago Pago Harbor. Two mountains overlook this site, Fatifati Mountain to the north at 370 m and Palapalaloa Mountain to the south at 470 m. Vaipito bedrock is comprised of Pago Volcanics which are olivine basalts (Stearns 1944). The soil here includes Aua very stony silty clay loam and the Urban land-Aua-Leafu complex (Nakamura 1984). The Aua soil consists of a very deep, well drained soil found on talus slopes. This soil type, located in the highlands of the Vaipito valley, exist from about 70 to 135 m. The Urban land-Aua-Leafu complex is a mixture of urban land, the Aua soil series, and Leafu silty clay and lies closer to sea level in the Vaipito valley from about 70 m above sea level down to the coast. The nearest modern settlement, Pago Pago, lies about two km northeast of Vaipito.

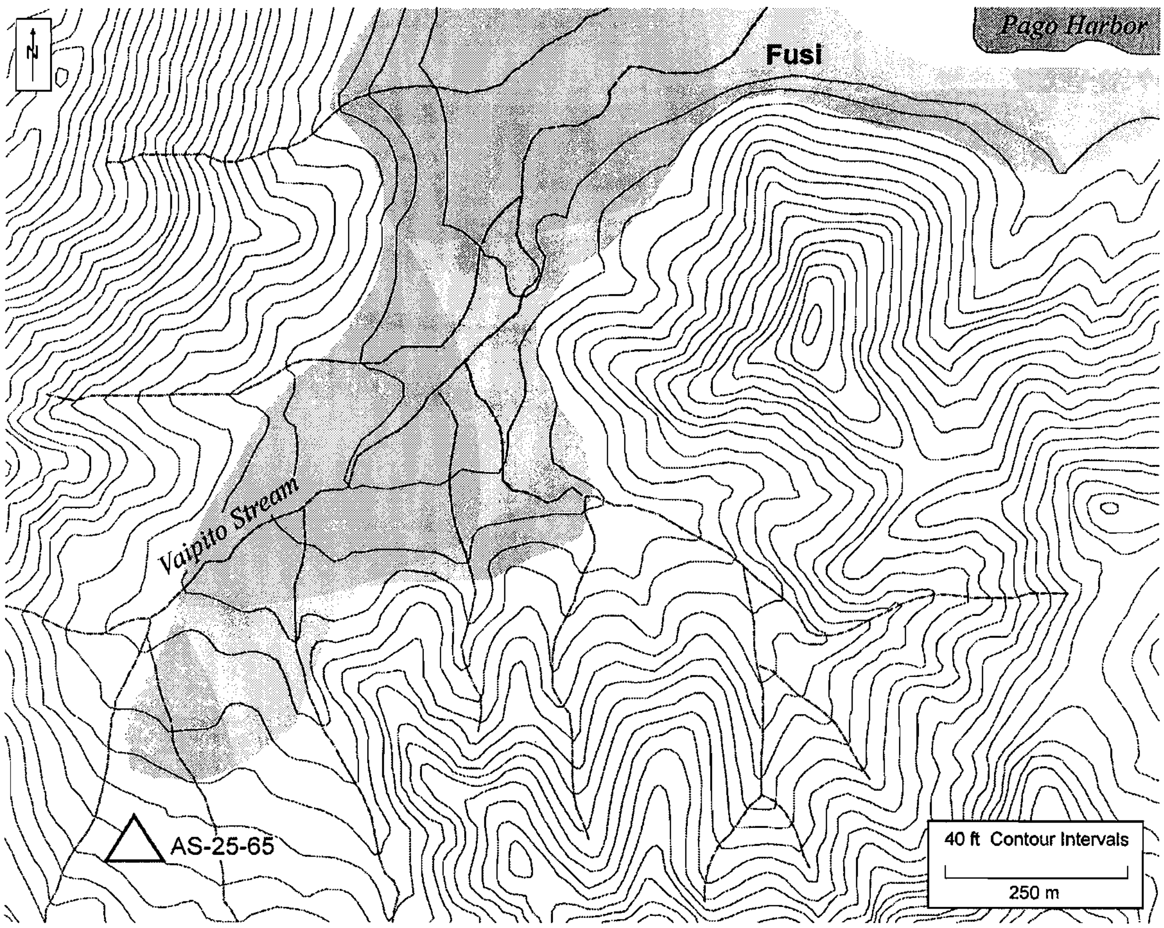

Figure 4.29. Map of Vaipito valley showing the location of site AS-25-62.

AS-25-62

AS-25-62 is a lithic manufacturing terrace located in the far back of Vaipito valley (Figure 4.30). The terrace is approximately 70 by 20 m and lies 120 m above sea level. The terrace surface is covered by grasses providing a low surface visibility (10 to 25 percent). AS-25-62 contained a dense surface scatter in the eastern portion of the terrace. Peripheral subsurface disturbances were noted at the terrace, comprised of a mechanically cut bank along its southern edge. The site's lithic assemblage was analyzed because of the high concentration of lithic debris, little was known about adze production in central Tutuila, and an uncalibrated ^{14}C date of 680 BP +/- 35 BP (sample no. 12992) was recovered in Layer III in association with the flaking activities. In February of 2003, archaeologists from the Archaeological Division of the American Samoan Power Authority extensively excavated at the terrace. Lithic artifacts recovered and analyzed came from Layer III of Test Units 3, 4, 11, 12, 13, 16, 17, 18 and 19, and include eight adze preforms, four flake tools, six adze flakes and 2,366 pieces of debitage.

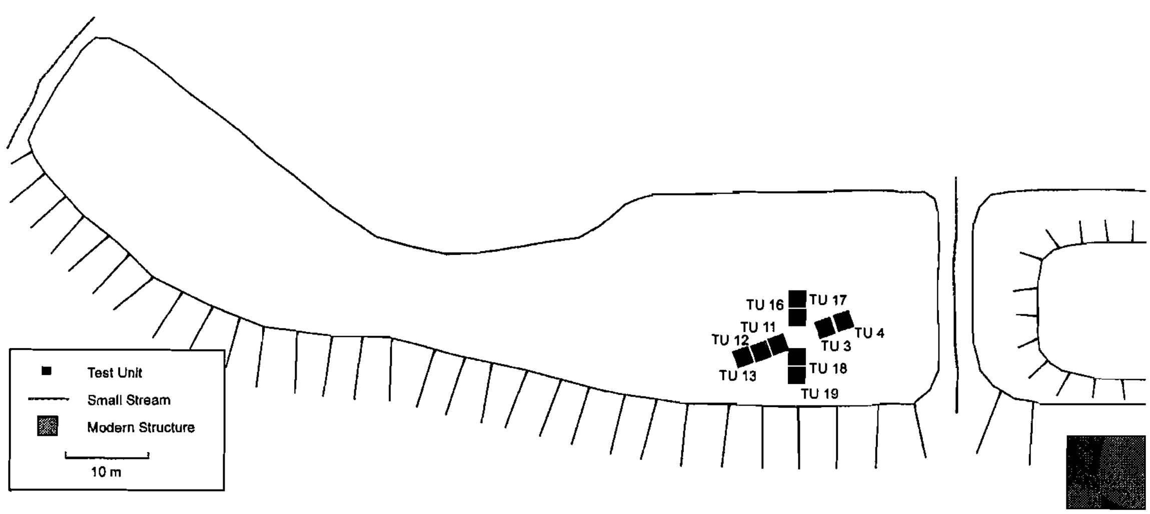

Figure 4.30. Plan view of Site AS-25-62

Auto Valley

Auto valley is found on the coast of the eastern side of Tutuila near the mouth of Fagaitua bay (Figure 4.31). The fairly flat coastline rises quickly to steep slopes away from the coast. Muliolevai stream runs out of the mountains into Fagaitua bay just to the north of Auto Villlage. Palapala Mountain rises to the northwest at about 395 m. The bedrock of Auto is made up of the Pago volcanic olivine basalts (Stearns 1944). Auto soil includes Urban land-Aua-Leafu complex, Urban land-Ngedebus complex, Aua very stony silty clay loam, and Fagasa family-Lithic Hapludolls-Rock outcrop association (Nakamura 1984). Investigations were made in this valley to ascertain the type of adze manufacturing occurring in eastern Tutuila.

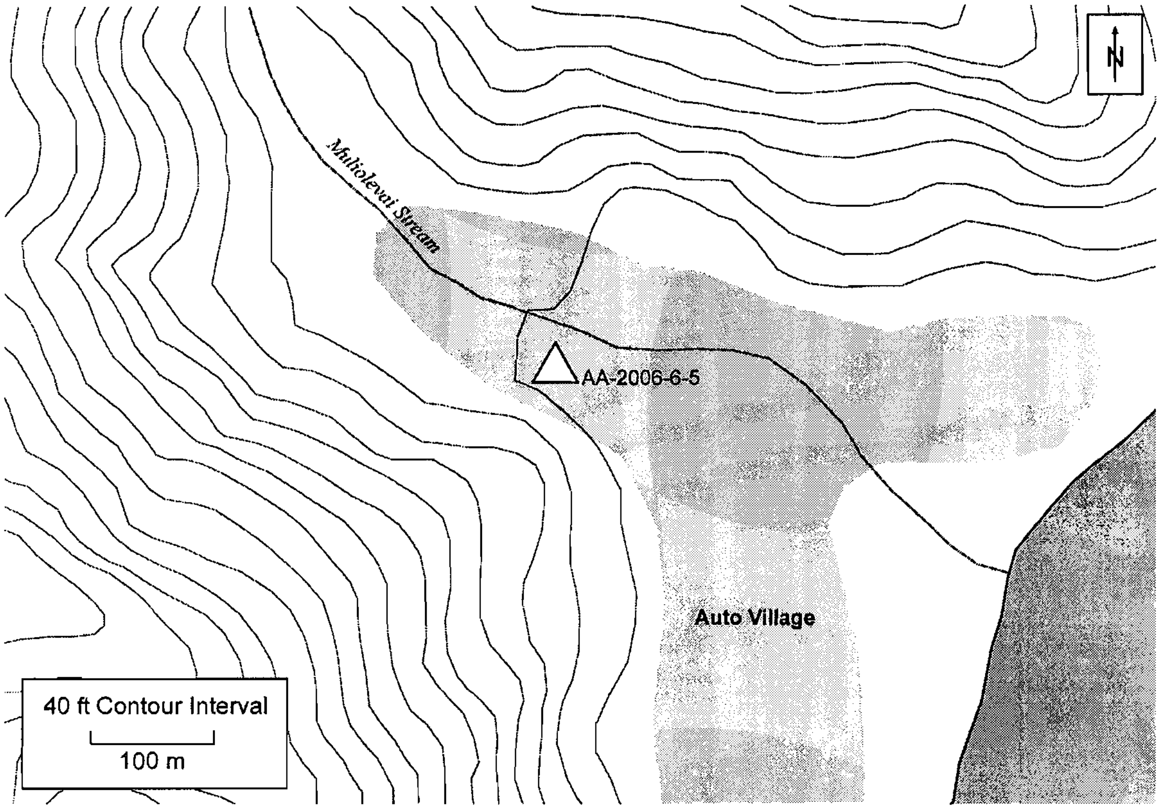

Figure 4.31. Map of Auto valley showing the location of archaeological investigations.

Auto Septic Terrace (AA-2006-6-5)

A five by five m flake scatter is located in the back of Auto valley near a residential structure. Next to a gravel driveway, the scatter was small and sparse (Figure 4.32). The site was excavated in part to investigate eastern Tutuila manufacturing sites as well as to provide an example of small production locales in the continuum of the total variation of craft production activities.

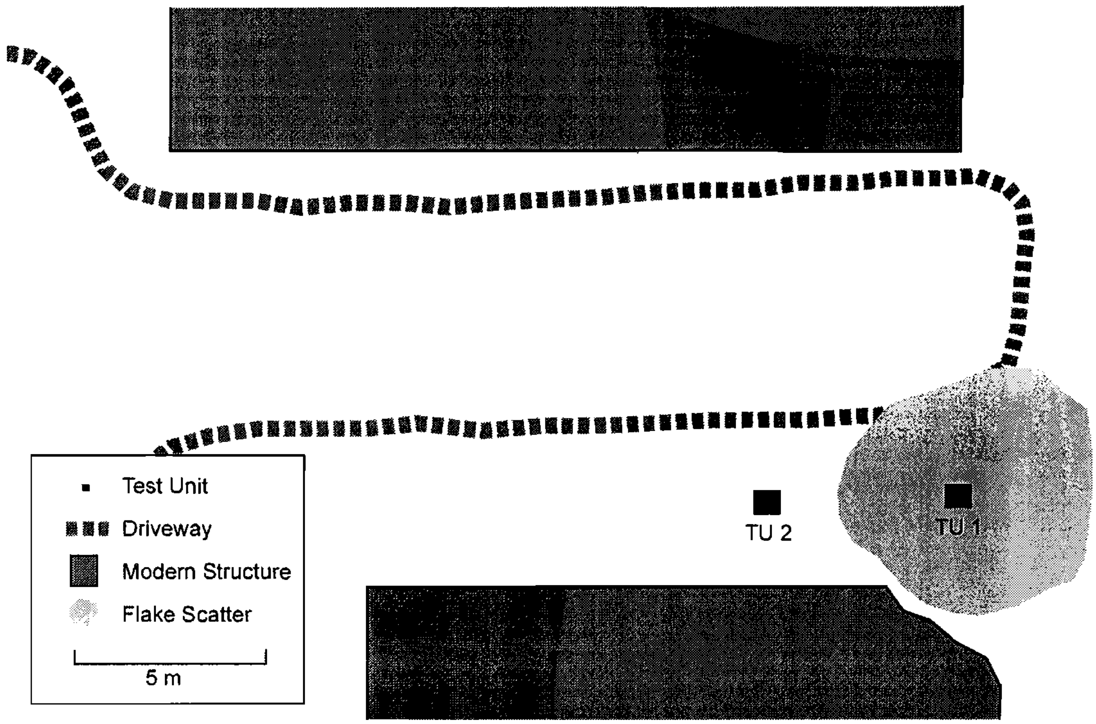

Figure 4.32. Plan view of the Auto Septic Terrace.

On July 15, 2006, two 50 by 50 cm test units were excavated. TU 1 was located in the center of the flake scatter near a cement pad from a demolished house. TU 2 was placed 5 m west of TU 1 outside of the flake scatter. Units were excavated in 10 cm levels, soil removed from the unit was screened through 1/4 inch mesh, and a total of .48 m^3 soil was excavated (Figure 4.33). Culturally sterile soil in the bottom two levels was the reason for the units' termination. In the test units, dark brown sandy loam in the top sixty cm overlaid by tan and brown beach sand. Artifacts recovered during excavation were one finished adze, four adze preforms, two flake tools and a total of 612 pieces of debitage.

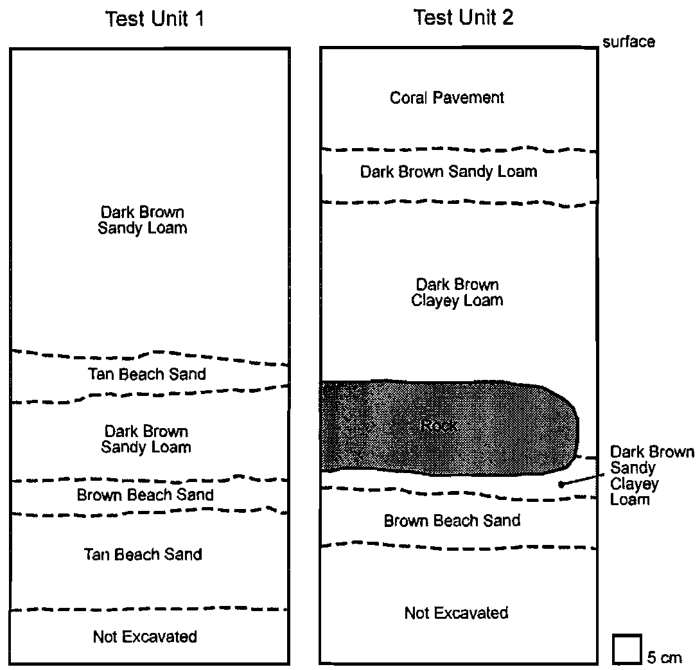

Figure 4.33. Soil profiles for test units from the Auto Septic Terrace.

Tula Valley

Tula is a coastal valley located on the very eastern side of Tutuila (Figure 4.34). The valley floor is relatively flat with the Vailoa Stream running through and emptying into the ocean. Olomoana Mountain lies to the southwest at 345 m above sea level. The bedrock here contains Olomoana Volcanics (Stearns 1944). Tula soil contains Urban land-Ngedebus complex, Aua very stony silty clay loam, Fagasa family-Lithic Hapludolls-Rock outcrop association, and Leafu stony silty clay loam (Nakamura 1984). The Aua soil, distinguished as a very deep, well drained soil lies at 215 m above sea level and below. The Fagasa family is mostly steeply sloped ridges and mountainsides found more towards the inner part of the island. The Urban land-Aua-Leafu complex, a mixture of urban land, the Aua soil series, and Leafu silty clay lies closer to sea level. Leafu silty clay, characterized as very deep somewhat poorly drained soil, is found on valley floors derived from igneous rock.

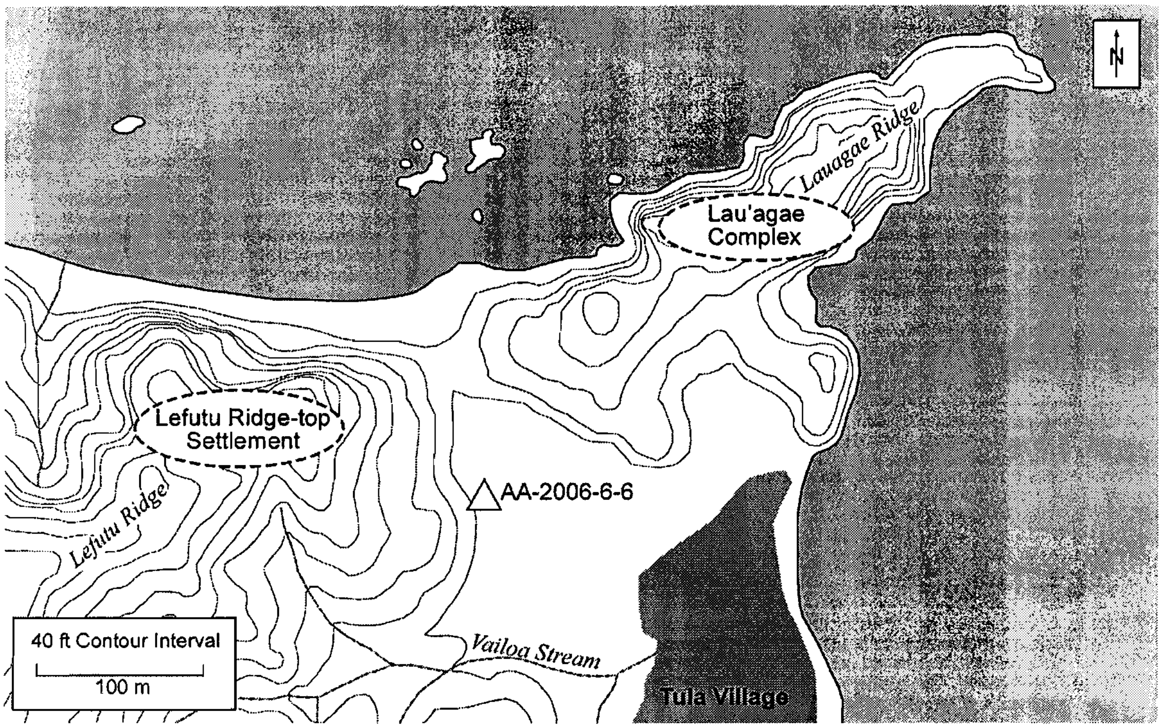

Figure 4.34. Map of Tula valley showing the locations of archaeological sites.

Tula Septic Terrace (AA-2006-6-6)

AA-2006-6-6 is a lithic manufacturing terrace associated with a larger ridgeline complex, most probably the site of the prehistoric Tula village, called Lefutu (Frost 1978; Pearl 2004; See Fig. 4.34). The 35 by 250 m site rests 20 m above sea level, and is located in a present day plantation and house lot with high surface visibility (80 to 100 percent). The Tula Septic Terrace contains three substantial lithic scatters at the western, eastern and northern edges of the terrace (Figure 4.35). Considerable disturbances were noted, including subsurface disturbances from a gravel driveway, modern house construction and mechanical grading.

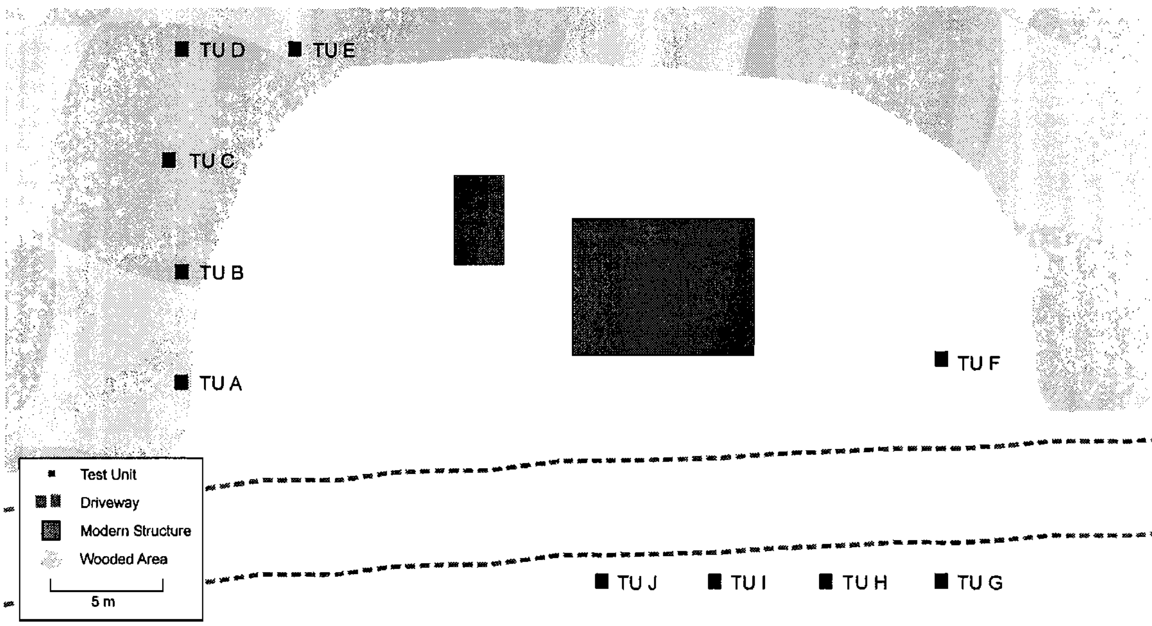

Figure 4.35. Plan view of the Tula Septic Terrace.

On July 21, 2006, 10 50 by 50 cm test units were excavated at the site. Test units A to D were located in the far east portion of the terrace in five m intervals along a north-south transect on a recently scraped area covered with water-worn pebbles (*ili ili*), coral, and lithic scatter. TU E was situated on a cobble scatter in between two coral fragment scatters in the western portion of the eastern terrace. TU F was placed south of the driveway in a flake scatter disturbed by mechanical grading along the terrace's western edge. Test units G to F were placed in the northern portion of the terrace at five m intervals over a flake scatter. Each test unit was excavated in 10 cm levels, soil removed from the probes was screened through 1/4 inch mesh, and a total of .95 m^3 soil was excavated. The average depth for the probes was 38 cm. Rock impasse was the reason for all units' termination. The soil was a dark brown clayey loam in the top 15 to 45 cm, below that clay content increased and soil color changed to reddish brown. Artifacts recovered during test excavations include seven finished adzes, 35 adze preforms, 15 flake tools, nine adze flakes and 1,492 pieces of debitage.

After summarizing the manufacturing sites investigated for my research, the following chapter delves into the methods and results of analyses performed on the recovered lithic assemblages. These data coupled with the above mentioned site contexts will be the basis for answering my research questions in Chapter VI.

CHAPTER V

LITHIC AND GEOCHEMICAL ANALYSES OF SAMOAN ADZE PRODUCTION: METHODS AND RESULTS

The following chapter reviews the methods of analyses used to study artifact assemblages recovered from the 17 archaeological sites on Tutuila, described in the last chapter, and summarizes their results. The first section reviews the mass flake analysis conducted on waste flake assemblages. I collected data on the size and stage groupings for a total of 181.19 kg of debitage. Next, the collected 27 finished adzes were measured, weighed and classified according to Green and Davidson's typology (1969b). Using the same typology, 115 preforms were typed accordingly to their expected finished counterparts, but were additionally classified as possible because of the preform's state of incompletion. Also, adze preforms from five sites were selected and further evaluated based on the reasons for their rejection in the manufacture process. Additionally, I examined non-formal tools by classifying 76 flake tools according to Clark's typology (Clark et al. 1998). Finally, 75 basalt samples are chemical characterized for provenance purposes using Wave-Dispersive X-Ray Fluorescence.

Methods of the Debitage Analysis

There are two theoretical observations about stone tool manufacture that are integral in documenting reduction sequences (Ahler 1989). First, the process is reductive, in that flakes struck from an original rock cannot be greater in mass than the original piece (Newcomer 1971). The controlled subtraction of mass during manufacture thus allows for efficient size-grading of waste flakes into categories reflective of production strategies. Second, there is a progressive removal of cortex in most stone tool production (Ahler 1989). Cortex is the visible rind on raw materials that is produced during the oxidization of elements within the stone from ambient oxygen in the environment. The cortex's weak physical composition makes its removal important for standardized tool strength and routinely was removed during initial flaking as a result.

These two simple observations, visible in lithic producing behaviors around the world, are also evident in adze manufacture in Samoa. In light of these two observations and the level of detail needed to document reduction strategies in Samoan adze production, it was important to choose an analytical method which not only addresses these two issues, but also one which can be utilized across assemblages for purposes of comparison. Currently, there are two dominant forms of lithic analysis. Individual flake analysis examines every flake in terms of its morphology and diagnostic characteristics to identify activity patterns. Mass flake analysis examines not individual flakes, but groups an assemblage quantitatively along one or more specific characteristics such as size or weight to determine past activities (Andrefsky 2007; Bleed 2001; Bradbury and Carr 1999; Magne 2001; Odell 2000, 2001; Rozen and Sullivan 1989a, 1989b; Steffen et al.

1998; Turner 2004; Turner and Bonica 1994). With over 180 kg of debris recovered from data collection, mass flake analysis was determined to be optimal for this project. While being efficient, it also provides compositional information vital in determining what activity stage of a larger reduction sequence was conducted within an assemblage. The particular version utilized for this dissertation documents the entire collected assemblage by the flakes' size and amount of cortex on the dorsal surface of flakes.

Size Category

The assemblage was first separated into five distinct size grades using a series of concentric circles (Figure 5.1). Size was chosen as the initial criteria due to its ability to indicate particular patterning in the reduction process (Ahler 1989), and although weight has been used elsewhere with success (Turner and Bonica 1994), the sheer amount of lithics would have made this too time consuming. Once sorted by size, the assemblages were then weighed, counted and entered into a database.

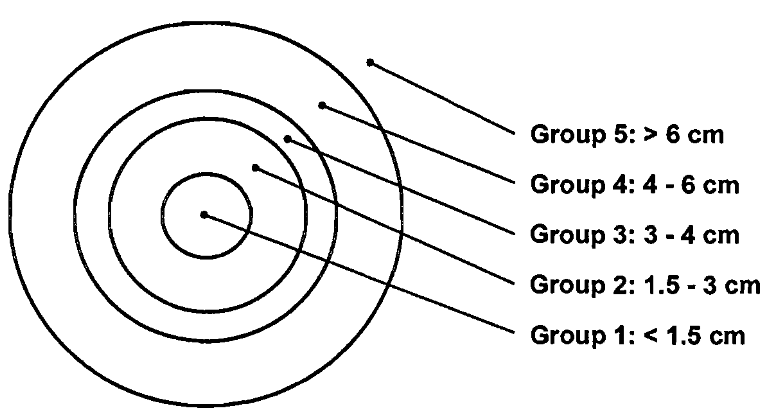

Figure 5.1. The size grouping used in the mass flake analysis.

Group 5 flakes are indicative of initial core reduction as well as the roughing out of blanks (Leach and Witter 1987). This is attributed to the overall size and mass of the flake, which is linked to the initial size of its parent material. Further, Group 5 flakes are thought to have a higher frequency in and around areas associated with quarries (Turner and Bonica 1994). Group 4 flakes are associated with the further reduction of blanks into preforms. The grouping's smaller overall size compared to group 5 is a reflection of the size of the blank from which it was struck, although, according to Turner and Bonica (1994), this group's placement in the reduction sequence depends largely on the presence and amount of dorsal cortex. Based on flake scar measurements on adze preforms from this study, Group 3 flakes mark the beginning of preform production and a departure from an initial roughing reduction strategy. Group 2 flakes are similar in nature to those in Group 3. The smaller flake size is associated with more of the final stage in preform production. Flakes exhibiting this size with no cortex indicate a shift towards fine trimming. Portions of preforms that interfere with the optimal overall shape for a finished adze would have been flaked off at this stage. Group 1 flakes are thought to be the final stage of bevel creation and fine trimming in preform production. While flakes falling into this category were sometimes fragmentary and can be attributed to shatter or termination/distal fracture, enough complete flakes were present allowing for an assignment to final trimming.

Dorsal Surface Category

To support the size grade data, dorsal surface characteristics were also analyzed. Because the presence of cortex on the dorsal surface of a flake is important in determining what stage of production the flake came from, each size class were further separated based on the dorsal surface characteristics. Utilizing Turner and Bonica's classification scheme (1994), flakes were grouped into three categories based on prevalence of cortex and the number of flake scars present on their dorsal surface (Figure 5.2). Flakes exhibiting cortex that had two or fewer flake scars were classified as primary, those exhibiting cortex in conjunction with more than two flake scars were deemed secondary. Flakes exhibiting no cortex were categorized as tertiary. This hierarchy was adhered to for size groups 2 to 5. The exception, Group 1 flakes, was simply identified based on the presence or absence of cortex on their dorsal surface, because their small flake scars could not reliably be identified.

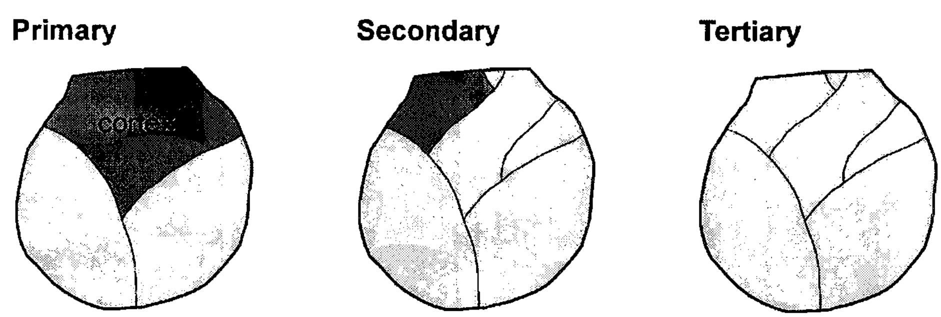

Figure 5.2. The stage grouping used in the mass flake analysis.

Results

Utilizing these two parameters, I analyzed the assemblages from 16 production centers. The results of the analysis are presented in following table (Table 5.1). The grouping results are listed as percentages of each assemble. For the purposes of comparable units of measure, each site's debitage is listed by the excavation unit recovered in to identify spatially-segregated activities occurring at the site. By utilizing the excavation unit as the standard in analysis, it allowed for discrete flake scatters to be analyzed separately and ease in compiling density measures for sites.

Table 5.1. Size and stage summary for debitage assemblages at archaeological sites.

Provenance	Weight	Group1	Group 2	Group 3	Group 4	Group 5	Primary	Secondary	Tertiary
Fagamalo Valley									
TU 2	2993.3 g	.1 %	19.6 %	29.5 %	28.7 %	22.1 %	9.0 %	9.2 %	81.8 %
Afao Valley, AA-2005-01									
TU 18	233.8 g	.1 %	13.3 %	25.2 %	41.4 %	20.0 %	.0 %	9.0 %	91.0 %
TU 19	22.4 g	5.8 %	79.0 %	15.2 %	.0 %	.0 %	.0 %	.0 %	100.0 %
TU 20	285.5 g	4.8 %	65.4 %	21.9 %	7.8 %	.0 %	2.0 %	3.7 %	94.3 %
TU 21	89.6 g	1.1 %	55.7 %	22.8 %	20.4 %	.0 %	6.7 %	2.2 %	91.1 %
Afao Valley, AA-2005-02									
TU 17	176.6 g	.1 %	14.1 %	10.0 %	41.0 %	34.8 %	.0 %	2.5 %	97.5 %
Tataga Matau, Star Mound Terrace - Layer B									
TR 1	17,727.1 g	.0 %	1.7 %	4.3 %	10.5 %	83.5 %	40.0 %	35.8 %	24.2 %
Malaeloa Valley, AS-32-13a									
TU 1	134.3 g	.0 %	.0 %	6.4 %	38.0 %	55.5 %	3.1 %	41.3 %	55.5 %
TU 2	497.6 g	1.9 %	26.1 %	21.6 %	13.4 %	37.0 %	5.5 %	15.0 %	79.5 %
TU 3	214.6 g	.6 %	21.3 %	23.7 %	22.6 %	31.8 %	1.3 %	45.7 %	53.0 %
TU 4	17.2 g	.0 %	14.0 %	19.8 %	66.3 %	.0 %	.0 %	.0 %	100.0 %
Malaeloa Valley, AS-32-13b									
TU 6	5279.3 g	1.0 %	17.2 %	18.7 %	29.2 %	34.0 %	5.8 %	26.3 %	67.9 %
TU 7	6677.2 g	.6 %	22.3 %	19.1 %	35.4 %	22.5 %	12.8 %	17.3 %	70.0 %
TU 8	4425.0 g	1.4 %	18.5 %	19.1 %	46.4 %	14.7 %	5.2 %	20.6 %	74.3 %
EU 1	33,161.4 g	1.2 %	28.2 %	22.5 %	32.8 %	15.3 %	10.0 %	16.3 %	73.7 %
Malaeloa Valley, AS-32-11									
TU 9	30,113.3 g	5.2 %	31.7 %	28.4 %	28.4 %	6.3 %	9.8 %	13.7 %	76.6 %
TR 12	9436.0 g	3.5 %	30.9 %	18.1 %	32.8 %	14.6 %	10.2 %	14.1 %	75.7 %
Malaeloa Valley, AS-32-15									
TU 11	1666.5 g	.7 %	11.2 %	11.9 %	24.1 %	52.1 %	11.4 %	45.2 %	43.4 %

Table 5.1 (cont). Size and stage summary for debitage assemblages at archaeological sites.

