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EASTER ISLAND OBSIDIAN FLAKE TOOLS: SITE INTERPRETATION THROUGH USE-WEAR ANALYSIS

by

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A DISSERTATION

Presented to the Department of Anthropology
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APPROVED: William S. Ayres
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Title: EASTER ISLAND OBSIDIAN FLAKE TOOLS: SITE INTERPRETATION THROUGH USE-WEAR ANALYSIS

Approved: Dr. William S. Ayres

Lithic studies, emphasizing use-wear analysis, were used to investigate problems concerning Easter Island prehistory. The research questions addressed focused on site typology, site specialization and site geographical location.

The lithic analysis dealt with obsidian edge altered flake tools because they are the least studied yet most numerous of all the artifact types found in Easter Island assemblages. A variety of attributes were recorded for each specimen with the major analytical focus being on edge use-wear microchipping. Based on this use-wear analysis the edges were placed into one of four altered edge categories. By using these categories, sites were characterized as emphasizing the working of hard or soft contact materials or as having an equal emphasis on both.

Site attributes of site type, location and specialization were investigated by relating each to site use-wear characterization. Analysis of these site-specific attributes produced a more refined

picture of the Easter Island settlement pattern. Sites typed as permanent or semi-permanent were found to be located on both the coast and inland and to represent generalized site activities. Sites typed as temporary were coastally oriented and are viewed as specialized or task specific. The relationship between the permanent and temporary sites is seen as an island wide pattern with regional distinctions also evident.

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Ayres, William and Robert L. Spear
1980 "Ant Atoll," Ponape Archaeological Survey, Interm Report 79-2. Submitted to Historic Preservation Committee, Ponape District, Trust Territories of the Pacific Islands.

Grabert, Garland F., and Robert L. Spear
1976 Archaeological Investigations at Birch Bay State Park, Department of Anthropology, Western Washington University, Bellingham.

Pettigrew, Richard, Brian L. O'Neill, Thomas J. Connolly and Robert L. Spear
1984 Archaeological Reconnaissance in the Camas Valley Vicinity of the Coos Bay-Roseburg Highway, Douglas County, Oregon, OSMA Survey Report 84-3.

Pettigrew, Richard and Robert L. Spear
1986 Archaeological Investigations at the Canyon Creek Site (35ML203) Malheur County, Oregon, OSMA Survey Report 86-1.

1984 Archaeological Investigations of Two Sites on the Cascade Lakes Highway, Deschutes County, Oregon, OSMA Survey Report, 84-2.

Spear, Robert L.
1980a "A Brief Discussion of Obsidian Use-Wear Experiments," Lithic Technology, No. 2.

1980b "Analysis of Chipped Stone Artifacts and Debitage From Archaeological Sites in Central Oregon," Buckly-Summer Lake Transmission Corridor Project, Report for the BPA.

Toepel, Kathryn, Robert L. Spear, Robert Sappington, Ruth Greenspan and Paul Baxter
1983 "Patterns of Prehistoric Land Use in Central Oregon," Contributions to the Archaeology of Oregon 1981-1982, ed. D. E. Dumond, Association of Oregon Archaeology Occasional Papers.

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GLOSSARY OF POLYNESIAN WORDS

<u>ahu</u> A religious and ceremonial structure that included a stone platform used as a base for large stone statutes and also as a burial cairn.

<u>ana</u> A general term for caves.

<u>hare</u> A general term for houses.

<u>mataa</u> A frequently occurring obsidian tool, usually 5 to 10 cm long often shaped like a spade with a tang. Used as a spear head and cutting tool.

<u>papa</u> A natural flat stone surface: the natural subsurface rock floors of caves.

<u>paenga</u> A worked piece of stone, especially carved curbstones of house foundations and slabs of <u>ahu</u> walls

<u>poro</u> A smooth, rounded beach stone.

<u>taheta</u> A depression carved into a rock surface for use as a container, particularly for water.

<u>umu</u> An earth oven, often found with upright stone slabs for the central firepit.

CHAPTER I

INTRODUCTION

The objective of this research is to address questions concerning Easter Island prehistory through analysis of the amorphous obsidian flake stone industry found on the island. Little studied by Oceanic prehistorians, these Polynesian flake stone industries are based on fine-grained rocks such as obsidian and basalt. These industries appear across Oceania in such widely scattered locations as New Guinea (White 1969, 1972), New Zealand (Shawcross 1964; Bellwood 1969), Hawaii (Schousboe et al. 1983), the Marquesas (Bellwood 1972) and Easter Island (Heyerdahl and Ferdon 1961). These industries center on the production of amorphous, generally unaltered flakes that do not easily lend themselves to morphological typologies such as those commonly used in Europe or the Americas.

Kirch notes that numerous questions about Pacfic Island lithic resources, such as those concerning trade, transport, exploitation, production procedures, manufacturing techniques, and utilization have for the most part been neglected (Kirch 1979:299). Easter Island provides an excellent opportunity for such studies because of its small size and extreme geographical isolation. The Island's small size limits the number of lithic quarries available and promotes island wide comparisons and its isolated nature allows analysis to be carried out without the "noise" of outside contacts and influences.

Four primary questions are considered in this research. These questions focus on the applicability of use-wear analysis to Easter Island research problems regarding site typology, site specialization and site geographical distribution. Each of these questions is more fully explored in Chapter II which introduces the research problems.

Chapter I presents a background from which this research can be viewed. This background is divided into two general sections; the first discusses previous archaeological research on Easter Island and the second section reviews current trends in the field of lithic use-wear analysis. The section on Easter Island archaeology is an introduction to the island setting and a general overview of the various kinds of archaeological research carried out there. As part of this overview, a specific discussion of previous habitation site investigations is presented; this emphasizes the flake stone tools among the recovered cultural remains.

The second section of Chapter I deals with lithic use-wear analysis. The majority of this section provides a review of the two primary analytical approaches currently found in use-wear studies. These two approaches are labeled the high-power approach and the low-power approach (Vaughan 1985).

Through this background the research discussed in Chapter II draws Easter Island prehistory and lithic use-wear analysis together into a unique study of the island's obsidian flake tools and their interpretative value. The chapter presents the research questions that are examined through lithic analysis and the methodology used to carry out such an analysis.

Chapter III reviews the data generated by the lithic analysis. The presentation is organized so that each site is briefly described in terms of its type, location, size, and overall artifact assemblage. Because this research focuses on obsidian edge altered flake tools, special attention is paid to the data concerning these flakes.

The fourth chapter is an analysis of the data from Chapter III and shows how these are used to address the research questions that are proposed. Chapter V provides the conclusions to this research and also examines the place of lithic use-wear analysis in the Pacific.

Archaeological Research

The Setting

Easter Island, the easternmost island of Polynesia, is roughly 3,700 kilometers from the coast of Chile and 1,900 kilometers east of Pitcarin Island, its nearest inhabited neighbor (Figure 1).

The island is roughly triangular in plan view and is made up of three major volcanoes built up from the Sala y Gomez Ridge (Clark 1975). The surface area of the island is 160 square kilometers and is dotted by more than 70 subsidiary eruptive centers. Easter Island has considerable topographic relief with elevations ranging from sea level to 510 meters (Figure 2).

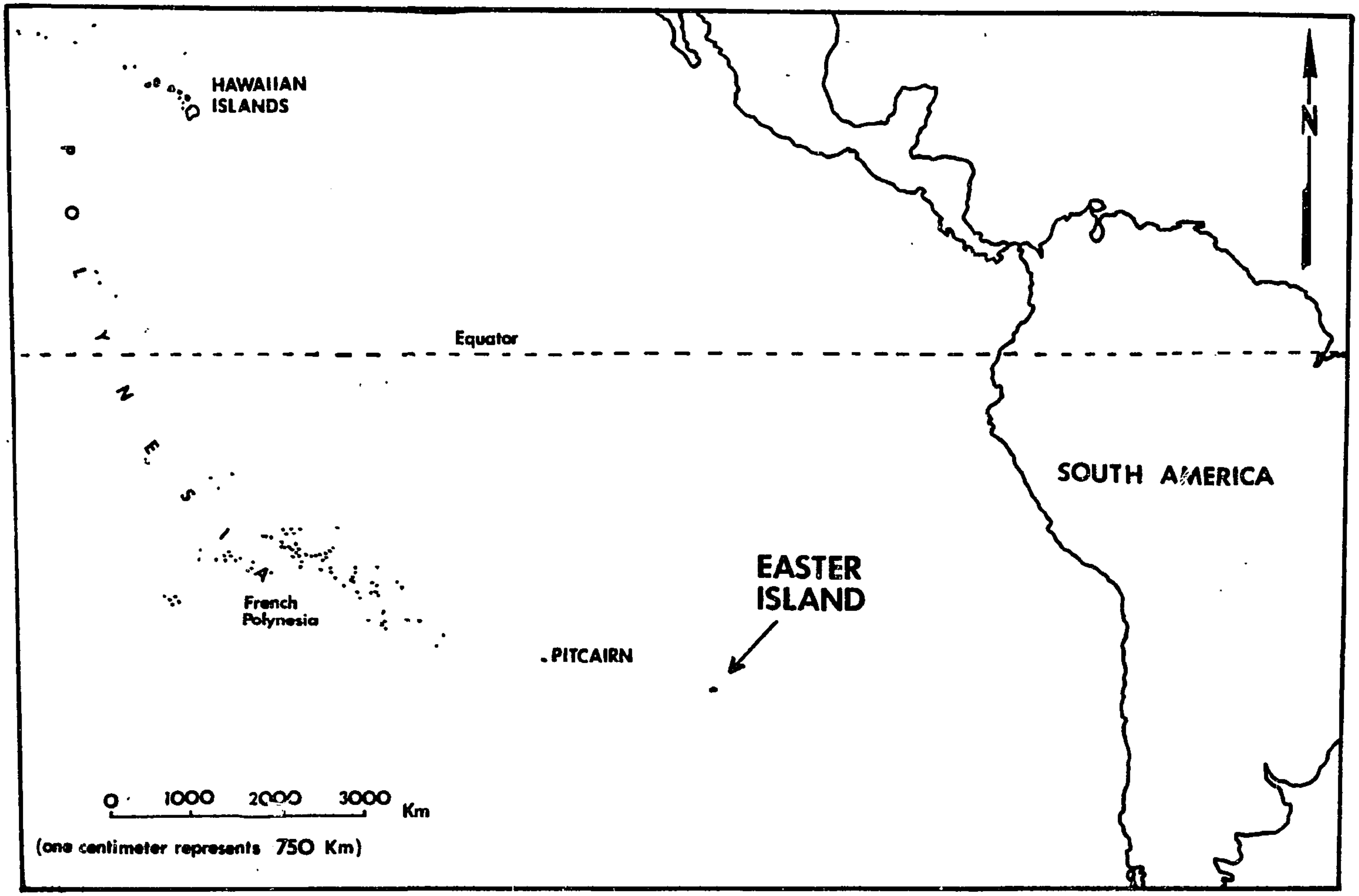

FIGURE 1. Location of Easter Island in the Pacific.

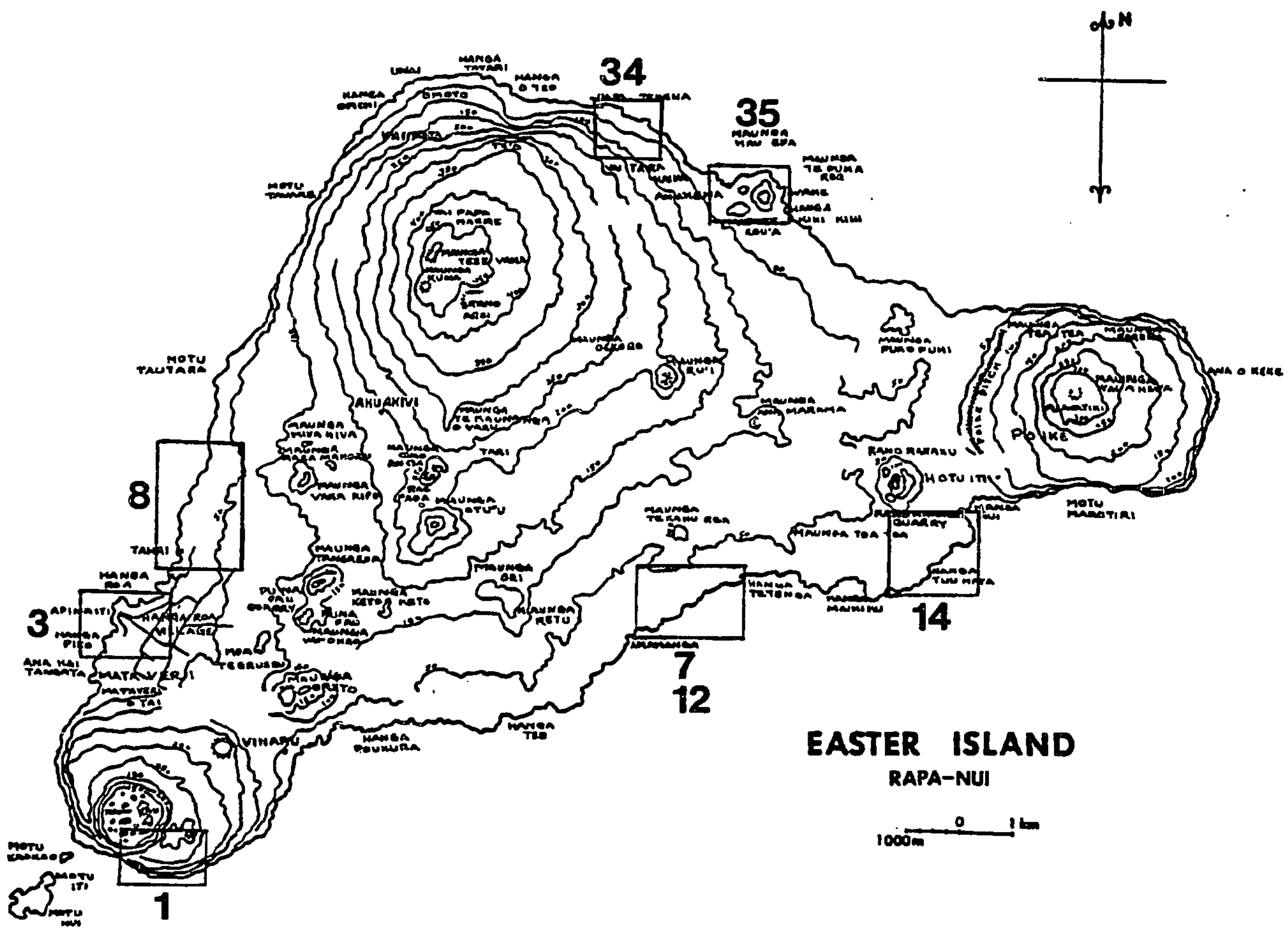

FIGURE 2. Easter Island with quadrangle locations (after Ayres 1975).

Each of the principal volcanoes has a different structure. Poike, which forms the eastern corner of the island, is a strato-volcano and is topped by a small, dry crater at 370 meters (Baker 1967). To the southwest Rano Kau stands at a height of 310 meters. The volcano's caldera is quite large and contains a freshwater lake that is extremely deep. The known obsidian sources, which provide the raw material for a variety of cultural artifacts, are all associated with Rano Kau: one, Orito, is related to a small parasitic crater on the mountain's northeast slope, another is found on the north rim of the caldera, and the third is on the three small islets just off shore. These islets are geologically part of Rano Kau (Baker 1967:119).

The volcanic activity that created Maunga Terevaka also formed the majority of Easter Island's land area. Unlike Poike and Rano Kau, Maunga Terevaka is a complex fissure volcano. It reaches a height of 510 meters. The summit has a small dry crater, but on its southeastern slope lies Rano Aroi, a crater containing a small fresh water lake.

Much of the island's shore line has been deeply eroded by the ocean which has created steep cliffs. Only at Hangaroa, Anakena, Ovahe, and Hanga O Honu can small beaches be found (Mulloy 1966:3).

In general the climate is warm and moderately humid. The average temperature is 21 degrees celcius; the warmest month is February and the coldest July, but the seasonal difference is only 5 degrees (Wright and Diaz 1962:9). Humidity is usually between 77 and 82 percent and annual rainfall averages about 1250 mm but it fluctuates greatly from this norm.

Today there are no permanent streams on the island and only a single intermittent stream on the south flank of Maunga Terevaka (Bandy 1937:159). In prehistoric times fresh water was available from the crater lakes, subterranean pools, and numerous natural and man-made catch-basins.

Owing to its isolated location the precontact flora and fauna of Easter Island were quite limited. The natural vegetation of the island has been described as a park-line savanna, with scattered groves of _toromiro_ trees (_sophora toromiro_) and shrubs interspersed with grasslands in more exposed locations (Skottsberg 1928:492). Besides _toromiro_ the other plant species included _Thespesia populnea_, soapberry (_Triumfetta semitriloba_), bunch grass (_Sporobulus_), _totora_ (_Scirpus riparius_) (Mulloy 1966:8), and as recently identified from pollen, Palm (_Palmae_) (Flenley and King 1984:1).

Plants introduced by the original population included sweet potatoes, taro, bananas, yams, gourds, sugarcane, paper mulberry, and _hau hau_ (_Hibiscus tiliaceous_; Mulloy 1966:8).