Provenance	Weight	Group1	Group 2	Group 3	Group 4	Group 5	Primary	Secondary	Tertiary
Malaeloa Valley, AS-32-7									
TU 1	10,358.0 g	2.0 %	30.4 %	24.4 %	35.9 %	9.1 %	9.4 %	11.1 %	79.6 %
TU 3	10,965.4 g	.4 %	25.7 %	24.4 %	36.2 %	13.3 %	7.9 %	15.4 %	76.8 %
Malaeloa Valley, AS-32-6-F4									
TU 2	7321.9 g	7.7 %	41.2 %	19.6 %	23.3 %	8.2 %	3.8 %	8.8 %	87.4 %
TU 3	2005.9 g	6.6 %	36.2 %	30.6 %	15.6 %	11.0 %	2.1 %	11.7 %	86.2 %
Pavaiai Village, AA-2006-6-2									
EU 1	7457.7 g	5.3 %	47.5 %	28.1 %	18.1 %	1.2 %	4.2 %	5.5 %	90.3 %
EU 2	361.9 g	.3 %	14.5 %	16.0 %	48.1 %	21.2 %	4.0 %	15.3 %	80.7 %
EU 3	3346.2 g	2.6 %	23.8 %	31.8 %	39.1 %	2.6 %	3.3 %	10.6 %	86.1 %
Pavaiai Village, AA-2006-6-3									
TR 1	38.8 g	.8 %	14.4 %	20.9 %	63.8 %	.0 %	38.9 %	29.0 %	32.1 %
TR 2	64.6 g	1.8 %	19.0 %	13.0 %	12.4 %	53.8 %	3.5 %	.0 %	96.5 %
Kokoland, AA-2006-6-4									
TU 1&2 (*minus STP 1*)	280.5 g	.9 %	16.4 %	16.1 %	58.7 %	7.9 %	12.1 %	18.9 %	69.0 %
VaipitoValley, AS-25-62 - Layer III:									
TU 3	925.9 g	.6 %	22.1 %	23.3 %	45.4 %	8.6 %	4.1 %	14.4 %	81.5 %
TU 4	1341.7 g	.3 %	25.4 %	22.3 %	43.4 %	8.7 %	.6 %	11.8 %	87.6 %
TU 11	1830.3 g	.2 %	13.6 %	17.8 %	34.2 %	34.3 %	5.6 %	15.2 %	79.2 %
TU 12	1762.6 g	.2 %	13.3 %	16.4 %	33.2 %	36.9 %	15.0 %	16.0 %	69.0 %
TU 13	170.5 g	.1 %	1.2 %	15.0 %	44.1 %	39.6 %	.2 %	28.8 %	71.0 %
TU 16	2448.5 g	.0 %	10.5 %	21.6 %	49.7 %	18.2 %	7.0 %	10.4 %	82.6 %
TU 17	2059.7 g	.3 %	17.4 %	26.4 %	39.0 %	16.9 %	6.1 %	13.7 %	80.2 %
TU 18	993.1 g	.0 %	1.5 %	20.0 %	33.4 %	45.1 %	16.6 %	11.4 %	72.0 %
TU 19	1206.9 g	.0 %	3.8 %	10.0 %	34.3 %	51.8 %	14.7 %	16.7 %	68.6 %

Table 5.1 (cont). Size and stage summary for debitage assemblages at archaeological sites.

Provenance	Weight	Group1	Group 2	Group 3	Group 4	Group 5	Primary	Secondary	Tertiary
Auto Valley, AA-2006-6-5									
TU 1	2773.8 g	.4 %	13.7 %	22.4 %	45.2 %	18.4 %	26.6 %	22.4 %	51.0 %
TU 2	1810.2 g	.4 %	25.7 %	22.4 %	36.2 %	13.3 %	36.1 %	18.6 %	45.3 %
Tula Valley, AA-2006-6-6									
TU A	2022.5 g	.1 %	3.5 %	10.7 %	29.5 %	56.2 %	22.7 %	15.4 %	61.9 %
TU B	931.6 g	1.3 %	11.6 %	9.4 %	46.5 %	31.3 %	30.8 %	10.5 %	58.7 %
TU C	1045.4 g	1.6 %	21.4 %	8.9 %	22.9 %	45.1 %	21.9 %	2.5 %	75.6 %
TU D	266.2 g	.6 %	8.1 %	5.5 %	35.5 %	50.3 %	.3 %	.0 %	99.7 %
TU E	64.2 g	7.4 %	50.3 %	29.4 %	12.9 %	.0 %	.0 %	.0 %	100.0 %
TU F	509.1 g	.1 %	15.9 %	15.9 %	44.2 %	23.9 %	32.7 %	10.6 %	56.7 %
TU G	884.1 g	2.6 %	22.4 %	15.8 %	29.5 %	29.8 %	5.1 %	31.3 %	63.6 %
TU H	891.9 g	.9 %	10.3 %	17.5 %	33.5 %	37.8 %	16.6 %	13.8 %	69.6 %
TU I	526.9 g	.6 %	10.5 %	16.6 %	43.9 %	28.4 %	4.3 %	18.2 %	77.5 %
TU J	1378.1 g	3.0 %	27.4 %	21.4 %	21.5 %	26.7 %	21.8 %	14.4 %	63.7 %

Samoan Adze Classification

This section focuses on the classification of the formal stone tools found during investigation. The typology utilized was created by Roger Green and Janet Davidson (1969b) as a revision of Buck's earlier version (1930). This typology, left unrevised since then, divides the adze assemblage into 10 types which share statistically significant measurements, morphological features and final grinding (See Fig. 2.7). In the newer typology, the basic distinctions among the types are as follows. Type I adzes have a flat trapezoidal cross-section that narrows front to back where the bevel is short and the final grinding occurs mainly along the bevel and front. Type II is defined as a quadrangular adze form, but has a pentagonal cross-section due to the bifacial reduction along its sides. With a short bevel, Type II also tends to be ground only along its front and bevel. Type III adzes are small, more rectangular adzes that are fully ground, except for their unfinished poll. Type IV and V are adzes with plano-convex cross-sections and are fully ground; the Type IV has a convex back and Type V has a convex front. Due to the scarcity of Type IV adzes, this type may simply be a variant of Type V adzes with the bevel location reversed to the back. Also, Type V adzes have a rounded cutting edge. Type VI, VII and VIII are triangular adzes with varying amounts of grinding. Type VI adzes have the apex of the triangle towards the front and are relatively similar in width versus thickness. Type VII adzes also have their apex to the front, but their thickness far exceeds their width. Type VIII consists of triangular adzes with the apex towards the back of the adze, and can either be extensively ground or crudely flaked. Type IX is a thick quadrangular adze, similar to Type I, but with the thickness nearly equal to their width. Type X adzes are very similar to Type III, because this type is both small and fully ground. The difference lies in that Type X adzes are as thick as they are wide.

Results

From my investigation of archaeological sites on Tutuila, there were 27 classifiable adzes – either whole, broken or fragmented - recovered with seven types present; Types I, II, III, V, VII, VIII and X (Table 5.2.). Thirteen adzes were excavated from test units, while 14 were collected in pedestrian survey. The adze type with the greatest frequency was type I (n=14) and least frequent type recovered was only one type III and one type VII. Six adzes are commonly associated with the Polynesian Plainware period consisting of Type V and VII, and present a picture of deep time depth in the recovered assembles.

In addition to the adzes forms defined in current typology, an additional wood-working form was also observed. After evaluating whether to create a new type to account for the form, it was determined to not be an adze, but a chisel based on morphological attributes discussed by Buck (1930:364-367). As only one was recovered in completed form, further consideration was deemed unnecessary for the purposes of this research. The following table lists the provenance, type, and morphological attributes for each basalt adze.

Table 5.2. Basalt adzes recovered during archaeological investigations.

Site	Context	Type	Status	Length	Width	Thick	Wt
AA-2005-1	TU 20, L 1	I	poll	37.7	36.6	19.4	54.1
AA-2005-1	surface	I	bevel & mid	89.4	36.6	11.3	68.2
AS-32-6-F4	EU F3, L 6	I	poll	51.0	46.3	18.3	88.4
AS-32-7	surface	I	bevel & mid	47.9	35.9	18.6	66.2
AS-32-7	surface	I	poll & mid	60.4	36.0	20.0	73.5
AA-2006-6-2	TU Y, L 3	I	bevel	48.1	46.5	19.0	73.6
AA-2006-6-3	TU 2Z, L 1	I	bevel	62.6	40.2	19.5	91.6
AA-2006-6-5	surface	I	midsection	52.9	33.8	13.5	45.6
AA-2006-6-6	TU H, L 1	I	fragment	42.6	34.5	20.2	56.7
AA-2006-6-6	TU D, L 1	I	fragment	48.1	37.2	22.5	61.2
AA-2006-6-6	surface	I	poll & mid	107.2	37.1	19.2	134.9
AA-2006-6-6	surface	I	poll	47.4	42.2	19.2	48.1
AA-2006-6-6	TU F, L 2	I	poll	32.9	34.2	18.9	43.7
AA-2006-6-6	surface	II	complete	88.9	41.7	23.0	103.1
AA-2006-6-6	surface	II	poll & mid	65.0	45.6	24.1	115.1
AA-2005-1	surface	III	bevel	33.1	24.2	9.3	16.8
AS-32-7	surface	V	bevel & mid	65.1	39.0	25.2	110.8
AS-32-7	surface	V	fragment	40.8	25.5	30.6	47.6
AA-2006-6-3	TR 2, Strat A/B	V	midsection	52.5	37.2	27.0	95.9
AA-2006-6-3	TU 4E, L 7	V	bevel	32.8	31.2	21.0	30.9
AA-2006-6-4	TU 1, L 1	V	poll	38.2	43.9	22.0	44.2
AA-2006-6-3	TU 2E, L 6	VII	complete	201.8	55.8	35.0	?
AS-32-17	surface	VIII	bevel	25.6	33.9	14.0	20.7
AS-32-7	surface	VIII	bevel	44.7	45.5	23.2	54.7
AS-32-13a	TU 1, L 3	X	bevel & mid	69.9	30.8	23.3	101.9
AA-2006-6-4	T 1, 60 cmbs	X	complete	100.2	36.2	21.8	137.8
AS-32-13a	surface	chisel	bevel	36.5	26.8	12.9	27.2

Samoan Preform Classification

For one reason or another, adze producers were not always successful, and as a result 108 discarded adze and seven chisel preforms were collected during investigations. As preforms represent a stage in the process of manufacturing a finished tool, the Green and Davidson typology can be employed with a few modifications. The first modification is to amend all typological classification with a caveat of "possible". Although they were completed to a point of making a typological determination, the lack of grinding makes more specific classifications risky. The second change is to add another designation for collected specimens that had been discarded even earlier in the manufacture process and thus making it more difficult to classify them. Here, these crude preforms were typed based on their cross-section -- quadrangular and triangular. The third modification is that I have included worked flake blanks as preforms, because these samples all had additional flaking on their surfaces before they were rejected. These flake blanks/preforms are also classified as quadrangular or triangular depending on their cross-section. These additional designations of crude preforms and flake blanks were included in this study, because of their ability to illuminate production trends.

For example, when only examining the "possible" typed preforms, triangular adzes compose 45 percent of adze production. But when including the crude preform category, the number decreases to 30 percent, and the flake blank category has 59 percent triangular forms. These results call attention to three interesting observations. First, triangular flake blanks were either easier to break than quadrangular forms, or selection at this earlier period may have been more rigorous. Second, the success of triangular adze manufacture in the crude preform category compared to quadrangular forms could be a result of the ease of bidirectional flaking, versus bimarginal, utilized during this stage. Third, the discard rate closer to the final stage of flaking creates a similar pattern between the two basic types. So, by adding these additional categories, a more robust picture can be developed.

Figure 5.3. Basalt adze preforms recovered during archaeological investigations.

Site	Context	Type	Status	Length	Width	Thick	Wt
AS-32-13b	EU 1, L 2	possible I	poll	64.8	36.0	24.4	84.0
AS-32-13b	EU 1, L 1	possible I	bevel	42.5	66.2	18.5	62.1
AS-32-13b	TU 7, L 1	possible I	poll & mid	65.3	50.3	18.2	109.4
AS-32-13b	TU 7, L 2	possible I	bevel	48.8	65.8	23.6	119.2
AS-32-6-F4	TU F3, L 1	possible I	midsection	56.0	53.0	23.6	122.4
AS-32-7	surface	possible I	bevel & mid	81.1	36.8	20.2	76.3
AS-32-7	TU 1, L 1	possible I	complete	88.4	37.5	16.7	84.6
AS-32-7	surface	possible I	bevel & mid	53.1	32.1	19.8	53.4
AS-32-7	surface	possible I	bevel	73.2	55.9	29.0	165.7
AS-32-7	surface	possible I	poll & mid	76.3	41.2	13.2	63.4
AS-32-7	surface	possible I	complete	76.7	36.7	29.5	87.5
AS-32-7	surface	possible I	bevel & mid	67.6	39.8	18.9	74.2
AS-32-11	TU 9, L 3	possible I	bevel	48.1	32.6	19.1	44.7
AA-2006-6-3	TU 2V, L 7	possible I	poll & mid	55.7	40.0	18.4	79.9
AA-2006-6-5	TU 1, L 1	possible I	bevel & mid	79.5	40.0	20.5	110.3
AA-2006-6-6	TU J, L 1	possible I	midsection	34.7	43.1	22.3	54.5
AA-2006-6-6	surface	possible I	bevel	42.6	31.7	15.2	42.5
AS-32-13b	surface	possible II	poll & mid	89.0	57.5	16.6	127.1
AS-32-7	surface	possible II	complete	76.5	43.4	28.3	110.2
AS-32-11	TU 12, L 1	possible II	complete	80.2	37.5	26.9	95.1
AS-32-11	surface	possible II	complete	82.4	43.5	21.5	91.2
AA-2006-6-6	TU A, L 1	possible II	midsection	40.5	49.8	19.1	66.3
AA-2006-6-6	surface	possible II	poll & mid	63.4	42.6	17.2	67.0
AA-2006-6-6	surface	possible II	complete	84.9	40.2	20.7	110.3
AA-2006-6-6	surface	possible II	bevel & mid	59.8	40.3	17.4	71.2
AA-2006-6-6	surface	possible II	bevel & mid	60.0	41.1	20.2	68.3
AS-32-11	TU 9, L 2	possible III	bevel & mid	69.7	38.5	24.7	93.2
AS-32-13a	surface	possible VI	poll & mid	104.1	48.4	37.9	238.7
AS-32-13b	EU 1, L 2	possible VI	complete	98.4	45.6	35.1	205.1
AS-32-13b	EU 1, L 1	possible VI	complete	82.0	29.0	19.6	70.3
AS-32-17	surface	possible VI	poll	45.8	30.3	15.6	32.2

Figure 5.3 (cont). Basalt adze preforms recovered during archaeological investigations.

Site	Context	Type	Status	Length	Width	Thick	Wt
AS-32-17	surface	possible VI	poll	38.1	36.0	22.7	42.8
AS-32-6-F4	surface	possible VI	poll & mid	94.0	39.4	33.2	149.3
AS-32-7	surface	possible VI	poll & mid	76.2	27.1	31.5	99.0
AS-32-7	TU 3, L 4	possible VI	poll	51.0	41.0	24.9	68.4
AS-32-7	surface	possible VI	poll & mid	78.5	50.0	23.9	125.2
AS-32-7	surface	possible VI	poll & mid	77.0	50.5	27.6	137.4
AA-32-11	TU 9, L 1	possible VI	poll	74.6	44.8	29.0	95.2
AA-32-11	surface	possible VI	poll & mid	71.3	29.4	22.9	61.1
AA-2006-6-2	TU 1, L 1	possible VI	poll	38.2	32.7	22.5	39.9
AA-2006-6-6	surface	possible VI	poll	46.4	26.7	19.1	37.0
AA-2006-6-6	surface	possible VI	poll	63.6	42.4	36.2	124.1
AA-2006-6-6	surface	possible VI	poll & mid	66.9	37.5	23.7	94.0
AA-2006-6-3	TU 2E, L 6	possible VII	complete	172.0	78.5	31.5	?
AS-32-13b	EU 1, L 1	possible VIII	poll	45.9	37.7	21.2	38.8
AS-32-13b	surface	possible VIII	poll & mid	78.3	48.5	28.9	120.3
AS-32-7	TU 1, L 2	possible VIII	bevel & mid	62.4	36.1	15.9	56.1
AS-32-7	surface	possible VIII	poll & mid	92.2	48.6	27.8	176.7
AS-32-7	surface	possible VIII	poll & mid	116.2	58.9	37.3	290.1
AA-2006-6-6	surface	possible VIII	poll & mid	78.3	48.6	23.6	138.0
AA-2005-2	TU 17, L 1	triangular preform	incomplete	85.7	35.9	28.2	100.6
AS-32-13a	surface	triangular preform	poll	49.7	53.8	31.0	116.8
AS-32-13b	EU 1, L 1	triangular preform	fragment	72.1	25.0	17.1	31.9
AS-32-13b	EU 1, L 1	triangular preform	poll	45.9	24.9	18.3	34.4
AS-32-13b	TU 6, L 1	triangular preform	bevel & mid	70.8	37.0	17.5	63.6
AS-32-7	TU 1, L 1	triangular preform	complete	90.4	35.0	31.7	127.9
AS-32-7	surface	triangular preform	complete	93.6	49.0	31.0	177.1
AS-32-7	surface	triangular preform	complete	85.7	44.6	29.0	155.8
AA-2006-6-5	TU 1, L 1	triangular preform	incomplete	91.4	39.3	36.3	154.5
AA-2006-6-5	TU 1, L 1	triangular preform	complete	150.8	35.8	23.3	129.7
AA-2006-6-6	surface	triangular preform	poll	47.8	42.9	20.2	62.5
AA-2006-6-6	surface	triangular preform	complete	130.9	46.1	35.9	318.7
AA-2005-1	surface	quadrangular preform	poll	62.5	49.6	23.8	111.8
AS-32-13b	EU 1, L 2	quadrangular preform	midsection	21.1	30.9	15.2	14.7

Figure 5.3 (cont). Basalt adze preforms recovered during archaeological investigations.

Site	Context	Type	Status	Length	Width	Thick	Wt
AS-32-13b	EU 1, L 2	quadrangular preform	fragment	41.1	20.4	15.2	17.1
AS-32-13b	EU 1, L 1	quadrangular preform	fragment	23.4	34.4	16.3	17.1
AS-32-13b	EU 1, L 1	quadrangular preform	midsection	27.6	46.5	17.9	37.4
AS-32-13b	EU 1, L 1	quadrangular preform	poll	24.3	40.1	16.3	29.0
AS-32-13b	EU 1, L 2	quadrangular preform	fragment	29.4	18.4	7.7	6.7
AS-32-13b	EU 1, L 1	quadrangular preform	fragment	66.2	45.1	19.3	48.3
AS-32-17	surface	quadrangular preform	midsection	47.1	37.2	19.3	39.7
AS-32-6-F4	TU F2, L 1	quadrangular preform	poll	52.0	47.8	13.6	57.9
AS-32-6-F4	TU F2, L 1	quadrangular preform	bevel	43.6	57.1	11.4	47.9
AS-32-7	TU 3, L 1	quadrangular preform	poll	83.6	64.6	36.9	282.5
AS-32-7	TU 1, L 2	quadrangular preform	incomplete	70.9	33.5	17.2	59.9
AS-32-11	TU 9, L 1	quadrangular preform	fragment	70.6	37.5	16.6	35.4
AS-32-11	surface	quadrangular preform	poll	66.2	37.7	21.6	71.3
AS-32-11	TU 9, L 1	quadrangular preform	bevel	48.4	33.8	17.7	39.3
AA-2006-6-6	surface	quadrangular preform	complete	70.4	27.9	19.6	81.0
AA-2006-6-6	surface	quadrangular preform	poll & mid	77.5	40.7	29.4	144.1
AA-2006-6-6	surface	quadrangular preform	incomplete	94.6	61.1	41.0	267.1
AA-2006-6-6	TU A, L 1	quadrangular preform	poll	42.3	30.6	15.6	26.7
AA-2006-6-6	TU F, L 1	quadrangular preform	poll	38.0	50.1	19.6	42.8
AA-2006-6-6	TU F, L 1	quadrangular preform	fragment	63.2	44.2	18.6	46.0
AA-2006-6-6	surface	quadrangular preform	poll	44.3	73.3	40.6	178.5
AA-2006-6-6	TU H, L 2	quadrangular preform	poll	65.5	43.1	29.4	129.2
AA-2006-6-6	surface	quadrangular preform	midsection	52.2	52.9	25.2	112.6
AA-2006-6-6	TU H, L 1	quadrangular preform	poll	58.8	43.9	30.9	129.1
AA-2006-6-6	surface	quadrangular preform	poll & mid	80.4	45.1	23.5	123.0
AA-2006-6-6	TU B, L 1	quadrangular preform	fragment	43.6	26.0	14.1	39.0
AA-2005-1	surface	triangular blank	incomplete	98.7	65.7	39.9	292.3
AS-32-13b	surface	triangular blank	incomplete	118.0	65.0	45.9	411.2
AS-32-6-F4	TU F2, L 1	triangular blank	incomplete	82.8	48.1	23.2	118.6
AS-32-7	TU 1, L 1	triangular blank	incomplete	76.6	48.1	21.8	120.7
AS-32-7	TU 1, L 1	triangular blank	incomplete	93.0	38.7	22.9	113.7
AS-32-7	TU 1, L 1	triangular blank	incomplete	88.4	45.1	21.9	118.4
AS-32-11	TU 12, L 1	triangular blank	incomplete	133.4	47.9	29.8	272.2

Figure 5.3 (cont). Basalt adze preforms recovered during archaeological investigations.

Site	Context	Type	Status	Length	Width	Thick	Wt
AA-2006-6-6	surface	triangular blank	incomplete	97.0	47.3	41.3	316.5
AA-2006-6-6	surface	triangular blank	incomplete	151.1	67.4	88.1	?
AA-2006-6-6	surface	triangular blank	incomplete	95.1	53.5	32.4	226.2
AS-32-13b	surface	quadrangular blank	incomplete	71.3	83.3	39.9	371.7
AS-32-11	TU 12, L 3	quadrangular blank	incomplete	77.5	46.3	22.5	130.9
AA-2006-6-5	TU 1, L 5	quadrangular blank	incomplete	80.1	55.4	29.9	191.2
AA-2006-6-6	surface	quadrangular blank	incomplete	92.4	62.9	45.5	290.8
AA-2006-6-6	surface	quadrangular blank	incomplete	77.7	57.6	43.3	332.8
AA-2006-6-6	surface	quadrangular blank	incomplete	102.5	78.2	33.2	335.9
AA-2006-6-6	surface	quadrangular blank	incomplete	81.9	42.7	21.8	109.4
AS-32-13b	TU 6, L 1	chisel preform	complete	65.5	36.5	19.9	62.6
AS-32-7	surface	chisel preform	complete	69.5	31.2	19.1	45.6
AS-32-7	TU 1, L 1	chisel preform	complete	79.1	30.0	13.9	53.1
AS-32-11	TU 12, L 4	chisel preform	complete	51.2	24.0	8.0	14.0
AA-2006-6-3	TR 2, Strat D	chisel preform	complete	87.7	28.8	16.7	58.7
AA-2006-6-6	TU F, L 2	chisel preform	complete	73.1	24.9	10.7	29.3
AA-2006-6-6	surface	chisel preform	complete	66.7	34.4	20.4	56.5

Classification of Preform Discard

Based on the analysis of numerous preforms and basalt cobbles, a number of different reasons for preform rejection are evident. The first is imperfections within the basalt material, itself, where tiny internal fracture lines impeded a producer's ability to break the stone to their intended pattern. The remaining reasons for rejection revolve around manufacturing error, either by striking too hard or in the wrong place, which highlights these past producers' decisions about reworking a mistake until ultimate discard (Figure 5.3). These manufacturing errors can be seen as a rejected preform with a single fracture prior to discard without any evidence of further reworking. Next, there are rejected preforms with multiple fractures where some reworking was attempted. There are rejected preforms with multiple flake scars along a fracture, where there were rejuvenation attempts for perhaps another tool type. Difficulties in bevel creation were also noted, and would have been the last step prior to grinding, which constituted the culmination of the most labor for a rejected preform. Stacking occurred when after repeated tries, a producer was unable to remove a specific portion of the raw material, and if too large would have required considerable and labor intensive grinding, and was rejected after repeated attempts. The last form is defined as unknown due to the almost completed nature of the preform, which upon examination, looks ready for grinding, but was not.

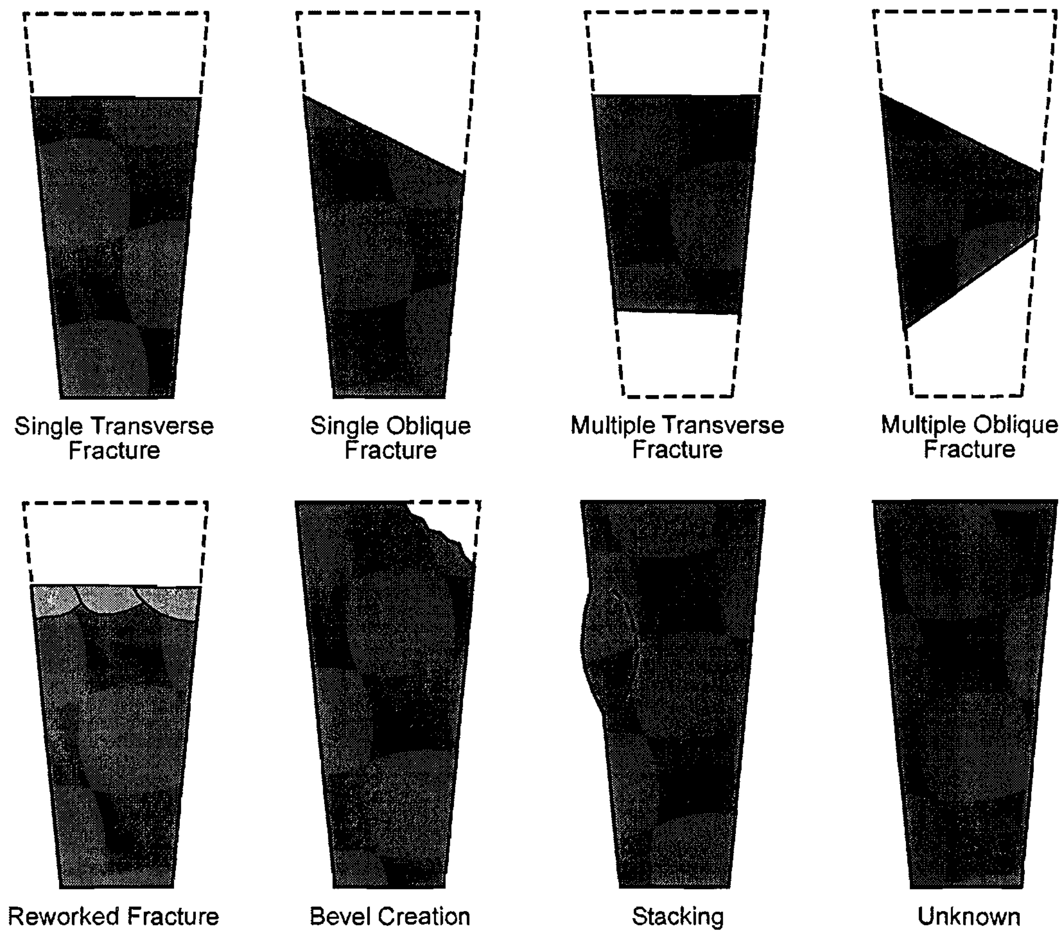

Figure 5.3. A classification scheme for preform manufacturing errors.

In the end, single fracture rejections denote an efficiency of production and an abundance of raw material, where early recognition of uncorrectable mistakes correlates to less time wasted and greater success in production. Five site assemblages with a total of 51 typed adze preforms were selected for further investigation (Table 5.4).

Table 5.4. Manufacturing error summary for preforms from selected sites.

Site	Total No.	Single Fracture	Multiple Fracture	Reworked/ Stacked	Bevel Creation	Unknown
AS-25-62	8	5	0	0	0	3
AS-32-13b	9	5	0	2	2	0
AS-32-7	15	12	0	0	3	0
AS-32-11	6	4	0	0	1	1
AA-2006-6-6	11	7	2	1	0	1

Samoan Flake Tool Classification

Flake tools represent additionally modified waste flakes. In general, there has been relatively little work on informal stone tools in Samoa by archaeologists. One exception is Jeffery Clark's work in eastern Tutuila through the 1980 and 1990s. He and his colleague's flake tool typology stands as the only comprehensive attempt to make sense of this certain tool class (Clark et al. 1998). Their nine class typology is based on both the tool's morphological attributes and its hypothetical function (Figure 5.4).

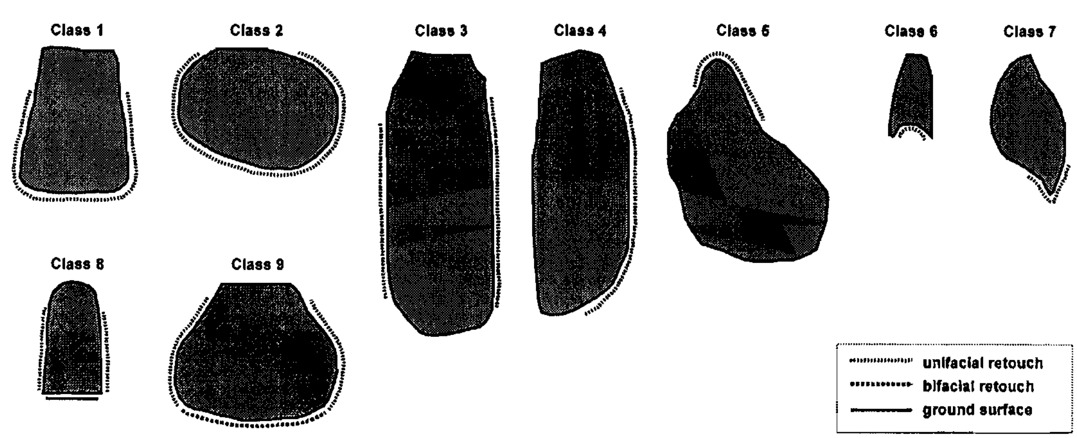

Figure 5.4. Diagram of the Samoan flake tool typology (adapted from Clark et al. 1998).

After sorting the debitage for lithic analysis, the flakes that had further flaking along one or more sides were macroscopically inspected and classified by the following criteria. Class 1 tools are U-shaped end-scrapers, commonly referred to as "coconut graters" in prior literature (Buck 1930:367). An end-scraper tends to be unifacially flaked along three of its sides, creating steep tapered sides, and was utilized potentially for scraping a wide variety of materials. Class 2 flake tools are rounded scrapers. These thinner flakes with an ovate outline are commonly retouched around their entire edge. Clark refers to them as either scraping or cutting tools. Class 3 tools are blade-like flakes with retouch occurring along the two long sides of the flakes. These flake tools are thought to be similar to knives used for scraping and slicing. Class 4 flake tools are termed backed-side scrapers, because although similar to class 3 tools, class 4 tools have one long side blunted. Class 5 or nose scrapers have an intentionally created protrusion through retouch. This protrusion, or nose, allowed for additional extension of the scraper into hard to reach crevices. Class 6 tools have a convex notch along one side. Clark assigned this tool type as a shaft scraper. Class 7 flake tools combine drills and burins. This type has a retouched edge tapering to a point, but routinely is incorporated into another flake tool type. Class 8 constitutes adzelets. Adzelets are retouched flakes with a ground bevel, which would have been used as finishing tools in wood-working projects. The final type, Class 9, is oval shaped, bifacially worked flakes.

From the collection of 17 archaeological sites, there were 76 flake tools recovered and six types present; Class 1, 2, 3, 4, 5, 6 and 9 (Table 5.5). Forty-four were excavated from test units, while 32 were collected in pedestrian survey of the sites. The largest group of flake tools were Class 1 (n = 37) followed by Class 3 (n = 11), Class 4 (n = 11), Class 2 (n = 10), Class 9 (n = 4), Class 5 (n = 2) and Class 6 (n = 1). Because it is unlikely that the presence of these flake tools was a product of discard due to their informal nature, the presence of these flake tools at adze manufacturing sites indicate that the sites were being utilized for activities other than simply stone tool production.

Table 5.5. Classified flake tools recovered during archaeological investigations.

Site	Context	Class	Status	Length	Width	Thick	Wt
AA-2005-1	surface	1	complete	5.88	3.63	1.42	45.50
AA-2005-1	surface	1	broken	5.10	3.11	0.91	21.60
AA-2005-1	excavated	1	complete	4.80	3.41	1.16	25.62
AA-2005-1	excavated	1	complete	5.29	3.44	1.05	15.80
AA-2005-1	excavated	1	complete	3.84	3.77	1.94	26.50
AA-2006-6-5	excavated	1	broken	3.55	3.06	0.98	23.10
AS-32-7	excavated	1	complete	5.93	4.20	2.00	66.42
AS-32-7	surface	1	complete	8.23	3.71	1.47	55.60
AS-32-7	surface	1	complete	7.08	3.10	1.41	31.09
AS-32-7	surface	1	broken	6.47	3.72	1.06	33.23
AS-32-7	excavated	1	complete	4.22	4.87	1.05	19.50
AS-32-17	surface	1	complete	5.80	3.87	1.54	40.89
AS-32-17	surface	1	broken	7.24	3.00	1.36	32.69
AS-32-13b	excavated	1	complete	4.99	4.11	1.41	34.58
AS-32-13b	excavated	1	complete	4.91	3.73	0.81	19.21
AS-32-13b	excavated	1	broken	3.33	2.80	0.73	10.17
AS-32-13b	excavated	1	broken	4.47	3.51	0.90	23.09
AS-32-13a	excavated	1	broken	6.20	4.99	1.15	49.66
AS-32-13b	excavated	1	broken	2.74	3.49	0.88	12.43
AS-32-13b	excavated	1	broken	4.59	4.34	1.11	33.80
AS-32-17	surface	1	complete	4.79	3.07	0.96	18.54
AS-32-7	surface	1	complete	6.95	2.35	1.53	52.97
AS-32-17	surface	1	broken	2.62	3.45	1.17	17.48
AS-32-13b	excavated	1	complete	5.60	3.72	1.13	26.87
AS-32-13b	excavated	1	complete	7.25	3.66	1.63	45.19
AS-32-13b	excavated	1	complete	5.28	3.34	0.69	21.83
AS-32-11	excavated	1	complete	5.28	2.99	0.96	19.84
AS-32-17	surface	1	complete	6.77	3.83	1.63	64.32
AS-32-11	excavated	1	complete	4.91	3.35	0.79	22.80
AA-2006-3	excavated	1	broken	4.75	3.70	1.58	39.90
AA-2006-6-6	surface	1	complete	5.87	3.87	1.74	57.91
AA-2006-6-6	surface	1	broken	5.82	3.44	1.37	44.64
AA-2006-6-6	surface	1	complete	4.53	3.74	0.93	25.00
AA-2006-6-6	surface	1	broken	4.01	3.50	1.16	26.60
AA-2006-6-6	excavated	1	broken	3.97	3.73	1.37	29.20

Table 5.5 (cont). Flake tools recovered during archaeological investigations.