Important fauna on the island in prehistoric times was limited to chicken and rat, both of which were introduced by humans. Conspicuously absent were the dog and pig. Marine resources were also less plentiful than at many other Pacific islands. Randall (1970:59) notes only 109 separate fish species around Easter Island, a number considerably less than the 350 species he identified for

Tahiti. The lack of a coral reef, probably owing to cool water temperatures, not only limits the number of fish species but has also restrained the mollusk population.

Previous Research

Prior to 1955, research on Easter Island had been limited to a number of unrelated expeditions. This body of initial work provided information on various aspects of the island's ecological, ethnogrpahic, and archaeological history (Geiseler 1883, Thomson 1891, Routledge 1919, Métraux 1940, Englert 1948).

The Norwegian Arcaheological Expedition in 1955-1956 was the first to carry out extensive subsurface excavations (Heyerdahl and Ferdon 1961, 1965). These excavations, as well as analysis of surface architecture, focused on the island's ahu, statues and the Orongo site. Work was also directed toward cave and house sites which will be discussed later in this chapter. In addition, dates were obtained for the first time through the use of radiocarbon and obsidian hydration determinations. Since the Norwegian Expedition several other projects have examined Easter Island architecture (Ayres 1971, 1973, 1981; Mulloy 1970, 1973; Mulloy and Figueroa 1978).

In 1968, McCoy carried out an extensive survey of the southern portion of the island (McCoy 1973). A total of 19.72 square kilometers was surveyed and 1,315 prehistoric residential and ceremonial features were recorded. As part of his work, McCoy described two classes of habitations, open-air thatch and stone houses and rockshelters. These two classes were divided into several defined types of rockshelters and house structures (McCoy 1973:44-87).

In the mid 1970s, the Universidad de Chile under the direction of Claudio Cristino and Patricia Vargas continued the general survey of the island. As of 1981 a total of 16 quadrangles covering close to 50 percent of the island's surface had been surveyed.

Ayres (1975) carried out a number of excavations on the island, focusing mainly on caves. This work examined the place of terrestrial and marine resources in the island's subsistence system. Much of the lithic cultural material recovered by Ayres on this project was used as the data base for this dissertation. Ayres also expanded the earlier three period chronology established by the Norwegian Expedition into a five phase sequence (1975:14-16). These phases are:

Settlement and Development Phase (A.D. 400-1000?)

Expansion Phase (A.D. 1000-1680?)

Decadent Phase (1680-1722)

Protohistoric (1722-1868)

Historic (1868 to present)

Stevenson (1984) studied 65 ceremonial centers and 184 residential sites from the southern coast of the island. Dated through a revised obsidian hydration rate, these sites were typed and used to develop phases that demonstrated the rise of four autonomous political units within his study area by 1600 A.D.

Besides these larger bodies of work there have been a number of shorter publications touching on a range of subjects. Evidence supporting the idea of environmental change and deforestation is presented by Flenley (1979) and Flenley and King (1984). A new obsidian hydration rate, experimentally derived, has been proposed for the island and tested against established radiocarbon dates (Michels et al. n.d.). McCoy has discussed the possibility of a core and blade industry (1976) as well as the value of earth ovens in the study of the island's settlement pattern (1978). Obsidian procurement and consumption has been studied by excavating at the Orito quarry (Stevenson, Shaw and Cristino 1984). Subsistence patterns have been investigated by studying fishing technology (Ayres 1981) and faunal remains (Ayres, Saleeby and Levy n.d.). In sum, the variety of archaeological investigations on Easter Island has included extensive site surveys, culture-historical reconstructions, and settlement and subsistence studies.

It was with the Norwegian Expedition that the first intensive work was done on Easter Island habitation sites and the accompanying material culture remains. Smith (1961) excavated two caves along the coast at La Perouse. Puapau cave was extensively investigated and was found in analysis to have two cultural zones; Zone I, prehistoric, and Zone II, historic. In addition to 103 European trade items, a number of other cultural items were recovered. These included mataa, perforators, a prismatic blade, various scraper types, chisels, adzes, stone and bone fishhooks, abrading and rubbing stones, worked bone and bone needles, worked wood, shell beads, and faunal remains consisting of bone and marine shell. Zone II was distinguished from

Zone I by the presence of all the historic debris and all but one of the provenienced _mataa_. Of the total 204 non-European artifacts, 91 (45%) were scraper forms.

O-hae is an elongate cave which was extensively modified by a wall and enclosure construction. Analysis determined two Zones; Zone II which contained all of the European trade items and most of the _mataa_, and Zone I which lay beneath. Other recovered cultural items include perforators, several scraper types, chisels, an obsidian disk, picks, a core, polished stone, adzes, abrading stones, bone fishhooks and needles, worked human bone, perforated fish vertebra, red ocher, and faunal remains consisting of bone and marine shells. Of the 203 non-European items, 72 (35%) were scrapers. Both cave sites are seen by Smith as having been occupied for a considerable length of time (1961:271).

Smith also excavated the Maunga Hav Epa house site located at the eastern side of Hanga Anakena on the island's north coast. Excavations of a house foundation, an associated enclosure, and a refuse deposit were completed. Cultural items were similar to those from the La Perouse caves with the exception of the number of cores (12) and scrapers (291) present. Of the total 388 non-European artifacts, 75 percent were scrapers.

Also at Anakena, Skjølsvold excavated a circular stone house designated E-2. Compared to the sites excavated by Smith, a more limited tool inventory was found here. Of the 155 artifacts, 130 were retouched or utilized scrapers, two were obsidian disks, 17 were adzes or adz-like tools, five were mataa, and one was a rubbing stone. Scrapers comprise almost 84 percent of the total recovered tool assemblege. Interpretation of the site function is uncertain, with both a "working house" and a dwelling being suggested uses (Skjølsvold 1961:303).

Ferdon excavated site E-5 located on the coast slightly east of Anakena. The site consisted of a stone house structure, a refuse mound, and a stone-lined pit oven. No European items were recovered and only two basalt adzes were found. Obsidian tools included cores, scrapers, perforators, tanged knives, one graver, and one mataa. Scrapers made up more than 60 percent of the entire tool assemblage (Ferdon 1961:308).

Ayres investigated a number of sites on the island in 1973, fully reporting on nine, including house foundations and caves (Ayres 1975). Overall, he found that obsidian tools made up 90 percent of all the artifacts recovered. Mataa and drills were the only common stylized tools and scrapers comprised the single largest body of tools. Cave sites were found to have fairly uniform amounts of retouched obsidian flakes ranging from 13.5 to 18.5 percent. One site (7-571) had almost 38 percent of its obsidian tools in the retouched flake category (Ayres 1975:88).

The first attempt to interpret how Easter Island obsidian scrapers were used through use-wear analysis was carried out by McCoy (1973). His excavations of a rectangular house on Rano Kau recovered 35 obsidian flake tools. McCoy analyzed a number of attributes of these flakes in an attempt to develop a formalized attribute list for Easter Island flake tools (McCoy 1973:55).

Four sites from the island provided material for lithic technology and tool use studies (Ayres and Spear n.d.). This work expanded earlier morphologically based tool types and examined utilized obsidian flakes in terms of use-wear attributes. This information was then used to assess the possible activities which occurred at each site.

The previous discussion indicates that obsidian was the dominant tool material on Easter Island and that at many sites scrapers were the major tool form. With the exception of McCoy (1973) and Ayres and Spear (n.d.) these tools have only been classified by macro-morphological types. Ferdon (1961), Skjølsvold (1961), Smith (1961), and Ayres (1975) use several scraper types in their anlaysis but these types impart little information on tool function. Utilized flakes are not morphologically typed and instead are placed into one general category.

The density of cultural remains found at Easter Island sites vary considerably from site to site. In some instances only a small handful of obsidian flake tools may be recovered. To have the best possible interpretation of such a site's place in the general site typology and settlement pattern it is important to know how those flake tools were used. Other sites contain thousands of cultural items based on different raw materials such as stone, bone, or coral. Clearly, understanding these sites depends on studying the entire collection although even in these cases a substantial portion of the artifact assemblage is made up of obsidian scraper types. In such instances it is important to know how these tools fit into the overall assemblage from a functional perspective. Yet it is a functional understanding of the amorphous flake tools that almost all of the previous Easter Island lithic analyses lack. To develop a functional understanding of these tools requires lithic use-wear analysis.

Lithic Use-Wear Analysis

Since the beginning of the discipline, archaeologists have tried to reconstruct stone tool use. A number of avenues have been pursued in the desire to assign function to a wide variety of stone tools.

S. Nilsson provided one of the earliest systematic functional classifications of stone tools. This was done by basing functional names on resemblances between prehistoric artifacts and various historic metal or wooden implements or ethnographic stone tools (1838-1843). This approach to the understanding of the use of an artifact has continued in one manner or another up to the present day (Vaughn 1985:3). Hayden and Kamminga have labeled this the "speculative functional approach" (1979:3). Today many tool classifications combine morphological and functional categories and some are supported by direct analogy from known ethnographic populations (Tindale 1965, Gould 1971, Hayden 1978).

Extremely little in the way of lithic functional analysis has been carried out in the Pacific region. While not an exhaustive list, examples from Asia, New Zealand and Hawaii represent work that has been done. Glover (1978) has described microliths in Indonesian flaked stone industries and Leach (1978) has discussed adz and large blade manufacture in New Zealand.

In the Philippines research has been done on the technological and functional analysis of lithic material from Rabel Cave (Ronquillo 1981). This study focused on amorphous flake stone tools and the attributes of edge angle, edge shape, use-wear and utilized edge length (Ronquillo 1981:8-10).

In southwest Thailand Pookajorn (1984) investigated the technological and functional aspects of lithic tools from Hoabinhian sites. In this analysis he discussed tool manufacturing techniques and categorized utilized stone tools into six groups depending on function (Pookajorn 1984:39).

Polynesian island flake tool analyses are exemplified by work done in New Zealand and Hawaii. Shawcross excavated a swamp site at Kauri Point on the North Island of New Zealand and recovered a large assemblage of obsidian flakes. Preliminary analysis indicated that "the conventional, typological categories as employed in Europe, could not be readily applied" To this assemblage (Shawcross 1964:7). Instead, Shawcross analyzed the flake attributes of size, edge length, edge shape and striking platform angle and thickness (Shawcross 1964: 15-16).

Bellwood (1969) also excavated a small ridge top site at Opito

Bay on the North Island of New Zealand. Like Shawcross, he found that traditional flake tool typologies were not useful for his site analysis. Rather, Bellwood used the attributes of flake size, edge length, edge shape, and edge angle to interpret his lithic assemblage (Bellwood 1969:207-209).

In Hawaii a detailed technological and edge-damage study was undertaken on seven sites in the Mudlane-Waimea-Kawaihae Road Corridor (Schousboe et al. 1983). In an attempt to provide a basis for the further study of amorphous obsidian flakes and cores, the authors developed descriptive and analytical procedures for the flakes and cores, reconstructed core-reduction sequences, and analyzed edge-damage patterns.

Several of these Pacific examples show the difficulty of classifying flake tool forms and identifying their function beyond the traditional morphological category of scraper. Hayden and Kamminga (1979) note that the term scraper, which is still employed to describe a wide range of retouched stone artifacts, almsot certainly has little functional integrity as a category.

Use-wear analysis began as early as the mid-nineteenth century when edge rounding and fine striations on Paleolithic and scrapers from Yorkshire Wolds were associated with the action of grit that came in contact with the tools while scraping skins (Greenwell 1865; Evans 1872). Experimentation in the formation of use-wear was carried out by Spurrell (1892) in an attempt to identify the lustrous polish on small blades from European and Near Eastern Neolithic sites.

Spurrell experimented on wood, horn, bone, and straw in his attempt to reproduce the polish. Later Vayson (1919, 1920), Curwen (1930), and Neuville (1934) entered this debate, and Curwen (1935) finally concluded that the polish was created by soft contact materials such as corn stalks.

Until fairly recently experiments and wear analysis were unsystematic and limited in scope and scientific control. A notable exception was Sonneenfeld's (1962) work on prehistoric hoes and axes which was an integrated and detailed experimental and microscopic wear study.

It was the publication of Semenov's (1964) Prehistoric Technology that has had the greatest effect on the study of use-wear. Semenov analyzed lithic material from three Paleolithic sites, Kostenki I, Timonovka, and Mal'ta. While his conclusions were of great interest, his major contribution was to show that systematic tool-use experiments were essential for understanding damage caused by use-wear.

Since the publication of Semenov's book, archaeologists have increasingly turned to wear studies to determine the use of stone tools. As more research has been carried out two basic approaches have been developed; these have been called the high-power and low-power approaches.

Higher-Power Approach

Use-wear falls into four basic categories: microchipping, striations, rounding, and micropolishes. The high-power approach tends to focus primarily on rounding and micropolishes using magnifications of 200X and greater. While a number of researchers have used this approach (Brink 1978; Kamminga 1977, 1979; Vaughan 1985), it was Keeley who initiated the characterization of micro-polishes (1976, 1977, 1978, 1980). The work of Keeley and others has resulted in the indentification of a number of polishes such as that from working bone (Anderson-Gerfaud 1981; Keeley 1980), antler (Anderson-Garfaud 1981; Keeley 1980), wood (Hayden and Kamminga 1973; Kamminga 1977), reeds (Vaughan 1985), plants (Keeley 1980, Witthoft 1967), tanned or dry hides (Brink 1978; Anderson-Gerfaud 1981; Keeley 1980; Vaughan 1985) and fresh hide and meat (Brink 1978; Moss 1983; Moss and Newcomer 1982). The usefulness of the high-power approach in determining the mode of utlization and the diagnostic category (i.e., bone, wood, hide, plant) is well established.

There are three limitations to the high-power approach. First, this approach requires microscopes that provide great magnification, frequently involving scanning electron microscopes (Kamminga 1979; Del Bene 1979). For most archaeologists such equipment is either not available or prohibitively expensive. Second, the slow speed with which analysis can be done tends to limit the number of specimens that can be studied. Finally, it takes a great deal of time to develop the interpretive skill necessary to study micropolishes. This skill is one that most archaeologists do not have.

Low-Power Approach

The low-power approach focuses attention on microchipping and to a lesser extent on striations, usually at magnifications of 60X or less. A number of workers have used the low-power approach in analyzing experimental and archaeological specimens (Keller 1966; Hayden 1979; Spear 1980; Coqueugniot 1983; Ayres and Spear n.d.).

It is the work of Trigham's group that set the tone for this approach. Tringham (1974), in conjunction with several others, carried out one of the first wide-ranging series of microwear tests. These tests show that microflaking can be used to determine how a tool was used (cutting, scraping, rotating) and the relative degree of hardness of the contact material.

Odell has attempted to refine this low-power method by further experimentation and then applying this information to archaeological material (1977, 1978, 1981, 1982). Del Bene (n.d.) and Spear (1980) also provide useful comparisons with the work of Tringham et al. Del Bene performed tasks that included working stone, bone, skins, meat, and wood. He used two contact material categories (hard and soft) and made detailed observations of tools used for cutting and scraping. Spear experimented with obsidian flakes on hard (bone, toromiro wood) and soft (bamboo sugar cane) contact materials. Both experimentors' results strongly support the initial findings of Tringham's group.

The major drawback of the low-power approach is that researchers usually can only identify the general contact material category, often termed hard or soft. Under circumstances where there appears to be a limited variety of contact materials it becomes more likely that specific identifications can be made (Spear n.d.a.).

On the plus side of the low-power approach is that most archaeologists can carry out such analysis. Stereoscopic microscopes are generally available and provide all the magnification that is necessary. Also, the analysis of microchipping is more quickly learned than are the identifications required by the high-power approach. Finally, it is possible to analyze economically a larger number of specimens with the low-power approach than can be done with the high-power approach.

In comparison, the primary interpretive value of the high-power approach is that specific categories of worked materials such as hides, plants, bone and antler can be identified; however, this high-power approach requires specialized equipment and training. The low-power approach allows for the identification of general classes of contact materials, often labeled hard and soft. The low-power approach thus provides quite similar, but less exact data, with far lower investments in equipment, training and time. Because the research design here called for use-wear study of obsidian flakes from a large sample of Easter Island sites, the low-power approach was used.

CHAPTER II

EASTER ISLAND OBSIDIAN FLAKE ANALYSIS

Introduction

Keely has stated that the goal and purpose of use-wear studies is to reconstruct the economic activities of prehistoric groups (1974:323). Towards this goal lithic analysis, including use-wear studies, can be used on Easter Island to examine tool use, site specialization, site typology, and site location as they relate to settlement patterns. While some of these research topics have been addressed by earlier studies on Easter Island, only McCoy (1973), Spear (1980, n.d.a.) and Ayres and Spear (n.d.) have approached them through use-wear analysis as well as morphological tool typologies.

Beginning from the first excavations of the Norwegian Expedition, archaeologists have found high frequencies of obsidian scraper forms in Easter Island assemblages. In some cases these scraper forms comprise almost the entire tool collection from sites (Spear n.d.b.). Smith (1961) found that 45 percent of the recovered artifact assemblage from Puapau cave and 35 percent of the artifacts from O-hae cave were scrapers. The artifact assemblage from the house site at Maunga Hav Epa contained a very high percentage (72%) of scraper forms (Smith 1961) as did the stone house at Anakena (84%; Skjølsvold 1961). Other excavators, such as Ferdon (1961), McCoy (1973), and

Ayres (1975), also found high percentages of scraper forms in the sites they investigated.

Easter Island obsidian scrapers have been classified by archaeologists into types based on the general morphology of the tool (Ferdon 1961; Skjølsvold 1961; Smith 1961; Ayres 1975; Ayres and Spear n.d.). While such types are useful in organizing collections, and may have chronological significance, they are not designed to address questions regarding tool use. For this analysis the macro-morphologically generated scraper types are not used and the term edge altered flake is used in place of the generalized term of scraper.

White (1969, 1972) found that lithic collections from the New Guinea highlands were not usefully typed on morphological grounds. This also proved to be true ethnographically when White and Thomas (1972:278) found that, "modern highlanders, then, do not regard their flaked stone tools as a series of formal or single-functional types, but as pieces of stone, parts of which may be used to perform certain activities."

Instead of using the entire artifact as the primary unit of analysis, White focused on the altered edge of the stone specimen. With such a perspective, White established a typology based on the edge shape and alteration by analyzing artifacts with a three part system (White 1969). By combining White's analytical approach with experimental obsidian use-wear data (Keller 1966; Greiser and Sheets 1979; Spear 1980), a functional analysis of the Easter Island edge altered flakes is possible.

Research Questions

Four primary research questions are addressed here; in brief these questions are:

1. Can the archaeological sites in this study be characterized in terms of use-wear analysis?
2. Can sites characterized by use-wear analysis be related to McCoy's (1973) existing site typology or are the activity sets represented independent of site type?
3. Can sites characterized by use-wear analysis be differentiated by geographic location?
4. Can use-wear analysis aid in defining site specialization?

The initial question focuses on the analysis and characterization of the edge altered flakes by the material they were used to work, that is, the contact material. By grouping the altered edges each site can be characterized by these categories. Once the sites have been characterized by the altered edge categories, they can be used to examine the three remaining research questions.

The second research question relates to the site typology established by McCoy (1973). By characterizing the sites in terms of use-wear as well as by McCoy's types a comparison can be made to see if the two methods of defining the sites complement each other or are independent of one another. McCoy's work from the southern portion of the island established two general classes of habitations: rockshelters and open-air thatch and stone houses (McCoy 1973:44-87). McCoy defined four types of rockshelter habitations; three of these are represented in this study sample.

Type 1 rockshelters (karava) are typically small niches or overhands, usually measuring 1.5 meters square or less. They rarely have pavements or modified interiors or earth ovens. These are seen as shelters briefly used for escaping foul weather or overnight stays (McCoy 1973:46). Here these sites are denoted by the code RT1 for Rockshelter Type 1.

Type 2 habitations (ana) are any cave, lava tube, or rockshelter larger than the Type 1 shelters. This type is divided into two sub-types, those that are permanent or semi-permanent and those considered temporary. Permanent and semi-permanent habitations are noted by some or all of the following features; walled mouths which partially seal an entrance, shallow firepits, earth ovens, extensive refuse deposits, and associated chicken houses and garden enclosures. Those habitations that lack these modifications and have only a minimal accumulation of midden are considered temporary (McCoy 1973:47). For this present study, the permanent and semi-permanent habitation sites are denoted by the code RT2-ST1 and the temporary sites are assigned the code RT2-ST2 which stand for Rockshelter Type 2 Sub-type 1 or 2.

Type 3 shelters, ana kionga, are specialized refuge caves often located on sheer cliffs or cleverly concealed, sometimes with elaborate corkscrew entrances (McCoy 1973:48). Sites 3-72 and 7-571 are identified as anal kionga. Although disturbed, both sites at one time featured elaborately constructed entryways. It is unclear, because of their disturbed nature, if these sites always served as specialized refuge caves, but based on the criterion established by McCoy, these sites can also be considered as permanent or semi-permanent habitations. As such, they are included in this study as _ana_ (RT2-ST1). No Type 4 shelters are included in this study because they are only found at or near the bottom of the talus slopes inside the caldera of Rano Lau (McCoy 1973:48).

McCoy also defined three open-air thatch and stone house types. The Type 1 house is an elliptical, boat shaped thatch hut (_hare paenga_) noted in the ethnographic record. These house types are coded FT1 for Foundation Type 1. Only one of McCoy's sub-types is present in this study sample. Sub-type B (STB) house forms are usually large and leave a clear archaeological imprint. These houses are made with dressed stone foundations and large well-made beach stone pavements. The size averages 1.5 to 2.0 meters broad by 10 to 15 meters in length. However, size varies greatly; lengths vary from less than five meters to almost 40 meters. McCoy states that these house forms are found only near _ahu_ and are the first dwellings inland of the _ahu_. He also notes that these houses only rarely are associated with chicken houses or gardens (McCoy 1973:61-64).

Type 2 (FT2) houses are round, thatch huts with a foundation of a single uncut course of stones. Sizes range from 1.5 to 9 meters in diameter with most being 2 to 4 meters in diameter. Concentrated in the Rano Kau area, these temporary dwellings are related to the time of the bird cult ceremony. Apparently used by commoners, these houses are not associated with chicken houses, gardens, or large refuse mounds (McCoy 1973:68-73).

The final house type is a rectangular, thatched form. Although these Type 3 (FT3) houses have stone foundations, they have only minimal midden deposits. McCoy suggests that a lack of related chicken houses and gardens indicates an early date for this house type. He also feels that the presence of hearths in addition to the scant midden indicates short-term winter occupation (McCoy 1973:77).

By classifying each of the sites with McCoy's typology and characterizing the use-wear present on flakes, the correlation between site type and activity can be examined. Application of the use-wear data will provide a more refined picture of McCoy's site typology.

The third research question is concerned with differentiating sites by geographic location. Behind this idea is the frequently found Polynesian high-island settlement pattern of the radial division of land (Bellwood 1979:309; Kirch 1984:272) such as seen in the Marquesas (Bellwood 1972), the Hawaiian Islands (Kirch 1985), and the Society Islands (Bellwood 1979). For Easter Island, Métraux (1940:143) states that "Land for each estate was probably a straight strip of land (kainga) which stretched away from the shore toward the interior of the land."

Associated with this radial land division is a coastal-inland settlement dichotomy based on different uses of the land section (Bellwood 1972:38-39; Kirch 1985:273-283). However, for Easter Island, McCoy states that a coastal-inland settlement dichotomy is meaningless because of the island's small size and environmental uniformity (McCoy 1973:171).

By characterizing sites through use-wear analysis, the concept of a coastal-inland dichotomy on Easter Island can be addressed. In doing so the basic Polynesian high-island settlement pattern can be approached from a site function perspective. This allows for the examination of McCoy's statement as well as providing a unique look at the Easter Island settlement system. Within the present site sample, these located directly on the coast are considered coastal while sites set back from the shore more than 200 meters are viewed as inland.

Related to the questions concerning site typology and location is the fourth question that of site specialization. At issue here is whether the labels of permanent or temporary applied by McCoy may also reflect sites that were used for several tasks or ones that were task specific.

Methods

Cultural material from 36 sites was available for this study (see Sampling, page 33). Within this material were some 25,000 pieces of obsidian including formalized tool forms, edge altered flakes and manufacturing waste debris termed debitage.

Because the focus of this study is on the edge altered flake tools, the formalized tools such as mataa, drills, small image eye-pieces, and chisels were only counted and recorded. Debitage analysis included assignment of each piece to a flake production category and a size group (these terms are defined below).

Following White's lead the analysis carried out in this research used the altered edge as the primary unit of analysis. Initial analysis of an implement recognized to have an altered edge consisted of recording the attributes of the whole specimen. These were length, width, thickness, weight, flake stage, and size. With the possible exception of the final two these attributes are commonly recognized. Raw material was restricted to obsidian. Object weights were recorded in grams. Length is the dimension measured from the bulb of percussion or the proximal end of the flake through the center of the flake to the distal end. Width was measured at right angles from the line used to measure length and was recorded at the widest point. Thickness was measured below the bulb of percussion at the thickest part of the flake. For those specimens that were angular "chunks" and not flakes, length was the greatest dimension on the piece, width the second greatest, and thickness the third greatest.

Flake production stage attributes fall into five categories:

1. Primary Flakes are flakes with cortex on 100 percent of the dorsal face.
2. Secondary Flakes are flakes with some cortex on the dorsal surface.
3. Interior Flakes are flakes with no cortex on the dorsal surface.
4. Shatter includes unidentifiable flake fragments.

5. Angular Waste contains angular, "chunky," nonflake pieces. Except for the highly modified implements, each stone item was categorized according to one of these five categories.

Flake size is a general attribute based on specimen comparison with arbitrarily established sizes. Figure 3 shows the sizing grid with its size of 0.5, 1.0, 1.5, 2.0, 3.0 and 5.0 cm. All flake debitage and edge altered flake tools were sized with this grid.

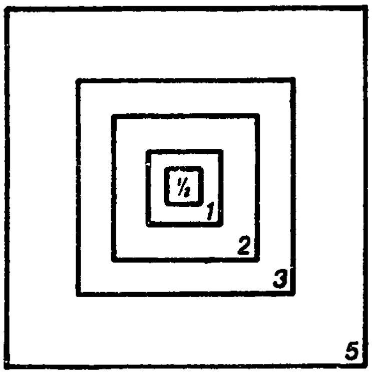

FIGURE 3. Sizing grid (in centimeters).

The primary analysis focused on the altered edge(s) of each stone implement. Attributes recorded here were edge shape, type of edge alteration, location of edge alteration, edge length, spine-plane angle, and edge angle.

Edge shape, as viewed in planeview from the dorsal side, was categorized as slightly or strongly concave, slightly or strongly convex, straight, irregular or pointed. The type of alteration was either intentional retouch or alteration only due to use-wear. Location was noted as either on the dorsal, ventral, or both flake surfaces.

For retouched edges two angle measurements were taken: the spine-plane angle, which is seen as a production angle (Hayden and Kamminga 1979:7), and the edge angle which is the angle created by the intentional retouching. Edges that showed only use-wear alteration were measured only for their spine-plane angle.

Previous work has shown the difficulty of examining use-wear traces on intentionally retouched edges through the low-power approach (Brink 1978; Keeley 1980; Vaughan 1985). Because of this difficulty and their relatively small numbers, retouched edges were not subjected to use-wear analysis.

Edges showing only use-wear alteration were subjected to an analysis based on the low-power approach that centered on micro-flaking damage. The attributes recorded were based on the previous work of Keller (1966), Tringham et al. (1974), Odell and Odell-Vereecken (1980), and Spear (1980). These attributes recorded the location, size, type, and relative intensity of edge microflaking.

The analysis of use-wear falls into four basic categories: microchipping, striations, rounding and micropolishes. The method of analysis used in this dissertation is the low-power approach with a focus on microchipping. Interpretation of the microchipping was based on (a) published literature, including micrographs of edge chipping (Hayden 1979; Odell 1977, 1981; Odell and

Odell-Vereecken 1980; Tringham et al. (1974); and (b) experimental work specifically related to the Easter Island situation carried out to provide a second body of comparative material (Spear 1980).

The two altered edge categories hard and soft reflect general classes of contact material. Experimental edges worked on hard contact materials are characterized by edge damage dominated by step and hinge fractures frequently extending back from the tool edge more than 2 mm. In contrast, edges worked on soft materials are distinguished by feather flakes as the dominant micro-flake type. These flakes are often less than 1 mm in length.

Interpretation of these data focused on the altered edge categories and edge shape in planeview. Each analysed edge was placed into one of four altered edge categories: hard, soft, retouched, or unknown. Edges interpreted as having been used on hard contact materials were placed in the hard category. Hard contact materials are items such as stone, bone, and wood. Edges used on soft materials such as reeds, sugar cane, or bamboo were placed in the soft category. Those edges exhibiting intentional edge modification were put in the retouched category. These edges are percussion retouched. Edges that showed only use-wear damage but that could not be placed in either the hard or soft category were put in the unknown category.

Sites were characterized by the percentage of edges found in all four of the altered edge categories. Those sites that were separated by no more than 10 percent in the hard and soft categories were considered to have an essentially even emphasis on the working of these classes of contact materials. Sites that were separated by more than 10 percent in the hard and soft categories were considered to emphasize the altered edge category that was greater. For example, site 8-82 has 26 percent of its altered edges in the hard category, 49 percent in the soft category, 11 percent in the retouched category, and 14 percent of its edges in the unknown category. In this case the working of soft materials was emphasized by the occupants of this site.

The second primary attribute used for interpretation was based on the general shape of the utilized edge as seen in planeview. All edges were recorded according to one of the following seven numbered edge shapes; (1) straight, (2) slightly concave, (3) strongly concave, (4) slightly convex, (5) strongly convex, (6) pointed, (7) irregular. These seven edge shapes were then compressed into four edge group categories to maximize frequency counts. These edge group categories are 1/7 straight and irregular, 2/3 concave, 4/5 convex, and category 6 the pointed edges.

Chronology

Specific dating of the sites was done through the two absolute dating methods of radiocarbon and obsidian hydration. Radiocarbon dating was carried out on five of the sites in this study. These were sites 1-193, 7-571, 12-210, 14-57a, and 35-8. Except for 1-193, dates from these locations occur from the mid-Expansion to Protohistoric Phases (Ayres 1975:97).

The obsidian hydration rate used here is that derived by Michels et al. (n.d.). In fact two rates were proposed, 6.29 Microns squared/ 1000 years for the Rano Kau and Orito sources and 7.30 Microns squared/1000 years for the Motu iti source (Michels et al. n.d.). Stevenson and Routledge both state that the Rano Kau and Orito locations were the primary sources for obsidian rather than Motu iti (Routledge 1919:223, Stevenson 1984:74-75). Because of this restriction the 6.29 Microns squared/1000 years rate is used in this study (Stevenson 1984:74-75). In addition to the hydration rind dates reported by Ayres (1975), twelve additional sites have been dated at the University of Oregon. The additional dates range from the mid-Expansion to Decadent Phase.

Overall, the dated sites fall into the later prehistoric and protohistoric periods even though some dates do go back to the early Expansion Phase (Ayres 1975:96). Given that most of the sites, especially the coastal and interior caves, were occupied at a time relatively late in the cultural sequence they are taken to be synchronic samples that can be readily compared.

Sampling

The original excavations carried out by Ayres were not initially designed to answer the research questions presented above. Among several goals, Ayres' research design focused on gathering data on portable material culture so that series of hypotheses relating to ritual center architecture, statuary, and the role of isolation in culture change could be tested (Ayres 1975:26).

To support his research design Ayres extensively excavated nine sites and tested another twenty-eight sites, primarily caves. These sites were located within the survey quadrangles shown and numbered in Figure 2. The exact site locations within each quadrangle are shown in Chapter III. Many of these test excavations were comprised of one or two test units so that the density and internal integrity of a site's cultural deposits could be ascertained (Ayres 1975:23).

Of the obsidian material studied all of the debitage was analyzed by production stage type and size. Given the high number of edge altered flakes in the artifact assemblages, detailed analysis of all of these flakes was not feasible. One hundred percent of the edge altered flakes from 21 sites were completely analyzed, but for the remaining 15 sites the sample sizes varied from 5 to 70 percent (see Appendix A).

Sample sizes were determined by the total frequency of edge altered flakes present in any given assemblage so that the sample population would fall near 50 items. Samples were derived by using random number tables to choose the study specimens (Haber and Runyon 1969:318-321; Runyon and Haber 1980:411-414).

Statistical examination of the data was carried out through the use of one and two variable chi-square tests and some measure of exact probabilities. The chi-square test was selected because it is a flexible, elementary means of calculating the discrepancy between observed frequencies and some alternate theoretical set of frequencies proposed by the researcher (Williams 1968:112). Whenever the chi-square test is performed in this dissertation the associated null hypothesis is that the tested frequencies are randomly distributed. Rejection of the null hypothesis is taken to mean that the tested frequency distributions are the result of human activity. A significance level of 0.10 was set before analysis but whenever a more rigorous level was met (i.e., 0.05 or 0.01) this level was noted. Because many of the samples tested in this research are small, the 0.10 significance level was chosen although this creates a greater risk of a Type I error, which is to reject a true null hypotheses (Thomas 1976:459).

CHAPTER III

DATA PRESENTATION

Introduction

This chapter is intended to present the basic data on the 36 sites used in this research. Each site is briefly described in terms of site type, location, size, and general artifact assemblage. Special attention is paid to the data concerning obsidian edge altered flakes. The chapter is organized by survey quadrangle number (see Figure 2) and site number.

Flake weights were obtained with an electronic balance and are accurate to four significant figures. Tool edge length and spine-plane angle measurements are accurate to two significant figures.

Quadrangle 1

1-185

Two sites were excavated in the Rano Kau Quadrangle (Figure 4). Located on an isolated southwest plateau of Rano Kau crater, site 1-185 (FT2) is a circular house foundation some 5.5 meters in diameter. The foundation was quartered and two of these quadrants were excavated (Figure 5).