Site	Context	Class	Status	Length	Width	Thick	Wt
AA-2006-6-6	surface	1	complete	4.81	3.54	0.78	24.29
AA-2006-6-6	surface	1	complete	5.06	3.37	1.57	35.62
AA-2005-1	surface	2	complete	4.37	3.84	0.53	13.10
AA-2005-1	surface	2	complete	4.59	3.96	0.67	45.90
AS-32-7	excavated	2	broken	3.71	3.97	0.81	18.26
AS-32-11	excavated	2	broken	5.45	3.93	0.88	27.61
AS-32-13b	excavated	2	complete	6.44	5.12	1.17	49.37
AS-32-7	excavated	2	complete	6.84	4.78	1.07	39.30
AS-32-7	excavated	2	complete	6.75	4.33	1.50	50.60
AS-32-7	excavated	2	broken	3.89	4.11	0.65	16.24
AS-32-13b	excavated	2	broken	2.74	4.55	1.09	13.44
AA-2006-6-6	excavated	2	complete	3.64	3.01	0.73	12.90
AS-32-7	excavated	3	broken	5.11	3.64	0.85	23.30
AS-32-7	surface	3	complete	4.82	2.31	1.07	16.21
AS-32-17	surface	3	broken	3.50	3.74	1.05	22.84
AS-32-11	excavated	3	broken	5.59	3.23	0.89	26.08
AS-32-7	excavated	3	broken	5.20	2.48	1.00	14.84
AS-32-7	excavated	3	broken	4.65	2.86	0.60	12.72
AS-32-7	surface	3	complete	6.71	2.80	0.87	22.40
AS-32-17	surface	3	broken	3.11	3.08	0.77	13.44
AS-32-13b	excavated	3	complete	7.59	3.55	1.19	38.86
AA-2006-6-6	excavated	3	complete	4.56	1.77	0.51	8.00
AA-2006-6-6	excavated	3	broken	5.27	3.42	1.07	31.00
AA-2006-6-5	excavated	4	broken	3.70	2.42	1.25	16.20
AS-32-13b	excavated	4	complete	5.80	3.20	1.15	31.61
AS-32-7	surface	4	complete	5.36	3.49	1.03	22.98
AS-32-17	surface	4	broken	4.29	3.89	1.30	30.37
AS-32-13b	excavated	4	complete	5.19	4.05	0.62	17.05
AS-32-7	excavated	4	complete	6.85	2.96	1.64	37.80
AS-32-13a	surface	4	complete	6.56	3.98	1.61	52.23
AS-32-7	excavated	4	complete	3.63	2.71	0.62	9.20
AS-32-7	surface	4	broken	4.11	2.15	1.01	10.94
AA-2006-6-6	surface	4	complete	5.14	3.50	0.95	19.20
AA-2006-6-6	surface	4	broken	5.25	2.60	1.12	21.15
AS-32-7	excavated	5	complete	4.49	2.11	0.57	6.40
AS-32-7	excavated	5	complete	5.68	3.37	0.60	18.20
AA-2006-6-4	excavated	6	complete	4.25	2.33	0.81	14.1
AA-2005-1	excavated	9	complete	4.11	3.84	1.73	39.40
AA-2006-6-6	surface	9	complete	4.57	4.16	1.77	46.83
AA-2006-6-6	surface	9	complete	6.27	4.09	1.71	77.64
AA-2006-6-6	surface	9	complete	4.47	3.70	1.70	47.01

Geochemistry of Samoan Adzes

The results of chemical characterization studies on geological and archaeological samples collected during my investigations, which was conducted in tandem with the adze production analysis, created a complementary and robust provenance database for Tutuila. In this section, I discuss the geochemical methods, sampling, statistical analysis and results of this research as well as the implications for intra-island and inter-island exchange.

The basis of exchange research is twofold; first, one must identify artifacts being transported between populations, and second, one must identify if those artifacts can be linked to specific, localized raw material sources (Neff 1998). Recent research has proved that Tutuila sources can be separated into distinct intra-island geochemical sources (Clark et al. 1997; Johnson et al. 2007; Winterhoff et al. 2007). This intra-island sourcing is possible on Tutuila because the chemical compositional differences among and within the island's volcanic episodes exceed the compositional variation within the quarried sources. Thus, source identification of transferred adzes can be conducted by statistically assigning those artifacts to the documented geographically discrete sources.

Tutuila Island was created by five major volcanic episodes which are divided internally by episodic basalt lava flows and was discussed in detail in Chapter II and IV. Here, I examine in greater detail the geochemical variation within a single volcanic episode – the Taputapu volcanics. Taputapu volcanics, located in the far western portion of Tutuila, are composed primarily of olivine basalts formed during the Pliocene Epoch range in thickness from two to 16 m (Stearns 1944:1305-1306). Internally, Taputapu formations have numerous cinder cones spotting the landscape, such as Oloava Crater, that later deposited thin olivine-poor basalt flows, andesitic basalt flows, red vitric tuffs and cinders throughout the area (Stearns 1944).

I chose Taputapu volcanics as a locale of inquiry because of the number of previously recorded quarry sites, and the relative lack of archaeological research on the western side of the island compared to the east (Clark 1993; Johnson et al. 2007). There are three documented production centers in the Taputapu region. The first center, Tataga Matau, located directly on a ridge above the town of Leone, and is the best-known of the three (Best et al. 1992; Leach and Witter 1990). The second center, the Malaeloa valley has archaeological sites with extensive production debris almost rivaling that of Tataga Matau (Winterhoff et al. 2007). The last center, the Maloata valley (Ayres and Eisler 1987) had extensive lithic workshops documented during site investigations suggesting an undiscovered local quarry source.

In this next section, I report on the sampling methods employed in documenting new geochemical data for basalt sources found in the Malaeloa and Maloata valleys. Then, I statistically compare the geochemistry of these new sources and the previously published geochemical signatures of Tataga Matau basalt. Finally, I evaluate analyzed adzes recovered from both Samoa and surrounding archipelagos, and document the origin of these transported materials.

Sampling Strategy

To examine adze source locales within western Tutuila, the author collected and analyzed 75 basalt samples from four different valleys (Ayres et al. 2001; Winterhoff 2003; Winterhoff et al. 2006; Table 5.6). To control for different raw materials and methods of acquisition, three types of samples were investigated. First, geologic samples were collected in different locations in each valley from outcrops, streams and the soil matrix. These samples enable us to determine if there is a direct connection between adze manufacture and available rock sources. Second, waste flakes were collected from cultural strata at archaeological sites. Flake samples from sites connect the prehistoric settlement pattern to resource use and extraction from specific geological source material. Third, samples from finished adzes and adze flakes were collected from different archaeological contexts to examine intra-island distribution.

Table 5.6. XRF samples collected during field research

Location	Geology	Flake	Adze
Malaeloa Valley	10	28	13
Maloata Valley	7	6	1
Asili Valley	0	0	3
Afao Valley	0	0	7

Geological Samples

Previous research has successfully documented the feasibility of geochemically differentiating basalt tool sources at an intra-island level on Tutuila (Clark et al. 1997; Johnson et al. 2007; Winterhoff et al. 2007). To further understand acquisition constraints in tool production, geological sampling was undertaken in an effort to continue assessing the diversity of possible basalt sources occurring within the Malaeloa and Maloata valleys (Figure 5.5 and 5.6)

All geological samples were struck off larger cobbles with a rock hammer. This sampling method allowed for more samples to be collected in the field and to ensure macroscopically that samples were tool-quality basalt. Two transects were conducted in Malaeloa to collect raw material samples from the floor to the valley's ridges. The first transect ran perpendicular to the western Lesui Ridge, where five samples were taken from the soil matrix and headland of Fuafua stream. The second transect ran upslope of the eastern Olovalu Ridge, where five samples were collected from the Vaitai stream and basalt outcrops. In Maloata, two locations were also sampled; three samples were taken from Maloata Stream, and four samples were taken from the soil matrix of Tuasina Ridge.

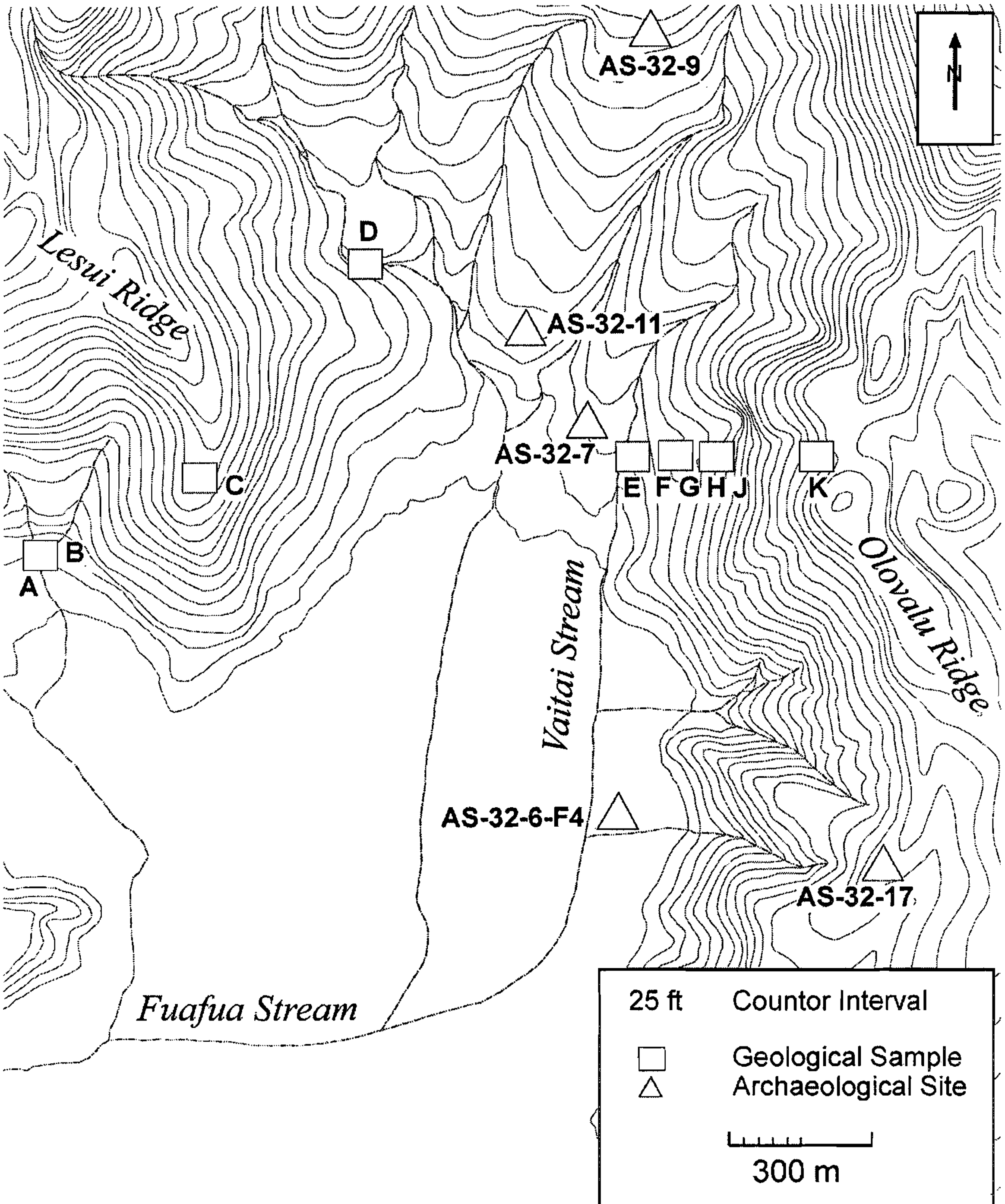

Figure 5.5. Map of Malaeloa valley showing sample locations (adapted from Winterhoff et al. 2007).

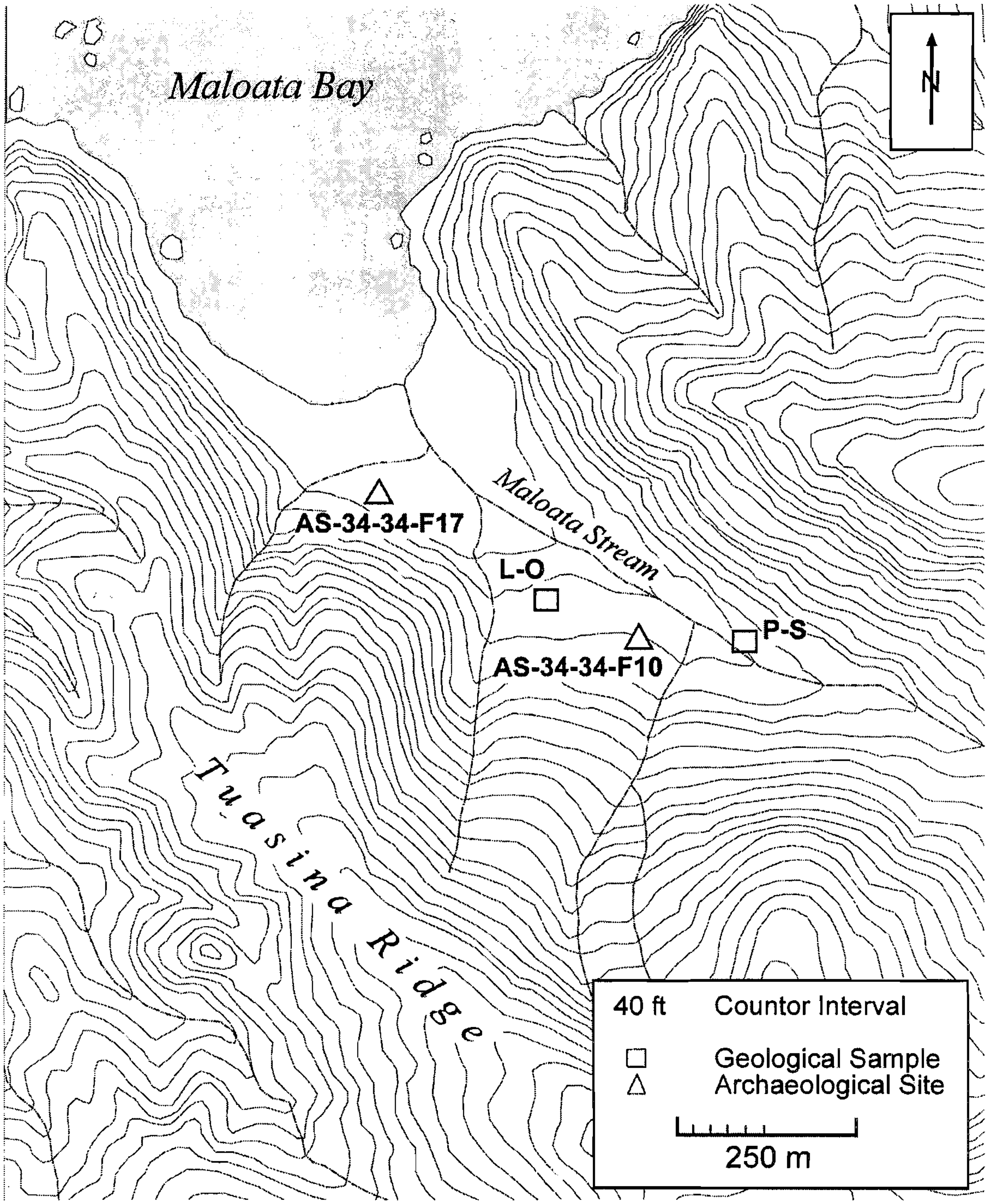

Figure 5.6. Map of Maloata valley showing sample locations (adapted from Winterhoff et al. 2007).

Waste Flake Samples

A total of 34 waste flakes were collected from seven stone tool production sites in the Malaeloa and Maloata Valleys. Flake samples were selected from a site assemblage's initial reduction flakes so that a stronger connection between the production site and the raw material source could be made. Samples were also taken from a different number of collection contexts; excavated samples were utilized to establish a cohesive acquisition record at a particular site, while surface flakes were used for purposes of understanding spatial segregation in the larger settlement context. In Malaeloa, five sites were sampled. Ten flake samples were collected from excavation units at site AS-32-7. Seven waste flakes were collected from excavation units in AS-32-6-F4. Four surface flakes were collected at site AS-32-17. Three surface flakes were collected at site AS-32-11. Lastly, three surface flakes were collected at a flake scatter at site AS-32-9. Based on archived material from excavations in 1986, two Maloata sites were sampled (Ayres and Eisler 1987). Four surface flakes were sampled from site AS-34-34-F17. Two waste flakes were collected from surface investigations at site AS-34-34-F10.

Adze Samples

Twenty-four adzes from the four different valleys represent my sample for geochemical analysis. All adze samples came from utilized adzes, represented by either a broken tool or a flake derived from an adze. Material was obtained using a 10 mm diamond tipped drill press or a diamond tipped saw blade. The method chosen for a particular adze took into account the adze's morphological shape and condition, so the least damage would be done. The following table lists each adze or adze flake selected for sampling (Table 5.7). For comparative purposes, this study also includes published geochemical data on 43 samples obtained from Tataga Matau, eight adze samples from other Samoan sites, and 29 adze samples recovered from sites located in the greater region (Best et al. 1992).

Table 5.7. Adze sample data for geochemical analysis.

Site	Valley	Context	Sample
AS-32-17	Malaeloa	surface	broken type VIII adze
AS-32-6-F4	Malaeloa	excavated	broken type I adze
AS-32-6-F4	Malaeloa	excavated	adze flake
AS-32-6-F4	Malaeloa	excavated	adze flake
AS-32-6-F4	Malaeloa	excavated	adze flake
AS-32-7	Malaeloa	surface	broken type I adze
AS-32-7	Malaeloa	surface	broken type I adze
AS-32-7	Malaeloa	surface	broken type VIII adze
AS-32-13a	Malaeloa	excavated	type X
AS-32-13b	Malaeloa	excavated	adze flake
AS-32-13b	Malaeloa	excavated	adze flake
AS-32-13	Malaeloa	excavated	adze flake
AS-32-13	Malaeloa	excavated	adze flake
Tuasina Ridge	Maloata	surface	broken type I adze
Village	Asili	surface	type I adze
Village	Asili	surface	broken type VI adze
Village	Asili	surface	broken type I adze
Village	Asili	surface	type I adze
Village	Afao	surface	broken type I adze
Village	Afao	surface	broken type I adze
AA-2005-1	Afao	surface	broken type I adze
AA-2005-1	Afao	surface	broken type III adze
AA-2005-1	Afao	excavated	broken type I adze
AA-2005-2	Afao	excavated	adze flake

Geochemical Methods

After archaeologically identifying Malaeloa and Maloata valleys as locales for basalt acquisition and tool manufacture, further research was conducted to determine if the composition of the locally available basalt in these valleys was different from other stone sources on Tutuila. All samples were characterized using a wave dispersive XRF automated spectrometer (Rigaku 3370) at Washington State University's GeoAnalytical Laboratory (Johnson et al. 1999). The WD-XRF spectrometer provides data on 10 oxides (SiO_2, Al_2O_3, TiO_2, FeO, MnO, CaO, MgO, K_2O, Na_2O and P_2O_5) and 17 trace elements (Ni, Cr, Sc, V, Ba, Rb, Sr, Zr, Y, Nb, Ga, Cu, Zn, Pb, La, Ce and Th).

Although there are a number of possible geochemical techniques available, such as Inductively Coupled Plasma Mass Spectrometry and Neutron Activation Analysis (Johnson et al. 2007; Kennett et al. 2004; Weisler and Woodhead 1995), XRF was chosen because of its lower cost allowing for the examination of more samples and its widespread use among other Pacific Island researchers allowing for the greatest degree of comparability with existing databases (Sheppard 1997; Sinton and Sinoto 1997; Weisler 1993b, 1997, 2004). XRF analysis is based on the detection of X-rays of varying energies produced by artificially excited elements and their constituent atoms (Jones et al. 1997). An XRF spectrometer measures and collects these resulting elemental concentrations. The technique is successful because elemental refractions occur in standardized and measurable amounts, thus allowing for comparisons of the X-ray intensity provided by each element. The chemical composition of the sample is then reported as a percentage of sample for each major element and then trace elements in parts per million. Source provenance is achieved by charting these variations in elemental compositions between artifacts and collected geological samples.

Statistical Methods

In order to trace artifacts to their sources, provenance research requires that "there exists some qualitative or quantitative chemical or mineralogical difference between natural sources that exceeds the qualitative or quantitative variation within each source" (Neff 2001:107-108). This provenance postulate is when the geochemical composition of a discrete source can be differentiated within the larger geological source in which it resides. Although sources will share general chemical characteristics with their neighbors, a discrete source will have enough standardized variation amongst these sources to be considered a unique geochemical unit. To examine the variation in resulting raw geochemical data, mathematical treatment is required to successfully differentiating the geochemical variation within and between sources (Harbottle 1982). Thus, the data require a multiple statistical analysis to translate and ascertain the certainty of possible provenance assignments. First, an exploratory matrix plot was created to examine relationships among variables and groupings of observations within the data sets (Fotheringham et al. 2000:76-77). Second, a cluster analysis was done to examine natural groupings of sources based on similarities of elemental data and geographic context (Rogerson 2006:263-266). A cluster analysis entails the placing of all data into a hierarchical structure which links related samples. Third, a multivariate statistical analysis was conducted to investigate the properties of variance-covariance among variables. In particular, principal components analysis (PCA) reveals the major underlying variables responsible for the variation within the data set (Rogerson 2006:259-262). Preliminary examinations of the data revealed asymmetric distribution of individual variables and curvilinear relationships among variables and so data were log transformed.

To examine geochemical differentiation among quarry sources in Tataga Matau, Malaeloa and Maloata, a matrix plot was utilized to analyze the recorded oxides from the waste flakes and geological samples from the three valleys within the Taputapu volcanics (Figure 5.7). A matrix plot shows all 10 oxide percentages, and can be used to evaluate possible variables for discriminating among basalt sources that are in close geographic proximity.

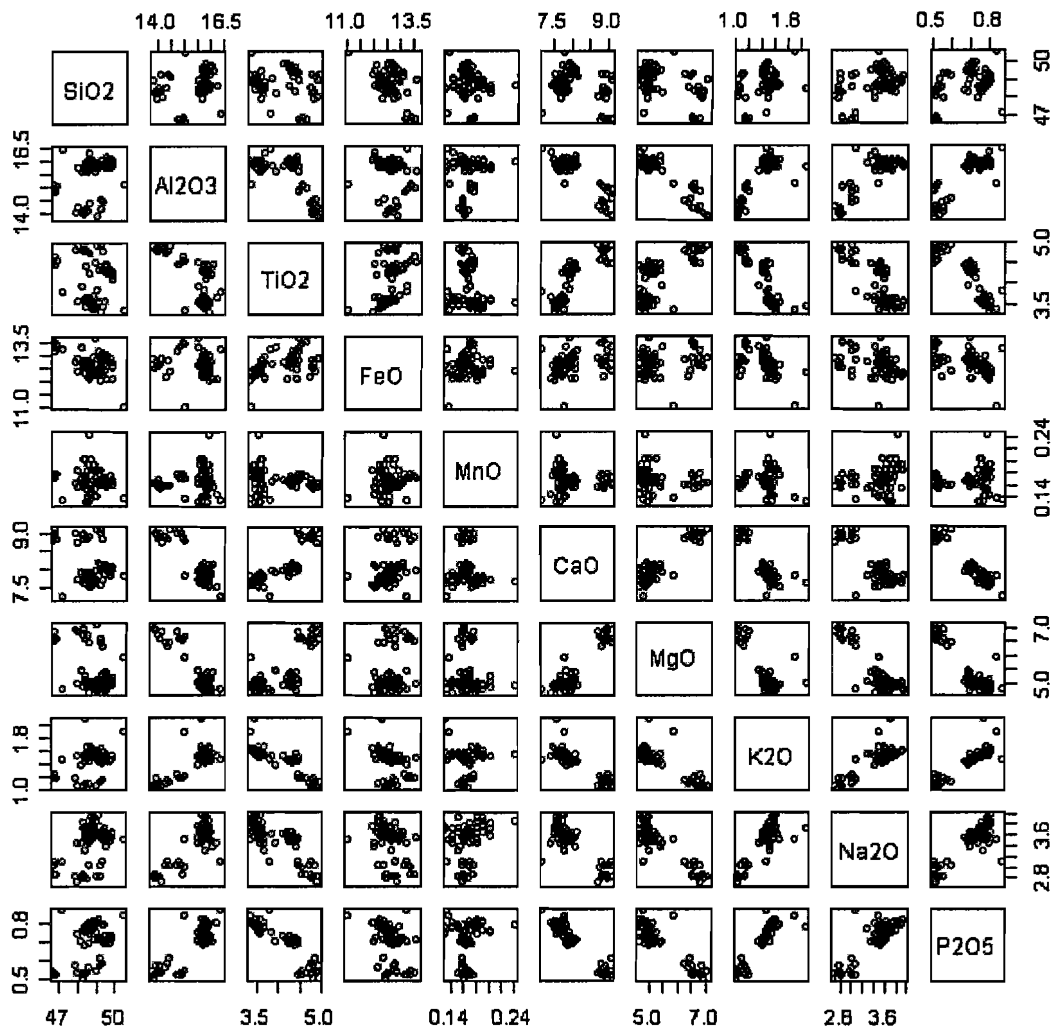

Figure 5.7. A Matrix plot of the major oxides from the geological and flake samples.

Out of 45 non-redundant plots, 5 bivariate plots show visually promising results of separation among the sources. As anticipated, individual scatterplots produced considerable overlap in composition between Tataga Matau and Malaeloa; however, some major oxides SiO_2, TiO_2, Al_2O_3, MnO, K_2O, CaO and P_2O_5 present good results in partitioning the three valleys' geochemistry into distinctive elemental composition groupings.

A K-means cluster analysis (with K varying between two and five) was performed to clarify visible groupings found in the bivariate plots. These cluster solutions differentiated among the sources with varying success. A two-cluster solution divided the source samples into two clusters; 1) Tataga Matau and Malaeloa flake samples, and 2) Malaeloa geology samples and Maloata. A three-cluster solution created a division between the Tataga Matau samples and the Malaeloa flake samples. A four-cluster solution then divided the Tataga Matau samples into two clusters, lithic workshops versus general activity areas within the larger quarry. Finally, a five-cluster solution separates the Maloata samples from the Malaeloa geology samples, retains the similarities found in the sampled geography, and follows the relationship proposed by the matrix plot. A few exceptions do appear as with overlap of geographic data and geochemical data in the cluster analysis dendrograms (not shown). Three Lesui Ridge geological samples -- A, B and D -- fall into the two Tataga Matau clusters. The remaining Malaeloa geological sample C from the Lesui Ridge falls within the Malaeloa Flake Cluster, these differences highlight that the ridgeline is composed of multiple lava flows. Samples A, B and D probably share the same lava flow as nearby Tataga Matau, but they also fall outside their respective clusters' compositional range on at least three elements apiece, so further work is need to more fully understand their deviation.

Principal Component Analysis (PCA) shows that the first three components account for the majority (94.3%) of the total variance in the geochemical sample set, and

$\log_{10}(Al_2O_3)$ and $\log_{10}(MgO)$ were the largest discriminating factors in the biplot of the first two components (Figure 5.8).

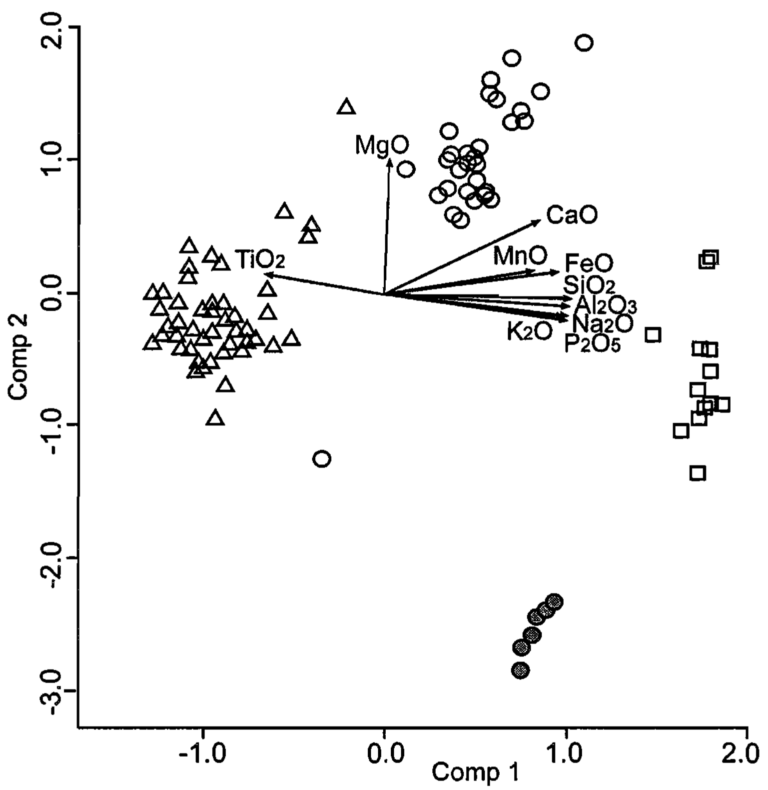

Figure 5.8. Principal component analysis of source samples (open circles are Tataga Matau samples, triangles are Malaeloa Group 2 and 3 samples, squares are Maloata samples, and shaded circles are Malaeloa Group 1 samples).

A scatterplot of the first two principal components displays the similar groupings as found in the cluster analysis. The scatterplot also supports the results from the earlier matrix plot (see Fig. 5.8). In the plot, symbols represent the 5 cluster membership from the K-means analysis (Tataga Matau samples have been combined for clarity).

Results

In an effort to determine the origin of transported adzes located in Samoa and beyond, the same discriminating variables, P_2O_5 and $Log10(TiO_2/FeO)$, utilized successfully in prior research were employed (Best et al. 1992; Figure 5.9). Best et al. (1992) did not include confidence ellipses in their scatterplot, but all quarry sources shown here have 99 percent confidence ellipses to aid in differentiating away adze sources with various degrees of statistical uncertainty. Malaeloa Group 1 is composed of the geological samples collected from Olovalu Ridge, and is connected to lava flows from the nearby Olovalu Crater. Malaeloa Group 2 is derived from waste flakes from the five archaeological sites sampled. Because of the high percentage of cortex flakes (21%) from AS-32-7 as compared to AS-32-6-F4 (12%) and the remote location of AS-32-9, the geological source of Group 2 is most likely lava flows that originated from Olovava Crater upslope of these sites. The final Malaeloa group, Group 3, came from the geological sampling of Lesui Ridge. The overlapping confidence ellipses of Tataga Matau and Malaeloa Group 3 in the following scatterplots are a result of their proximity to two unnamed craters that separate them producing similar volcanic histories for the two sources. In addition, the overall large size of the Malaeloa Group 3 ellipse is due to the low number and variability of the samples. The utilization of Group 3's source data should be considered only with caution and, until more sampling is conducted, this source will be removed from my analysis.

Based on the success of differentiating the five basalt sources with the original scatterplot, two additional plots were created. The first plot shows adzes recovered within the Samoan archipelago (Figure 5.10) plotted on the cluster ellipses determined for figure 5.9. The second shows those adzes recovered from outside Samoa (Figure 5.11) plotted in a similar fashion. These two scatter plots highlight four distributional levels defined by the observational units of increasing geographical distances traveled between the adze's production source and its consumption locale; intra-valley, inter-valley, intra-archipelago and inter-archipelago. This is significant in relation to Sahlins' work on social distance and exchange, and will be discussed in more detail in the following chapter.

Intra-valley distribution is demonstrated at two sources. Nine Malaeloa adzes were connected to the Malaeloa Group 2 source, and one adze found in Maloata Valley was matched to the Maloata source (Figure 5.10). Intra-Island distribution occurs with regard to three sources. Five adzes of Tataga Matau material were recovered in three locations; three adzes from Afao, one from Asili and one from East Tutuila at AS-21-6. Two adzes found in Afao were manufactured from Malaeloa Group 2 basalt. One adze collected in Malaeloa as well as two adzes from Asili are geochemically connected to Maloata. There are two examples of Intra-Archipelago distribution occurring among western Tutuila sources. One adze of Tataga Matau material was recovered at site SA-3 in Upolu, and an adze manufacture in Malaeloa was collected at Luatuanu'u, Upolu.

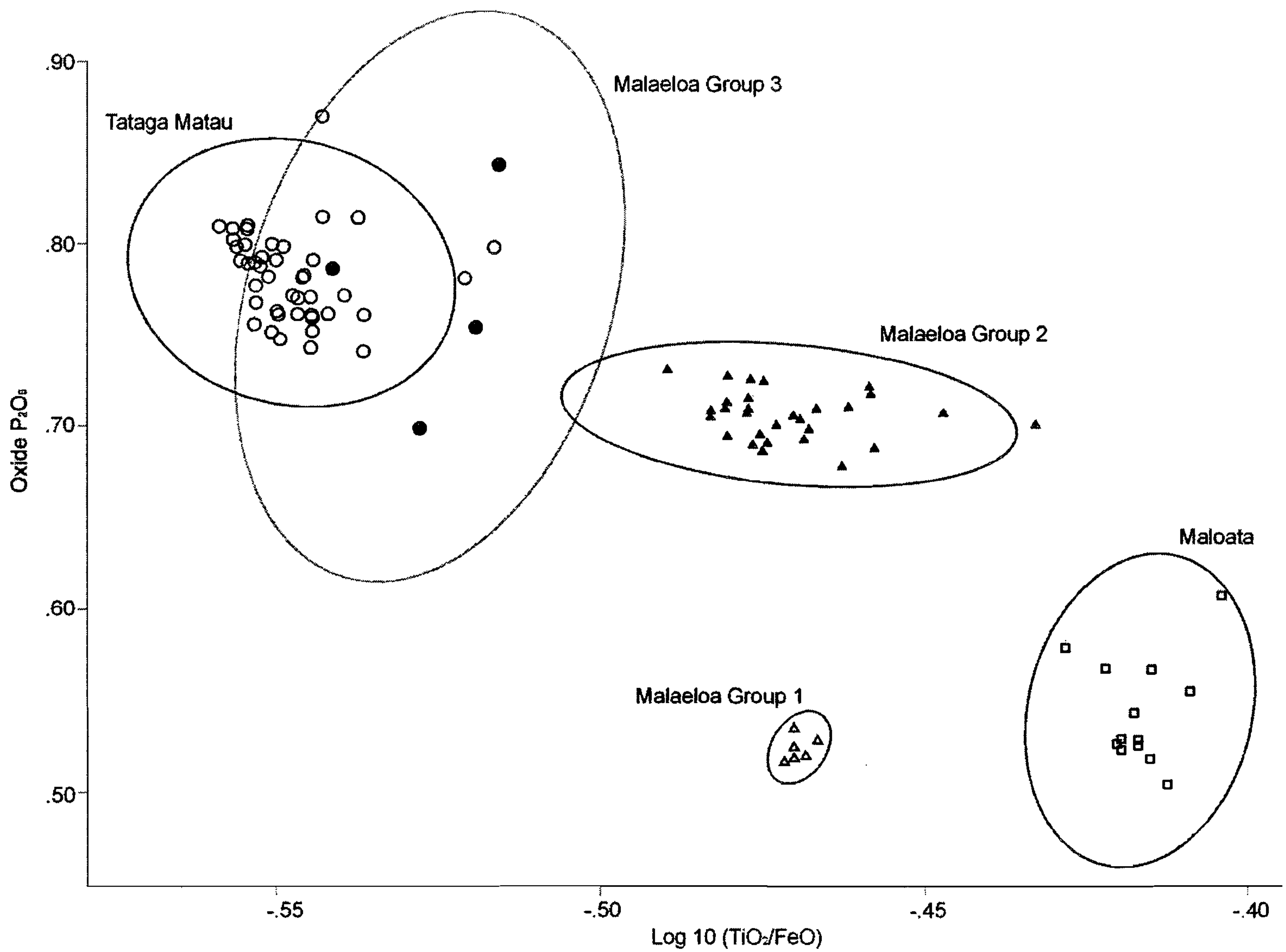

Figure 5.9. A scatterplot of western Tutuila source samples with 99% confidence ellipses.

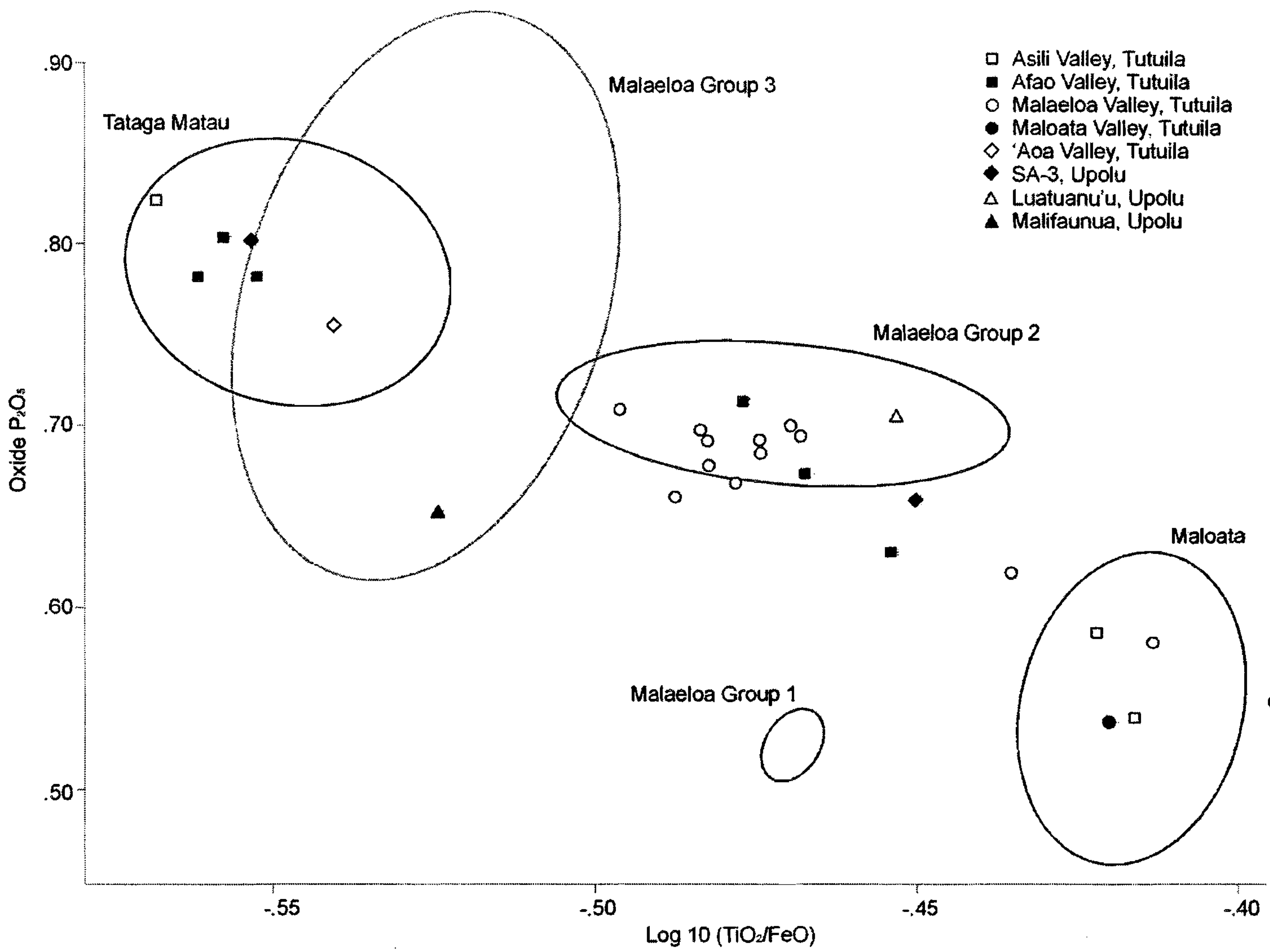

Figure 5.10. A scatterplot of western Tutuila sources and from adzes recovered within the Samoan archipelago, with 99% confidence ellipses.

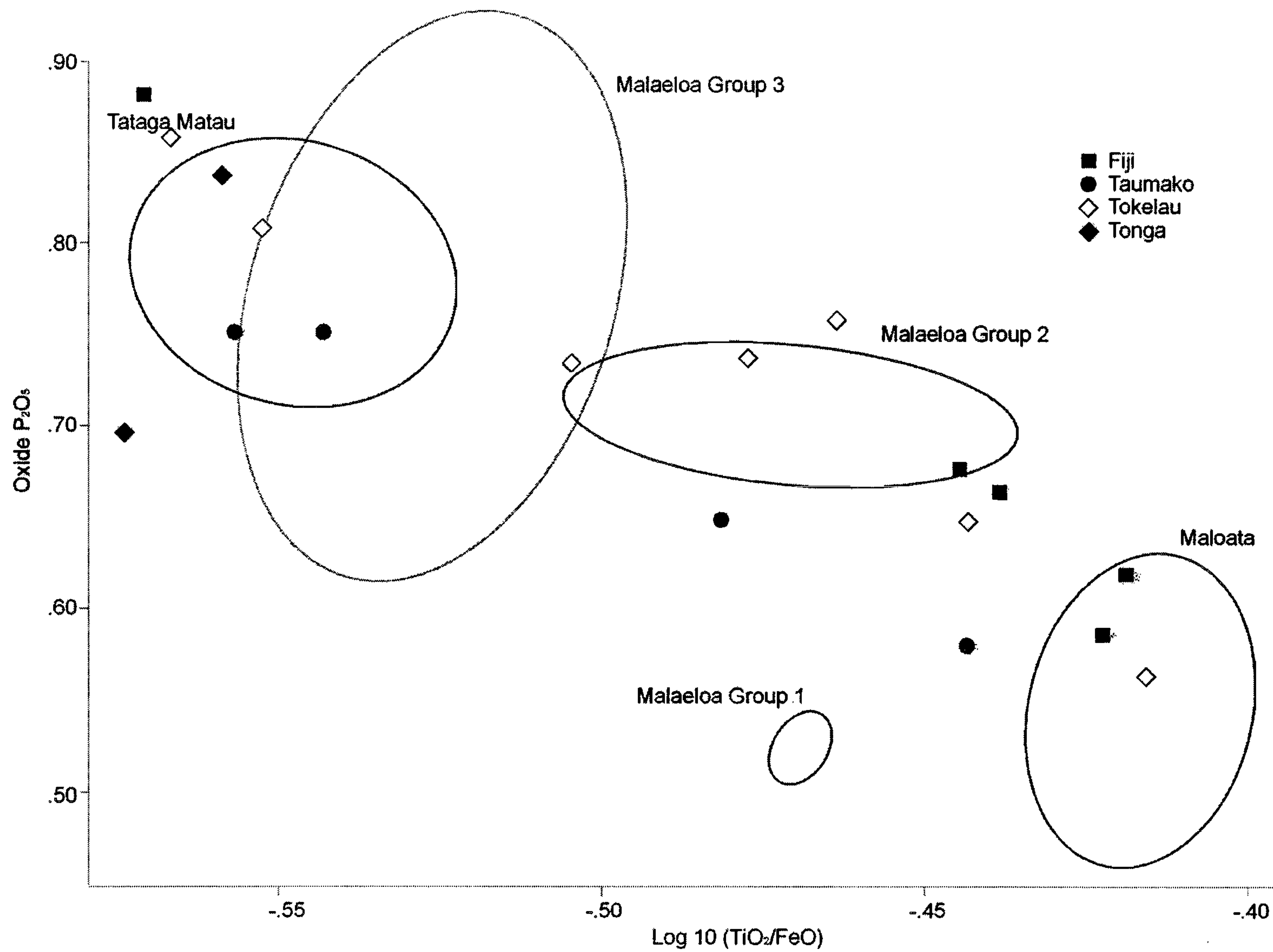

Figure 5.11. A scatterplot of western Tutuila sources and Adzes recovered from outside Samoa, with 99% confidence ellipses.

Based on the geochemical provenance data, there are at least three different sources in western Tutuila present in inter-archipelago distribution; Maloata, Malaeloa Group 2 and Tataga Matau. Examples of Inter-Archipelago distribution are observed by the presence of two adzes of Maloata material recovered in Fiji and one in Tokelau. Next, adzes made from Malaeloa Group 2 basalt were unearthed in Fiji and in Tokelau. Finally, two adzes from Tataga Matau stone were found on the Santa Cruz Islands, one was found in Tonga, and one was uncovered in Tokelau.

In this chapter, the methods of analysis were outlined and the results were reported. Based on the results of the debitage analysis, there is a continuum of manufacture behaviors present on Tutuila, ranging from the mainly large primary flakes recovered in abundance at the Starmound Terrace in Tataga Matau to the few small tertiary flakes collected at TU 19 at the AA-2005-1. Although discarded adzes provide information on mainly tool consumption, the presence of adzes for the purpose of this study offers insights into which adzes were favored for local production and intra-island exchange as almost 50 percent were Type I. With 108 preforms recovered in varying degrees of completion, a striking result surfaces. Only four triangular finished adzes were recovered during investigations, but 45 triangular preforms were recovered, composing 44 percent of the total assemblage. This data calls attention to the unequal distribution of what should be a relatively common adze form, based on preform data. In addition, a surprising number of expedient tools were collected and analyzed at the production sites. As a commonly overlooked tool type, flake tools seem to be an integral secondary by-product of adze manufacture with interesting implications. Related to raw material acquisition and distribution, geochemical characterization was conducted on geological and archaeological samples. The provenance results show that discrete sources can be defined even within a single valley, and that intra-island distribution of adzes was being conducted as well as vast societal exchange networks. In the next chapter, I discuss my research questions and evaluate the proposed test hypotheses in light of the information provided in chapter VI and V.

CHAPTER VI

A DISCUSSION OF THE SOCIAL RELATIONS OF ADZE PRODUCTION AND CHIEFLY STATUS IN ANCIENT SAMOA

The aim of my dissertation is to investigate Samoa's political transformation from an earlier *ranked* to a historic *stratified* chiefdom. My research examines this transition by archaeologically charting the different leadership strategies employed within Samoa's economic systems. These strategies reflect how ancient leaders controlled commodity production in varying aspects to their benefit. Here, basalt adzes and their manufacturing debris represent an optimal proxy for testing the type of control a Samoan leader exerted, because stone tool studies can address issues such as interaction with the natural environment, specialization in production, and product circulation in exchange networks. The results of this research help fill a major void in our current anthropological understanding of the evolution of Polynesian chiefdoms.

The transition from ranked to stratified chiefdoms is a fundamental crossroad for political complexity in human societies. During this shift, societal members solidify the social relationships allowing for permanent stratification and internal inequalities (Arnold 1996; Brumfiel and Earle 1987; Goldman 1970; Sahlins 1958). In this dissertation, I take the position that prestige competition exercised by emerging elites within the context of economic organization was the dominant mechanism for this change.

My research focuses on the articulation of prehistoric Samoan economy, specifically its stone tool industry, with the political transformation recorded in the Traditional Samoan period dated from 1700 to 300 years ago. The chiefs in this stratified structure constituted a hierarchical position claiming greater privileges over agricultural lands, wealth tribute and surplus labor (Goldman 1970:250-261). These chiefly positions enabled individuals to manage the populace through social debt, to control the exchange rate of produced commodities, and to compete constantly with peers for additional status and power. This competition is what Schortman and Urban cite as the motivation for societal differentiation (2004:192), so archaeologically locating the start of that competition in prehistory would also record the temporal origin of the position. During the Polynesian Plainware period, the early Samoan chiefdom was kin-based (Kirch 1984:62), and labor was tied intimately to households. To compete in prestige competitions, leaders needed to develop new strategies to accumulate surplus while not usurping kin obligations. During this earlier period characterized by low populations throughout the archipelago and a technologically-simple economy, I suggest the key to creating this surplus would have come from establishing efficiency in manufacture. Craft specialization is a re-organization of production among highly skilled producers who could produce commodities more efficiently than a just the household level. For the purposes of this dissertation, craft specialization also documents the strength of affiliation between producers and their leaders (Torrence 1986; Johnson 1996), where the strength of this affiliation correlates to the amount of wealth generated by craft specialists used to finance the emerging elites or the specialists, themselves.

Craft specialization was clearly present in Samoan society during the Historic period. Ample evidence documents the important position held by guilds and craftsman in Samoa's political structure or *fa'amatai* (Buck 1930; Goldman 1970; Kramer 1902). Numerous craftsman guilds were reported; ranging from house construction to sail makers to tattooers (Stair 1897). However, the presence of stone tool specialists has been poorly documented, because of the rapid replacement of traditional wood-working tools with the introduction of more efficient metal tools making it "difficult to know in what regard the occupation of adze manufacturing was held" (Green 1974:254).

Because of the other guilds' embedded presence within Samoan society at Western contact, the optimal departure point for archaeological inquiry for the development of a stone tool guild lies in the Traditional Samoan period. With respect to adze production, I have documented significant increases in the magnitude of stone tool manufacturing during this period (Figure 6.1). Thus the important question to ask is if organizationally this increase in production reflects the presence of adze specialization producing for non-local consumption or just greater numbers of local producers and consumers?

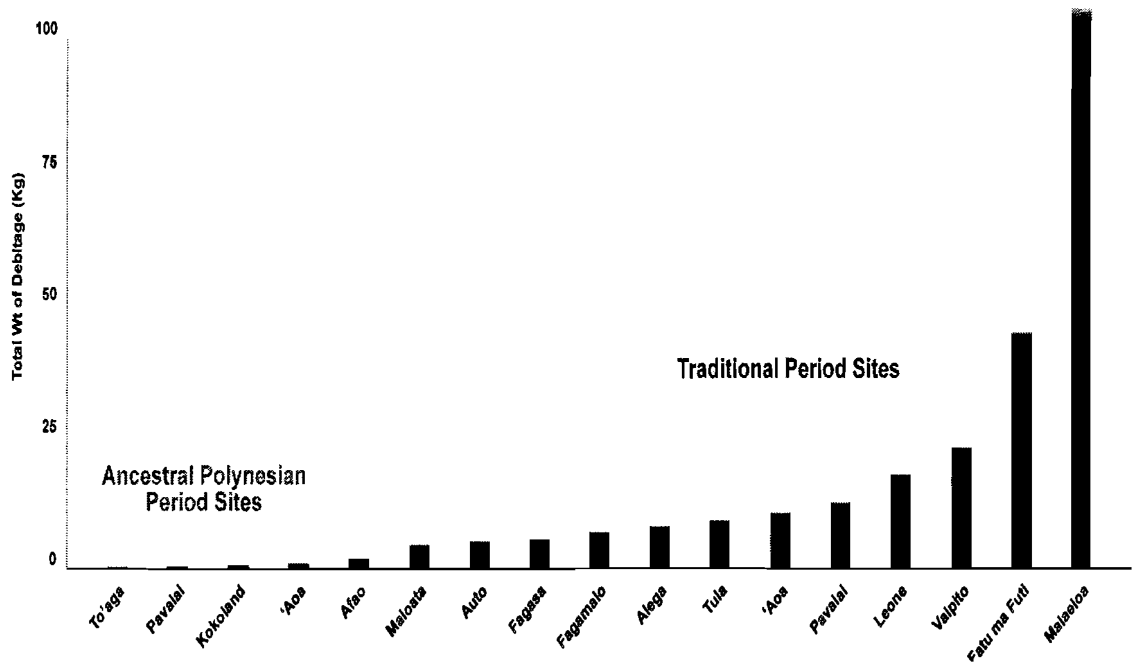

Figure 6.1. Waste flake amounts recovered from adze production sites on Tutuila.

When examining the mechanisms responsible for the documented intensification of adze production during the Traditional period, it is necessary to first account for potential bias in purported coeval population increases across the archipelago. Kirch estimated the population of Samoa at Western contact at around 80,000 people (1984:98), which was a substantial increase from earlier periods, where proto-Samoan populations have been hypothesized to have been low in numbers and highly dispersed (Davidson 1979; Kirch 1984, 2000). Perhaps then, the documented increase in adze production was simply a product of greater numbers of household producers. Previous researchers have failed to examine this issue systematically, and have left this question as a significant void in understanding the development of craft production in Samoan prehistory. In the next section, I examine lithic assemblages from around Tutuila in order to address this shortcoming.

Research Question One

The question posed in Chapter III was whether craft specialization was present in Samoa's ancient stone tool industry. I hypothesize that a change in the social organization of production was responsible for the increases witnessed in adze production during the Traditional Period. In order to test this, I analyze lithic assemblages from sites dated to before and after this political transition, when craft specialization should manifest as material changes in the efficiency of manufacture. Manufacturing efficiency is measured three-fold by evaluating the frequency of manufacturing success of completing preforms, the standardization of the adze reduction process, and the selective production of a smaller range of adze types at different sites.

Manufacturing Success

One of the immediate impacts of specialization is that producers spent more time producing. This extra familiarity routinely reveals, itself, in greater manufacturing success, because producers would accumulate greater skills through increased practice. This greater skill leads to less frequent accidents and easily avoidable production problems. Thus, production debris recovered at later sites would contain fewer examples of errors, such as a lower frequency of rejected preforms than in earlier production sites.

I document the frequency of rejected preforms in lithic assemblages by including only preforms and blanks recovered from excavations. It is assumed that during rejection, broken preforms were left with their lithic debris, while the ones collected in pedestrian survey are not necessarily spatially attached to the discrete production episodes found in individual flake scatters. Because of variations in sampling from my research and others, five comparable site assemblages with 51 preforms and blanks were selected for further investigation (Table 6.1). These sites were chosen, because they contained high numbers of incomplete tools and offered a good sample of high production sites across Tutuila from the Traditional Samoan period. Production density, a measure of manufacturing intensity, was recorded as total weight of waste flakes divided by the amount of soil removed to uncover it. The rejection rate is a relative measure of how frequently a preform was rejected in context to the amount of production occurring.

Table 6.1. Production information from selected sites.

	Blanks Excavated	Preforms Excavated	Production Density	Rejection Rate
AS-25-62	1	8	6.71 kg/m^3*	1:1.34
AS-32-13b	0	17	68.33 kg/m^3	1:0.25
AS-32-7	3	6	71.07 kg/m^3	1:0.13
AS-32-11	2	6	105.47 kg/m^3	1:0.08
AA-2006-6-6	0	8	8.11 kg/m^3	1:0.99

*approximated excavated amounts based on field notes

The results present a marked advancement in manufacturing success at the Malaeloa manufacturing sites, where the rejection rate at site AS-32-11 (Toa Terrace) in the Malaeloa Valley was almost 17 times lower than that of site AS-25-62 in the Vaipito

Valley. Although, this is a limited dataset in comparison with the breadth of manufacturing occurring in prehistoric Tutuila, it does demonstrate that there were dramatic differences in production success among producers during the Traditional period.

Spatial Segregation of Activities

Production efficiency can also be achieved by standardizing the adze reduction process, which can be observed in the spatial segregation of specific manufacture activities across the landscape (Ahler 1989:101-106). Specialists will segregate their activities to benefit from the repetition of particular tasks. This repetition and institutionalized knowledge leads to the standardization of manufacturing techniques which then increases the overall production efficiency (Costin 1991:39). This additional efficiency enables specialists to out produce households without the need to increase their labor input; thus, allowing specialists to gain a competitive edge in producing more stone tools. Documented during the early historic period, some Samoan craft guilds took advantage of segregating activities by being tied to particular villages and workshops as they practiced their specialty (Buck 1930:85). So in testing, if purposeful segregation occurred in production, then lithic assemblages at individual sites and a range of sites within a valley would reflect these different production stages. If there was not, then all lithic assemblages would show functionally similar production stages internally.

As outlined in Chapter II, basalt adze manufacture can be classified into four general categories; acquisition, blank production, preform reduction and grinding (Leach and Witter 1987), but these categories are too broad when exploring spatial segregation within adze production, especially when examining preform reduction. Variability in preform reduction, as a stage, encompasses the greatest amount of flaking variation; thus at this stage, and because of this, producers would have the most to gain in efficiency from simplifying and standardizing this production stage.

To chart the spatial segregation of adze production, there are variations in the physical variables that produce distinct flake shape, size and type. According to Whittaker (1994:91), three independent variables determine the geometric shape of flakes (Figure 6.2). First, the platform depth is the distance from the core's edge where the hammerstone impacts in flake removal. So if a manufacturer strikes close to the platform edge, the resultant flake will be small, thin and relatively flat (Leach and Witter 1987:44). If the strike is further back, larger flakes with a marked increase in the bulb of percussion will result. Second, the exterior platform angle describes the relationship of the platform to the exterior surface of the core. All things being equal, the closer this angle is to 90° the longer the flake length, until the exterior platform angle exceeds 90° and no flake is then produced. The final variable, force of the strike, is the amount of energy applied to flake removal where increases in force create larger and larger flakes. As basalt is extremely tough, a number 5 on the Lithic Grade Scale (Callahan 1979), more force on average is needed to create purposeful flakes.

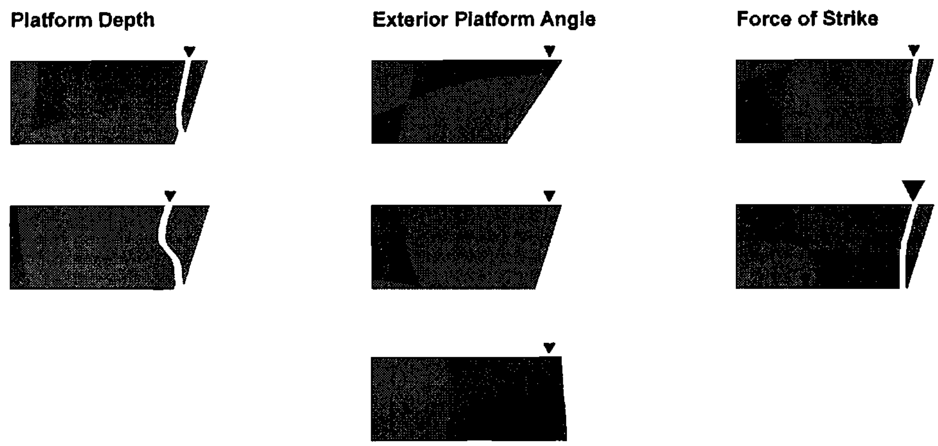

Figure 6.2. A graphical representation of three pertinent manufacturer variables in Samoan adze manufacture (adapted from Whittaker 1994).

Using this information, I divide the preform reduction category into three additional stages; initial reduction, intermediate reduction and final reduction. Each stage has been created to reflect changes in the physical variables of stone tool manufacture, and applied to the composition of flake assemblages utilizing the aggregates from the earlier lithic analysis (Winterhoff and Rigtrup 2006). Initial reduction reflects the rapid reduction of a flake blank into the approximate shape of the desired preform using a high strike force and largest platform depth. Intermediate reduction composes the more purposeful shaping of the rough preform into an almost completed preform using a medium amount of force, shallower platform depth and more care on the selection of the exterior platform angle. Final reduction, using the least force, entails the last stage of shaping and bevel creation prior to grinding. Figure 6.3 graphically summarizes these three as stages. However, I want to express caution that these are archaeologically-useful categories, but more experimental knapping research would greatly enhance its overall effectiveness in other Polynesian contexts.

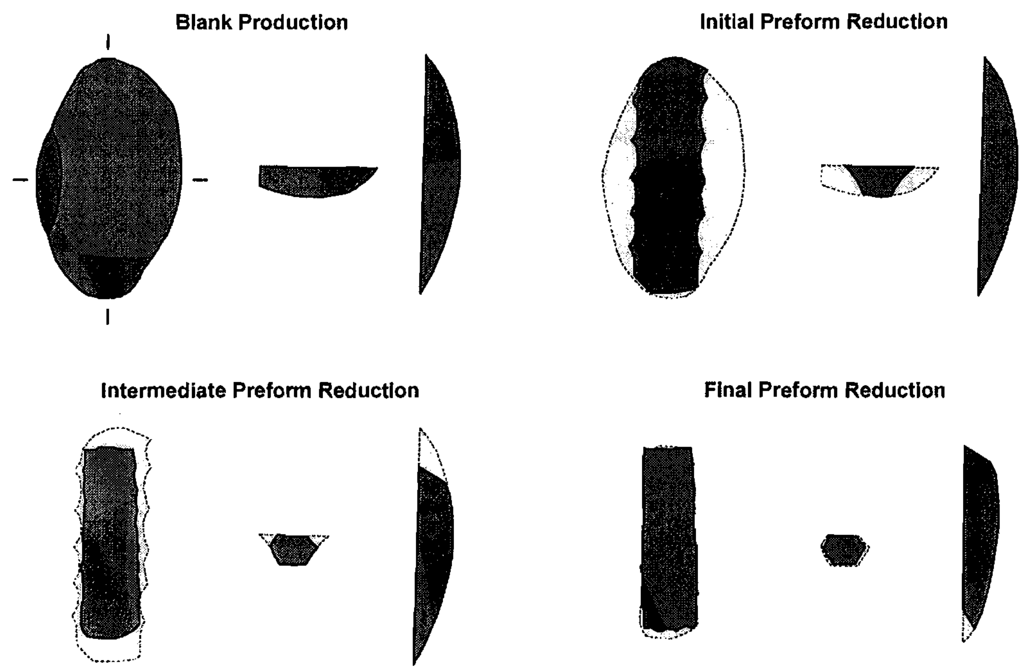

Figure 6.3. Stage diagram of preform reduction (adapted from Leach and Witter 1987: Figures 10, 11 and 12).

Leach and Witter provide insightful information pertaining to adze manufacture (1987, 1990); however, their research does not address on how this information would be reflected in lithic assemblages. In an effort to address that issue, I have compiled a stylized diagram of stage compositions for lithic assemblages, based on the critical examination of Leach and Witter's work, an understanding of the physical properties inherent in stone tool production and an intensive examination of archaeological materials. To provide quantifiable limits for each stage's size and cortex composition, I incorporate two additional lines of evidence. First, limited experimental results on blank production from Leach and Witter (1985; Table 6.2) provide tentative size limits for blank production prior to preform reduction. In their results, all three flake blanks' long axis were larger than the Size Group 5 flakes (less than six cm) I utilized in my debitage analysis. These data provides an upper limit to the other preform reduction categories, where the majority of their flakes would be recovered in Size Groups 1 to 4. These results provide the parameter for blank production.

Table 6.2. Flake blank measurements

	Max Length (cm)	Max Width (cm)	Max Thickness (cm)
Blank A	6 – 10	3 – 8	.5 – 1
Blank B	10 – 30	5 – 20	1.5 – 4
Blank C	10 – 40	3 – 10	2 – 8

Second, flake scar analysis was utilized to record the proportions of different size and stage groups present on nearly completed preforms. During the analysis of preforms from four Malaeloa Valley sites – the Tuitasi Terraces, Toa Terrace, Frog Terraces and AS-32-6-F4; a total of 800 visible flake scars on 47 preforms were measured along their longest possible axis in an effort to replicate the same parameters utilized by my size grade analysis. Next, flake scars touching cortex on the adze preform, were recorded as cortex flakes; whereas, flake scars whose edges were not in contact with cortex were deemed tertiary. To make the flake counts comparable, each flake scar was assigned an average flake weight based on their respective size grade's average weight calculated from assemblages at the same four Malaeloa sites totaling almost 40,000 flakes. The results of this analysis provide the parameters for intermediate preform reduction (Figure 6.4).

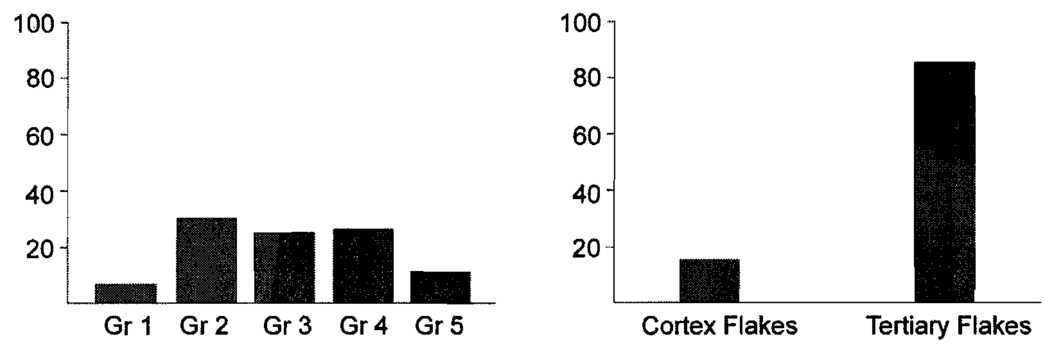

Figure 6.4. Results from flake scar analysis on Malaeloa preforms using percentages of group sizes from the mass flake analysis.

The remaining stages, initial and final, were calculated according to relative size grades which corresponded to the desired outcome producers were attempting to achieve. For example, the final stage in preform reduction would contain only small flakes from bevel creation on an already modified preform. Here, producers conducting this stage would create flakes falling into Size Group 1 and 2 categories with little to no cortex present. The resultant diagram presents my calculations (Figure 6.5).

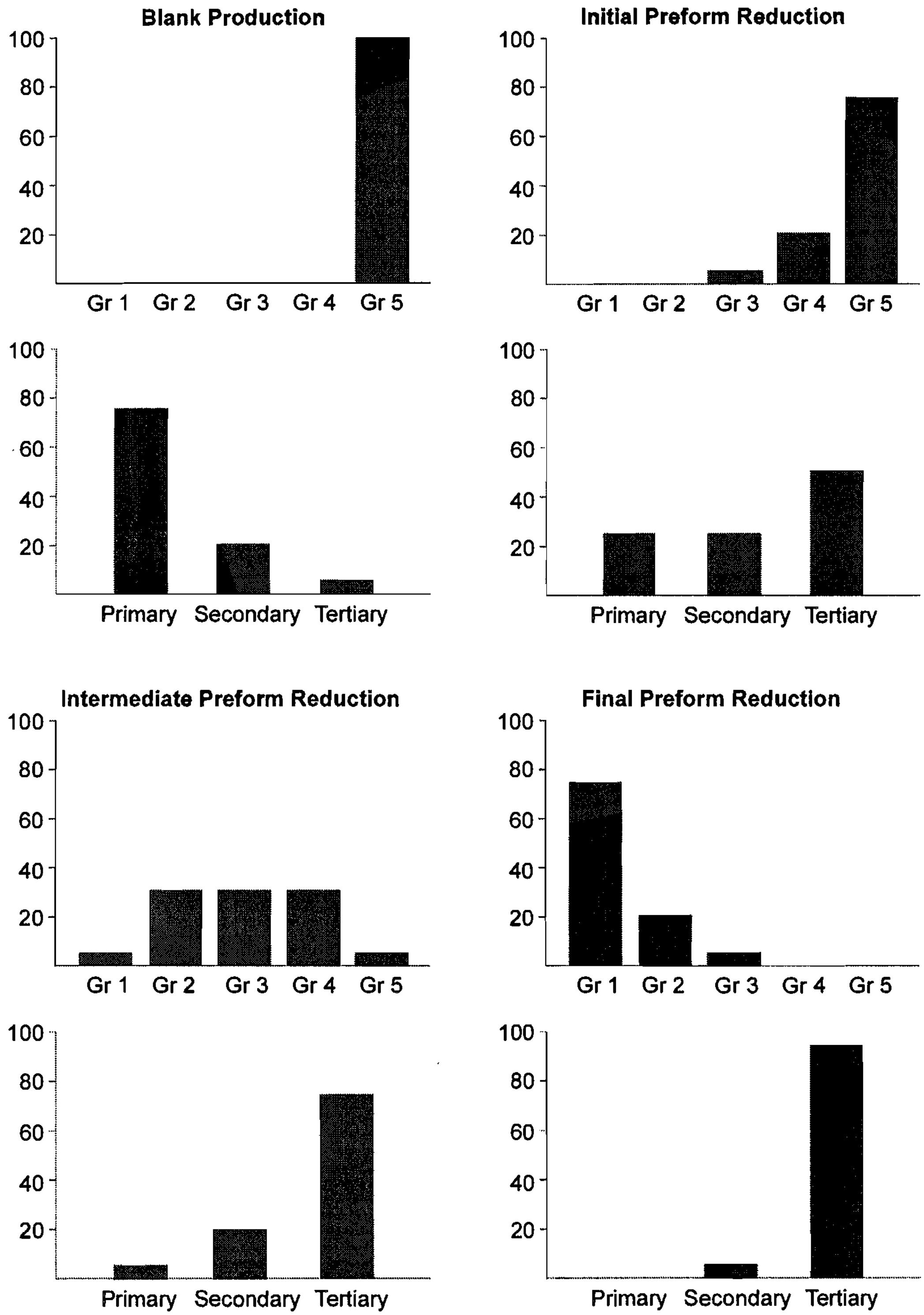

Figure 6.5. A stylized diagram of reduction stage based on size and stage grade categories.

The next step in determining if spatial segregation was occurring in adze production is to select the appropriate scale of investigation. As discussed previously, because spatial segregation can occur within a single production center, a single producer focused on initial reduction in one corner and another focused on final flaking, the site is not an adequate unit of measurement. The correct scale of measurement is individual lithic scatters. As an archaeological feature, a lithic scatter entails a discrete spatial representation of human behaviors involved in stone tool manufacture. As test units sample these scatters, individual test units become the archaeological unit for adequate testing.

Based on the lithic data recorded in 49 test units, I created a Central Tendency scatterplot from the weighted mean of all five flake size groups and the percentage of secondary flakes in each category (Rogerson 2006:27-29; Figure 6.6). The weighted mean of flake size provides the central tendency of the five size groups, and the secondary flakes were utilized because as a stage category, they had the most amount of variation in the reduction stages. The designation of each production stage was calculated around a centroid based on the information provided in Figure 6.5.