Recovered basalt remains from 1-185 include two adzes, a hammerstone and 17 basalt flakes, one of which was utilized. Obsidian

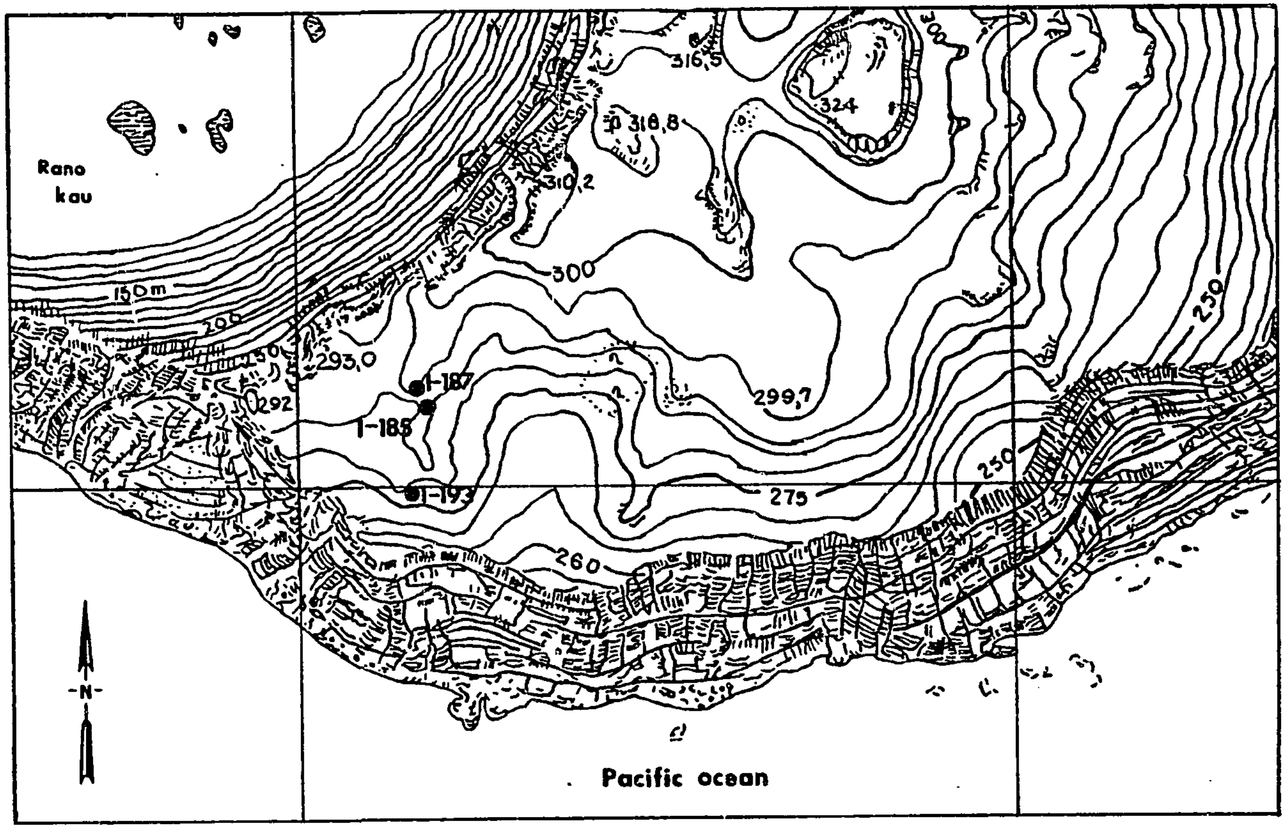

FIGURE 4. Quadrangle 1, site locations (after Ayres 1975).

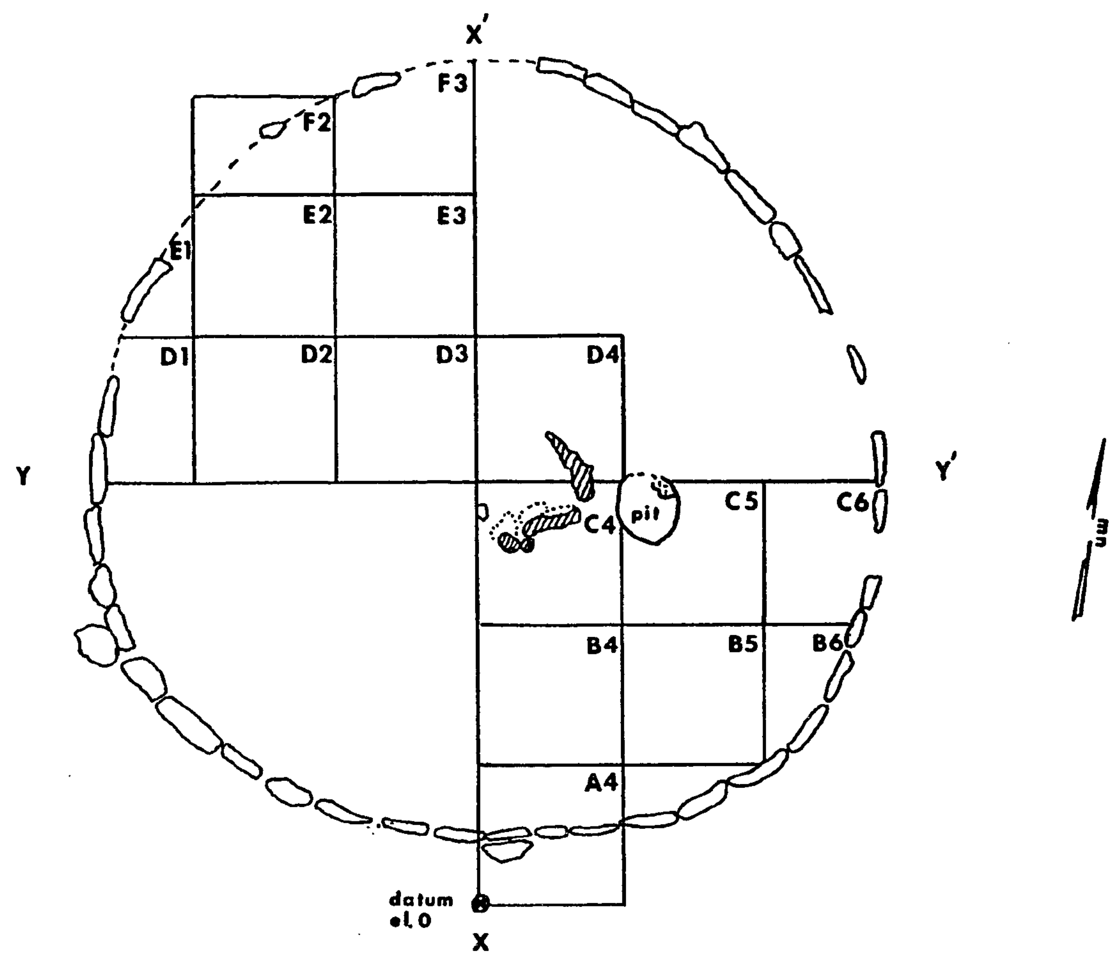

FIGURE 5. Site 1-185, Rano Kau, plan view (after Ayres 1975).

cultural debris includes one statue eyepiece, 11 unworked nodules, 32 edge altered flakes, and 138 pieces of debitage.

Thirteen (30%) of the altered edges fall into the hard category, 13 (30%) into the soft category, 11 (26%) are retouched, and 6 (14%) fit the unknown category. With respect to edge type Group 1/7 has 22 (51%) edges, Group 2/3 has 10 (23%) edges and Group 4/5 has 11 (26%) edges. One and two variable chi-square tests on the contact material category and on the edge type groups found no statistically significant distributions.

Only 38 percent of the edge altered flakes fit into size groups 2, 3 or 5 while the remainder fit the smaller Groups 0.5 and 1. The mean flake weight in the hard category is 8.12g and the range is 1.20 to 37.20g. The range in the soft category is 0.60 to 8.70g and the mean is 2.77g. For the retouched category the flake weights vary from 1.50 to 72.60g, with a mean of 11.45g. This mean is strongly skewed by one extremely large flake which is 63.20g heavier than the next heaviest flake.

Mean tool edge length for the hard category is 16mm and 14mm for the soft. The range of lengths in the hard category varies from 10 to 31mm, while the range in the soft category is 8 to 29mm. Retouched edges average 17mm and range from 8 to 41mm.

The mean spine-plane angle for the hard category is 60 degrees and the range is 20 to 100 degrees. For the soft category the range is 21 to 57 degrees and the mean is 35 degrees. Figures of spine-plane angles, such as Figure 6, are designed to illustrate the

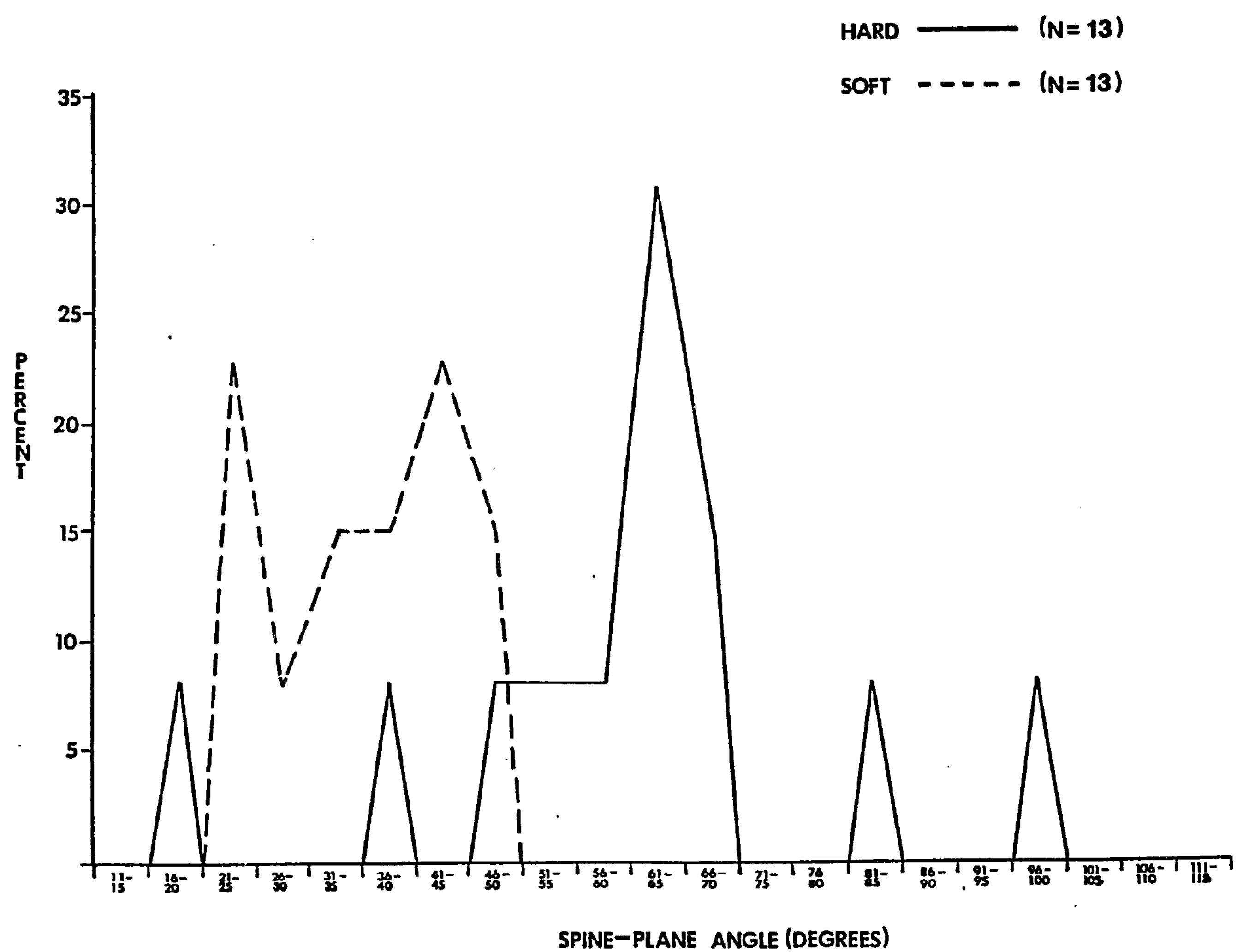

FIGURE 6. Site 1-185, range of spine-plane angles.

distribution of the spine-plane angles in these two categories. The mean edge angle in the retouched category is 64 degrees and the range is 45 to 83 degrees.

Dating of the site was done with obsidian hydration. The two dates were 629 ± 74 and 666 ± 185BP. These dates suggest a fourteenth century, Expansion Phase age.

1-193

Site 1-193 (FT3) is a rectangular, round cornered house foundation constructed of upright stones (Figure 7). The foundation is situated on a modified terrace overlooking the 300 meter high cliff escarpment of Rano Kau.

Cultural debris were limited to basalt and obsidian materials. Basalt artifacts included one adz, one adz chip, two hammerstones, and four unworked flakes. Obsidian items included 43 edge altered flakes and 146 pieces of debitage.

The hard altered edge category is made up of 25 (39%) edges, the soft category 17 (26%) edges, the retouched category 11 (17%) edges, and the unknown had 12 (18%) edges. The edge type Groups 1/7 and 2/3 have almost even frequencies, 26 (40%) for Group 1/7 and 27 (42%) for Group 2/3. Group 4/5 contained 12 (18%) of the altered edges. As at site 1-185, the chi-square test found no statistically significant differences between the expected and actual frequencies in either the altered edge categories or the edge type groups.

Eighty-two percent of all the edge altered flakes fit size

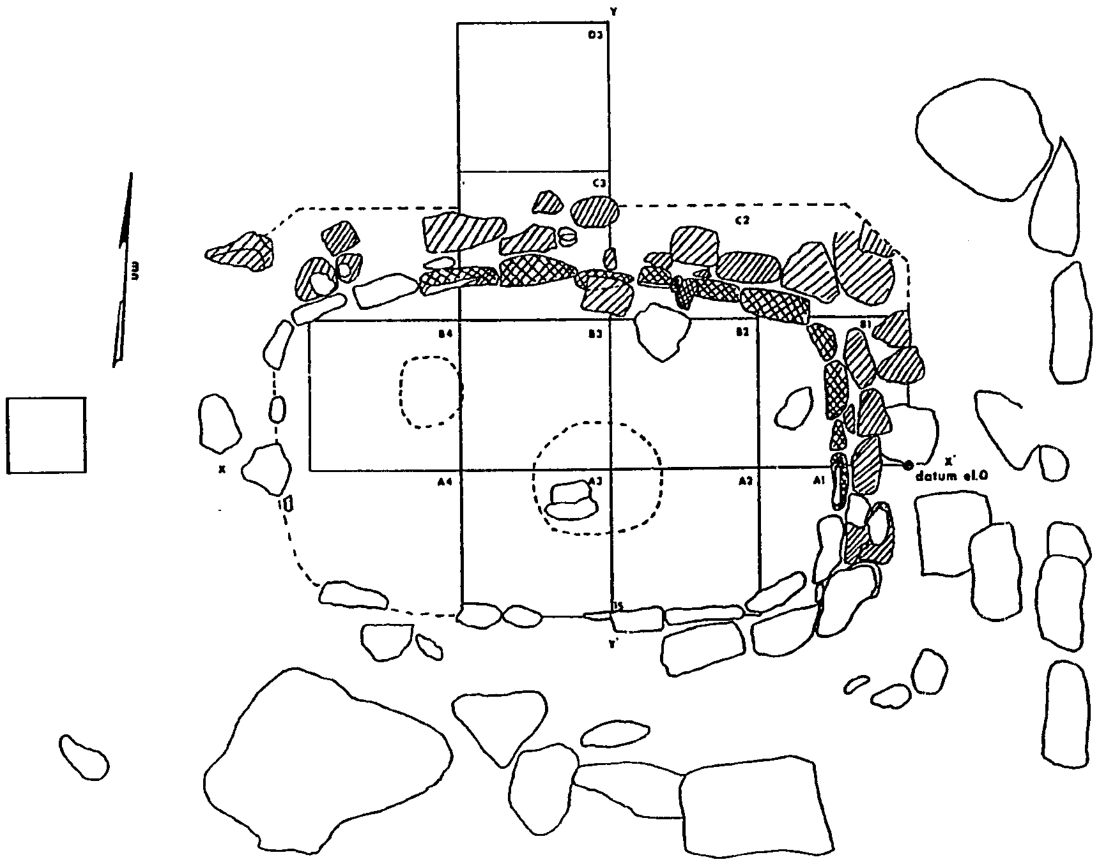

FIGURE 7. Site 1-193, Rano Kau, plan view (after Ayers 1975).

Groups 2, 3 or 5. The mean weight in the hard category is 16.06g the range is 0.20 to 119.90g. This mean weight is skewed by one extremely large flake. The soft category has a range of weights varying from 0.45 to 48.60g and a mean of 14.98g.

The length of tool edge favors the soft category with a mean of 24mm while the hard category has a mean of 17mm. The range of edge lengths in the soft category is 8 to 56mm and for the hard category it is 5 to 36mm.

In the hard category the range of spine-plane angles is 19 to 111 degrees and the range in the soft category is 26 to 51 degrees. The means for these two categories are 57 degrees for the hard category and 37 degrees in the soft. Figure 8 shows the distribution of the angles for these two categories.

The dating of this site was done through both obsidian hydration and radiocarbon. The radiocarbon date of contemporary is viewed as not representing the primary period of site usage (Ayres 1975:42). The hydration dates of 185 ± 37 and 296 ± 74 BP. indicate a construction and use period during the late Expansion Phase, probably in the late seventeenth century.