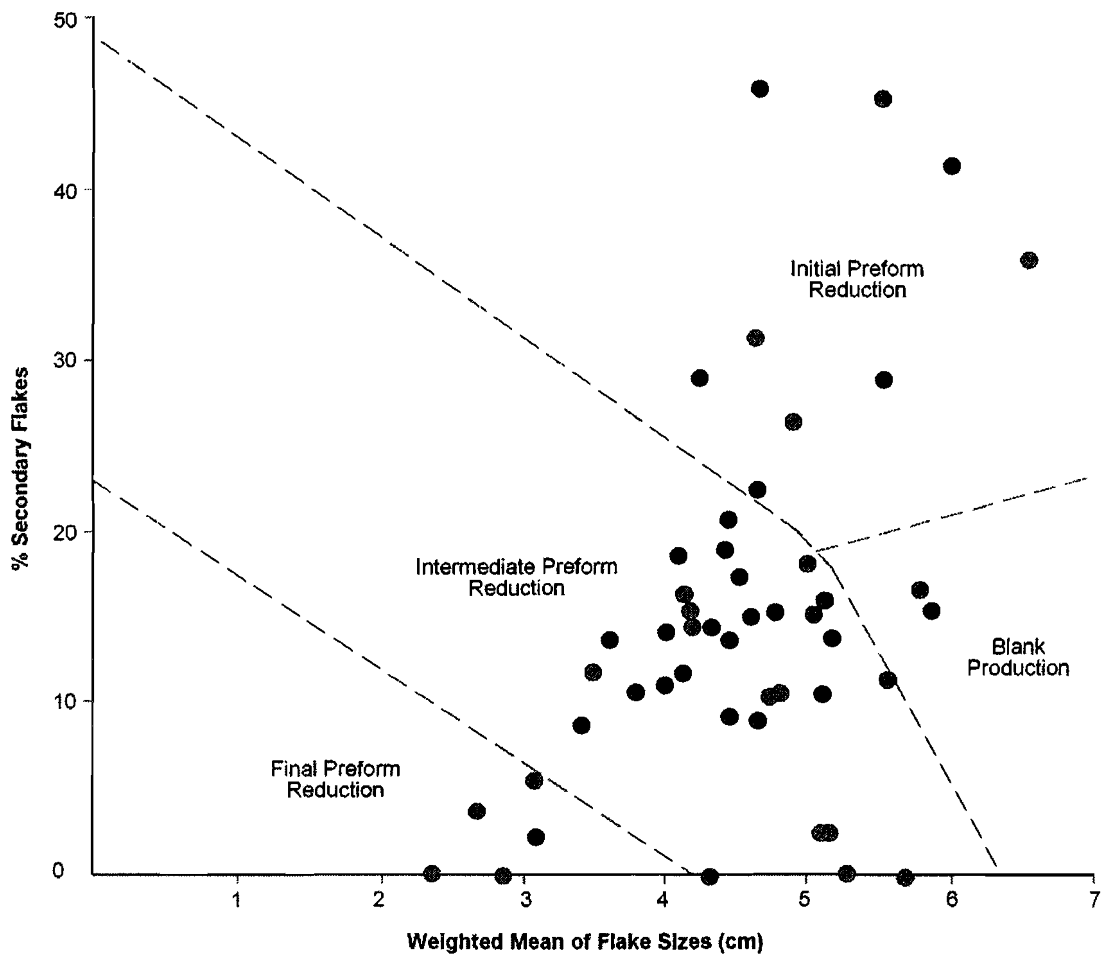

Figure 6.6. Production stage diagram of test unit assemblages.

The results from this analysis show that out of 49 total test unit assemblages; two were blank production loci, nine were initial, 33 were intermediate and five assemblages are final preform reduction loci. After examination, there are seven production centers with multiple stages present. The Afa Terrace in the Afao valley has both final and intermediate stages present. The Auto Septic Terrace in the Auto valley has initial and intermediate stages. In the Malaeloa valley, the Frog Terraces and Pigtrap Terraces have initial and intermediate stages. The Tula Septic Terrace and AS-25-62 also are internally differentiated. But perhaps the most interesting results are from the Polynesian Plainware period site – Pavaiai P6, which also contains different stages. To summarize, spatial segregation was present in Samoa's stone tool industry, even among the earlier periods, and is possible to determine which stage of tool production was undertaken at flake scatters and production workshops. However, Malaeloa valley is the only production locus that has multiple sites with at least 10 kg of debris and segregated activities. This single situation is a regrettable by-product of extensive archaeological sampling by the author in this particular valley which has not been conducted elsewhere, but further documentation in other valleys should alleviate this bias.

Product Specialization

As one means of increasing efficiency, tool makers can specialize in producing certain types of products at different production centers. By focusing on only one adze type, a producer could reduce the amount of manufacture variation and reduce the number of distinct skill sets needed. A specialist who manufactures only one adze type requires less training, which allows them to focus on perfecting a few skill sets enabling increases in manufacturing efficiency. If this form of manufacturing efficiency was present in Samoan adze production, then different production sites would contain specific adze preform types (Figure 6.7). Based on a survey of recovered preforms at production centers from Tutuila, there are three sites with substantial production levels as well as differences between quadrangular versus triangular adze production: the Frog Terraces, Toa Terrace and Tula Septic Terrace. However, there may be a possible bias in these results. This bias entails triangular forms were completed more routinely and thus circulated away from the production site. However, if it were only one site, I would agree that it was a result of this bias, but with three different sites containing the same results from this research, I propose these results demonstrate that product specialization was present and occurred in the Traditional period.

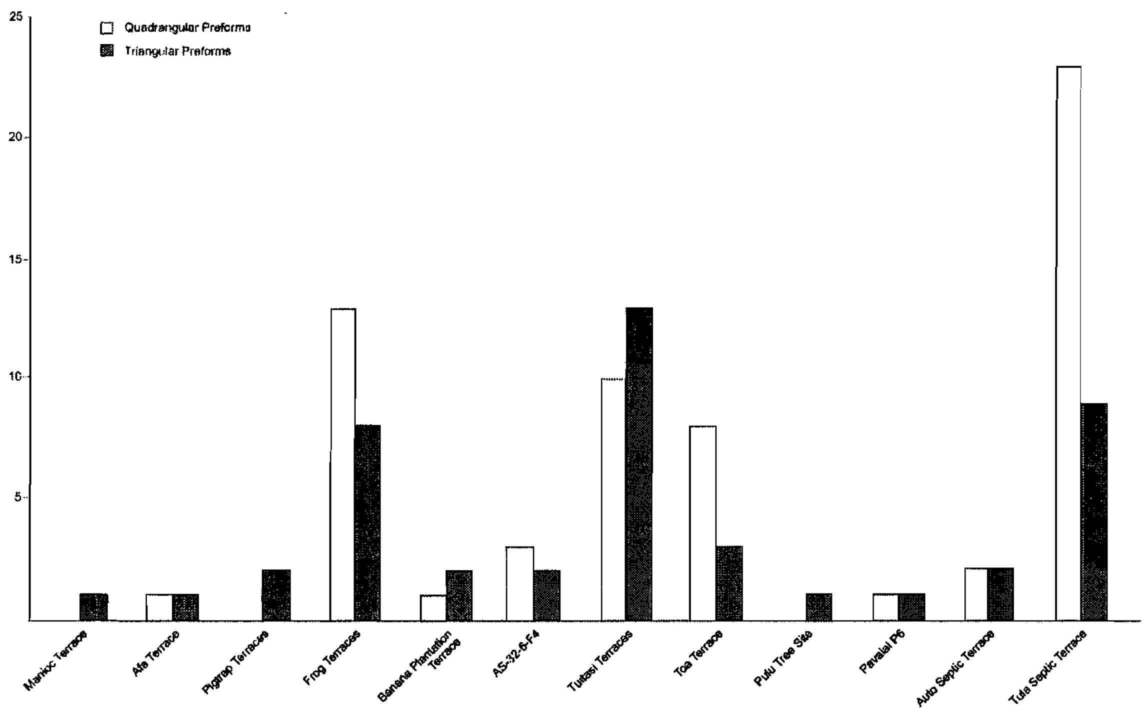

Figure 6.7. Preform types from Tutuilan production centers.

The overall results in these efficiency measures support previous conclusions that specialization was a part of Samoan adze production (Ayres and Eisler 1987; Clark 1993; Clark et al. 1997; Green 1974; Leach and Witter 1990), and was a probable mechanism for the recorded production increases during the Traditional Samoan period. There is ample evidence to document that stone tool manufacture was a specialized activity; the dramatic increase in the success of preform completion, the presence of spatial segregation of discrete production stages, and the locations producing specific products. However, this still leaves only a simplified understanding of how adze producers interacted with the larger Samoan society. Perhaps then, the real question is how the coeval emergence of stratified chiefs and craft specialization were reflected in their relationship? Did this new economic organization facilitate political strategies and motivations of the bourgeoning hierarchical leadership? In the next section, I answer these questions by classifying the type of specialization present by utilizing lithic and settlement data within a set of four organizational parameters.

Research Question Two

I documented adze specialization in ancient Samoa in the last section, the second question revolves around what type of specialization was being conducted. I stated earlier that I think Samoan adze specialists were organized in a similar fashion as other Samoan *tufuga* guilds, but what does that suggest about the archaeological record of specialized labor? Reviewing the organizational structure of the best documented group of craftsman – the carpenter's guild, Buck states that sub-groups of the larger guild were in "the immediate association with particular chiefs to various villages" (1930:84). These chiefs/craftsman held lineage-titles that according to oral history connected them the original group of builders called the *Sa Tangaloa*. The guild's sub-groups were also spatially associated with districts; for example, Buck names two for Tutuila – *Ainga sa Le Malama* and *Ainga sa To*. Originally, membership was traced through kin according to oral history (Buck 1930:84-85), but with increasing populations, kin-relationships weakened. Buck also states that by the Historic period, non-kin members were admitted to these sub-groups to compensate. These sub-groups were internally organized into masters and apprentices categories, where individual masters were in competition with others for independent housing contracts from other non-guild chiefs. These contracts, consisting of feasts, food, housing and other status items in payment, provided the skill and energy to construct a guest house. This form of organization is defined in Costin's typology as *nucleated workshops*, where "larger workshops aggregated within a single community, producing for unrestricted regional consumption" (1991:8: See Fig. 3.1). To determine if this is the form of specialization occurring in Samoan adze production, there are four variables to review: concentration, intensity, scale and context (Costin 1991:8-18).

The Concentration of Production Loci

The first parameter, *concentration,* consists of the relative density of craft production occurring in a particular society. Relating to territoriality and resource availability, production can either be nucleated within a specific locale or dispersed over an entire region (Figure 6.8).

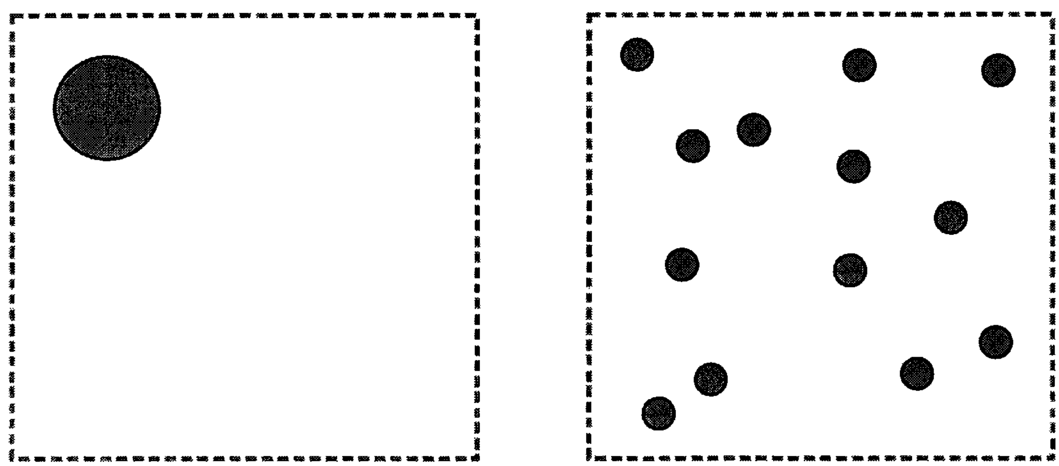

Figure 6.8. A diagram of nucleated (left) and dispersed (right) production density in a region.

Examining the loci density in Tutuila documented in this study shows dispersed pattern of production sites occurring in the Traditional Period. However this is misleading, when you expand the lens to the societal level (Figure 6.9), then there is a marked concentration in Tutuila only – with only three additional production loci recorded elsewhere in the archipelago: Mt Vaea in Upolu and two in Manu'a (Best et al. 1992:58; Weisler 1993a). Although researchers have not examined the two large western islands of the Archipelago specifically for adze manufacturing, a number of multi-year field projects in the 1960s and 70s failed to encounter any significant amount of flaking debris on islands composed of similar basalt as Tutuila which should have provided at least local adze production (Green and Davidson 1969a, 1974; Jennings and Homer 1980). I propose that this lack of evidence is not a product of sampling, but in fact, an issue of resource availability. The wide prehistoric distribution of adzes from Tutuila also attests to the quality of its basalt and desirability of these products (Best et al. 1992). Based on this data, Samoan adze production was very nucleated.

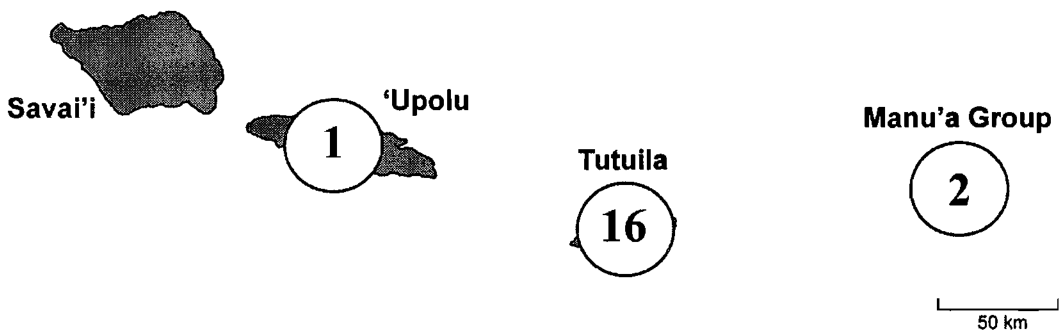

Figure 6.9. Map of Samoa showing the concentration of adze manufacturing locales.

The Intensity of Production

Second, *intensity* describes a producer's work-load expended on their craft: part-time or full-time. Ultimately this parameter is the most difficult to quantify, because a producer's intensity can be low but sustained over a long period of time or high for a short period of time, and the resultant assemblage would look relatively the same. Although this issue would normally be just a time-dependent variable of manufacture, the lack of reliable dates associated with flake scatters makes it necessary to collapse this variable. To create a quantifiable measure, production intensity is examined here according to the density of manufacture in a contextually-based approach. This was accomplished by dividing the total weight of debitage recovered by the cubic meter of cultural soil that was removed to uncover it (Figure 6.10).

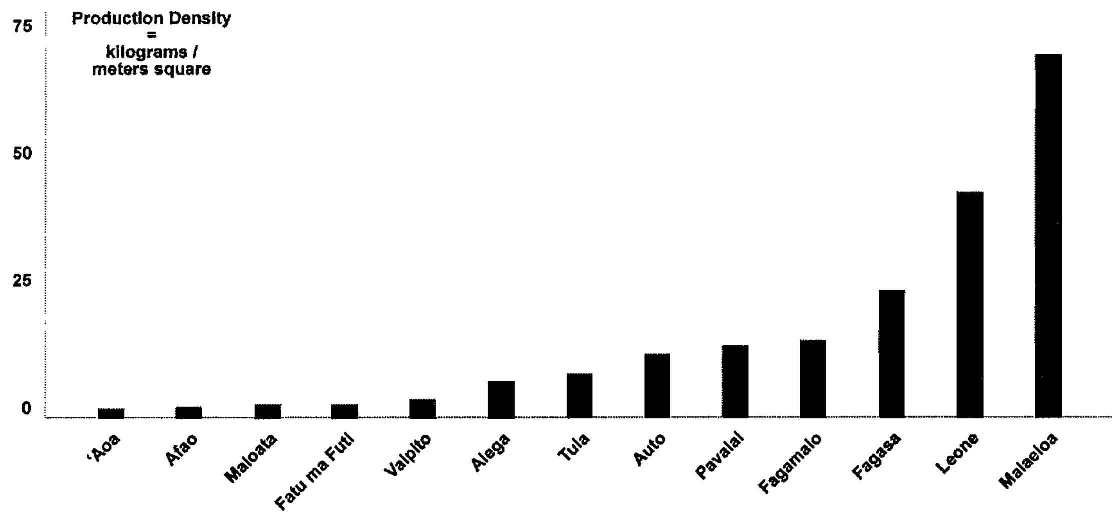

Figure 6.10. The production density of Tutuila's lithic assemblages calculated per valley.

Differing densities show that there is marked variation among production loci, such as between sites in 'Aoa and Malaeloa. There are issues with sampling, such as at Tataga-Matau where only portion of the lithic debris was analyzed; nevertheless, a strong pattern still emerges. In addition, there are related data to take into account to determine the workload of Samoan adze specialists, such as skill levels, scheduling, and risk (Costin 1991). First, the flaking skills recorded in adze manufacture during the Traditional period are the same as earlier periods, and did not change except for the magnitude. Next, Samoan subsistence practices provided ample sustenance with a low demand of labor compared to other Polynesian societies (Goldman 1970:246).

Based on the summation of early missionaries and ethnographers, "[Samoa's] rich soil is so easily cultivated that the small amount of labor usually bestowed upon it, simply scratching the surface, is quickly rewarded..." (Stair 1897:53). With these low demands for subsistence, individuals could have easily supplemented their livelihood with adze production. The risk a specialist accrues when relying on adze manufacture as their sole form of livelihood is connected to the consumption rates of their commodities. Even though households required these tools for a range of activities, adzes were wood-working tools required for home and canoe construction as well as land clearance. But, what frequency would individuals have needed them for daily or even seasonal activities? Coming to a concrete answer is beyond the scope of this present study, but I suggest that adze consumption would have been low locally, except for wood-working craftsman. Thus, the shallow pool of repeat consumers as well as limited skill level would have made this activity a particularly risky full-time venture.

The Scale of Production

The third parameter, *scale*, looks at the type of production units located in a particular community. This parameter measures production organization at the local level, where the larger the size of the facility equates to the larger number of craftsman producing there. If production was occurring at the household level the number of producers per valley would be larger than at specialized workshops, but the output of adze production would correlate with local consumption, and would be relatively low as it was in earlier periods. But at a workshop, a specific facility designed for production, producers have made a labor investment in creating a specialized settlement unit. These workshops would facilitate larger numbers of craftsmen thus increase the amount of total production. To determine if ancient Samoans produced adzes in association with households or workshops, a unit's internal composition, its overall size and the amount of debris being produced need to be considered (Figure 6.11).

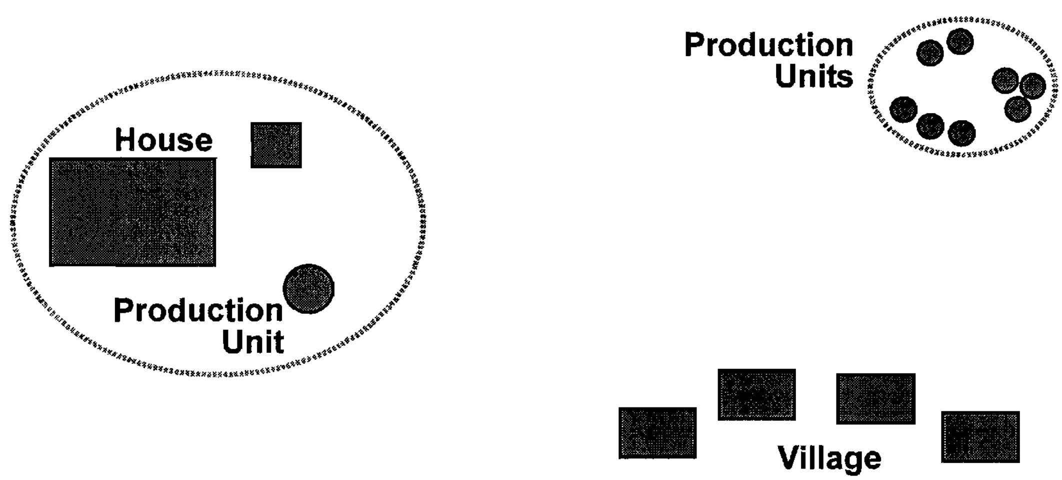

Figure 6.11. A diagram of household (left) and workshop (right) production facilities.

On Tutuila, both forms are present during the Traditional Period. In the Afao Valley, an example of household production is recorded at the Afa Terrace (see Fig. 4.5), where two prehistoric house structures and light lithic scatters are recorded on the same terrace construction. I recorded a total of .63 kg of debris composed mainly of small tertiary flakes. Based on the amount and type of debitage recovered, the manufacturing activities were small scale, probably consisting of either tool rejuvenation or final flaking of a few preforms. In the Malaeloa Valley, I located numerous workshops during survey. These specially-created terraces contained dense flake scatters and few or no residential features. For example, the Frog Terraces contained 49.5 kg of lithic debris composed of a variety of flake sizes and stages representing substantial preform production (See Fig. 4.15).

In looking at the rest of the sites across Tutuila, there are other communities with lithic workshops present. These are located throughout Tutuila at Tataga Matau, at sites in the Tula, Vaipito, Fagasa valleys (Williams 1993) as well as the Tafuna Plain. Although not surveyed for this project, two other communities, based on their locations and proposed production frequencies, could have also contained adze workshops; Le'aeno (Clark et al. 1997) and Alega (Clark 1993) in Eastern Tutuila.

Controlling Production

The last parameter, *control,* relates to the nature of who benefits from a producer's labor, the producer directly or the community's leader, and what was the motivation for the production increases recorded in the Traditional Period (Figure 6.12). If a community leader was in control over adze production, then attached specialists would have manufactured products for the purposes of wealth accumulation. In response to that control, attached specialists would work close to restrictive features such as administrative or defensible positions. Manufacturing sites, themselves, would be larger, so leaders could benefit by merging their controlled labor into one easily restrictive locale. If the individual producers were in control, then adze production was performed to supplement their horticultural income and production would occur near residential structures. These independent producers would negate the energies of controlling production, so they could focus on maximizing their own production. In their efficiency, independent producers would mainly utilize small and interspersed manufacturing sites close to available resources.

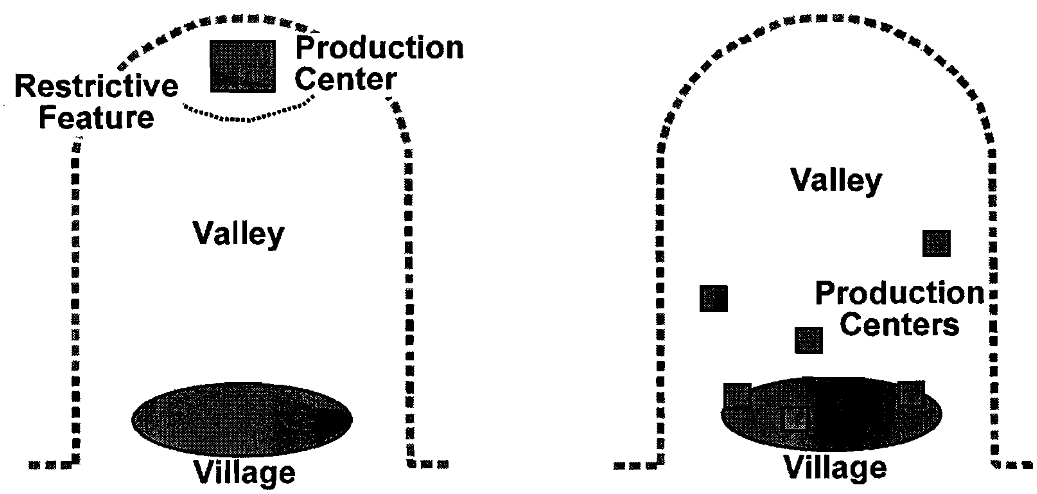

Figure 6.12. A diagram of attached (left) and independent (right) settlement patterns.

Looking at examples from the production loci that have been recorded on Tutuila, I identify the control over production by examining the spatial relationship of manufacturing sites and their associated features in the larger community settlement. Based on this examination, both forms, attached and independent, seem to be present during the Traditional period. The loci that have dispersed household units without any restrictive features present are found in Afao, Fatu ma Futi (Addison et al. 2006) and ‘Aoa (Clark and Michlovic 1996). These valleys have small ‘independent’ manufacturing households located within valley floor. Examples of attached workshops located in either peripheral locations or near defensive features are Tataga-Matau, Le’aeno, Malaeloa, Fagasa and Tula (Figure 6.13)

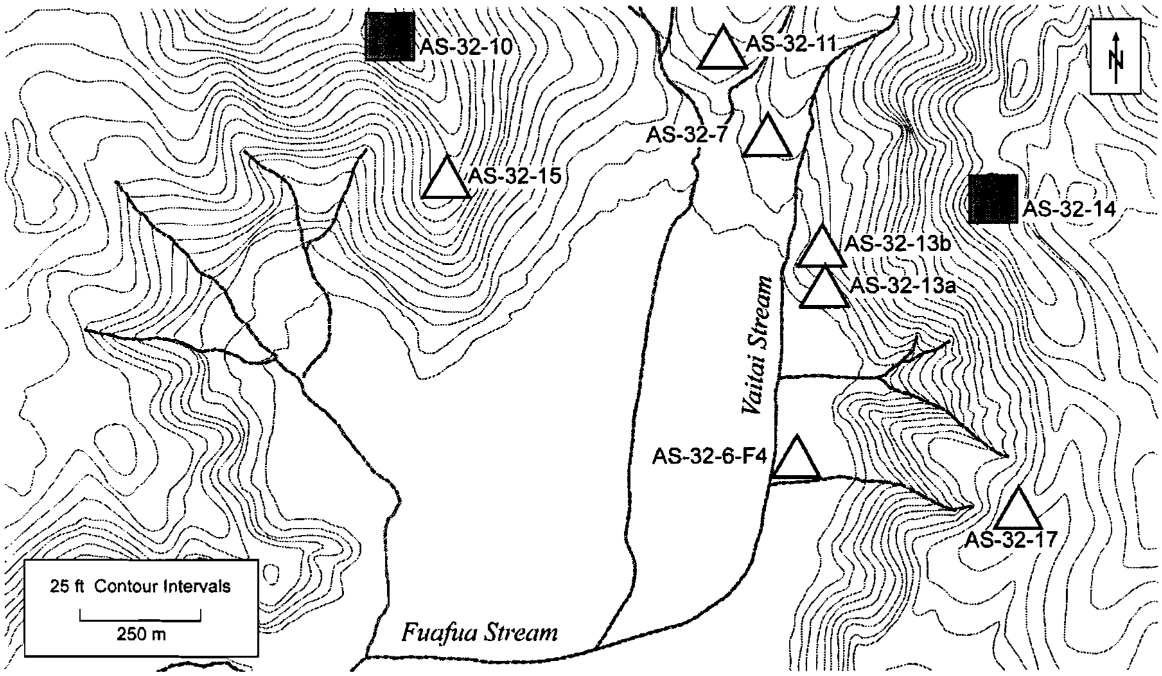

Figure 6.13. A map of Malaeloa's settlement pattern emphasizing the relationship of adze production sites (triangles) and defensive features (squares).

So, what was Samoa's type of craft specialization in prehistory? Previous researchers have stated:

> [F]uture studies will demonstrate that many separate sources supplied the small adzes used on a routine basis by ancient Samoans, but that only one or two quarries offered the fine-grained relatively homogeneous material in a form suited to the manufacture of large … forms required by specialist canoe and house builders. [Leach and Witter 1987:51]

Leach and Witter's conclusion creates a setting of differential status of production centers, and based on my review of other stone tool productions sites on Tutuila, I agree with that statement but I disagree with the special status affixed to Tataga Matau. Tataga-Matau does not represent an anomaly, but more accurately, the complex represents one end in a larger range of adze production activities. In fact, I show that there were two forms of production organizations occurring simultaneously on Tutuila Island during the Samoan Traditional Period. This distinction would account for the two forms of intensification occurring in the Traditional period (see Fig. 6.1), the slight increase at the majority of the Traditional period sites was a product of greater numbers of layman producers and the exponential increases were a result of a stone tool guild's activities. This variation could muddle interpretations, unless one remembers what Roger Green said over thirty years ago - basically all adzes were not created equally (1974:254-255).

In Samoa, adzes were employed as both utilitarian items for subsistence and wealth generating goods by craftsman guilds. For utilitarian adzes, *individual production* was conducted by part-time independent producers at dispersed households for intra-valley distribution. Examples of this situation are recorded at Auto, Tula, Alega, Fagamalo, Pavaiai, Afao, Asili, Vaipito and Fatu ma Futi. For guild adzes, *nucleated workshops* were organized by master craftsman or elites for wider distribution for the purposes of wealth accumulation; here, attached specialists worked part-time at centralized workshops. Examples include Le'aeno, Fagasa, Malaeloa and Maloata. As I have produced evidence for elite control over labor in Samoan adze production, the next question I ask is if the influence of leaders ended at only labor or were there other strategies employed to gain additional surplus for prestige competition.

Research Question Three: Control of Resources

What other forms of control did Samoan leaders have over adze production? My hypothesis is that during the later Traditional Samoan period, Samoan elites developed control over access to high-quality basalt sources and the distribution of the finished products. Hypothesis 3.1 states that Samoan leaders increased their ownership over resources, which could be archaeologically witnessed in the construction of territorial markers, restrictive locations and/or defensive features. There are number of factors affecting a leader's decision to spend energies in protecting their space from a larger population; 1) the availability of the resource in the local landscape, 2) the social and physical decisions on resource choice and 3) the socially accepted means of acquisition strategies.

The restrictions placed on tool-quality basalt in the Pacific represent a two-fold issue. First, there must be a quality geological source within the archipelago, and second, the source must be in a localized environment that can be restricted. As most of the Samoan archipelago is composed of volcanic high islands, oceanic basalt is available for the majority of the population whether they reside in Manu'a, Tutuila, Upolu or Savai'i. Basalt extraction locales have been documented on Manu'a (Weisler 1993a), Tutuila (Clark et al. 1997), and Upolu (Best et al. 1992:58). However, there is a great disparity among the three in the number of extraction sites per island. Manu'a and Upolu each have only three documented sites; whereas, Tutuila has more than 17.

Prior research (Clark et al. 1997; Leach and Witter 1987) has called attention to the variations in types of procurement occurring at extraction locales on Tutuila. In order to be able to physically restrict access to a desired resource, a leader needs to determine the viability of such a task depending on the micro-environment tool-quality basalt is located. There are three specific locations on Tutuila where basalt can be garnered; the outcrop/boulder, the soil matrix and the stream bed. Each location provides logistical issues in relation to restricting access. The stream bed can contain an ample supply of water worn cobbles of varying sizes as well as prime locations for grinding slabs. The high rainfall in Samoa's tropical climate produces excessive erosion, as a result, cobbles from the soil matrix make their way into the stream. In the stream, the force of flooding along ridges can move these cobbles from higher elevations that are inaccessible to more accessible valley floors. Thus, a stream bed provides a long sinuous line of access for adze producers to acquire their basalt, making restrictions difficult over the stream's distance. However, the quality of stream cobbles located in the stream is related to its drainage basin. If the valley's geological environment lacks tool-quality basalt then there will also be a dearth in the stream beds. Outcrops, boulders and cobbles from the soil matrix are more geographically discrete and are easier to restrict. Outcrops can be easily found on the surface and require less preparation in which to strike flake blanks. Boulders and outcrops do have the disadvantage of having fewer striking platforms over time due to the reductive process of stone tool production. Basalt cobbles acquired from the soil matrix require larger energy investments as they are recovered by moving earth. At Tataga-Matau and sites in Malaeloa, extensive terrace construction along ridgelines produced an ample supply of tool-quality basalt as well as stable working and agricultural areas. These terrace complexes tend to be located more peripherally, and as such, would have made access restriction more feasible.

The next factor in determining what conditions were needed to acquire from a certain resource is material choice. Based primarily on a performance variable for stone tools, it is assumed that the stronger the basalt the more often that resource will be chosen. From material strength tests conducted on eighteen geological samples acquired from western Tutuila, the samples "generally fall on the upper end of published values on basalt" (John Logan, personal communication 2006). The tests evaluated the raw materials' tensile strength, which documents the maximum amount of compressive stress prior to breakage. Four locations in the Taputapu volcanics were sampled; Malaeloa samples had an average of 4008.2 psi, Maloata had 4897.7 psi, Asili had 3526 psi, and Afao had an average of 3597 psi. These scores relate quite well to the archaeological observations, as Malaeloa and Maloata valleys contained large production centers as well as regionally distributed products, while Asili and Afoa valleys do not. This is a research avenue ripe for further study; regrettably, I only collected a limited sample set, where testing basalt from Tataga Matau quarry and other quarries from around Tutuila and Samoa would provide a clearer picture on material choice.

Next, social strategies of acquisition are composed of the status of a resource and a leader's control over the resource among the larger population. Direct (and embedded) acquisition of tool-quality basalt presupposes that non-kin or extended kin have unfettered access to a resource as well as the inherent production knowledge in which to produce their own products (Binford 1983:273-275). Reciprocal acquisition, the routine form of economic interaction in Samoa, utilizes a low level form of exchange, not motivated by materials, but on the process of obligation in either as redistribution or a socially-motivated material exchange (Sahlins 1965:141-145). Trade or indirect acquisition is primarily about accumulating wealth which limits social ties in economic decisions. These styles of acquisition would have been greatly influenced by changes in marriage relations during different periods of time as well as any changes in the cultural value held in basalt resources.

To determine if Samoan leadership controlled basalt sources, the types of control at their disposal need to be discussed further. Based on a continuum of the additional labor required for restricting a resource, there are four forms of social control at the disposal of Samoan leadership. The first and least labor intensive form of controlled access is permission. Here, a leader individually gauges a person's access to the desired resource, but gaining permission is a personal act and not archaeologically observable. Next, a set of socially-accepted codes for who is granted access, these codes or constraints require energies in their embedded maintenance within the social realm such as first fruit rights and communal feasting, but are not necessarily related to a specific resource. As competition builds in relation to a resource, territorial markers can be placed around that resource. This third form of access control can physically manifest, itself, as stone fences or piles (Buck 1930: 322), which can also be seen as delineating an internal area separate from the surrounding landscape. In addition to these built markers, Samoans have a long history of using natural markers to delineate land ownership (Krämer 1902); however, these types of markers such as trees, creeks or anomalous stones are very difficult to verify archaeologically. Lastly, defensive features may be placed in and around highly contested resources. Although dependent on the placement of tool-quality basalt resources in the landscape, these resources can have attached defensive features to protect the wealth potential it possesses. In Samoa, typical defensive features that have been defined as mainly hill-forts with terrace and ditch complexes. These hill-forts can cover the apex of the ridge or simply extend along a length of ridge line incorporating natural precipices, and large stone walls (Best 1993:413-426). An excellent example of these types of defensive features was recovered during my archaeological survey of the Malaeloa valley at sites AS-32-10 and AS-32-14 (Figure 6.14). Each site is located in peripheral ridge sites composed of terraces, trench cuts, and earthworks; regrettably, no artifacts or radiocarbon samples were recovered during investigation, so a temporal or complete functional designation cannot be given to either site.