Quadrangle 3

Quadrangle 3 is centered around Hanga Piko Bay on the southwest coast of the island (Figure 9). Three cave sites, two coastal and one interior, are represented here.

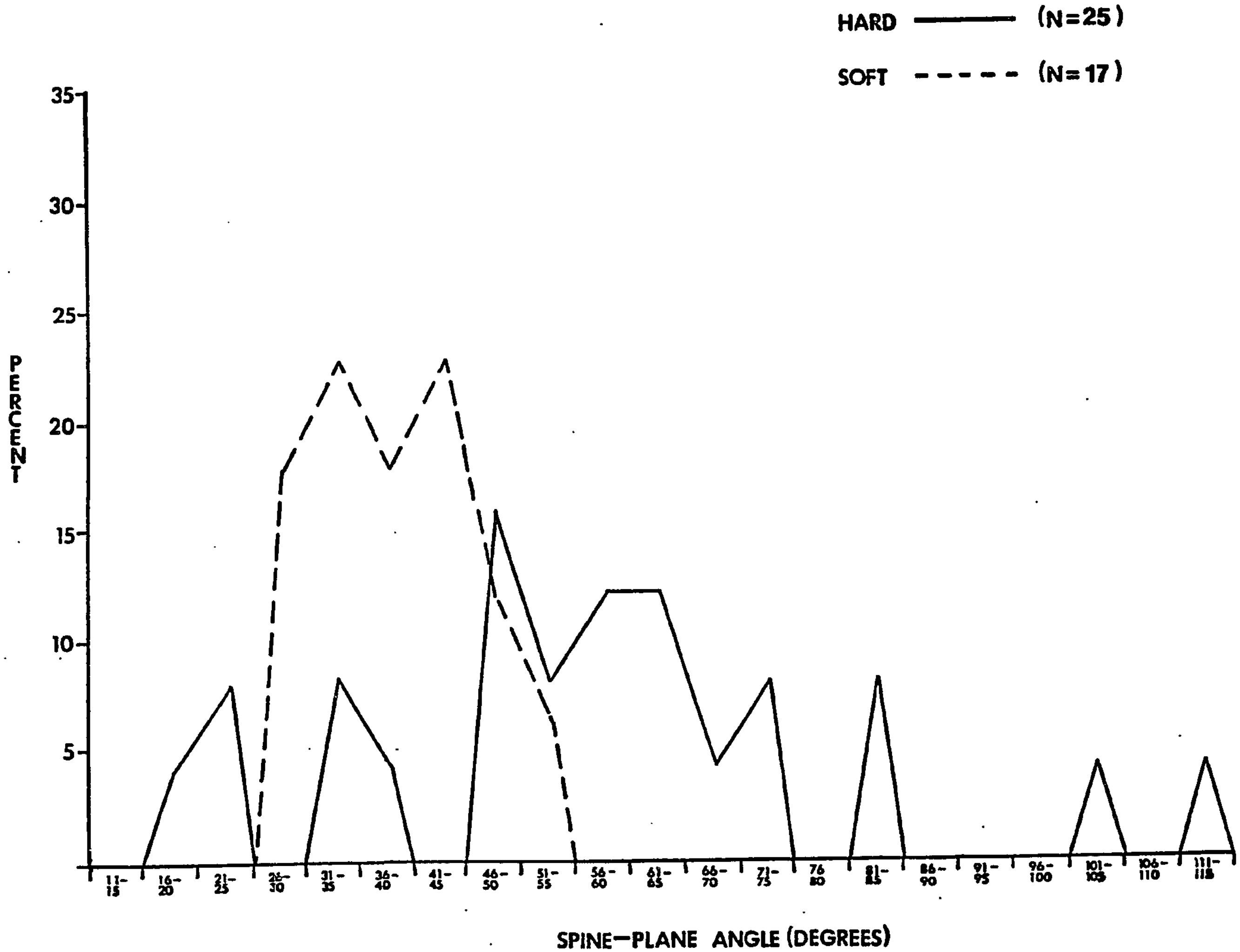

FIGURE 8. Site-193, range of spine-plane angles.

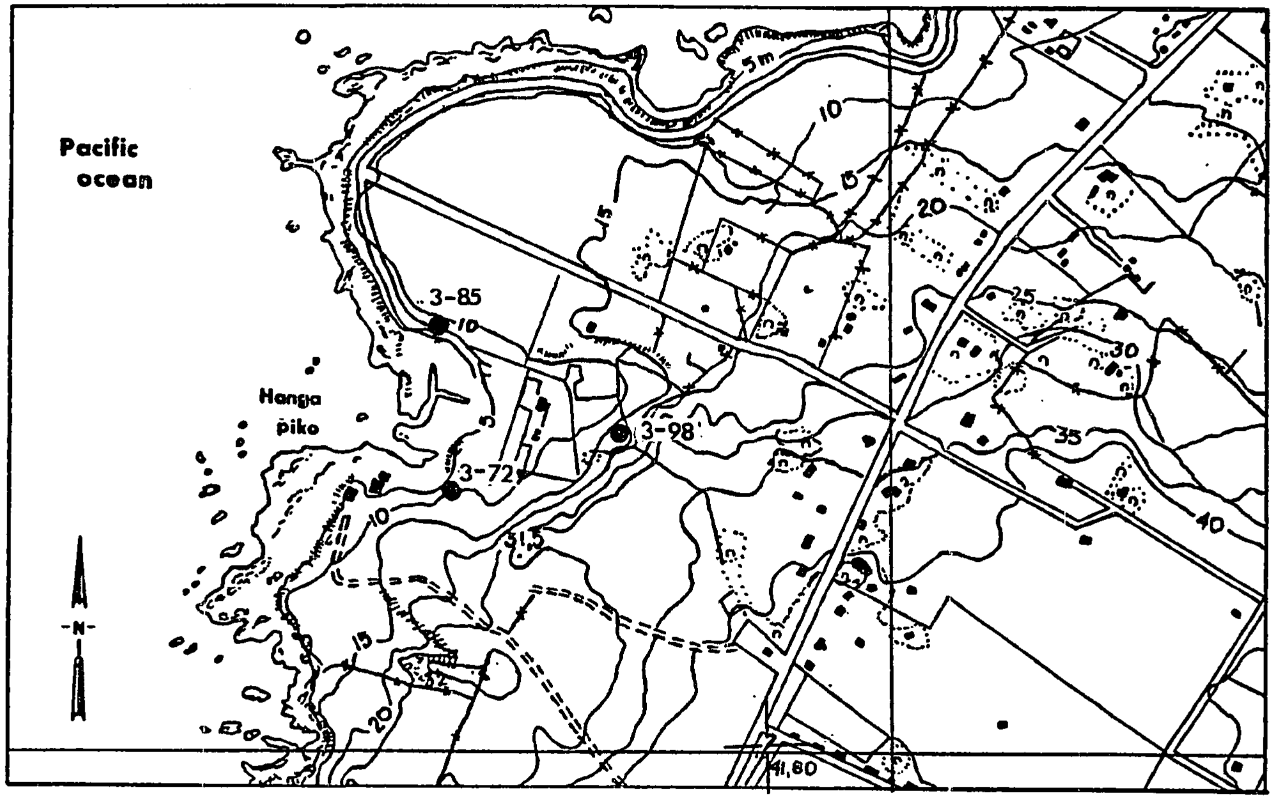

FIGURE 9. Quadrangle 8, site locations (after Ayres 1975).

3-72

Site 3-72 (RT2-ST1) is a coastal cave. The cave is 16 square meters in area and is situated at an elevation of five meters. Three test units were excavated at this cave, showing only 20 to 30cm of soil buildup above the rock floor. Although highly distributed, construction at the cave included a walled-in front and an elaborate entryway. Obsidian artifacts at this site included six drills, three mataa, 85 edge altered flakes, and 198 pieces of debitage. Also present were one core, one basalt adz and one basalt pounding stone.

3-85

Site 3-85 (RT2-ST2) is a coastal cave five meters above sea level with an interior area of slightly more than 22 square meters. The fill of the cave was loose soil and debris down to 20cm, below which lay rock and gravel. The single test pit recovered historic metal and glass, shell, bone, and coral. Artifacts included one bone needle, two pieces of cut bone, two coral files, one basalt hammer-stone, four obsidian mataa, 35 edge altered flakes, and 42 pieces of obsidian debitage.

3-98

The interior cave, 3-98 (RT2-ST1), is approximately 15 meters above sea level and is 42 square meters in area. The stratigraphic succession in the single test pit was highly disturbed and contained a large amount of historic material. At 25cm a thin layer of shell midden representing a living floor was discovered. Little cultural debris was recovered but included the following obsidian items; five mataa, one file, one bifacially worked object, 23 edge altered flakes, and 36 pieces of debitage. The cave mouth was walled in with an entrance provided near the top.

Dates for all three sites were based on obsidian hydration readings. In each case the derived dates indicated that site occupation began during the middle of the Expansion Phase.

Altered Edge Data

The following three tables present the basic data on the number of altered edges and flakes, the altered edge categories, the edge types, and the frequency of debitage and flake tools (see Table 1).

TABLE 1. Quadrangle 3 Altered Edge Data

Site	No. Edges	No. Flakes	Ave	Hard		Soft		Ret		Un	
				f	%	f	%	f	%	f	%
3-72	85	59	.144	18	21	43	51	12	14	12	14
3-85	83	35	2.37	36	43	39	47	4	5	4	5
3-98	46	23	2.00	16	35	20	44	3	6	7	14

Table 2 provides the data on the edge type groups.

TABLE 2. Quadrangle 3 Edge Types

Site	Edge Types 1/7 f	%	2/3 f	%	3/4 f	%
3-72	55	65	21	35	9	10
3-85	51	61	19	23	13	16
3-98	32	70	11	25	3	6

Table 3 shows the information concerning the debitage and edge altered flakes.

TABLE 3. Quadrangle 3 Debitage and Flake Tools

Site	No. Deb.	No. Tool	Ratio	Percent Flake Tools
3-72	198	59	3.36:1	22
3-85	42	35	1.20:1	45
3-98	36	23	1.56:1	39

Table 1 shows that site 3-72 has a lower average number of altered edges per flake than does either 3-85 or 3-98. Both 3-85 and 3-98 have essentially even distributions of edges in the hard and soft categories and small percentages of retouched edges. In contrast, site 3-72 has a large frequency of edges used on soft contact materials and a large percentage of retouched edges.

Table 2 presents the edge type groups. For all three sites Group 1/7 is dominant with Group 2/3 being the second most frequent and Group 4/5 being the least frequent.

The third table illustrates the relationship of the debitage and edge altered flakes. Although each site is different, sites 3-85 and 3-98 have much smaller ratios of debitage to edge altered flakes than does site 3-72. Viewed another way, sites 3-85 and 3-98 have a greater percentage of flakes used for tools than does 3-72.

At site 3-72, 64 percent of the edge altered flakes fall into the size categories 2 and 3. For the debitage, 52 percent of the material fits into size categories 2 and 3 while 48 percent fell into the smaller size categories.

The weight of the altered flakes appears to be related to the contact material worked. For flakes used on hard material the range is 1.09 to 33.97g, mean a average of 7.77g. The range for flakes associated with soft contact materials is 0.73 to 11.62g, with a mean of 4.39a.

The range of spine-plane angles worked on hard contact materials is 35 to 67 degrees and the mean is average 51 degrees. The range for those edges used on soft materials is 22 to 64 degrees and the mean is 39 degrees. Figure 10 illustrates the distribution of the spine-plane angles related to both the hard and soft altered edge categories.

The length of the altered edge varies only slightly between the categories hard and soft. In the hard category the length range is

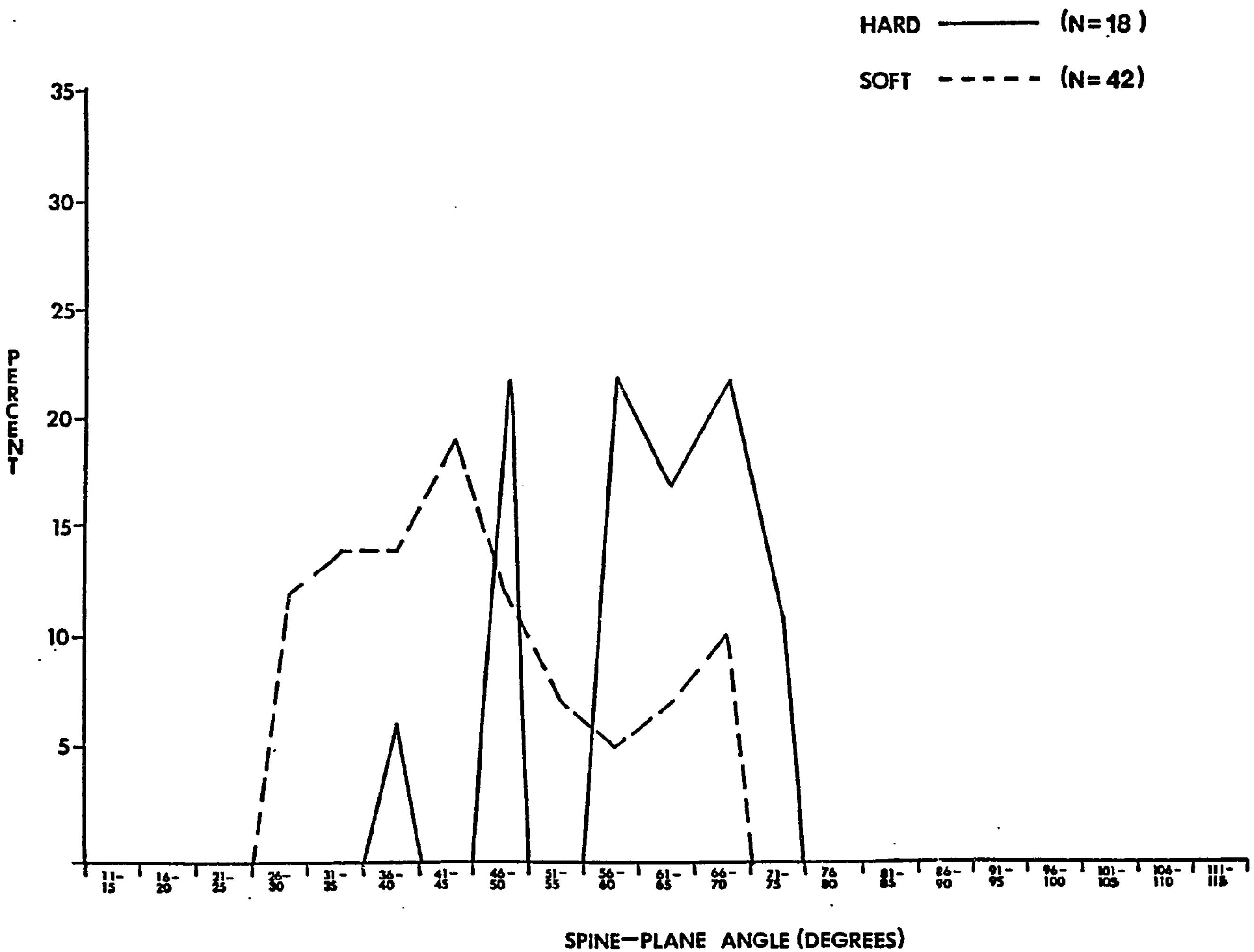

FIGURE 10. Site 3-72, range of spine-plane angles.

5 to 30mm while in the soft category the range is 4 to 26mm. The mean for both categories is 14mm.

Retouched edges make up 14 percent of all the altered edges. Eighty-two percent of the flakes in this category fit into sizes 2 and 3. Flakes with retouched edges have a mean weight of 8.25g. The length of retouched edges was substantially larger than those related to hard or soft mateirals, with a mean of 18mm. The edge angle created by intentional retouching ranged from 52 to 78 degrees with a mean of 69 degrees.

At site 3-85, 84 percent of the edge altered flakes are from size Groups 2 and 3 which is quite similar to the debitage, where 87 percent of the flakes fall into these large size groups. In regard to flake weight, flakes associated with hard contact materials ranged in weight from 1.82 to 22.54g with a mean of 9.23g. For flakes associated with soft materials the range is 1.08 to 18.43g with a mean of 5.76g.

A distinction is also evident in the relationship between spine-plane angle and contact material. The range in the spine-plane angles for edges used on hard materials is 14 to 91 degrees with a mean of 55 degrees. For edges related to soft mateirals the range is 17 to 60 degrees with a mean of 33 degrees. Figure 11 shows the distribution of the spine-plane angles for edges worked on either hard or soft contact materials.