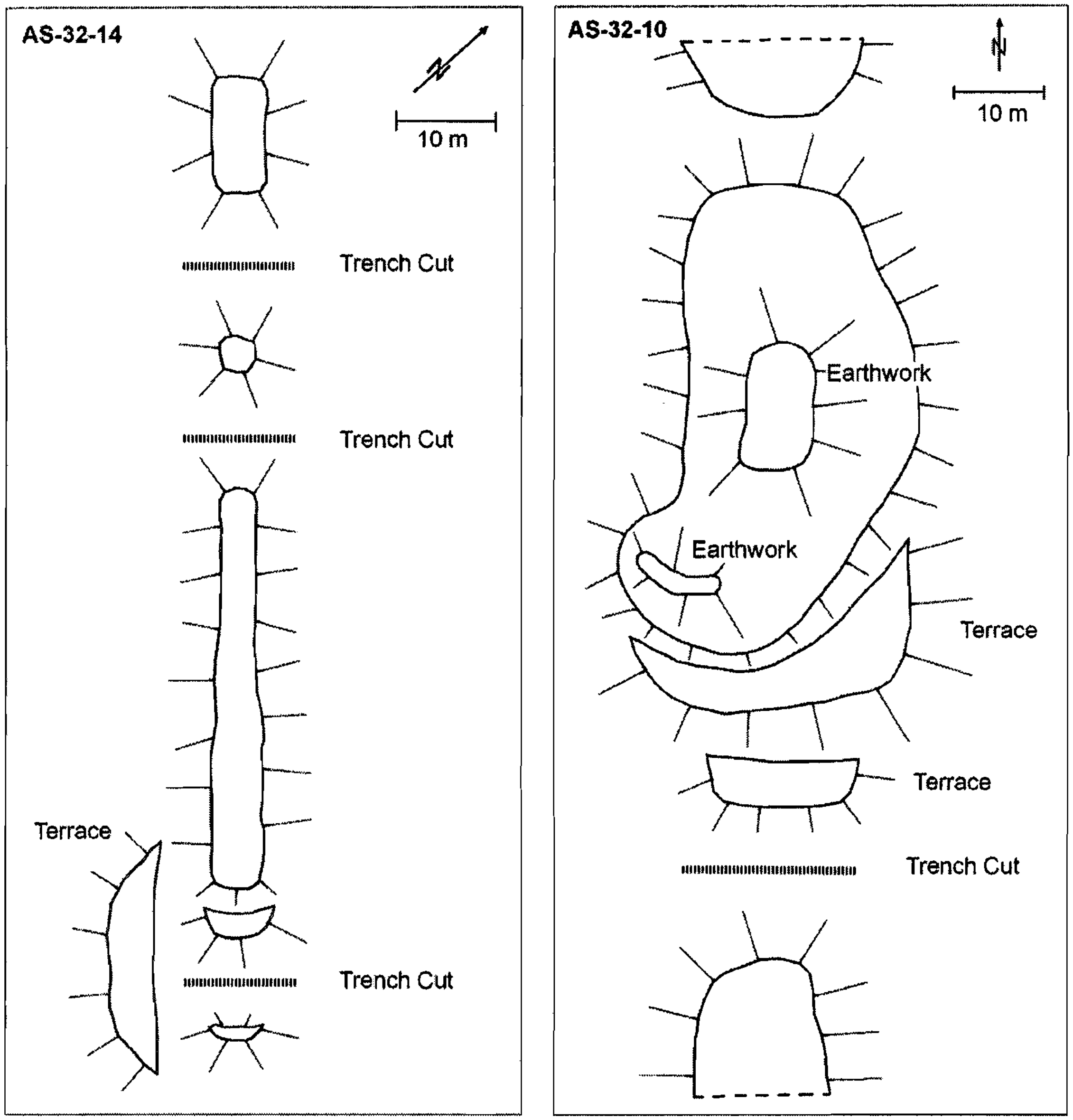

Figure 6.14. Plan view of sites AS-32-10 and AS-32-14, in the Malaeloa valley.

Creating and maintaining defensive features requires a great deal of energy above the normal production work associated with adze production. Less energy-intensive restrictive features can simply entail placing production centers in a peripheral location in relation to the larger settlement, thus making access more difficult. Either way, defensive or restrictive features in association with stone tool production can be viewed as either last resorts for beleaguered leaders or valued investments for highly desired resources. Also it cannot be stressed enough, that large defensive features, such as hilltop forts, were probably built for the other valued resources in production -- the community and its labor force. Leach and Witter also note this fact in discussing the presence of defensive features at Tataga Matau (1990:80).

To accurately test hypothesis 3.1, it is necessary to review the available settlement data connected with production centers, where the association of defensive features and production centers range temporally and spatially. For the following analysis, 14 separate localities of adze production have been investigated from around Tutuila (Figure 6.15). Some sites for this analysis were not discussed in Chapter IV, because I did not analyze their lithic assemblages, but they will now be discussed in greater detail.

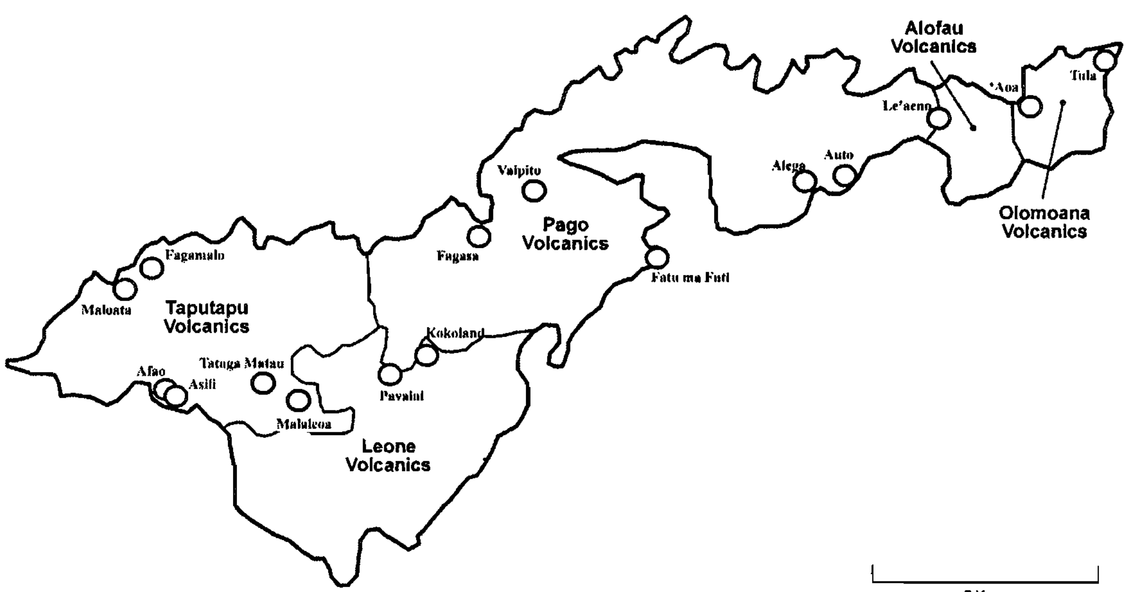

Figure 6.15. Map of Tutuila showing investigated locales of restricted access.

Table 6.4 summarizes the available data and documents production loci by their general geographical location, levels of production and by their association with restrictive features. In response to the above mentioned variables for testing Hypothesis 3.1 – the strength of association and concentration of production – in deciding on whether a leader was restricting access, there are a couple issues that require some further attention. The following summary of evidence needs to be viewed as a tentative measure, because there were substantial variations in the types and amount of data collection occurring at each site during its investigation. In addition, there is survey bias attached to this analysis, because defensive features located in other portions of valleys may be present but not documented. For example, in Maloata only the valley floor was investigated, but the surrounding ridgelines were not (William Ayres, personal communication 2006).

Table 6.4. Documented production centers located in Tutuila.

Location	Production	Temporal Association	Spatial Association
Afao Valley	Low	Low	Low
Fagamalo Valley	Low	Low	Low
Maloata Valley	High	Low	Low
Malaeloa Quarry	High	High	High
Tataga Matau Quarry	High	High	High
Pavaiai & Kokoland	High	Low	Low
Fatu ma Futi	Low	Low	Low
Fagasa Valley	High	Low	Low
Vaipito Valley	High	High	High
Alega Valley	High	Low	Low
'Aoa Valley	Low	Low	Low
Auto Valley	Low	Low	Low
Lau'agae Quarry	High	High	High
Tula Valley	High	High	High

Out of the above 14 production loci, five sites have recorded high concentrations of stone tool production *and* are at least in some spatial association with a defensive feature or are peripherally located. These five sites and Fagasa valley, added for contrast, are discussed further to better assess if their ultimate location was a product of a leader's decision to restrict access or was simply a matter of geological happenstance.

Tataga-Matau

In reviewing the production sites in association with access restriction, the first and possibly the best example is Tataga-Matau (Leach and Witter 1990). Tataga-Matau, first visited by Peter Buck in 1927, has become the best-known basalt quarry in Samoa. Archaeological analysis of the site began in 1985. Helen Leach and Dan Witter, over the course of two field seasons, mapped and excavated at the quarry complex. In addition to their insightful research on production stages and extraction techniques, the archaeologists have documented an impressive and dispersed ridge top complex that contained numerous quarry areas, terraces, star mounds, earthworks and defensive trenches (with the aid of Simon Best in 1988). Taking into account the ridgeline modifications at the site, the quarry areas are located quite a distance apart, and although there are defensive trenches in association with the complex, they are not the main restrictive features. Past leaders would have utilized the site's upland location as the primary restrictive feature from the more coastal and densely populated village of Leone located over a kilometer and a half away.

Vaipito

AS-25-62 is a single terrace with extensive stone tool production evidence residing inside a larger, but unsurveyed, terrace complex located in the uplands of Vaipito valley. Extensive excavations were conducted by the Archaeological Division of American Samoan Power Authority in 2003. Regrettably, the terrace has been modified by modern earthmoving activities, so the relationship of terrace to a larger complex is unknown and further survey work is needed. In the end, I conducted lithics analysis on materials excavated from a cultural lens dating to thirteenth century A.D. In this assemblage, there were nine performs and slightly more than 14 kg of flaking debris. Although no defensive features were documented, the large production center is located 1.4 km upslope from Fusi village in the Pago Pago harbor. In the back of the Vaipito valley, site AS-25-62's location makes one question whether it was purposefully constructed there to restrict access or it was part of a larger residential area? Due to the current population heavily centered around Pago Pago harbor, the location of a nearby reservoir and extensive housing construction in the immediate vicinity, this disturbance may make it difficult to ultimately assess this question. In addition, more work is needed in evaluating if the Vaipito stream, running through the center of the valley, furnished tool-quality basalt over a long distance of the stream bed or if the source was more discrete. But that said, the site is still peripheral relative to the coast, the likely location of sustained human settlement.

Lefutu

The Lefutu Ridge contains an inland settlement, AS-21-2, located on a broad ridgetop approximately 700 m west of the current village of Tula (Clark 1989:38-44). Site AS-21-2 has been investigated multiple times by earlier archaeologists (Frost 1978; Clark and Herdrich 1989; Pearl 2004). Site AS-21-2 was occupied starting in the Traditional Samoan Period at approximately fourteenth century A.D. (Pearl 2004:336-337) to the historic period (Clark 1989:43). AS-21-2 is most aptly described as a residential complex, because the site is composed of at least 12 house foundations but only *one* defensive trench (Clark 1988). In addition, the site's location is relatively close to the coast and habitations creating a situation of easy access. During recent archaeological investigations near AS-21-2, a wide array of manufacturing activities was documented at site AA-2006-6-6. At the Tula Septic Terrace, there were 35 adze preforms recovered as well as almost 9 kg of waste flakes from 10 50 x 50 cm test units with lithic production deposits dated to sixteenth century A.D. This date coupled with its location immediately downslope of AS-21-2 make the sites closely connected. Interestingly, the raw material being utilized at the site was not from locally available rock outcrops in the nearby ridge slope, but from creek cobble obtained from a nearby stream bed 200 m away. Based on my survey of the ridgetop site as well as Clark's documentation, the production center, he Tula Septic Terrace, would have been capable of providing the required tools for site AS-21-2 and nearby residential sites. Even though there were a high number of broken performs recovered during the pedestrian survey, it is the amount of debris recovered which makes a case for he Tula Septic Terrace insufficient to provide additional surplus for prestige competition. However, the nearby Lau'agae quarry complex, documented by Clark and Herdrich (1993), covers roughly 10,000 m^2 and consists of at least 12 separate production centers. This quarry is near both residential remains and two star mounds, but its location, similar to AS-21-2, make it unlikely that restrictive measures were in place at the production center.

Le'aeno

The Le'aeno Quarry, AS-21-110, is located near defensive features of ditches and steep terraces along Le'aeno Ridge in eastern Tutuila (Clark et al. 1997:72). Clark described intensive production activities occurring at this quarry as well as two neighboring quarries (Figure 6.16). Regrettably these sites have no temporal association, but their peripheral location to the coast and villages in conjunction with a number of defensive features does provide a strong case for restricted access.

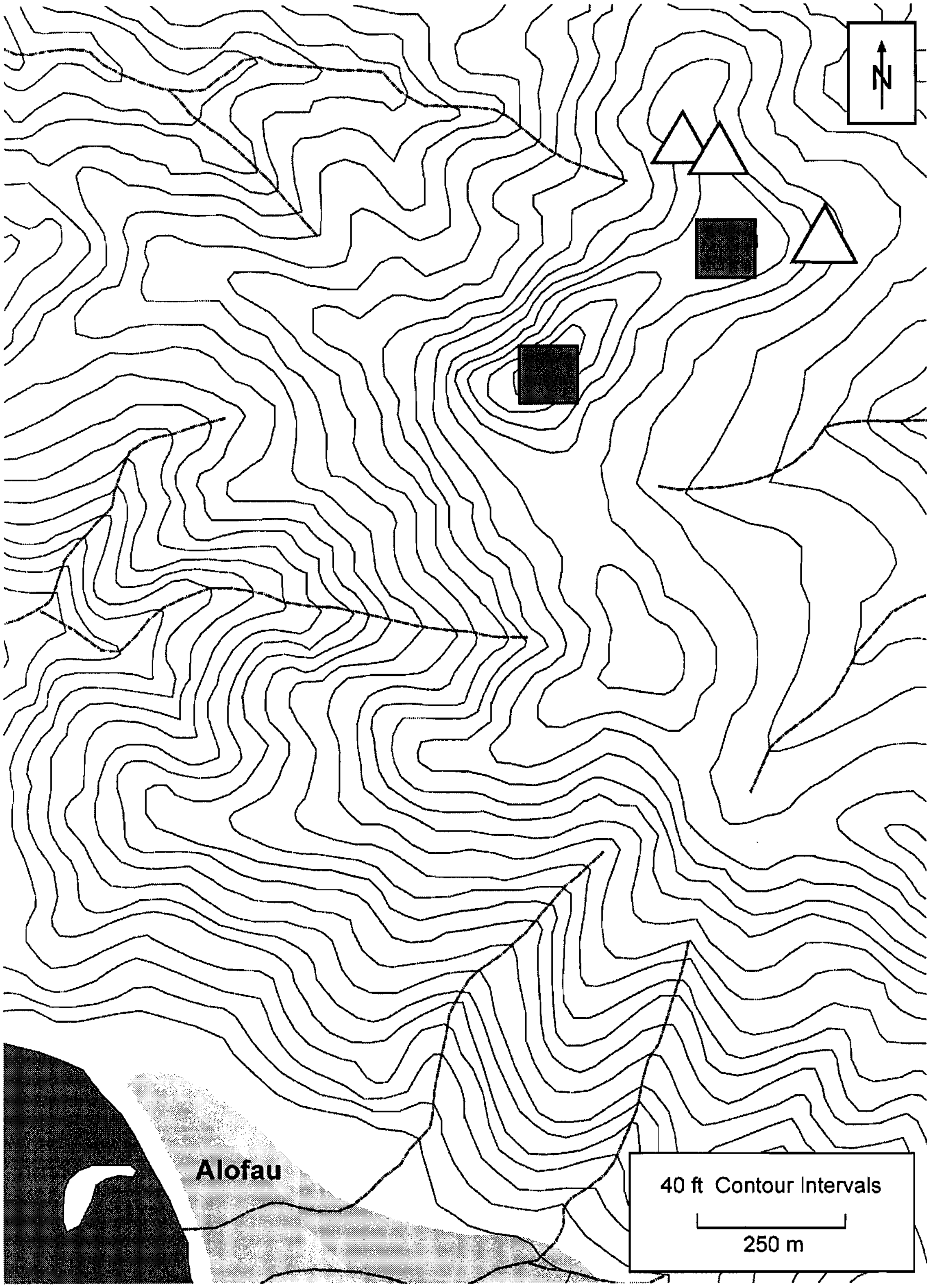

Figure 6.16. Map of the Le'aeno production complex (triangles) and defensive features (squares).

Fagasa

The Fagasa quarry is loosely connected spatially to nearby ridgeline fortifications, (Best 1993:423; Figure 6.17). In August of 1991, David Herdrich conducted a survey of the production centers and surrounding area (personal communication 2005). During his survey, he noted numerous workshops along the back of the valley and lower regions of the surrounding ridges. However, taken in a larger settlement context, I think that the evidence shows the production centers are ultimately closer to the coast near Fagatele village, and are placed at the base of the ridges, so if access had been restricted at these sites, it would have required more methods, but ones not archaeologically visible.

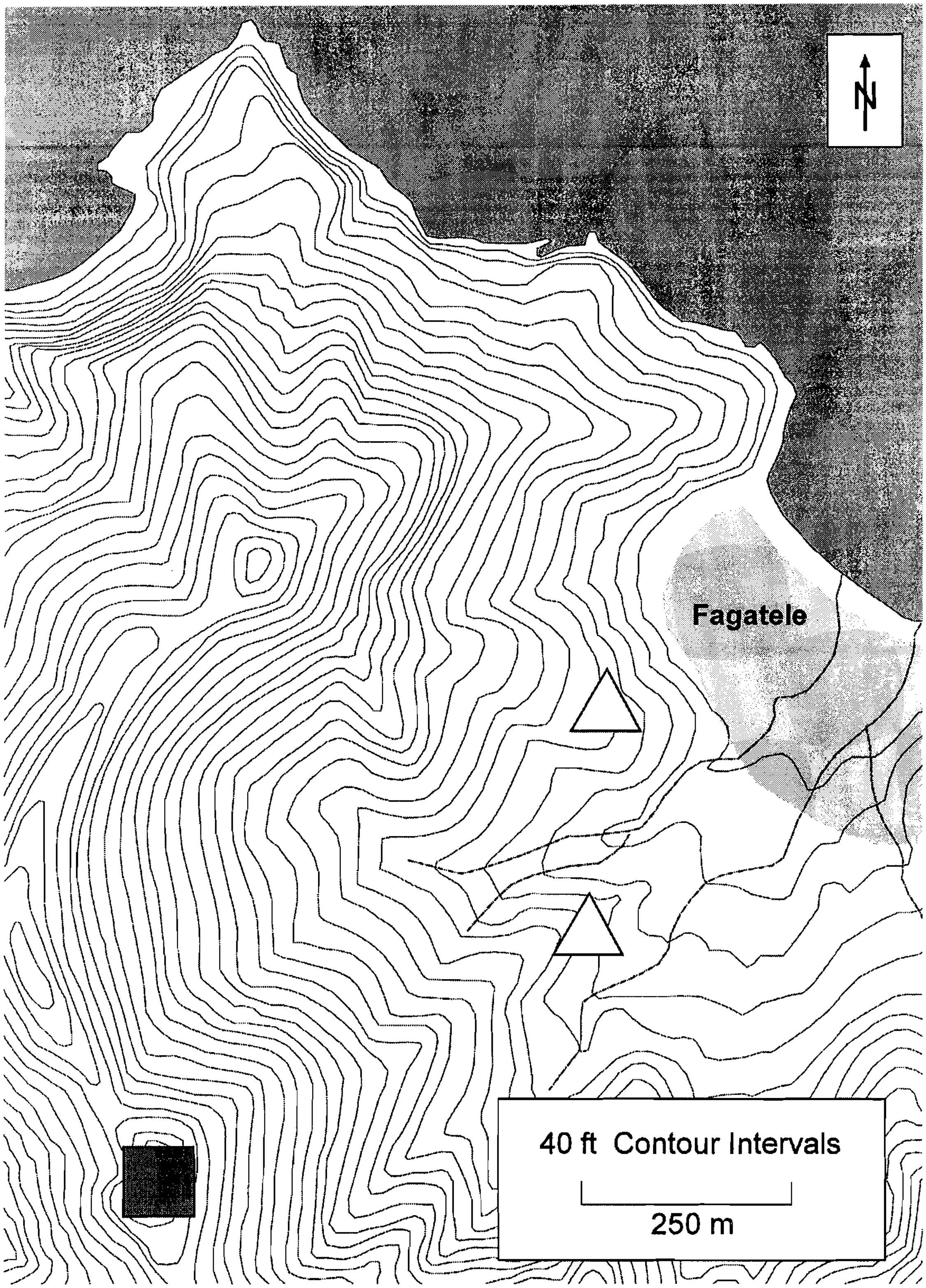

Figure 6.17. Map of Fagasa's settlement pattern emphasizing the relationship of adze production sites (triangles) and defensive features (squares).

Malaeloa

Malaeloa Valley has intensive production locales in the rear slopes dating to the later Traditional Samoan period dating to 900 to 200 years ago, and also has defensive features on its surrounding ridges. Sites AS-32-10 and AS-32-14 are defensive ridgetop sites allowing for an observation position to view the entire southwestern side of the island (Winterhoff et al. 2006). At these defensive sites, no cultural or datable materials were encountered during limited excavations, so no temporal designation can be provided for them. Their presence does call attention to why such features were needed at this inland valley, and the peripheral location of the valley itself from the coast and other populations suggests that the production centers at the back of the Malaleoa valley were at least in some small measure in spatial association with the valley's defensive sites, especially taking into fact Tataga-Matau's dispersed settlement.

The availability of high-quality raw material, alone, was not the only reason why chiefs would have placed these production sites at such restrictive locations, because the vast majority of production sites, with similar quality basalt, are found in highly accessible locations across Tutuila. Also, there are data to suggest that although adze production was conducted in association with defensive features, it seems that the defensive features were being primarily maintained for other reasons, such as people. Leach and Witter touch on this by stating the fortifications at Tataga-Matau were:

> [I]n strategic terms, the defensive features could have been used to control access to the three main quarry areas, and the excavations at the Lower Ditch confirmed that stone working occurred both before and after earthwork construction. At one phase of the complex's long history,

> therefore, the quarries were closely associated with the fortifications, though it must be made clear that the ditches and scarps also protected what were probably living areas. [Leach and Dan Witter 1990:80]

In sum, defensive features alone do not account for the entirety of ancient Samoan abilities to restrict access, but if one takes in to account sites located in peripheral locales, a stronger argument for a political motivation for control can be made, especially at the Tataga-Matau, Le'aeno and Malaeloa production centers.

Research Question Three: Control of Distribution

Did Samoan leaders control the distribution of the specialists' products? In hypothesis 3.2, I stated that Samoan leaders benefited by controlling exchange in their internal prestige competition. Regrettably, the amount of information required to answer this question fully is unavailable, because more provenance research is needed in the region for both distributed adzes as well as possible sources. Nevertheless, some tentative statements can be made. Adze exchange relates directly to the larger economic principles embedded in a Samoan and West Polynesian-East Melanesian cultural milieu. Based on my new provenance data, I recognize four levels of distribution involving Tutuilan adzes: Intra-Valley, Inter-Valley, Intra-Archipelago and Inter-Archipelago. These mutually exclusive levels of exchange define the observational units of increasing distances traveled by the product, which supplies important indications on the decreasing relationship between producer and consumer within stratified societies (Sahlins 1965:149-158).

Intra-Valley Distribution

Intra-valley distribution describes the movement of adzes within a village community, where reciprocal acquisition entails the collection and allocation of materials through immediate social connections. Intra-valley distribution is demonstrated by the occurrence of nine adzes or adze flakes in Malaeloa Valley that originated from Malaeloa Group 2 basalt. Similarly, one adze found in Maloata Valley was manufactured from the defined Maloata source.

Inter-Valley Distribution

Inter-valley distribution refers to movement of materials among various villages on Tutuila (Figure 6.18). As outlined previously, basalt tools were used as political wealth within Samoa's chiefdom, because adzes were used in the manufacture of high status craft items, employed as specialized tools by a formalized carpenter guild, and most importantly, basalt tools were manufactured within a politicized geography. Examples of inter-valley distribution are recorded by the presence of three adzes found in Afao, one from AS-21-6 in 'Aoa, and one adze found in Asili, all of which were sourced to Tataga Matau. Likewise, we found one adze in the Malaeloa valley and two adzes in Asili made from Maloata basalt. Two adzes found in Afao were made from Malaeloa Group 2 basalt.

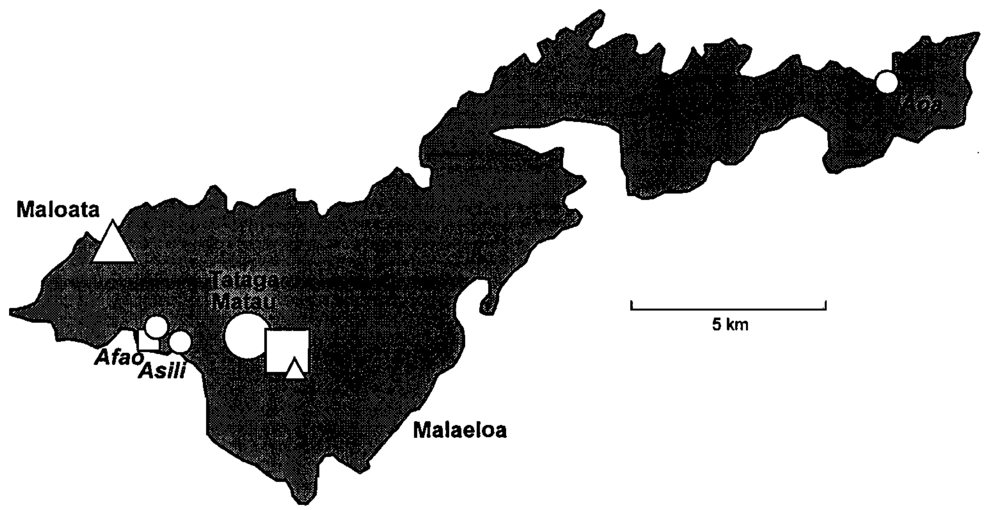

Figure 6.18. Intra-island distribution of adze samples.

Intra-Archipelago Distribution

Intra-archipelago distribution encompasses behaviors associated with adze transport between Tutuila and elsewhere in the Samoan archipelago, and presents an expansion of relationships found in Inter-Island exchange (Figure 6.19). Examples of intra-archipelago distribution include the presence of a Malaeloa Group 2 provenanced adze in Luatuanu'u on Upolu, and a Tataga Matau basalt adze was found at Sasoa'a, Upolu.

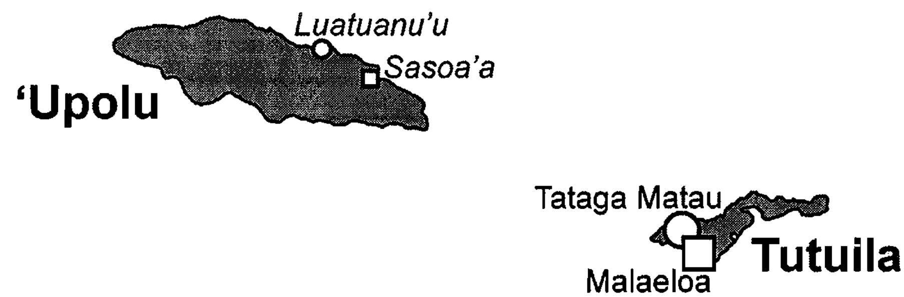

Figure 6.19. Intra-archipelago distribution of adze samples.

Inter- Archipelago Distribution

Inter-archipelago distribution of adzes refers to trade exchange between independent societies (Figure 6.20). Kaeppler (1978) is often cited to show the social mechanisms of regional interaction. She discusses trade partnerships within the fifteenth to eighteenth century A.D. network among chiefs of Fiji, Tonga and Samoa, and describes the social exchange of raw materials and spouses among these cultural entities within the realm of chiefly competition. Examples of inter-archipelago distribution are observed by the presence of two Maloata adzes in Fiji and one in Tokelau. Additional adzes made from Malaeloa Group 2 were found in Fiji and in Tokelau. Two adzes from Tataga Matau were found on the Taumako Islands in Island Melanesia, one was found in Tonga, and one was uncovered in Tokelau.

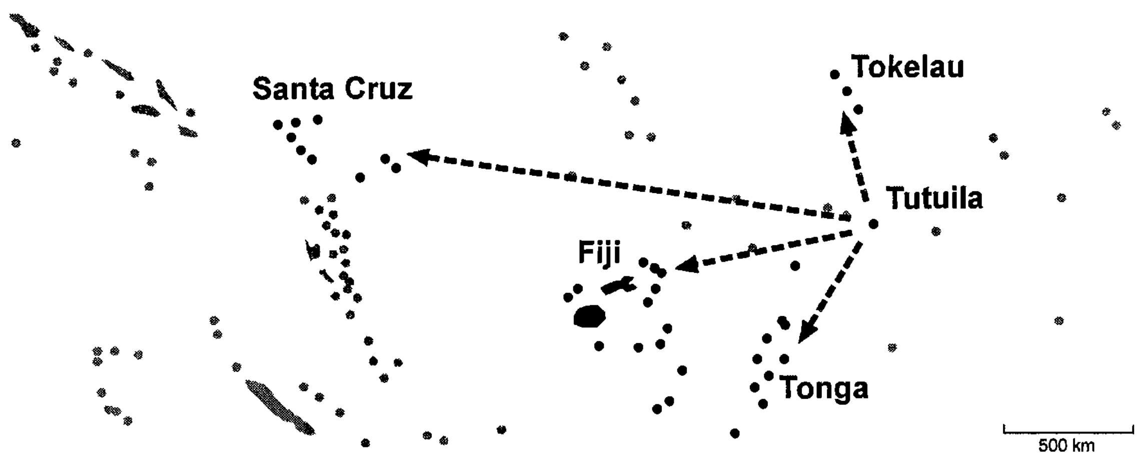

Figure 6.20. Inter-archipelago distribution of adze samples.

If adze distribution was a component of internal elite competition, then negative reciprocity should only be present within Samoa during the Traditional period and in conjunction with emerging stratification as reflected in a greater focus on inter-archipelago distribution. Although the data set is too small to make such a definitive determination, there is still an interesting note to be made. Early ethnographers (Buck 1930; Krämer 1902) have noted that Tutuila had multiple chiefly name-lineages vying for social prestige within the greater Samoan politic. In relation to the geochemical data I have presented, there are two titles, *Fofo* and *Itulagi*, which offer insights into understanding the relationship of adze circulation and Tutuila's political structure. These two name-titles split western Tutuila (Figure 6.21).

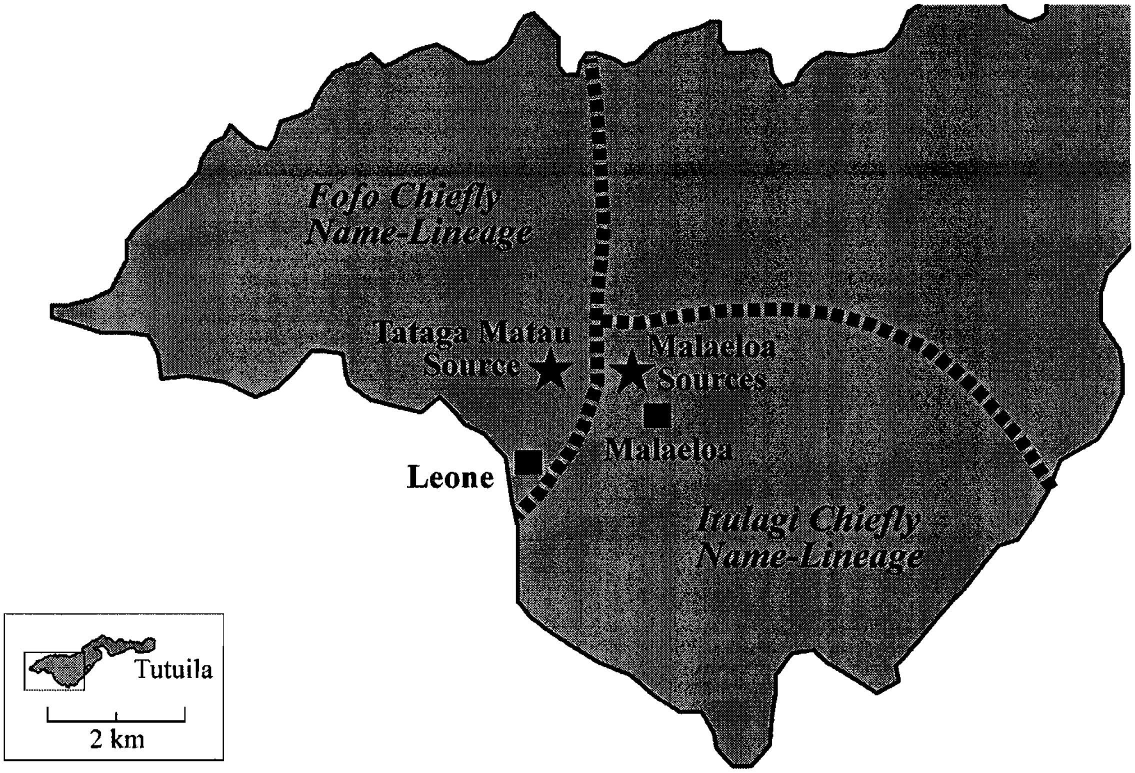

Figure 6.21. Map of western Tutuila with approximate boundaries between the *Fofo* and *Itulagi* chiefly name-titles outlined by Krämer (1902).

Fofo chiefs controlled numerous villages and families on the west and the north portions of the island, and *Itulagi* chiefs controlled the west and south. Ethnographically, *Fofo* controlled Leone as its central village, and administered the quarry site of Tataga Matau, as recorded by Buck (1930:330); whereas, the *Itulagi* chief oversaw Malaeloa as a constituent village in its larger holdings. This political divide illuminates an important variation in political boundaries and economy that would have provided motivation for their chiefly control. In my examination, the differential distribution of transferred adzes corresponds to chiefly control in inter-archipelago trade networks. Inter-archipelago exchange and its negative reciprocal negotiations is how a chief can generate and display material wealth without impinging on his or her more immediate social relations. Albeit limited, the two chiefly name-titles in western Tutuila do provide an example of this occurrence with having adzes from their lands recovered abroad marking their participation. This line of research, in its beginning stages, holds future promise in successfully documenting the development and forms of prehistoric exchange networks occurring in West Polynesia.

In this chapter, I evaluated my three research questions and related hypotheses outlined in Chapter III with the data I collected and discussed in Chapters IV and V. The first research question asked if adze specialists were present in prehistoric Samoa. Based on multiple measures of manufacturing efficiency, I recorded craft specialization occurring at a number of production centers. In the second research question, I asked if stone tool specialists existed, then what type of specialization occurred and its relationship to leadership strategies employed by Samoan elite. Utilizing the four parameters outlined by Cathy Costin's research in craft specialization (1991), I documented a new form of economic organization for the Traditional Samoan period, *nucleated workshops*, which is a form of craft specialization routinely connected to increasing political complexity and stratified authority. The third research question asked if Samoan elites had controlled adze production and the labor of adze specialists, then did these chiefs also have authority over other parts of the economic system. Based on settlement patterns and site data from large production centers, I concluded that Tutuila chiefs did position production centers in restrictive locales for the purpose of controlling access to a desired commodity. Then with chemical characterization data, I was able to document the presence of multiple levels of geographic distribution of Tutuila adzes. From these data in conjunction with Sahlins' model on exchange and social relationships, I concluded that Tutuila chiefs controlled the distribution of adzes manufactured from their lands using negative reciprocity for inter-archipelago exchange networks. The next chapter summarizes my conclusions, outlines my contributions to Samoan archaeology, lithic studies and our understanding of Polynesian economies, and concludes with how Tutuila, as a study in political economy, provides an intriguing insight into an endogamous mechanism for the evolution of Polynesian political complexity.