The length of the altered edges is not significantly different between those associated with hard or soft materials. The length of

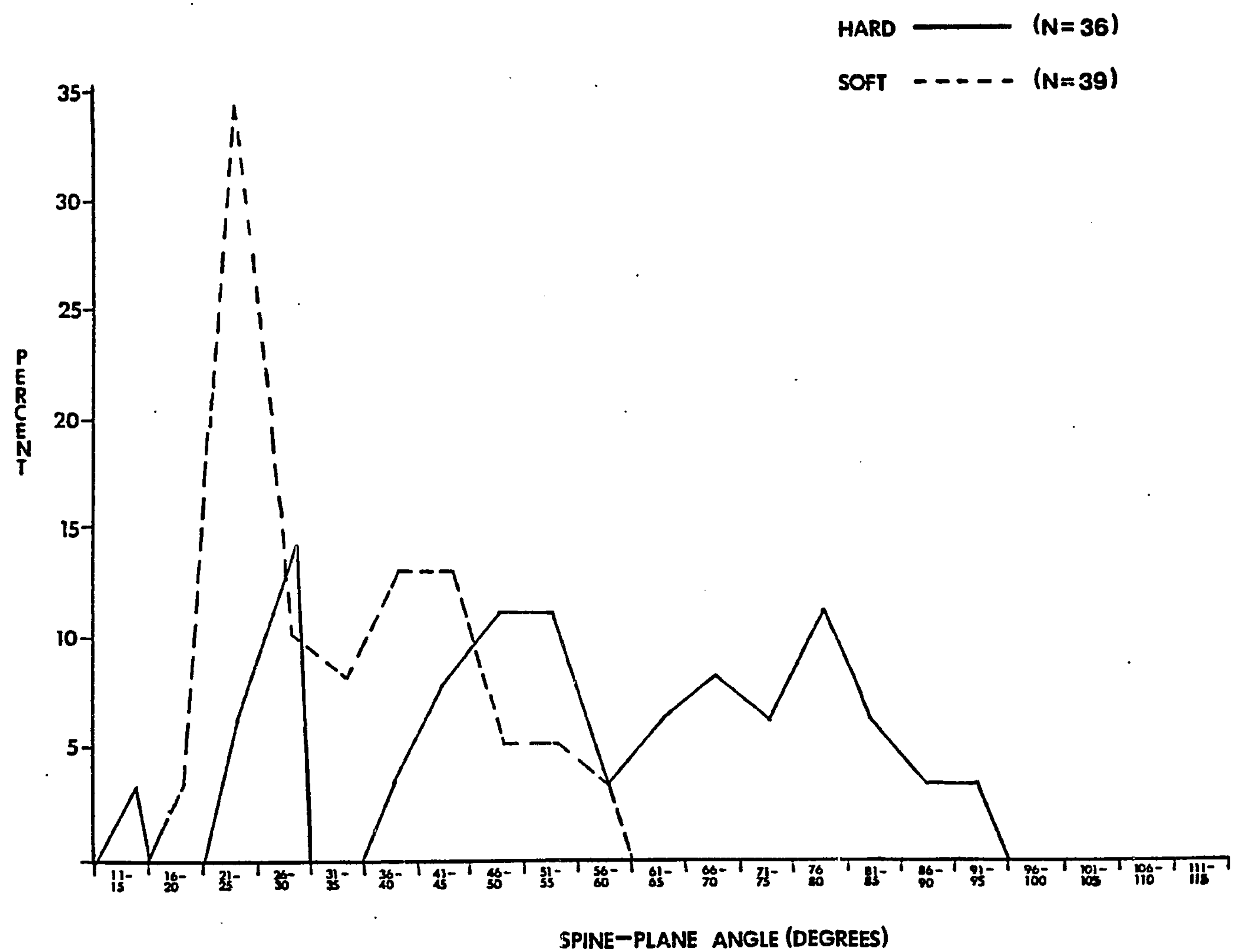

FIGURE 11. Site 3-85, range of spine-plane angles.

the edges used on hard materials range from 6 to 43mm with a mean of 18mm, for edges worked on soft materials the range is 6 to 36mm with a mean of 17mm.

Seventy-six percent of the edge altered flakes at site 3-98 fall into size categories 2 and 3. This contrasts with the debitage where 57 percent of the material is from these same size categories.

Flakes used on hard materials tend to be heavier than those used on soft materials. The weight range of flakes worked on hard materials is 0.38 to 15.36g and the mean weight is 6.57g. Those flakes worked on soft materials ranged in weight from 0.59 to 14.23g, with a mean of 5.06g. The spine-plane angles related to hard and soft materials varied considerably. The range of angles related to hard materials is 28 to 88 degrees, the range related to soft materials is 18 to 65 degrees. The mean for the hard category is 48 degrees, for the soft category it is 35 degrees. Figure 12 shows the distribution of the spine-plane angles related to edges worked on hard and soft contact materials.

For edges used on hard materials the range of lengths is 6 to 36mm, with a mean of 13mm. The edge length range related to soft materials is 5 to 28mm, with a mean of 15mm.

In using the chi-square statistic to evaluate each of the sites the following intrasite patterns emerged. At site 3-72 there is a major difference in the frequency of edges in the altered edge categories. A one-variable chi-square test finds a statistically significant difference, owing mostly to a higher than expected

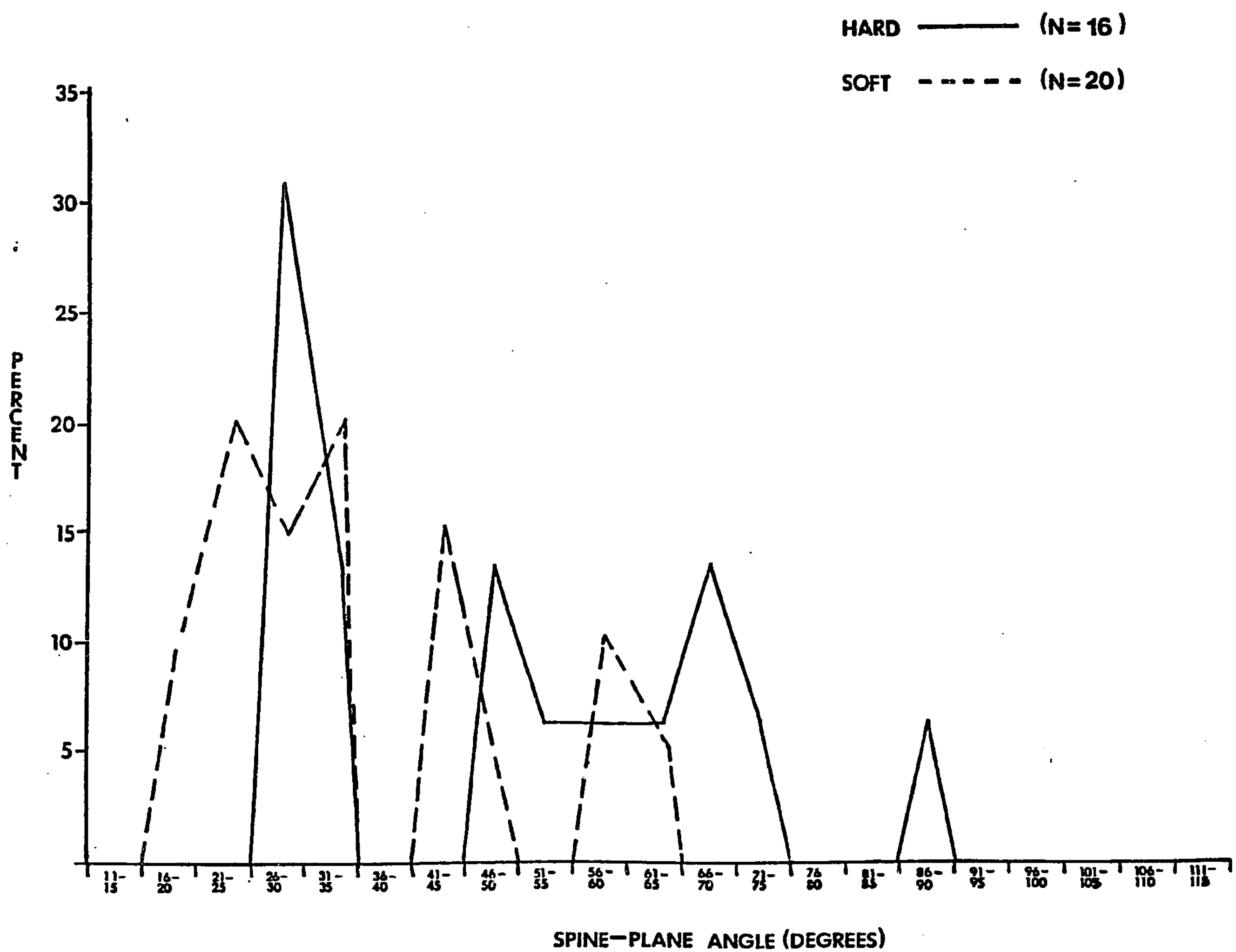

FIGURE 12. Site 3-98, range of spine-plane angles.

occurrence of edges in the soft category (X^2 = 7.40, α 0.05, 2 df).

The same test with the edge type groups finds Group 1/7 occurred more often and Group 4/5 less often than expected (X^2 = 13.40, α 0.05, 2 df). Within the hard altered edge category the frequencies found in Groups 1/7 and 2/3 were the same with eight, in Group 4/5 the count was two.

The edge type groups related to the soft category were found to significantly vary statistically (X^2 = 12.19, α 0.01, 2 df). Much of this difference is due to a higher than expected occurrence in Group 1/7 and lower than expected frequencies in Groups 2/3 and 4/5.

A two-variable chi-square test between the hard and soft categories in relation to the edge type groups also proved significant (X^2 = 8.25, α 0.05, 2 df). The test indicates that for the hard category there is a larger than expected frequency of edges in Group 2/3 and a smaller frequency in Group 1/7. For the soft category there is a smaller than expected frequency in Group 2/3.

At site 3-85 there is a significant difference between the frequency of edges found in the hard, soft and retouched categories (X^2 = 9.52, α 0.01, 2 df). The majority of this difference is due to a lower than expected occurrence of edges in the retouched category. Within the edge type categories as a whole there is a strong emphasis on edge type Group 1/7 (X^2 = 10.05, α 0.01, 2 df). Group 2/3 occurs with edge frequencies near those expected while edges in Group 4/5 occur less often than expected.

Edge types within the soft category also favor Group 1/7 (X^2 =

8.22, α 0.05, 2 df) at the expense of Groups 2/3 and 4/5. There is no significant difference between edge type groups in the hard contact material category. Groups 1/7 and 2/3 both contain 13 edges while Group 4/5 has five edges.

Between the hard and soft categories there is a statistically significant difference in relation to the edge type groups (X^2 = 9.08, α 0.05, 2 df). The difference in this case is due in large part to the greater than expected frequency of edges in Group 2/3 in the hard category.

Interior site 3-98 shows no statistically significant difference between the altered edge categories. The edge type groups are distinguished through the use of the chi-square test which indicates a greater than expected frequency in Group 1/7 and a less than expected frequency in group 4/5 (X^2 = 9.75, α 0.01, 2 df). The frequencies found in the hard and soft categories are greatest in Group 1/7. There is no important difference between these two altered edge categories in regard to edge type groups.

Quadrangle 7

7-571

Figure 13 shows the location of site 7-571 (RT2-ST1) in the Akahanga Quadrangle. This coastal cave, of some 52 square meters, was tested by eight units, six inside the cave and two just outside the cave mouth. Construction at the cave included a walled off cave mouth and a stone-wall entryway (Figure 14).

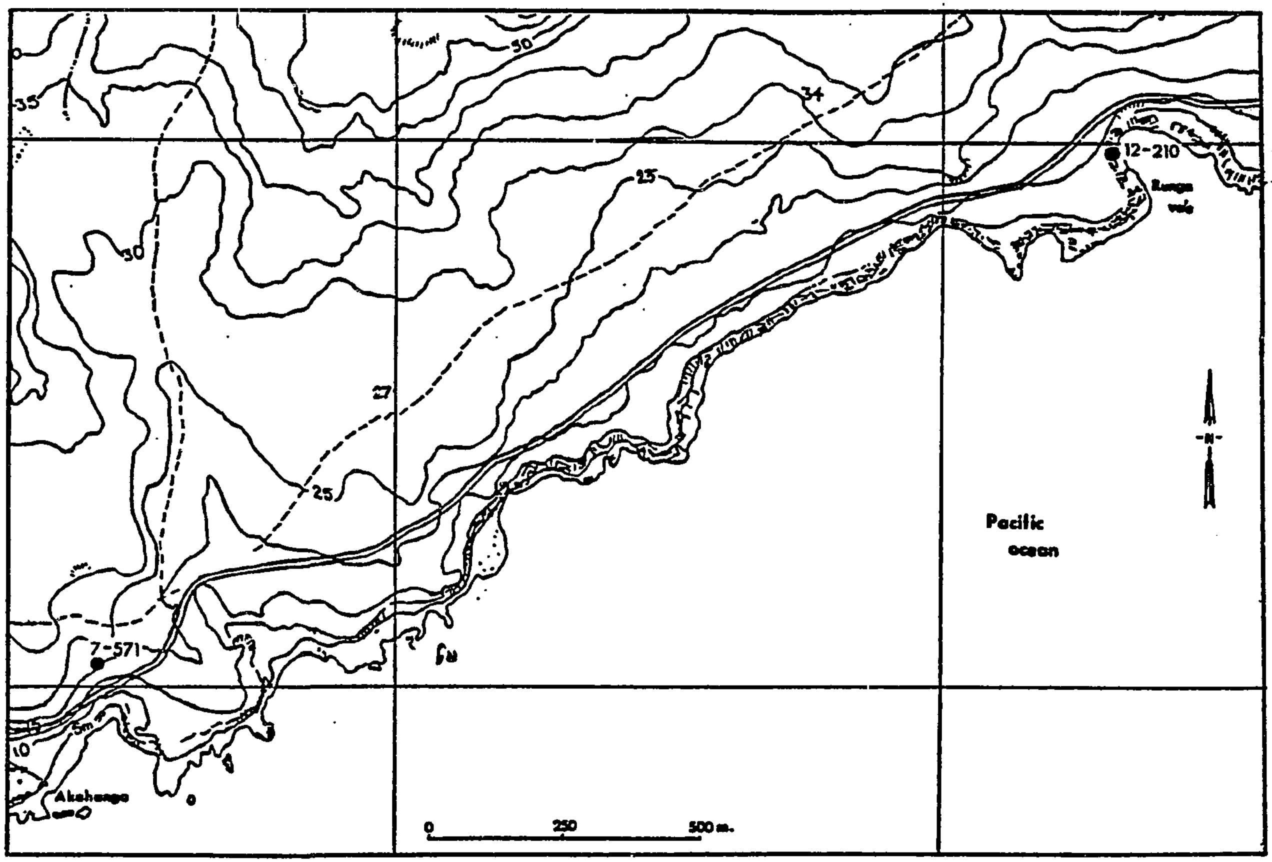

FIGURE 13. Quadrangles 7 and 13, site locations (after Ayres 1975).

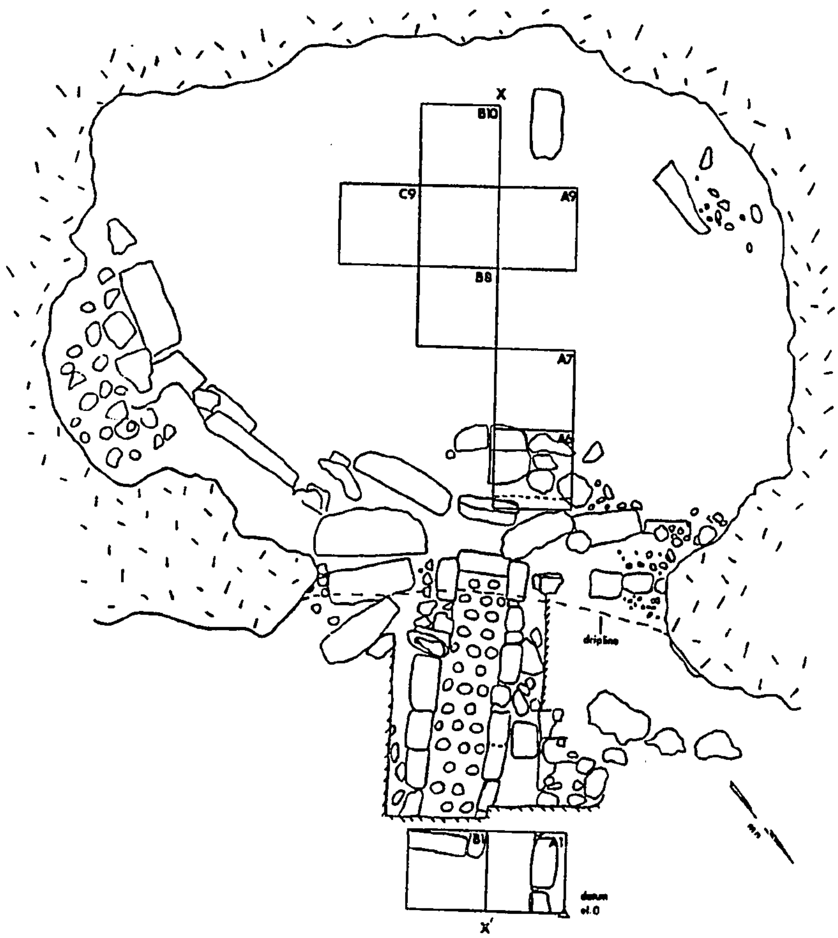

FIGURE 14. Site 7-571, Akahanges, plan view (after Ayres 1975).

Dating of the site was done with a number of obsidian hydration dates and a single radiocarbon date. The obsidian readings indicate a very late time for the primary site occupation which was during the Proto-Historic Phase. The radiocarbon date supports such an assumption.

Two hundred forty-four bone artifacts were recovered, including a large number of needles and three fishhooks. Nineteen coral files and an abrader were also found. A variety of basalt artifacts were also present; these included four adzes, one axe/adz blank, 12 hammerstones, three adz chips, one knife, 21 poro flakes, and eight other pieces of basalt. A number of obsidian items were also recovered. Among these were 30 mataa, 15 files, seven drills, one eyepiece, and several thousand altered and unaltered flakes.

Only three of the excavation units (B8, B10 and C9) were used for this analysis. A total of 275 edge altered flakes and 737 pieces of debitage came from these units. A twenty percent sample (N=54) was drawn from the edge altered flakes and used in the edge analysis.

A total of 87 altered edges were present on the 54 sample flakes for an average of 1.61. Of the 87 edges 29 (34%) fall into the hard category, 35 (40%) in the soft category, 14 (16%) in the retouched category, and 5 (10%) in the unknown category. Within the edge type groups, Group 1/7 has 49 (56%) of the edges, Group 2/3 has 24 (28%) edges and group 4/5 has 14 (16%) edges.

Although there is no statistically important variation in the altered edge cateogry, there is one among the edge type groups. Overall, these edge groups show a difference among themselves at the 0.05 level (X^2 = 7.48, 2 df), this difference is due to a higher than expected frequency in Group 1/7. Both the hard and soft categories reflect this overall pattern of statistical significance (X^2 = 5.67, α 0.10, 2 df for the hard category X^2 = 5.56, α 0.10, 2 df for the soft category).

The ratio of debitage to edge altered flakes is 2.67:1. Excluding the highly formed tools, 27 percent of the obsidian lithic material available was used as edge altered flakes. Thirty-eight percent of the debitage fit size Groups 2, 3 or 5 and 62 percent fit the smaller size groups. For the edge altered flakes, 87 percent fit into the larger size groups and only 13 percent fall into the smaller size Groups 1/2 and 1.

A chi-square test of the relationship between edge altered flakes, debitage and size was carried out. By compressing the size attribute category into two possibilities, flakes less than or equal to size category 1 and those larger than category 1, a two variable, four cell matrix can be created. Using this matrix, the chi-square test confirmed that there was a highly significant difference between the edge altered flakes and debitage in relation to size.

The average flake weight related to hard contact materials is 6.88g, with a range of 1.53 to 15.93g. The range in the soft category is 0.48 to 14.71g and the mean is 4.28g. The mean weight of a flake in the retouched category is 5.60g while the range is 2.23 to 14.77g.

The mean tool edge length in the hard category is 16mm and in the soft category it is 14mm. The range is 7 to 38mm in the hard category and 5 to 29mm in the soft. In the retouched category the lengths vary from 9 to 16mm and the mean is 15mm.

The mean edge angle of the retouched edges is 74 degrees and the angles range from 44 to 89 degrees. The spine-plane angles vary from 22 to 92 degrees in the hard category and 20 to 55 degrees in the soft. The mean angles are 49 degrees for the hard category and for the soft category it is 40 degrees. Figure 15 illustrates the distribution of the spine-plane angles in the two categories hard and soft.

Quadrangle 8

8-82

The Tahai Quadrangle, located on the western coast of the island, is represented by 12 sites (Figure 16). The first of these is 8-82 (RT2-ST2) a 64 meter square coastal cave located at an elevation of nine meters. A single test pit encountered sterile papa at 50 to 60cm with a midden concentration at the 10 to 30cm level.

Artifacts from the site included three coral files, five scoria abraders, one basalt adz, one mataa, one obsidian drill, and an obsidian chisel. A total of 102 edge altered flakes and 44 pieces of debitage were also recovered.

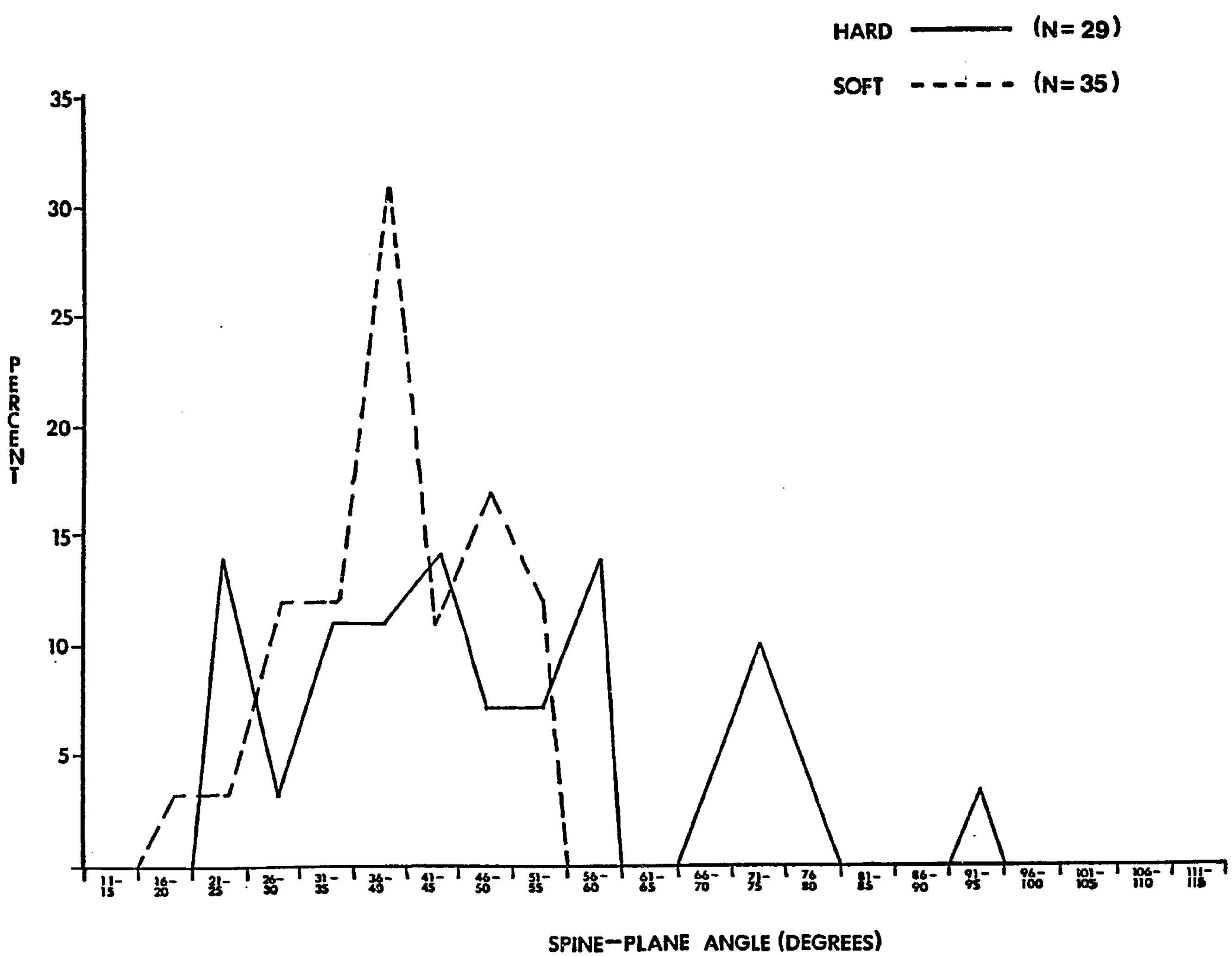

FIGURE 15. Site 7-571, range of spine-plane angles.

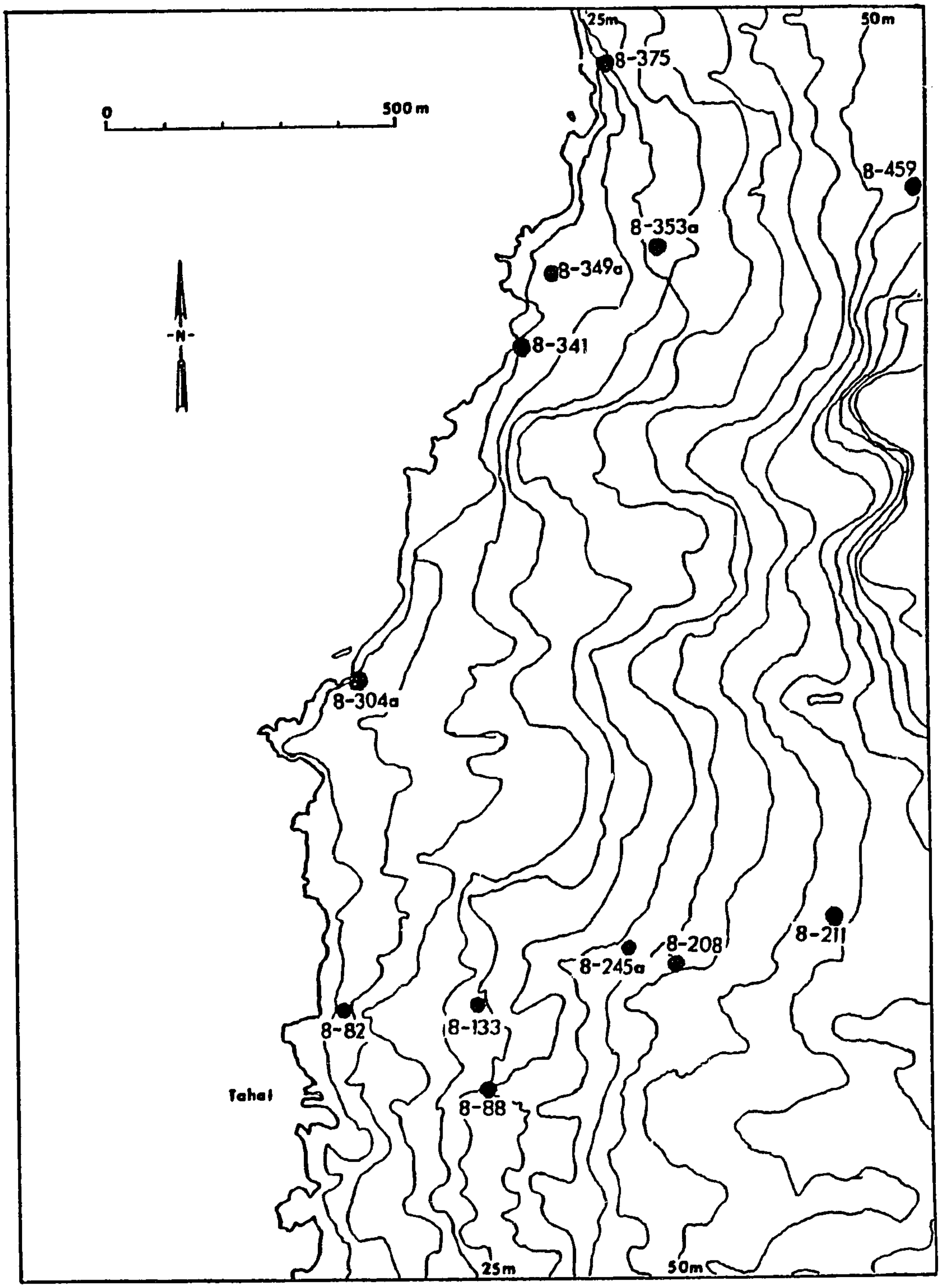

FIGURE 16. Quadrangle 8, site locations (after Ayres 1975).

8-88

Site 8-88 (RT2-ST2) is a small interior cave situated on a terrace about 320 meters from the coast at an elevation of 25m. The two test pits examined in the 24 square meter interior contained shell concentrations, wood charcoal, and an ash lens. Artifacts recovered included four bone tools as well as the following obsidian specimens; one bifacial object, one core, one abrader, one awl, one _mataa_, five drills, and 47 edge altered flakes. Debitage was made up of 12 basalt and 20 obsidian pieces.

8-133

Site 8-133, the only oven house (_hare umu_) in the site sample, is approximately 270 meters from the coast at an elevation of 24 meters. Midden materials were scant throughout the excavation and a single firepit was found. Two bone needles, two _mataa_, three obsidian drills, one basalt knife, one adz flake, and 76 edge altered flakes make up the site tool complement. Debitage consisted of two basalt and 16 obsidian flakes. All of this material came from four test units.

8-208

Site 8-208 (RT2-ST2) is an interior cave 40 meters above sea level and approximately 575 meters from the coast. This small (12 square meters) cave, known as Ha'u Renga, was tested in the center by a single test pit dug to a depth of 50 to 55cm. Recovered from this excavation were three bone needles, two coral files, three hammerstones, one mataa, 116 edge altered flakes, and 32 pieces of debitage.

8-211

Roughly 300 meters east of 8-208 lies a second interior cave 8-211 (RT2-ST1). Called Ngaheva, this cave is 50 meters square in area at an elevation of about 60 meters. The cave originally had a walled-in front but it had been disturbed by recent digging. One test pit was dug to a depth of 50cm and contained two bone tools, 43 edge altered flakes, and nine pieces of obsidian debitage.

8-245a

Site 8-245a (RT2-ST1) is situated 500 meters from the coast slightly west of 8-208. This inland cave is 20 square meters and is 40m above sea level. Construction in the cave was limited to a wall built across its front. The first test unit extended to 55cm and encountered a firepit. The second test pit encountered stone bedrock at 50cm. Cultural material included one coral file, two basalt adzes, seven mataa, two obsidian drills, one obsidian chisel, and two obsidian cores. Edge altered flake tools totaled 179 and there were five basalt and 114 obsidian pieces of debitage.

8-304

Approximately 6 meters above sea level site 8-304 (RT2-ST2) is a highly disturbed coastal cave. A single test pit placed in this cave recovered one mataa, one awl, 28 edge altered flakes, and six pieces of debitage.

8-341

Site 8-341 (RT2-ST2) is a coastal cave 10 meters above sea level. The cave, which is 70 meters square, was tested by two adjoining test pits. Very little midden was present in the gravelly matrix. Recovered artifacts included three bone tools, three drills, 58 edge altered flakes, and 24 pieces of debitage, 18 obsidian and six basalt.

8-349a

At site 8-349a (RT1) a single test pit was dug just outside the entrance to a small inland cave. Only six meters square the cave produced one spherical stone, one obsidian drill, 12 edge altered flakes and, 11 pieces of debitage.

8-353

Site 8-353a (RT2-ST1) is located some 225 meters inland at an elevation of 18m above sea level. Called Haha Ura, this 54 square meter cave has been walled off across its front. Although only one test pit was excavated, a heavy concentration of midden was encountered. Within the midden contrxt of shell and bone, the following artifacts were recovered: three bone needles, two pieces of cut bone, one fishhook, one coral file, one basalt adz, and one hammerstone. The obsidian component included six mataa, seven drills, one file, 82 edge altered flakes, and 46 pieces of debitage.

8-375

Site 8-375 (RT2-ST2), located on a 15 meter high coastal cliff, covers an area of 40 square meters. The single test pit extended 30cm deep and contained very little midden. Cultural remains, all of which were obsidian, included one bifacial object, one drill, 18 edge altered flakes, and 20 pieces of debitage.

8-459

Site 8-459 (RT1) is a small (8 square meters) inland cave roughly 600 meters from the coast at an elevation of 55 meters. One test unit contained two bone needles, one mataa, one obsidian file, one obsidian core, 28 edge altered flakes, and 36 pieces of debitage.

Sample percentages of the edge altered flakes varied from 30 to 100 percent. All of the edge altered flakes were analyzed from seven sites but a fifty percent sample was studied from sites 8-82, 8-133, 8-208 and 8-353a. For site 8-245a a sample of 30 percent was selected for detailed analysis.

Six of the 12 sites were dated by the obsidian hydration method. In each case the dates indicate site occupation no earlier than the late Expansion Phase. The other six undated sites are felt to also fall within this time frame (Ayres 1975:96).

Altered Edge Data

Table 4 presents data on the number of flakes and altered edges per site and the distribution of the edges in the four categories hard, soft, retouched and unknown. Of the 12 sites eight emphasize either the hard or soft categories and four sites have essentially even percentages in these two categories

TABLE 4. Quadrangle 8 Altered Edge Data

Site	No. Edges	No. Flakes	Ave	Hard		Soft		Ret		Un	
				f	%	f	%	f	%	f	%
8-82	87	50	1.74	23	26	42	49	10	11	12	14
8-88	72	47	1.53	27	37	23	32	10	14	12	17
8-133	60	46	1.30	16	27	31	62	5	8	8	13
8-208	77	58	1.29	25	33	36	48	4	5	10	13
8-211	55	43	1.28	19	35	21	38	10	18	5	9
8-245a	98	54	1.81	38	39	43	44	4	4	13	13
8-304a	41	28	1.46	5	12	33	80	1	3	2	5
8-341	98	58	1.69	31	32	56	57	2	2	9	9
8-349a	15	12	1.25	7	47	5	33	1	7	2	13
8-353a	70	41	1.71	21	30	35	50	4	6	10	14
8-375	28	18	1.56	7	25	15	54	3	11	3	11
8-459	42	28	1.50	17	40	15	36	6	14	4	10

The second table, table 5, shows the distribution of the various edge type groups by frequency and percentage. Edge type Group 1/7 is the dominate group in 11 out of 12 sites. Seven of the 12 sites have basically even percentages of Groups 2/3 and 4/5. Four sites have more edges in Group 2/3 and one site has a higher percentage in Group 4/5. Three sites also have edge type 6.