CHAPTER VII

CONCLUSIONS

> *For a social activity – and with it its corresponding and organizing ideas and institutions – to play a dominate role in the functioning and evolution of a society... it is not enough for this activity to fulfill several functions; it must be necessarily, in addition to its own ostensible purpose and its explicit functions, function directly and internally as a relation of production.*
>
> Maurice Godelier (1978:765)

In ancient Polynesia and elsewhere, chiefly power was drawn from the effective use of resources in the economic, militaristic, social and/or ideational realms (Earle 1987; Goldman 1970; Kirch 1984; Sahlins 1958). My research explores how the investigation of basalt adze production, a material representation of the economic realm, offers insights into the prehistoric transition of Samoa's political complexity. To accomplish this, I examined economic indicators of how Samoan chiefs could have increased their societal status within the political realm. These indicators include; 1) increasing production, 2) restricting access to scarce resources, and 3) controlling distribution.

In Tutuila, Samoan chiefs historically employed their power over groups of untitled men, family lands, tribute, disputes and feasting, and I have made a strong case that this type of authority was exercised over basalt adze production in the archaeologically-known past. Adzes, a very significant technological resource, were manufactured from high-quality basalt situated within a geography parceled by different '*aiga* and *matai* (Krämer 1902; Goldman 1970), were utilized by other specialists manufacturing wooden status items (Buck 1930), and were exchanged outside of Samoa as part of an inter-societal trade network (Kaeppler 1978; Weisler 1997). These data establish that this artifact class is vital in charting status changes within Samoa's prehistoric polities, particularly in how changes in waste debris from adze production allow us to monitor shifts in the social organization of their production. Craft specialization is one aspect of this organization which facilitates opportunities for ancient leadership to accumulate material and social wealth. In Polynesia, specialization is cited as an increasingly significant strategy for financing emerging elites, because it can greatly increase production levels without diverting large amounts of labor from the population as a whole (Bayman and Moniz-Nakamura 2001; Cleghorn 1986; Earle 1987, 1989; Kirch 1984, 1991; Lass 1998; Spielmann 2002).

During the political transition in question, archaeologists have also documented an increase in the amount of adze production as well as an expansion in the regional distribution of Tutuila's adzes. But at the same time, these economic changes corresponded with a proposed swell in Samoan populations (Kirch 1984:98). So in my research, I asked three inter-related questions in an effort to explain if this material shift was a result of political maneuvering or primarily an issue of demographics. Those questions are; 1) was craft specialization present in Samoa's ancient stone tool industry, 2) if so, what type of specialization was being practiced, and 3) what additional types of control did Samoan leaders employ over adze production?

To answer these questions, I conducted detailed debitage analysis, typological classification and geochemical characterization of lithic assemblages from seventeen archaeological sites on Tutuila Island. Based on the results of these analyses as well as from site data, I established the presence of stone tool specialists as the explanation for the increase in adze production occurring in the Traditional Samoan period. At these adze specialization sites, I documented not only vast amounts of waste debris but also multiple measures of manufacturing efficiency. Utilizing Costin's comprehensive typology, I then determined that the type of specialization was *nucleated workshops*, defined as a consolidated group of producers manufacturing adzes for non-local distribution (1991:10). The archaeological sites classified as nucleated workshops start to appear approximately 800 years ago and mark the first presence of this new form of Samoan economic organization, not only for adze production, but perhaps for the other forms of *tufuga*. In addition, I documented continued local production of adzes by non-specialists during the same period. These sites continue a low production out-put witnessed in earlier periods. This dual production system is similar to how the historic carpenter *tufuga* designed and manufactured chiefly structures, but commoners were responsible for their own house construction (Buck 1930:84).

> Political power rests upon economic efficacy, which is measured by the general aura of abundance within which a chief lives, by his ability to promote economic growth, and by his capacity as a donor. The first of these measures is largely symbolic, defining the physical setting of a chief. The second is a more active measure, testing both religious and secular capabilities. The third is the most specific measure, involving the chiefs in immediate and concrete relations with the community. [Irving Goldman 1970:18]

As Goldman outlines above, the development of increased Tutuilan chiefly power required that chiefs promoted economic growth to maintain needed surplus levels. Because of the limited arable land and other forms of traditional surplus, I propose that the presence of these stone tool *tufuga* on Tutuila, with its abundance of high-quality basalt, would have provided that economic stimulus for Tutuila's elites. It is not coincidental that the presence of these adze specialists post-dated the emergence of stratified status in Samoa by only a short period of time. On Tutuila, chiefs utilized these basalt adzes as an avenue to gain material surplus, so they could participate in the larger Samoan prestige competitions.

In addition to this re-organization of labor, there is also evidence for increasing elite control over resources based on the peripheral locations of larger manufacturing loci. I examined settlement data from manufacturing sites around Tutuila, and was able to show that the production loci with the greatest amount of debris correlated to remote and restrictive locations. Raw material availability, as a single parameter, cannot alone account for the placement of these production sites, because less restrictive locations with similar quality basalt found in valleys were not utilized in a similar manner. Although I conclude that the settlement placement was a product of Samoa's politicized geography and increased chiefly authority over managerial responsibilities, further research in Upolu and Savai'i will aid in shedding more insight into this spatial component of Samoan authority.

Finally, I propose that there was chiefly control over the circulation of Samoan adzes, and the differential distribution displayed between the *Fofo* and *Itulagi* titled elite in western Tutuila represents an example of this competitive trading. However, with this provenance research, one important question remains. If this dramatic increase in adze production occurred on Tutuila, where were all the finished commodities ending up? I encourage future geochemical sourcing in the rest of the archipelago, because I believe this work will ultimately provide the key to understanding how the local politics of production relates to the societal politics of exchange.

As a by-product of my analyses, I was also able to investigate a range of research issues in addition to addressing my primary research questions. Compared with previous adze production research on Tutuila, which typically focused on just a particular valley or a single site (Ayres and Eisler 1987; Ayres et al. 2001; Clark 1993; Clark and Michlovic 1996; Leach and Witter 1990), this study was the first to sample a wide variety of manufacturing sites around Tutuila and to systematically document the range of behaviors connected to Samoan adze manufacture and its relationship to socio-political changes by relating specialized production methods to spatially-differentiated quarries and workshops. Based on the amount and stages of debris present at these sites, I found a substantial variety of adze manufacturing occurring in Tutuila ranging from the simple rejuvenation of a dulled adze blade at habitation sites to the mass production of adze preforms at special activity sites. The magnitude of adze manufacturing activity on Tutuila is not matched anywhere else in the archipelago. I surmise that this situation is a result of the abundant high-quality basalt present on Tutuila; however, this was not the ultimate cause for its occurrence.

Another significant issue in Samoan adze studies is the lack of an accepted methodology utilized to investigate waste flake assemblages (see Clark 1993 and Leach and Witter 1990). To alleviate this issue, I proposed and implemented a successful form of mass flake analysis that can chart reduction sequences with a simple two-fold examination. It is my hope that this highly efficient and replicable method will now be incorporated in subsequent archaeological projects and allowing assemblage analysis to be more comparable across Samoa as well as easing the time constraints of lithic studies for cultural resource archaeologists in the future.

Helen Leach and Dan Witter have enhanced our knowledge on how Samoan adze producers manufactured their finished products (1987, 1990). I have contributed to this research by examining how differential discard patterns of quadrangular and triangular adze preforms can provide additional clues to that process. I have found that the successful manufacture of either form of adze preform varies according to the stage of reduction a producer was conducting. Also, I have noted that preforms were most frequently discarded after producers caused an initial transverse or oblique fracture across its length. In relation to tool discard, a broken preform's quick rejection is linked to the substantial amounts of high-quality raw material available and indicates a form of manufacturing efficiency.

Another contribution from my research to the investigation of Samoan stone tool production is the intriguing temporal difference I recorded in the distribution of basalt flake tools. A total of 76 flake tools were noted, which composed 35 percent of the total tool assemblage I collected at the different production sites. Based on Jeffery Clark's work in the Samoan flake tools (Clark et al. 1998), the presence of these informal tools shows a substantial secondary activity in Samoan stone tool production. In my investigations, this statement is true for adze manufacturing in the Traditional Samoan period, but is not the case for the Polynesian Plainware period because only two flake tools were recorded from sites of this period. The frequent presence of flake tools in later lithic assemblages is a by-product of an increased focus on adze production throughout Tutuila, where they represent another technological enhancement in efficiency as more of the waste material was put to a useful purpose during the later period.

Numerous chemical characterization studies relating to Samoa and their adzes have been conducted over the last 15 years (Best et al. 1992; Clark et al. 1997; Di Piazza and Pearthree 2001; Johnson et al. 2007; Sheppard et al. 1997; Weisler 1993a, 1998; Weisler and Kirch 1996). I complement this research by recording two additional valley sources, Malaeloa and Maloata, and adding twenty-four sampled adzes to a slowly growing geochemical database. The results of my geochemical research can be used to document that valleys can contain differentiated geological sources and that Tutuilan adzes were recovered in varying distances from their source. Although the distribution of Samoan adzes is commonly associated with long-distance exchange networks (see Best et al. 1992), it is clear that adze distribution also occurs at local levels; within the valley of its manufacture (n = 10), within Tutuila (n = 8), and within Samoa (n=2). From these varying spatial levels of adze distribution, I suggest this pattern is representative of redistribution exchange at the intra-valley level and the remaining adzes constituted reciprocal transactions occurring across status relationships within Samoa (see Sahlins

1972:185-276). Additionally, my characterization study documents the presence of multiple sources within the Malaeloa valley. The differential distribution from these sources accentuates the spatial distinctions in Samoan social exchanges. Malaeloa Group 2 has nine adzes recovered at sites from all around the valley, which would have reflected redistribution of local materials among a closely-related kin group. In contrast, Malaeloa Group 1 had no recovered adzes linked to its related production site, AS-32-13b, which both had a substantial amount of waste debris – 49.5 kg. I have interpreted the absence of this source material among Malaeloa adzes as reflecting the restricted use of this material for specialized production and trade. Additional characterization studies on adzes and sources will aid in determining the close relationship of adze distribution and small scale political strategies that I documented in this study.

A hallmark of political economy studies is the stress placed on an internal mechanism as the fundamental factor for cultural change. In the model below, I follow in that tradition by positing an endogamous mechanism, prestige competition with its focus on the accumulation of social status, as the dominant process for the changing political complexity on Tutuila Island, which can be seen as a reflection of Samoa in general. I do not dismiss the advantages of their environmental context with respect to high-quality basalt, but rather, I stress the elite's desire for accumulating prestige and status within the greater Samoan political system and their strategies for achieving this as the major cause for the evolution of this stratified Polynesian chiefdom.

Adze Production and Emerging Elite

My discussion of adze production and specialists calls into question an intriguing ethnohistoric observation that Tutuila was the least politically important island in the Samoan archipelago. Although Tutuila was able to create substantial surplus in respect to adze production, the island did not hold sizable political status at Western contact. In fact, Krämer in 1902 stated that the island held no great titles and was ultimately subservient to chiefs on Upolu. Originally, I assumed that this may have been a recent situation exasperated by European and American powers, but from numerous conversations with local chiefs from around Tutuila, I have found this view to be corroborated by their oral traditions. I propose an economic explanation centered on chiefly strategies to account and explain the ethnohistoric situation by outlining the prehistoric connection to adze production and social status over time (Figure 7.1).

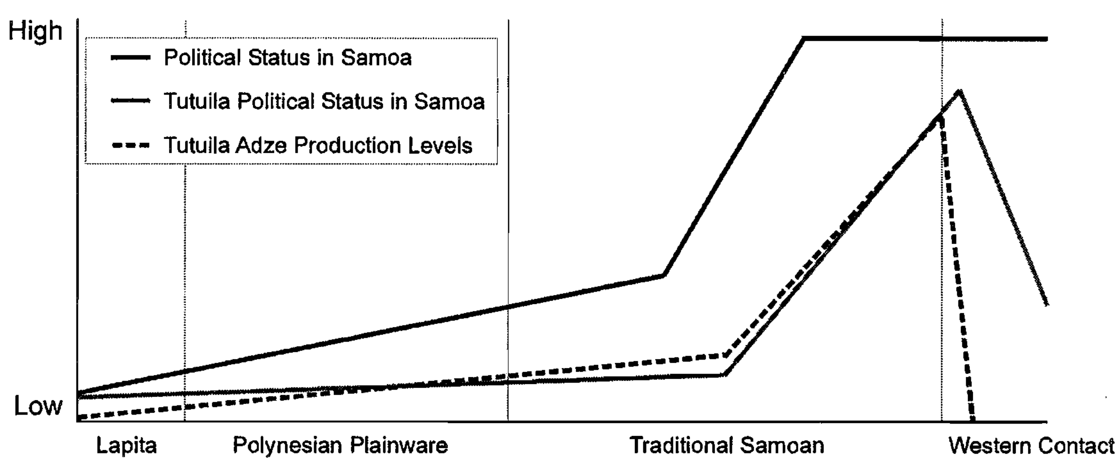

Figure 7.1. A graphic illustration relating adze production to the emergence of elites on Tutuila.

Beginning in the Polynesian Plainware period, 2500 to 1700 years ago, and lasting through a portion of the Traditional Period, the island of Tutuila was a production locale for mainly local, but also limited archipelago-wide distribution. In the earlier period, I propose that Tutuilan chiefs transported finished adzes to relatives located on other islands in a manner similar to general reciprocity, or allowing visiting relatives to have direct access to the raw material. Then at roughly 1000 years ago, things changed in Samoa, the beginnings of high levels of prestige competition and their material manifestations began to occur in Samoa (see Davidson 1979). In response to the increasing political complexity in the archipelago, I propose kin obligations lessened within the archipelago as Tutuila's elites started to accumulate both social and material wealth. Residing in a geologically rich island, Tutuilan chiefs began to restrict access and demand payment for their products witnessed by adzes being distributed to far off places like Tokelau, Fiji, Tonga and beyond, and the dramatic increases in production at communities around Tutuila, like Tataga Matau, Malaeloa, Le'aeno and perhaps at Lau'agae in Tula. Tutuila became famous by being able to monopolize high quality wood working tools used as status items; however, this relationship dramatically changed at Western contact. At this time, European traders and goods entered into these exchanges (Green 1974:254). Although, the Samoa Archipelago was sighted early in the exploration of the Pacific Ocean, a more intensive interaction was delayed by the local massacre of a French crew (see Dunmore 1994). And, as a result, Samoa, most particularly Tutuila, was left to stagnate in a growing regional exchange of western trade goods for almost 100 years. Regional island interaction continued during this period, but instead of acquiring Tutuila's high quality basalt through trade, past consumers went with newer and better metal tools, which changed old trade relationships. *Then* Tutuilan leaders, without much else too contribute; fell in political standings as chiefs from the more highly populated Upolu began to politically incorporate them.

The evolution of Polynesia's complex chiefly systems is a long standing issue in anthropology, and my archaeological research has identified that specialized goods were a significant factor in the elevation of elite status in many Polynesian contexts. Tutuila provides an excellent case for how political motivations and chiefly strategies incorporated newly-developed adze specialists and high-quality basalt as strategic resources for accumulating material surplus in prestige competition.

APPENDIX A

ILLUSTRATIONS OF SELECTED ADZES

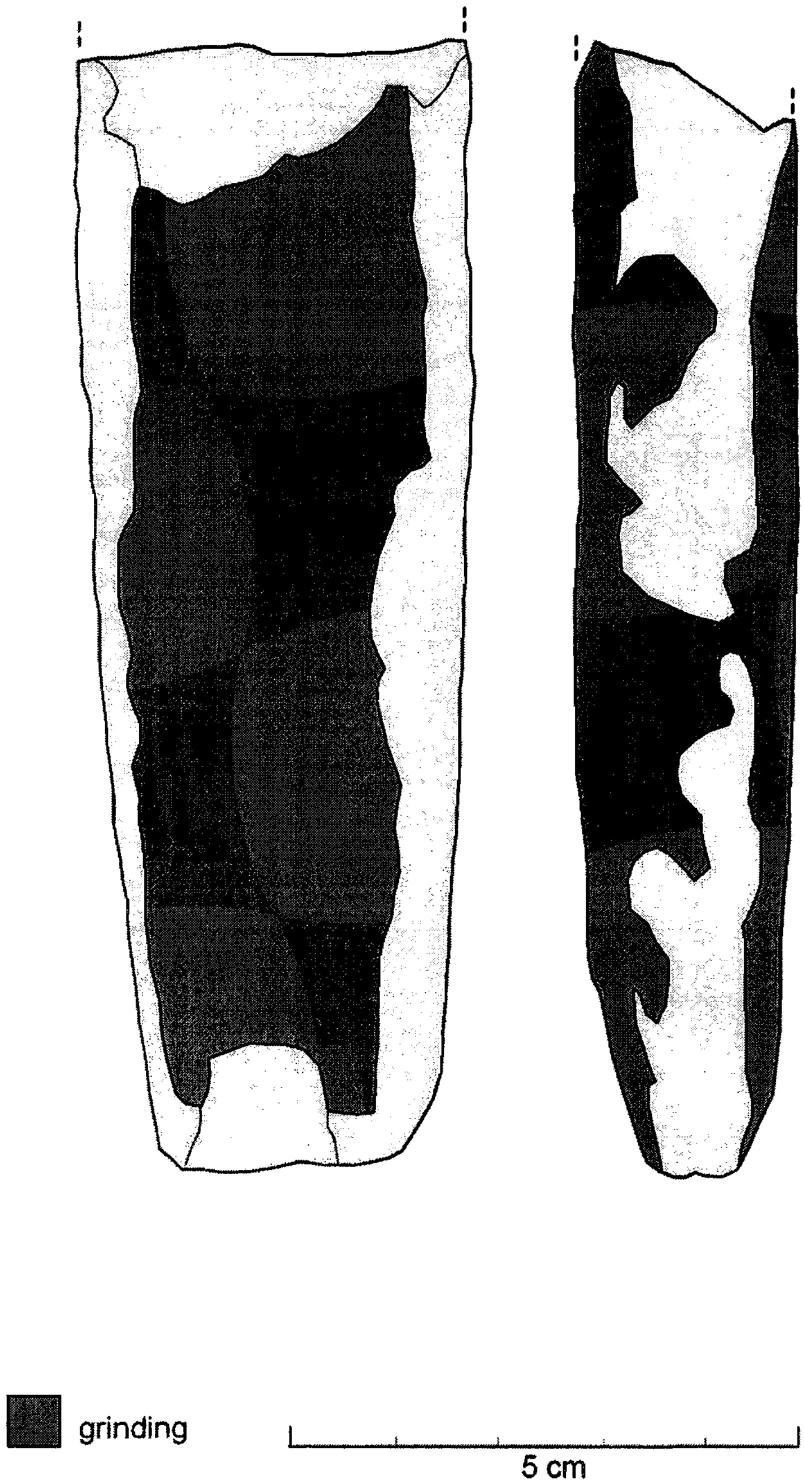

Figure A.1. A broken Type I adze recovered at AA-2006-6-6 during pedestrian survey (bevel missing).

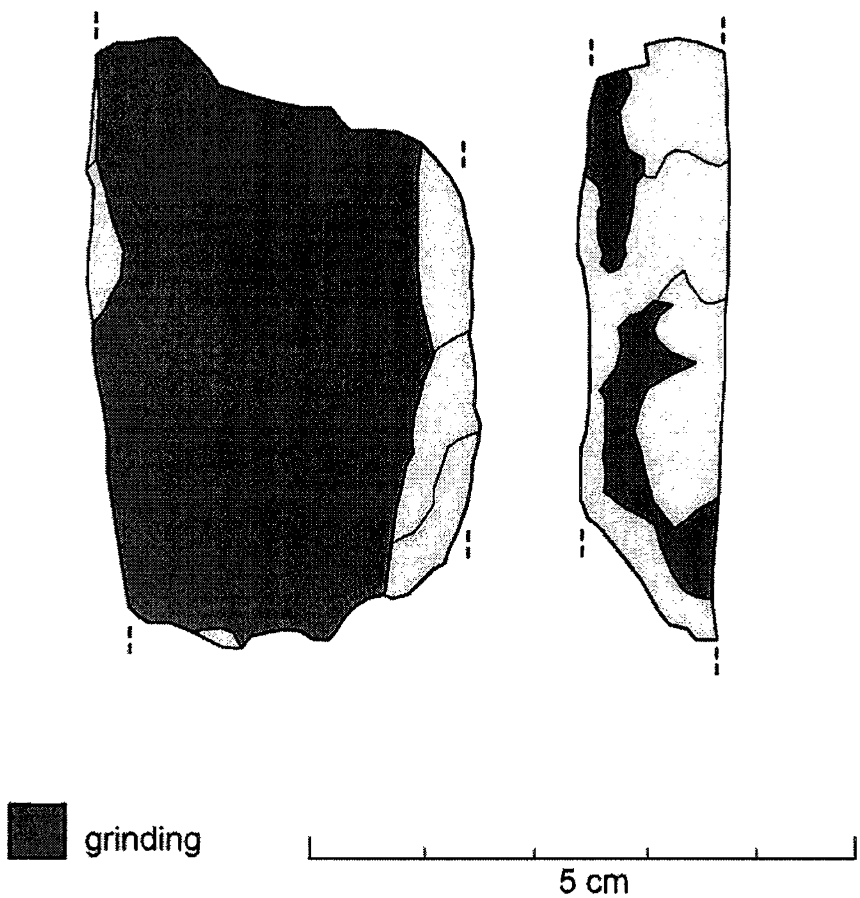

Figure A.2. A broken Type I adze recovered at AA-2006-6-6 during pedestrian survey (bevel and poll missing).

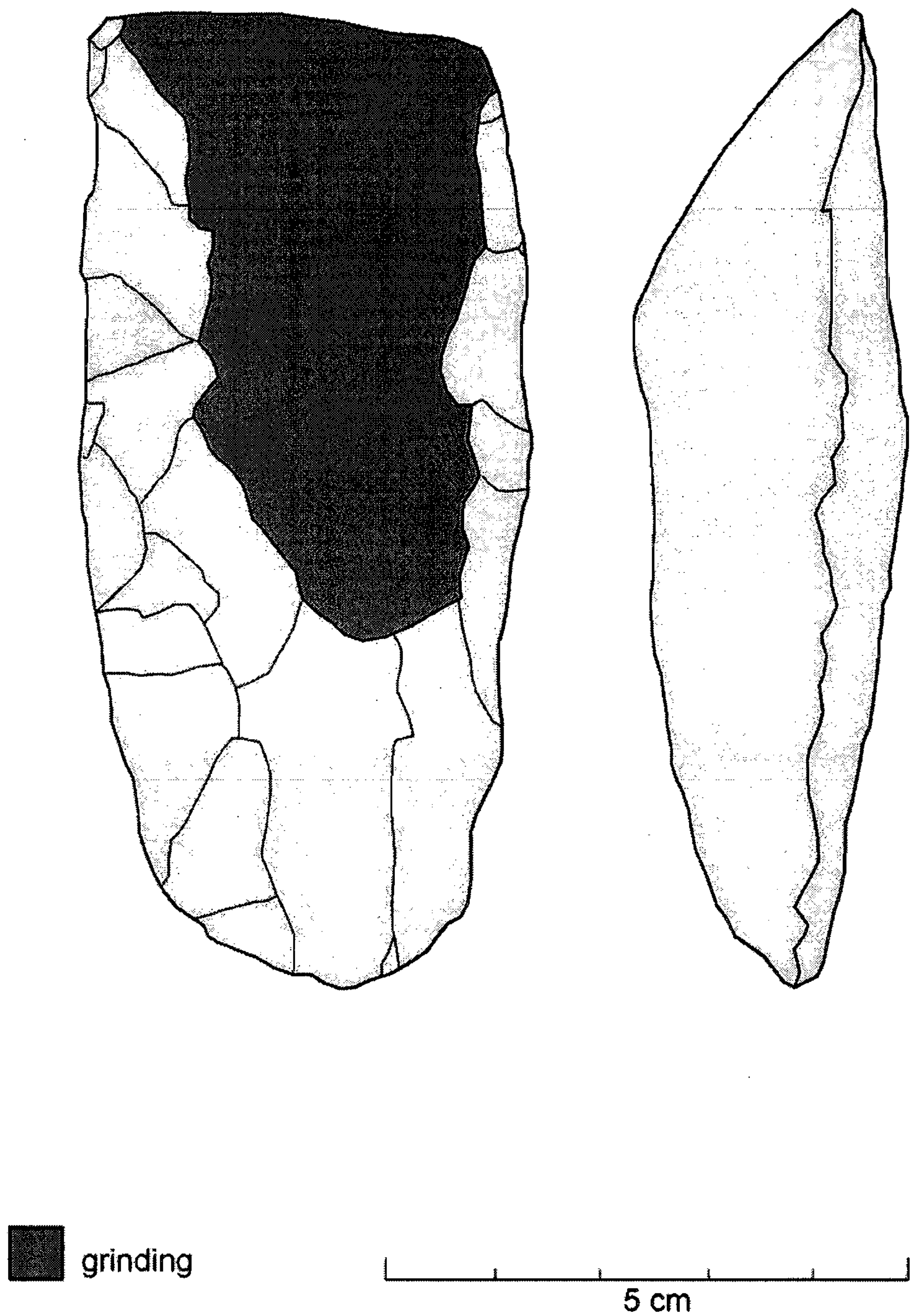

Figure A.3. A complete Type II adze recovered at AA-2006-6-6 during pedestrian survey.

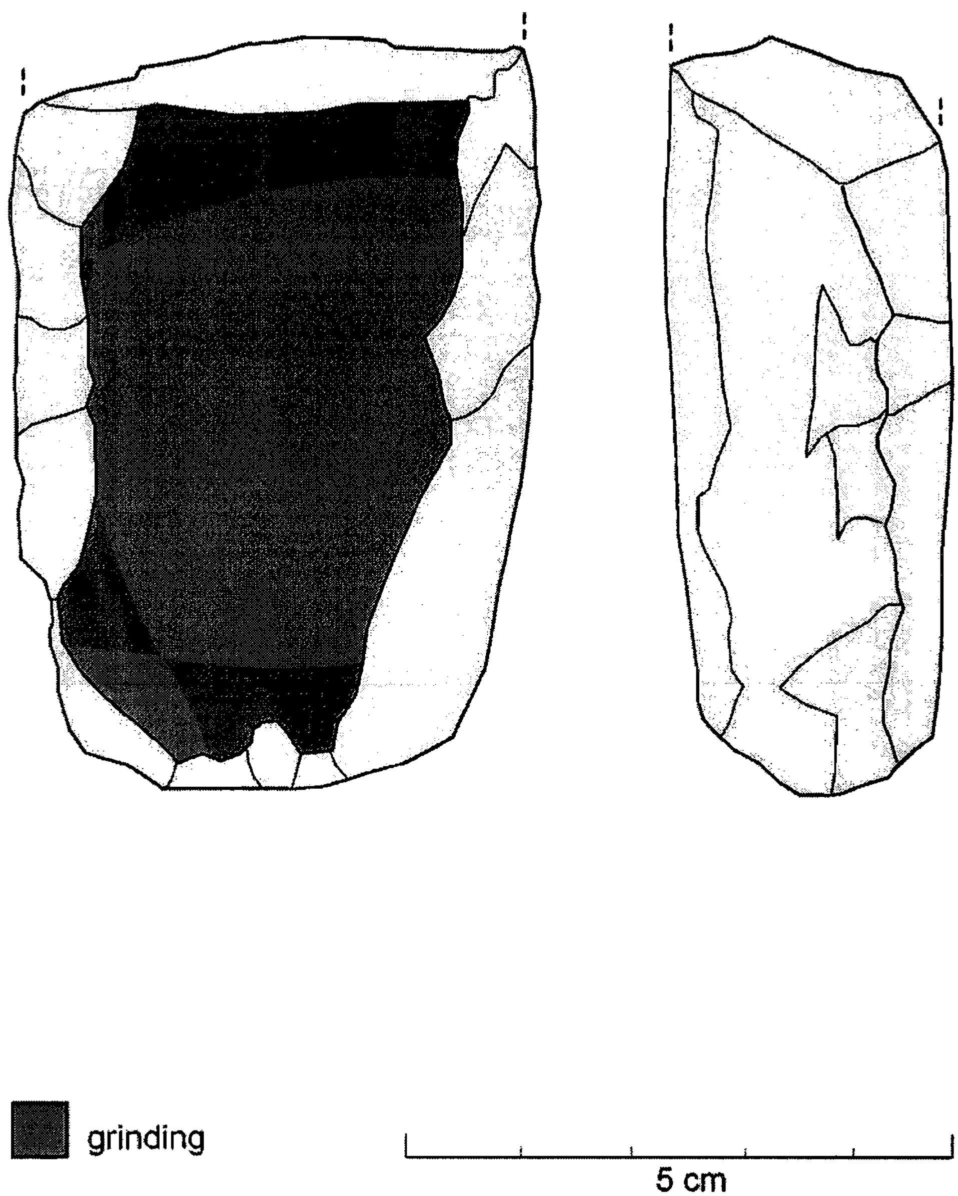

Figure A.4. A broken Type II adze recovered at AA-2006-6-6 during pedestrian survey (bevel missing).

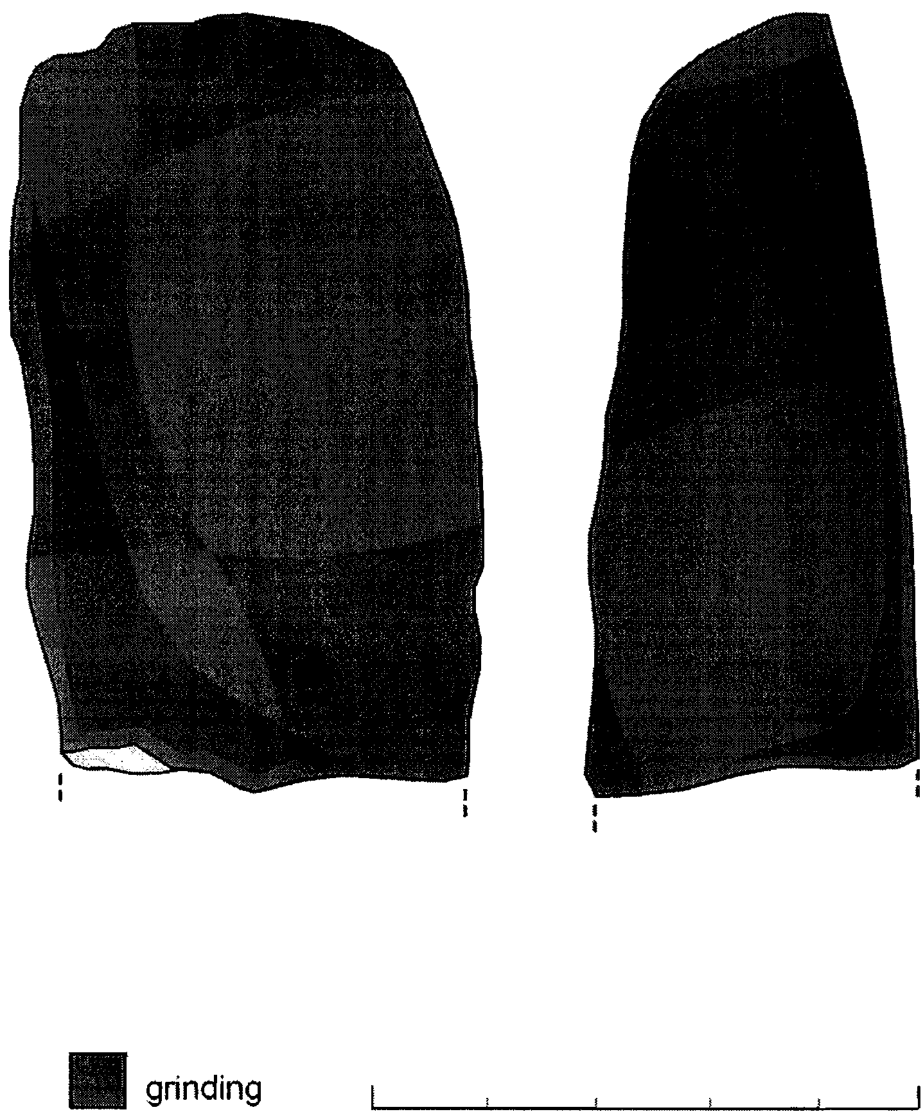

Figure A.5. A broken Type V adze recovered at AS-32-7 during pedestrian survey (poll missing).

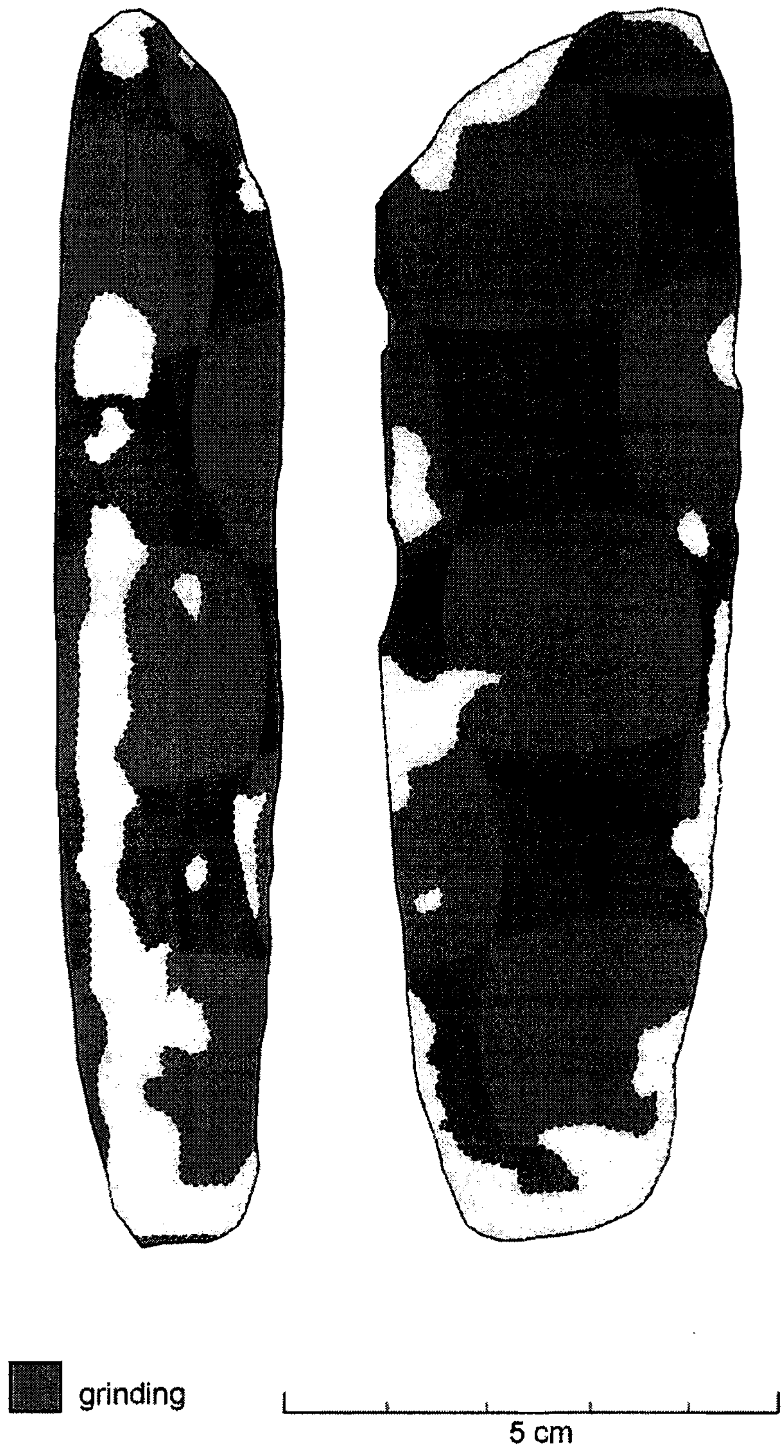

Figure A.6. A complete Type VII adze recovered at AA-2006-6-3 during excavation of EU 2.

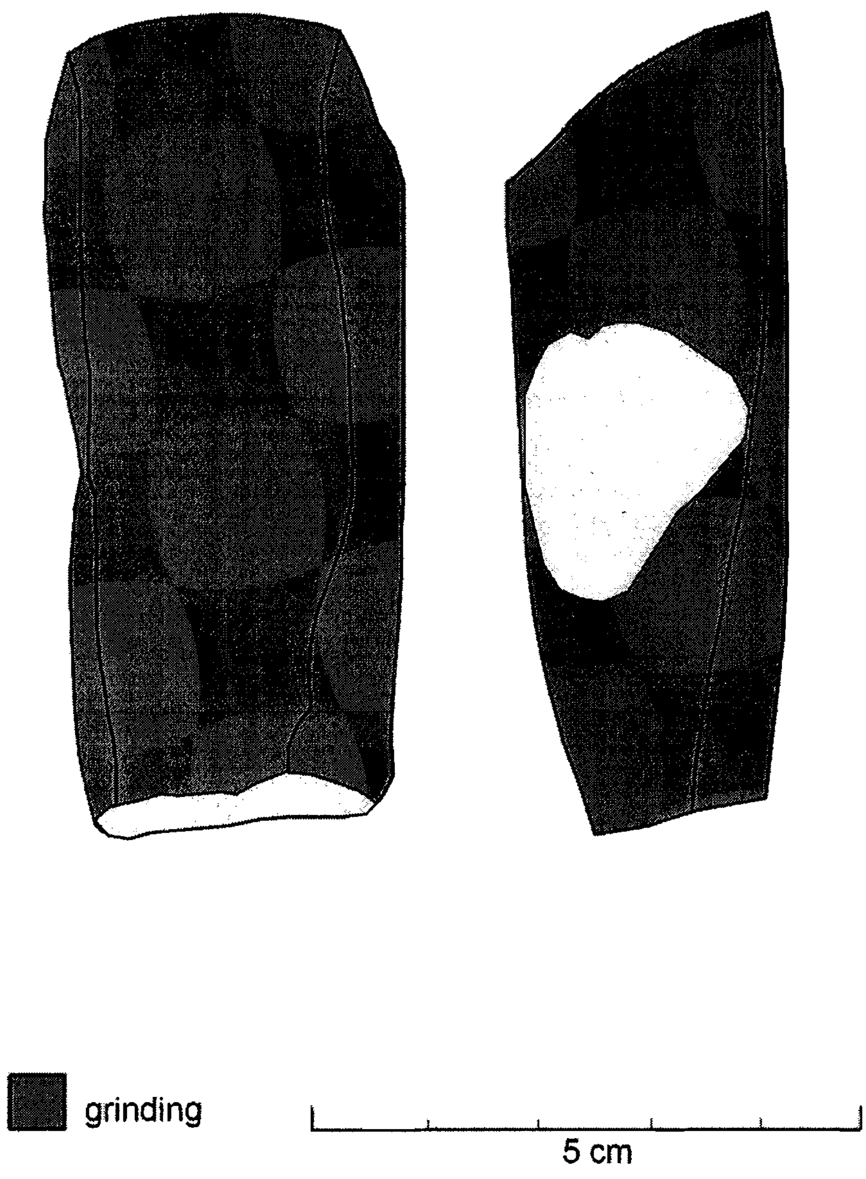

Figure A.7. A complete Type X adze recovered at AS-32-13a during excavation of TU1.

APPENDIX B

SIZE AND STAGE SUMMARY FOR DEBITAGE ASSEMBLAGES

BY TEST UNIT LEVELS AT ARCHAEOLOGICAL SITES

Appendix B. Size and stage summary for debitage assemblages by test unit levels at archaeological sites.

Provenance	Total Weight (in grams)	Group1 (0-1.5 cm)	Group 2 (1.5-3 cm)	Group 3 (3-4 cm)	Group 4 (4-6 cm)	Group 5 (>6 cm)	Primary Flakes	Secondary Flakes	Tertiary Flakes
Fagamalo Valley: TU 2									
Layer I	32.1 g	.0 %	20.2 %	79.8 %	.0 %	.0 %	47.6 %	20.3 %	32.1 %
Layer II	2874.3 g	.0 %	20.0 %	29.5 %	29.9 %	20.6 %	7.4 %	9.3 %	83.3 %
Layer III	86.9 g	.0 %	8.3 %	10.2 %	.0 %	81.5 %	47.8 %	.0 %	52.2 %
Afao Valley, AA-2005-01: TU 18									
Level 1	221.9 g	.0 %	12.8 %	25.4 %	40.8 %	21.0 %	.0 %	9.5 %	90.5 %
Level 2	10.6 g	.0 %	18.0 %	24.5 %	57.5 %	.0 %	.0 %	.0 %	100.0 %
Level 3	1.3 g	7.7 %	92.3 %	.0 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Afao Valley, AA-2005-01: TU 19									
Level 1	22.4 g	5.8 %	79.0 %	15.2 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Afao Valley, AA-2005-01: TU 20									
Level 1	203.3 g	4.7 %	62.5 %	23.3 %	9.5 %	.0 %	2.8 %	2.9 %	94.3 %
Level 2	42.7 g	6.2 %	62.6 %	31.2 %	.0 %	.0 %	.2 %	.0 %	99.8 %
Level 3	39.5 g	4.1 %	83.5 %	4.8 %	7.6 %	.0 %	.0 %	10.3 %	89.7 %
Afao Valley, AA-2005-01: TU 21									
Level 1	21.8 g	.5 %	15.6 %	.0 %	83.9 %	.0 %	.0 %	.0 %	100.0 %
Level 2	36.9 g	1.1 %	65.0 %	33.9 %	.0 %	.0 %	.0 %	6.5 %	93.5 %
Level 3	8.9 g	.0 %	100.0 %	.0 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Level 4	17.4 g	.0 %	54.6 %	45.4 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Level 5	4.6 g	10.9 %	89.1 %	.0 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Afao Valley, AA-2005-02: TU 17									
Level 1	89.3 g	.0 %	11.0 %	4.9 %	43.1 %	41.0 %	.0 %	5.0 %	95.0 %
Level 2	46.3 g	.4 %	17.1 %	.0 %	28.7 %	53.8 %	.0 %.	0 %	100.0 %
Level 3	18.8 g	.0 %	29.8 %	70.2 %	.0 %	.0 %	.0 %.	0 %	100.0 %
Level 4	22.2 g	.0 %	7.2 %	.0 %	92.8 %	.0 %	.0 %.	0 %	100.0 %

Appendix B (cont). Size and stage summary for debitage assemblages by test unit levels at archaeological sites.

Provenance	Total Weight (in grams)	Group1 (0-1.5 cm)	Group 2 (1.5-3 cm)	Group 3 (3-4 cm)	Group 4 (4-6 cm)	Group 5 (>6 cm)	Primary Flakes	Secondary Flakes	Tertiary Flakes
Malaeloa Valley, AS-32-13a: TU 1									
Layer 2	79.0 g	.0 %	.0 %	5.6 %	.0 %	94.4 %	.0 %	5.6 %	94.4 %
Layer 3	55.3 g	.0 %	.0 %	7.6 %	92.4 %	.0 %	7.6 %	92.4 %	.0 %
Malaeloa Valley, AS-32-13a: TU 2									
Level 1	231.6 g	.0 %	13.1 %	20.3 %	14.2 %	52.4 %	.0 %	6.2 %	93.8 %
Level 2	130.6 g	3.6 %	45.1 %	15.3 %	7.7 %	28.3 %	.0 %	9.0 %	91.0 %
Level 3	135.4 g	3.4 %	30.1 %	29.7 %	17.8 %	19.0 %	20.1 %	35.7 %	44.2 %
Malaeloa Valley, AS-32-13a: TU 3									
Level 1	214.6 g	.7 %	21.3 %	23.7 %	22.6 %	31.8 %	1.3 %	45.7 %	53.0 %
Malaeloa Valley, AS-32-13a: TU 4									
Level 4	17.2 g	.0 %	14.0 %	19.8 %	66.3 %	.0 %	.0 %	.0 %	100.0 %
Malaeloa Valley, AS-32-13b: TU 6									
Level 1	3057.7 g	.6 %	10.9 %	16.5 %	26.4 %	45.6 %	7.1 %	30.4 %	62.5 %
Level 2	1481.6 g	2.1 %	26.1 %	18.7 %	35.3 %	17.8 %	5.1 %	14.8 %	80.0 %
Level 3	655.3 g	.6 %	28.1 %	29.7 %	29.0 %	12.7 %	2.1 %	28.4 %	69.5 %
Level 4	84.7 g	.0 %	2.7 %	13.2 %	23.1 %	60.9 %	.0 %	60.9 %	39.1 %
Malaeloa Valley, AS-32-13b: TU 7									
Level 1	4023.4 g	.6 %	22.4 %	19.7 %	30.7 %	26.6 %	16.0 %	17.1 %	67.0 %
Level 2	2157.5 g	.4 %	21.3 %	18.2 %	42.3 %	17.8 %	9.2 %	18.6 %	72.2 %
Level 3	451.3 g	1.4 %	26.1 %	17.0 %	45.1 %	10.5 %	2.5 %	13.0 %	84.5 %
Level 4	45.0 g	2.4 %	26.7 %	38.4 %	32.4 %	.0 %	.0 %	12.9 %	87.1 %
Malaeloa Valley, AS-32-13b: EU 1									
Level 1	15,095.4 g	1.0 %	22.5 %	20.6 %	37.1 %	18.8 %	7.4 %	18.8 %	73.8 %
Level 2	12,266.7 g	1.0 %	30.4 %	24.0 %	31.5 %	13.0 %	12.2 %	15.2 %	72.7 %
Level 3	5377.9 g	1.7 %	37.5 %	24.8 %	24.7 %	11.3 %	13.0 %	12.8 %	74.2 %
Level 4	421.4 g	3.2 %	47.8 %	21.7 %	24.0 %	3.3 %	2.6 %	3.2 %	94.2 %

Appendix B (cont). Size and stage summary for debitage assemblages by test unit levels at archaeological sites.

Provenance	Total Weight (in grams)	Group1 (0-1.5 cm)	Group 2 (1.5-3 cm)	Group 3 (3-4 cm)	Group 4 (4-6 cm)	Group 5 (>6 cm)	Primary Flakes	Secondary Flakes	Tertiary Flakes
Malaeloa Valley, AS-32-13a: TU 8									
Layer 1	2116.0 g	1.8 %	23.4 %	21.4 %	38.9 %	14.5 %	6.2 %	18.3 %	75.5 %
Layer 2	566.1 g	1.2 %	22.5 %	23.7 %	52.6 %	.0 %	.0 %	20.8 %	79.2 %
Level 3	845.7 g	1.5 %	14.1 %	20.6 %	49.3 %	14.5 %	7.5 %	27.1 %	65.4 %
Level 4	742.1 g	.4 %	9.5 %	10.6 %	55.4 %	24.1 %	4.6 %	23.2 %	72.3 %
Level 5	155.1 g	.3 %	2.8 %	3.3 %	67.6 %	26.0 %	.0 %	3.3 %	96.7 %
Malaeloa Valley, AS-32-11: TU 9									
Level 1	9598.3 g	2.0 %	23.3 %	35.5 %	33.2 %	6.1 %	11.1 %	14.4 %	74.5 %
Level 2	13,482.5 g	8.5 %	33.5 %	23.7 %	26.3 %	8.1 %	10.1 %	12.7 %	77.3 %
Level 3	4930.4 g	4.4 %	41.3 %	26.9 %	23.3 %	4.1 %	7.5 %	12.9 %	79.6 %
Level 4	1771.3 g	.8 %	36.2 %	29.2 %	33.0 %	.8 %	7.6 %	19.3 %	73.0 %
Level 5	330.8 g	.3 %	32.6 %	32.4 %	28.2 %	6.5 %	4.7 %	13.2 %	82.0 %
Malaeloa Valley, AS-32-11: TR 12									
Level 1	3598.5 g	3.6 %	30.7 %	14.4 %	29.1 %	22.2 %	12.8 %	20.1 %	67.1 %
Level 2	3219.8 g	4.4 %	34.5 %	17.5 %	32.7 %	11.0 %	9.8 %	9.0 %	81.2 %
Level 3	1739.0 g	3.2 %	27.0 %	20.1 %	42.1 %	7.6 %	7.3 %	8.3 %	84.4 %
Level 4	794.7 g	.6 %	23.1 %	31.3 %	33.1 %	11.9 %	6.7 %	20.3 %	73.1 %
Level 5	84.0 g	2.7 %	58.7 %	38.6 %	.0 %	.0 %	8.2 %	14.8 %	77.0 %
Malaeloa Valley, AS-32-15: TU 11									
Level 1	741.7 g	.3 %	3.6 %	8.0 %	19.6 %	68.4 %	1.1 %	48.6 %	50.3 %
Level 2	924.8 g	1.0 %	17.2 %	15.0 %	27.8 %	39.0 %	19.5 %	42.4 %	38.0 %
Pavaiai Village, AA-2006-6-2: EU 1									
Level 1	4506.6 g	5.0 %	47.4.0 %	29.1 %	17.6 %	.9 %	3.7 %	6.5 %	89.8 %
Level 2	2285.7 g	5.0 %	46.3 %	27.1 %	20.7 %	.9 %	5.2 %	3.8 %	91.1 %
Level 3	665.3 g	7.8 %	51.9 %	24.9 %	12.1 %	3.4 %	4.2 %	5.1 %	90.8 %

Appendix B (cont). Size and stage summary for debitage assemblages by test unit levels at archaeological sites.

Provenance	Total Weight (in grams)	Group1 (0-1.5 cm)	Group 2 (1.5-3 cm)	Group 3 (3-4 cm)	Group 4 (4-6 cm)	Group 5 (>6 cm)	Primary Flakes	Secondary Flakes	Tertiary Flakes
Pavaiai Village, AA-2006-6-2: EU 2									
Layer 1	350.5 g	.1 %	14.3 %	15.4 %	48.3 %	21.8 %	4.2 %	14.7 %	81.1 %
Layer 3	11.4 g	4.2 %	18.7 %	33.7 %	43.4 %	.0 %	.0 %	33.7 %	66.3 %
Pavaiai Village, AA-2006-6-2: EU 3									
Level 1	1708.3 g	3.6 %	30.6 %	34.1 %	31.7 %	.0 %	3.9 %	10.3 %	85.8 %
Level 2	1291.8 g	1.9 %	17.4 %	28.8 %	45.0 %	6.8 %	3.1 %	8.3 %	88.6 %
Level 3	346.1 g	.8 %	14.4 %	31.0 %	53.9 %	.0 %	1.3 %	20.0 %	78.7 %
Pavaiai Village, AA-2006-6-3: TR 1									
Layer D	33.3 g	1.0 %	16.8 %	24.3 %	57.9 %	.0 %	45.2 %	17.4 %	37.4 %
Pavaiai Village, AA-2006-6-3: TR 2									
Layer D	64.6 g	1.8 %	19.0 %	13.0 %	12.4 %	53.8 %	3.5 %	.0 %	96.5 %
Kokoland, AA-2006-6-4: TU 1&2									
Level 1	7.9 g	9.6 %	32.0 %	.0 %	58.4 %	.0 %	.0 %	.0 %	100.0 %
Level 2	49.6 g	.0 %	4.2 %	.0 %	95.8 %	.0 %	4.2 %	.0 %	95.8 %
Level 3	71.0 g	1.4 %	21.3 %	22.2 %	24.0 %	31.1 %	8.1 %	31.1 %	60.8 %
Level 4	105.5 g	.7 %	14.5 %	23.5 %	61.3 %	.0 %	20.5 %	29.3 %	50.2 %
Level 5	33.6 g	.0 %	17.6 %	.0 %	82.4 %	.0 %	.0 %	.0 %	100.0 %
Level 6	12.8 g	.0 %	39.8 %	35.3 %	24.9 %	.0 %	35.3 %	.0 %	64.7 %

Appendix B (cont). Size and stage summary for debitage assemblages by test unit levels at archaeological sites.

Provenance	Total Weight (in grams)	Group1 (0-1.5 cm)	Group 2 (1.5-3 cm)	Group 3 (3-4 cm)	Group 4 (4-6 cm)	Group 5 (>6 cm)	Primary Flakes	Secondary Flakes	Tertiary Flakes
Auto Valley, AA-2006-6-5: TU 1									
Level 1	826.8 g	.0 %	7.3 %	11.8 %	54.0 %	26.9 %	23.7 %	14.7 %	61.5 %
Level 2	159.4 g	.9 %	19.9 %	20.6 %	36.1 %	22.6 %	6.4 %	.8 %	92.7 %
Level 3	372.8 g	.4 %	15.1 %	27.6 %	56.8 %	.0 %	16.9 %	26.0 %	57.1 %
Level 4	564.1 g	.3 %	16.6 %	33.2 %	32.4 %	17.6 %	25.6 %	40.4 %	34.0 %
Level 5	247.6 g	.9 %	11.3 %	36.9 %	50.9 %	.0 %	31.6 %	41.1 %	27.2 %
Level 6	441.5 g	.4 %	14.3 %	14.0 %	36.8 %	34.5 %	48.4 %	12.0 %	39.6 %
Level 7	74.9 g	3.5 %	59.9 %	5.7 %	30.8 %	.0 %	25.5 %	13.6 %	60.9 %
Level 8	64.1 g	.0 %	.0 %	66.8 %	33.2 %	.0 %	.0 %	14.5 %	85.5 %
Level 9	22.7 g	.0 %	5.2 %	.0 %	94.8 %	.0 %	53.9 %	.0 %	46.1 %
Auto Valley, AA-2006-6-5: TU 2									
Level 3	201.1 g	.4 %	12.3 %	12.6 %	12.2 %	62.5 %	62.5 %	12.2 %	25.3 %
Level 4	363.4 g	.5 %	26.1 %	20.0 %	47.7 %	5.8 %	31.1 %	3.2 %	65.6 %
Level 5	173.7 g	.9 %	51.5 %	20.6 %	27.0 %	.0 %	24.4 %	.0 %	75.6 %
Level 6	131.2 g	1.2 %	28.0 %	44.8 %	26.0 %	.0 %	11.9 %	5.3 %	82.8 %
Level 7	771.0 g	.2 %	13.0 %	18.9 %	33.7 %	34.3 %	45.8 %	27.4 %	26.7 %
Level 8	169.8 g	.0 %	4.8 %	5.6 %	29.1 %	60.5 %	2.4 %	48.2 %	49.4 %
Tula Valley, AA-2006-6-6: TU A									
Level 1	1625.1 g	.0 %	1.3 %	6.5 %	29.3 %	63.0 %	21.5 %	13.1 %	65.4 %
Level 2	342.7 g	.3 %	10.3 %	24.9 %	31.3 %	33.1 %	30.4 %	27.6 %	42.0 %
Level 3	34.3 g	.0 %	7.5 %	50.8 %	41.8 %	.0 %	4.4 %	.0 %	95.6 %
Level 4	20.5 g	.5 %	61.7 %	37.8 %	.0 %	.0 %	22.0 %	13.4 %	64.6 %
Tula Valley, AA-2006-6-6: TU B									
Level 1	394.3 g	1.9 %	14.4 %	13.9 %	26.5 %	43.3 %	12.8 %	.0 %	87.2 %
Level 2	384.3 g	.6 %	9.1 %	5.9 %	60.9 %	23.5 %	54.0 %	17.9 %	28.0 %
Level 3	80.8 g	2.6 %	16.4 %	.0 %	81.0 %	.0 %	21.0 %	.0 %	79.0 %
Level 4	72.2 g	.1 %	4.3 %	13.9 %	40.2 %	41.6 %	15.8 %	40.2 %	44.0 %

Appendix B (cont). Size and stage summary for debitage assemblages by test unit levels at archaeological sites.

Provenance	Total Weight (in grams)	Group1 (0-1.5 cm)	Group 2 (1.5-3 cm)	Group 3 (3-4 cm)	Group 4 (4-6 cm)	Group 5 (>6 cm)	Primary Flakes	Secondary Flakes	Tertiary Flakes
Tula Valley, AA-2006-6-6: TU C									
Level 1	339.0 g	1.7 %	26.5 %	.0 %	20.9 %	50.8 %	14.1 %	5.8 %	80.1 %
Level 2	448.8 g	1.6 %	8.6 %	7.8 %	21.2 %	60.9 %	28.6 %	.0 %	71.4 %
Level 3	132.8 g	2.3 %	46.9 %	24.7 %	26.0 %	.0 %	10.7 %	5.3 %	84.0 %
Level 4	124.8 g	.8 %	26.6 %	20.6 %	31.3 %	20.7 %	30.6 %	.0 %	69.4 %
Tula Valley, AA-2006-6-6: TU D									
Level 1	242.2 g	.1 %	7.6 %	3.5 %	33.5 %	55.3 %	.0 %	.0 %	100.0 %
Level 2	20.0 g	3.5 %	.0 %	30.1 %	66.4 %	.0 %	3.5 %	.0 %	96.5 %
Level 3	4.0 g	15.8 %	84.3 %	.0 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Tula Valley, AA-2006-6-6: TU E									
Level 1	48.5 g	8.2 %	52.8 %	39.0 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Level 3	15.8 g	4.8 %	42.6 %	.0 %	52.7 %	.0 %	.0 %	.0 %	100.0 %
Tula Valley, AA-2006-6-6: TU F									
Level 1	161.1 g	.2 %	11.6 %	23.8 %	64.4 %	.0 %	39.1 %	.0 %	60.9 %
Level 2	123.7 g	.0 %	25.0 %	17.9 %	24.7 %	32.4 %	13.3 %	7.2 %	79.5 %
Level 3	167.3 g	.0 %	3.6 %	9.2 %	38.3 %	48.9 %	48.9 %	18.3 %	32.8 %
Level 4	34.3 g	.0 %	45.9 %	15.0 %	39.1 %	.0 %	15.0 %	43.0 %	42.0 %
Level 5	7.0 g	.0 %	100.0 %	.0 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Level 6	15.7 g	.0 %	14.2 %	.0 %	85.8 %	.0 %	.0 %	.0 %	100.0 %
Tula Valley, AA-2006-6-6: TU G									
Level 1	351.3 g	.6 %	7.1 %	4.8 %	31.5 %	56.1 %	1.3 %	64.2 %	34.5 %
Level 2	250.1 g	3.2 %	29.0 %	20.0 %	36.9 %	10.9 %	12.8 %	1.9 %	85.4 %
Level 3	129.8 g	4.4 %	16.6 %	18.5 %	30.4 %	30.2 %	.0 %	17.6 %	82.4 %
Level 4	112.1 g	5.4 %	57.1 %	31.5 %	6.0 %	.0 %	7.6 %	16.9 %	75.5 %
Level 5	34.3 g	2.2 %	43.6 %	34.0 %	20.3 %	.0 %	.0 %	13.9 %	86.1 %
Level 6	6.5 g	5.4 %	.0 %	22.5 %	72.2 %	.0 %	.0 %	.0 %	100.0 %

Appendix B (cont). Size and stage summary for debitage assemblages by test unit levels at archaeological sites.

Provenance	Total Weight (in grams)	Group1 (0-1.5 cm)	Group 2 (1.5-3 cm)	Group 3 (3-4 cm)	Group 4 (4-6 cm)	Group 5 (>6 cm)	Primary Flakes	Secondary Flakes	Tertiary Flakes
Tula Valley, AA-2006-6-6: TU H									
Level 1	474.0 g	1.2 %	10.9 %	22.4 %	27.9 %	37.6 %	3.9 %	23.7 %	72.4 %
Level 2	143.9 g	.5 %	8.3 %	7.5 %	5.9 %	77.8 %	57.4 %	.0 %	42.6 %
Level 3	139.3 g	.5 %	8.9%	10.9 %	79.7 %	.0 %	.0 %	.0 %	100.0 %
Level 4	31.1 g	1.1 %	9.7 %	8.5 %	80.7 %	.0 %	.0 %	34.8 %	65.2 %
Level 5	103.7 g	.5 %	12.0 %	20.7 %	21.6 %	45.2 %	45.2 %	.0 %	54.8 %
Tula Valley, AA-2006-6-6: TU I									
Level 1	338.0 g	.7 %	9.6 %	11.7 %	33.7 %	44.3 %	5.8 %	23.1 %	71.1 %
Level 2	73.3 g	.5 %	12.7 %	42.6 %	44.2 %	.0 %	4.0 %	2.2 %	93.8 %
Level 3	27.1 g	.0 %	13.9 %	25.1 %	61.0 %	.0 %	.0 %	5.4 %	94.6 %
Level 4	34.1 g	1.1 %	17.7 %	.0 %	81.2 %	.0 %	.0 %	44.4 %	55.6 %
Level 5	54.5 g	.0 %	6.3 %	18.6 %	75.1 %	.0 %	.0 %	.0 %	100.0 %
Tula Valley, AA-2006-6-6: TU J									
Level 1	936.8 g	4.3 %	28.3 %	14.7 %	18.7 %	34.0 %	19.9 %	17.5 %	62.6 %
Level 2	220.8 g	.5 %	30.4 %	28.6 %	40.5 %	.0 %	13.2 %	11.2 %	75.6 %
Level 3	220.4 g	.0 %	20.4 %	42.7 %	14.5 %	22.4 %	38.8 %	4.7 %	56.4 %

APPENDIX C

THE GEOCHEMICAL DATA FOR SAMPLES COLLECTED IN THE MALAELOA AND MALOATA VALLEYS

Appendix C. The geochemical data for samples collected in the Malaeloa and Maloata valleys.

Geological Samples			Unnormalized Major Elements (Weight %)										Major Element
ID	Valley	Location	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Total
A	Malaeloa	Lesui Ridge	48.9	3.5	15.7	12.3	.2	4.7	7.7	3.7	1.6	.8	99.0
B	Malaeloa	Lesui Ridge	48.2	3.8	15.5	12.5	.2	4.6	7.8	3.5	1.5	.7	98.4
C	Malaeloa	Olovafu Ridge	45.6	4.5	14.6	13.2	.2	6.4	8.7	2.8	1.1	.5	97.5
D	Malaeloa	Lesui Ridge	47.1	3.9	15.2	13.0	.2	5.3	7.7	3.4	1.3	.7	97.8
E	Malaeloa	Lesui Ridge	49.5	3.3	14.8	10.8	.1	5.8	7.6	3.4	1.9	.8	98.1
F	Malaeloa	Olovafu Ridge	46.3	4.4	14.6	13.1	.2	6.5	9.0	3.0	1.1	.5	98.8
G	Malaeloa	Vaitai Stream	46.4	4.5	14.9	13.3	.2	6.6	8.7	2.9	1.2	.5	99.3
H	Malaeloa	Olovafu Ridge	46.2	4.5	14.8	13.2	.2	6.5	8.7	2.8	1.2	.5	98.6
J	Malaeloa	Olovafu Ridge	45.9	4.4	14.5	12.9	.2	6.7	8.8	3.0	1.2	.5	98.0
K	Malaeloa	Olovafu Ridge	46.3	4.5	14.8	13.2	.2	6.6	8.9	3.0	1.1	.5	99.1
L	Maloata	Tuasina Ridge	48.3	4.7	14.3	12.1	.2	6.4	8.8	3.0	1.1	.6	99.3
M	Maloata	Tuasina Ridge	48.0	4.8	13.9	12.5	.2	6.9	8.9	2.8	1.0	.5	99.4
N	Maloata	Tuasina Ridge	48.0	4.8	14.0	12.5	.2	6.5	8.8	2.8	1.1	.5	99.2
O	Maloata	Tuasina Ridge	47.7	4.7	13.8	12.3	.2	6.9	8.9	2.8	1.0	.5	98.8
P	Maloata	Maloata Stream	48.0	3.7	15.6	13.0	.2	4.3	7.4	3.3	1.6	1.2	98.3
Q	Maloata	Maloata Stream	47.7	4.9	14.1	12.8	.2	6.8	8.7	2.7	1.0	.5	99.3
R	Maloata	Maloata Stream	48.0	4.8	13.8	12.4	.2	6.9	8.9	2.8	1.0	.5	99.3
S	Maloata	Maloata Stream	47.9	4.8	14.0	12.5	.2	6.7	8.8	2.8	1.0	.5	99.2

Appendix C (cont). The geochemical data for samples collected in the Malaeloa and Maloata valleys.

Geological Samples							Unnormalized Trace Elements (ppm)												
ID	**Ni**	**Cr**	**Sc**	**V**	**Ba**	**Rb**	**Sr**	**Zr**	**Y**	**Nb**	**Ga**	**Cu**	**Zn**	**Pb**	**La**	**Ce**	**Th**	**Nd**
A	11	3	15	226	312	43	673	389	45	45.9	31	10	187	4	40	96	4	57
B	13	2	17	250	295	38	654	376	44	44.6	30	14	187	5	38	92	4	54
C	90	40	21	323	251	31	472	291	35	33.6	25	31	156	5	28	61	3	38
D	19	3	16	257	268	28	623	351	41	41.4	27	18	182	5	36	85	4	51
E	142	164	17	218	366	52	755	367	37	36.9	29	35	180	5	39	99	4	60
F	90	38	21	322	239	24	511	288	46	34.0	25	33	163	4	31	67	4	46
G	92	39	23	324	248	36	482	294	36	34.0	27	25	148	4	30	64	2	43
H	93	40	23	322	236	35	477	285	40	33.3	25	33	155	5	35	67	2	45
J	97	40	21	318	237	32	489	287	35	33.7	27	39	145	4	28	58	4	40
K	88	38	23	320	259	27	496	294	39	34.8	26	29	152	4	34	67	3	46
L	120	149	20	285	207	23	572	311	36	34.7	24	42	155	4	27	69	3	46
M	133	184	22	296	201	23	535	300	35	33.4	26	37	150	4	27	69	3	44
N	135	183	21	295	202	28	535	299	35	34.2	27	44	151	4	28	65	4	41
O	137	179	21	295	202	26	534	295	34	33.1	25	44	166	5	26	68	4	43
P	20	13	15	197	356	44	835	374	61	41.9	30	14	214	5	40	105	5	72
Q	144	195	21	303	221	27	509	299	47	33.2	25	49	161	5	34	69	3	58
R	144	191	21	300	203	24	528	290	34	31.8	26	34	154	6	26	63	2	39
S	139	183	21	297	209	26	530	298	37	33.5	27	43	154	4	35	69	3	46

Appendix C (cont). The geochemical data for samples collected in the Malaeloa and Maloata valleys.

Adze Samples			Unnormalized Major Elements (Weight %)										Major Element
ID	Valley	Location	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Total
I	Malaeloa	AS-32-17	48.0	4.3	15.7	12.5	.2	4.8	7.9	3.4	2.0	.7	99.4
II	Malaeloa	AS-32-6-F4	48.0	4.1	15.7	12.4	.2	4.8	7.7	3.5	1.7	.7	98.8
III	Malaeloa	AS-32-6-F4	46.1	4.9	15.8	13.4	.2	5.7	8.3	3.3	1.3	.6	99.6
IV	Malaeloa	AS-32-6-F4	47.8	4.2	15.5	12.5	.2	4.9	7.8	3.5	1.4	.7	98.4
V	Malaeloa	AS-32-6-F4	48.0	3.7	13.9	11.7	.1	7.3	8.0	3.2	1.8	.7	98.6
VI	Malaeloa	AS-32-7	46.4	5.3	14.2	13.2	.2	6.1	8.6	2.8	1.1	.5	98.5
VII	Malaeloa	AS-32-7	47.6	4.0	15.5	12.2	.2	4.9	7.6	3.4	1.4	.7	97.4
VIII	Malaeloa	AS-32-7	47.9	4.2	15.8	12.8	.2	4.9	7.7	3.4	1.5	.7	99.0
IX	Malaeloa	AS-32-7	46.9	5.1	14.3	13.1	.2	6.1	8.6	2.9	1.1	.6	98.8
X	Malaeloa	AS-32-11	48.2	4.2	15.7	12.9	.2	4.6	7.7	3.5	1.4	.7	99.1
XI	Malaeloa	AS-32-11	47.9	4.2	15.5	12.8	.2	4.9	7.7	3.4	1.4	.7	98.7
XII	Malaeloa	AS-32-13a	48.4	4.1	15.7	12.1	.2	4.7	7.8	3.6	1.4	.7	98.7
XIII	Malaeloa	AS-32-13b	47.7	4.1	15.6	12.4	.2	4.8	7.6	3.5	1.4	.7	98.0
XIV	Malaeloa	AS-32-13b	42.4	4.7	17.3	12.1	.2	5.0	6.0	2.2	1.2	.9	92.1
XV	Maloata	Tuasina Ridge	47.6	4.8	13.7	12.6	.2	6.8	8.9	2.8	1.0	.5	98.9

Appendix C (cont). The geochemical data for samples collected in the Malaeloa and Maloata valleys.

Adze Samples							Unnormalized Trace Elements (ppm)											
ID	Ni	Cr	Sc	V	Ba	Rb	Sr	Zr	Y	Nb	Ga	Cu	Zn	Pb	La	Ce	Th	Nd
I	21	4	15	242	296	49	749	381	41	42.9	29	17	166	4	37	84	4	54
II	22	4	16	234	301	41	746	382	40	44.4	29	13	182	6	35	87	4	53
III	43	7	19	311	267	37	602	337	40	39.6	26	29	176	5	34	76	4	51
IV	21	5	15	238	286	35	742	371	40	42.9	27	19	186	5	37	79	4	54
V	152	220	16	253	387	53	706	349	33	38.3	28	38	169	7	36	92	4	53
VI	98	96	19	306	210	28	672	291	32	31.0	25	30	156	6	25	63	3	43
VII	21	4	14	228	283	37	730	376	40	42.3	28	18	175	6	35	86	4	53
VIII	24	10	15	240	296	43	740	389	41	44.8	28	22	196	5	33	84	4	55
IX	95	99	20	294	219	28	694	294	33	30.8	26	32	153	4	28	72	3	45
X	25	5	15	237	287	39	744	380	43	43.2	27	19	188	6	35	86	4	52
XI	24	5	15	238	274	39	741	373	41	42.3	28	18	220	6	36	87	3	53
XII	22	4	15	228	288	33	755	378	41	43.0	29	20	180	4	34	94	3	54
XIII	23	5	16	234	290	36	735	380	40	43.3	28	19	182	5	35	82	5	53
XIV	29	4	16	252	290	30	488	420	46	47.1	31	27	236	6	34	89	4	55
XV	136	179	21	296	209	23	534	298	34	34.2	26	36	156	4	26	67	3	41

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