TABLE 5. Quadrangle 8 Edge Types

	Edge Types							
	1/7		2/3		4/5		6	
Site	f	%	f	%	f	%	f	%
8-82	64	74	11	13	12	14	0	0
8-88	36	50	21	29	15	21	0	0
8-133	23	38	14	23	21	35	2	3
8-208	46	61	21	28	8	11	0	0
8-211	26	48	14	26	15	27	0	0
8-245a	55	56	22	22	20	21	1	1
8-304a	18	44	13	32	10	24	0	0
8-341	56	57	29	30	13	13	0	0
8-349a	8	53	6	40	1	7	0	0
8-353a	33	47	19	27	16	23	2	3
8-375	16	58	7	25	5	18	0	0
8-459	26	62	12	29	4	9	0	0

Table 6 summarizes the statistically significant results of the one-variable chi-square test as applied to each site in relation to contact material categories and edge type groups. Sites 8-349a and 8-375 are excluded because their edge frequencies are too small for chi-square analysis.

TABLE 6. Summary of Statistical Significance Quadrangle 8

Site	Altered Edge Chi-Square	Sign. Level	Edge Type Chi-Square	Sign. Level
8-82	6.90	0.05	9.21	0.01
8-88	----	----	----	----
8-133	6.54	0.05	----	----
8-208	8.13	0.05	9.94	0.01
8-211	----	----	----	----
8-245a	10.59	0.01	7.97	0.05
8-304a	15.59	0.01	----	----
8-341	16.41	0.01	9.64	0.01
8-353a	8.04	0.05	5.90	0.10
8-459	----	----	----	----

Table 7 indicates a high degree of utilization of the obsidian lithic material in the Tahai Quadrangle sites. At ten of these sites more than 50 percent of the available obsidian was utilized as edge altered flakes. Ten of the 12 sites also show extremely small ratios of debitage to edge altered flakes.

At site 8-82, 65 percent of the debitage and 78 percent of the edge altered flakes fall into size groups 2, 3 and 5. The weight of

TABLE 7. Quadrangle 8 Debitage and Flake Tools

Site	No. Deb	No. Tools	Ratio	Percent Flake Tools
8-82	44	102	0.42:1	70
8-88	20	47	0.42:1	70
8-133	16	76	0.21:1	83
8-208	32	116	0.28:1	78
8-211	9	43	0.21:1	83
8-245a	114	179	0.64:1	61
8-304a	6	28	0.21:1	82
8-341	18	58	0.31:1	76
8-349a	11	12	0.92:1	52
8-353a	46	82	0.56:1	64
8-375	20	18	1.11:1	47
8-459	36	28	1.28:1	44

the altered flakes range from 2.12 to 14.38g in the hard category and 0.86 to 14.38g in the soft category. The mean for the hard category is 6.07 versus 4.27 for the soft category.

Tool edge length also favors the hard category which has a mean of 19mm to 12mm for the soft category. The range for the former is 7 to 36mm and for the latter it is 4 to 27mm.

The range of the spine-plane angles for the soft category is 16 to 51 degrees, with a mean of 30 degrees. The mean for the hard category is 54 degrees and it ranges from 18 to 94 degrees. Figure 17 presents the distribution of these angles.

For the retouched edges the mean weight is 5.79g, with a range of 2.30 to 15.99g. Tool edge length varied from 9 to 35mm, with a mean of 28mm. The edge angles ranged from 59 to 90 degrees and the mean was 72 degrees.

The cave site 8-88 had 60 percent of its debitage and 68 percent of its edge altered flakes in size groups 2 and 3. The mean weight of flakes in the soft category was 3.42g, for the hard category 3.33g and for the retouched category 5.91g. The range for the soft category was 0.52 to 10.36g compared to 0.73 to 7.75g for the hard category. For the retouched flakes the range was 1.45 to 12.66g.

The length of edges in the soft category ranged from 5 to 42mm, with a mean of 17mm. For the hard category the lengths varied from 8 to 23mm, and the mean was 15mm. For the retouched edges the range was 8 to 26mm, with a mean of 16mm.

The mean spine-plane angles were 60 degrees for the hard category and 39 degrees for the soft. The range for the hard category was 20 to 102 degrees and for the soft category it was 13 to 68 degrees. The edge angles for the retouched edges varied from 60 to 82 degrees and the mean was 73 degrees. The distribution of the spine-plane angles is shown in Figure 18.

At the oven house site (8-133) only 9 percent of the debitage fits into size 2 and 3 while 67 percent of the edge altered flakes fit into these size groups. The weight of the altered flakes favors

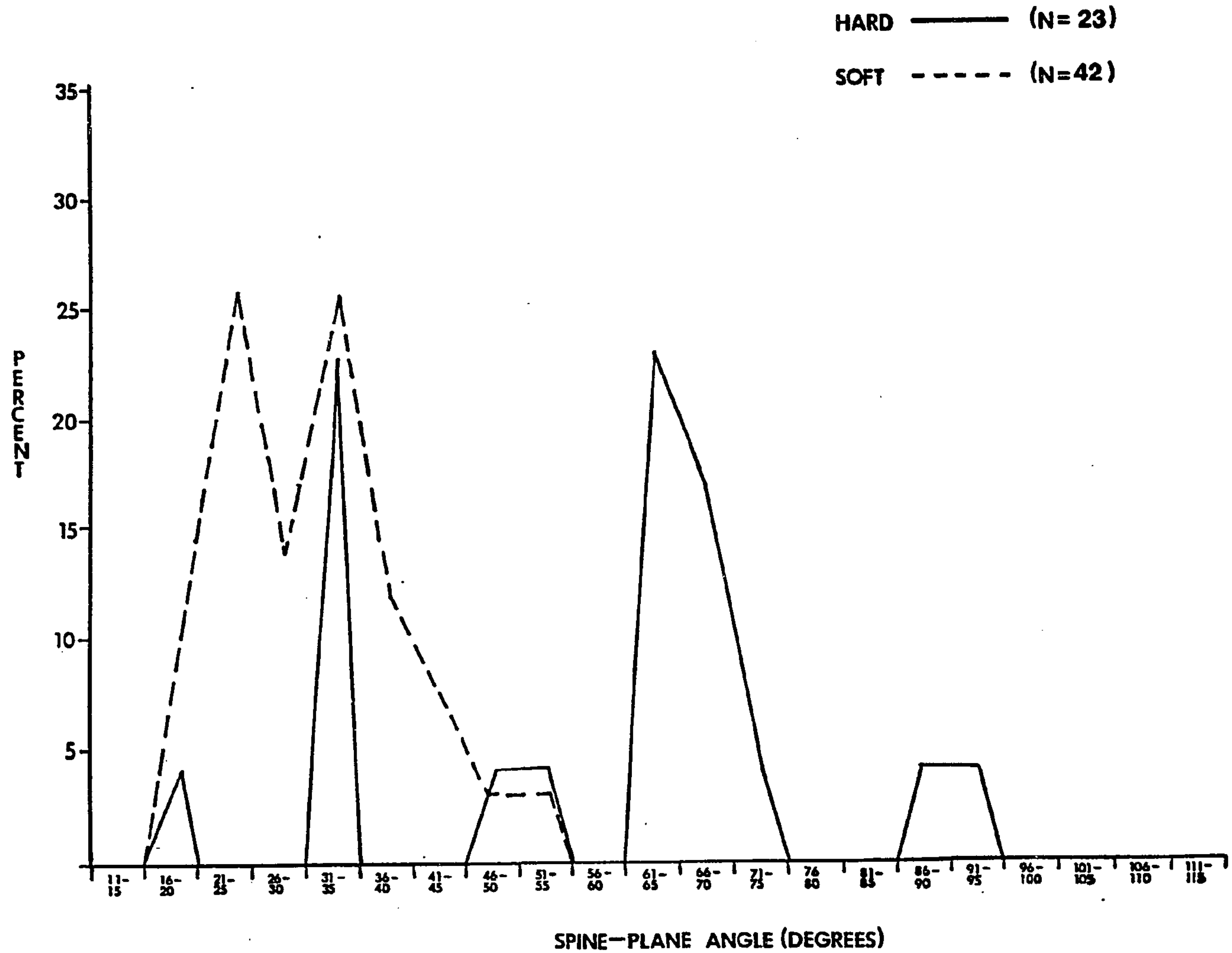

FIGURE 17. Site 8-82, range of spine-plane angles.

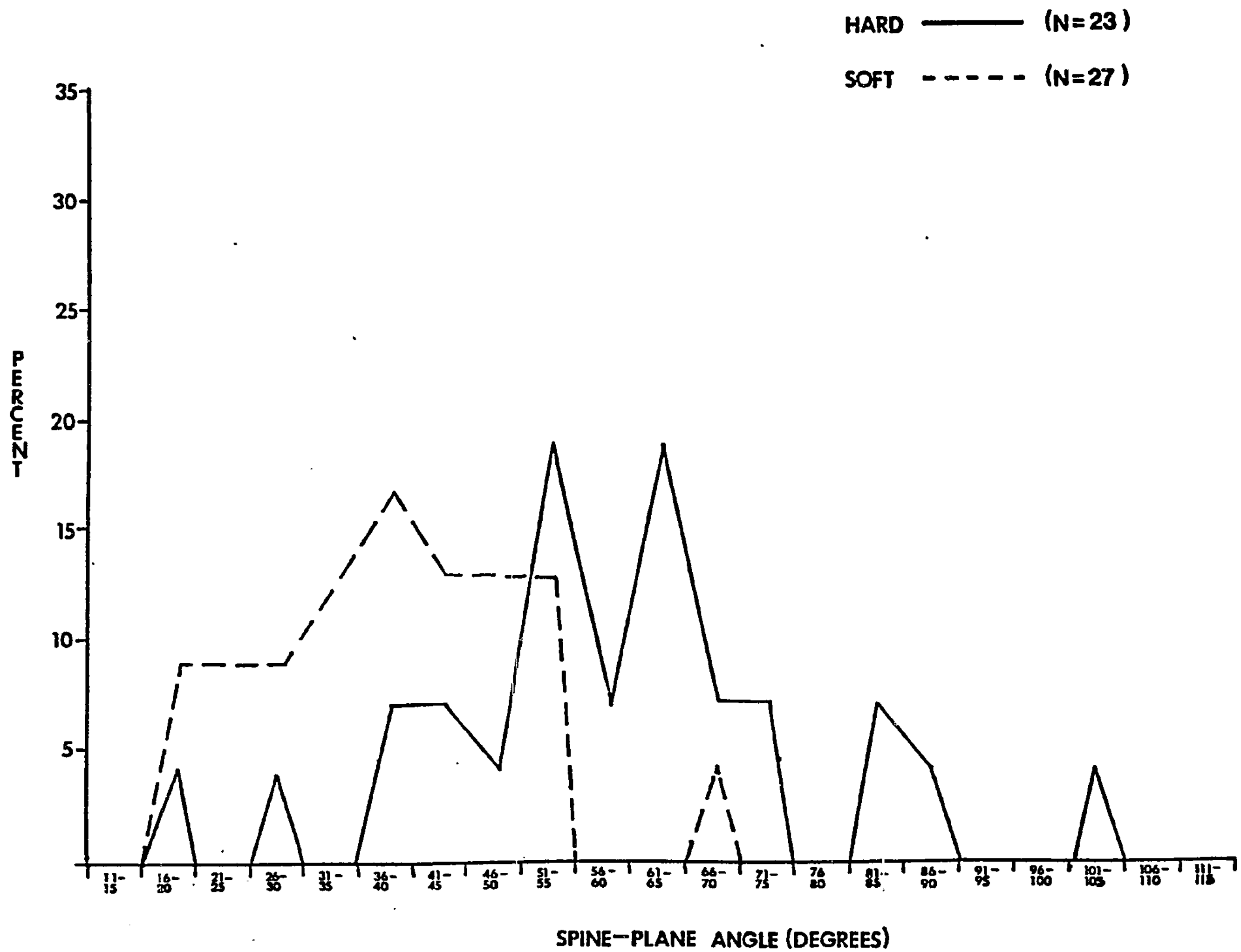

FIGURE 18. Site 8-88, range of spine-plane angles.

the hard category where the mean was 5.15g and the range was 0.85 to 11.17g. The mean weight for the soft category is 4.01g and the range is 0.61 to 15.61g.

The length of the tool edge for the soft category varies from 7 to 80mm, with a mean of 17mm. The range in the hard category is 5 to 36mm and the mean is 15mm.

The spine-plane angles seen in Figure 19 vary from 21 to 83 degrees in the hard category and the mean is 51 degrees. The soft category has a mean of 36 degrees and a range of 17 to 72 degrees.

At site 8-208 59 percent of the debitage and 68 percent of the edge altered flakes fit size groups 2 and 3. All three of the attributes of weight, length, and spine-plane angle are greater in the hard altered edge category. For the hard category the mean spine-plane angle is 53 degrees, with a range of 28 to 71 degrees, for the soft category the mean is 34 degrees and the range is 17 to 54 degrees. The distribution of these angles is presented in Figure 20.

The mean tool edge is 15mm in the hard category and 12mm in the soft. The length of edges in the hard category vary from 5 to 27mm and 5 to 33mm in the soft.

The mean weight for the soft category is 3.77g with a range of 1.06 to 9.51g. In contrast the range in the hard category is 1.08 to 18.54g, with a mean of 5.85g.

Seventy-seven percent of the edge altered flakes at 8-211 fit size groups 2, 3 and 5. Of the nine pieces of debitage recovered,

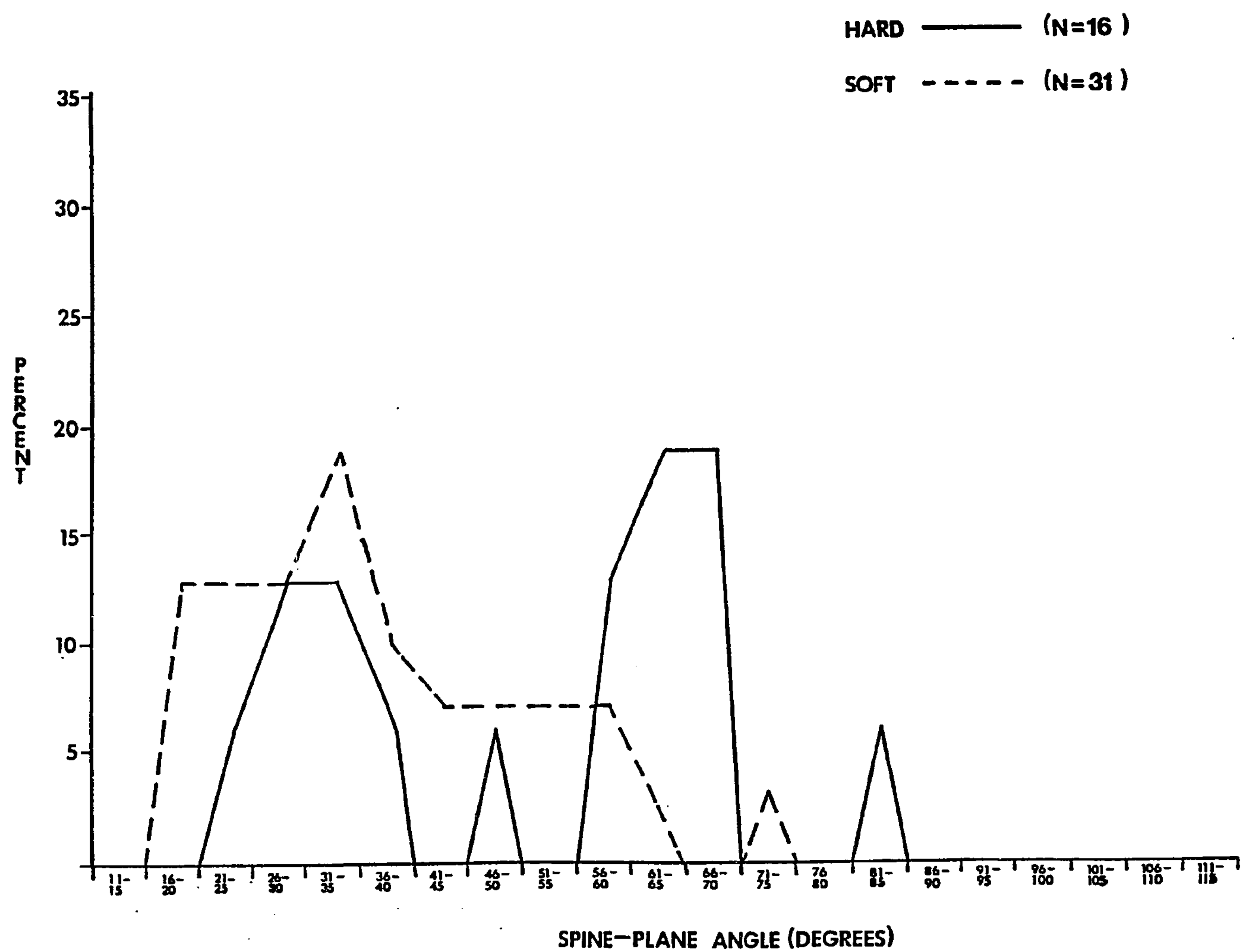

FIGURE 19. Site 8-133, range of spine-plane angles.

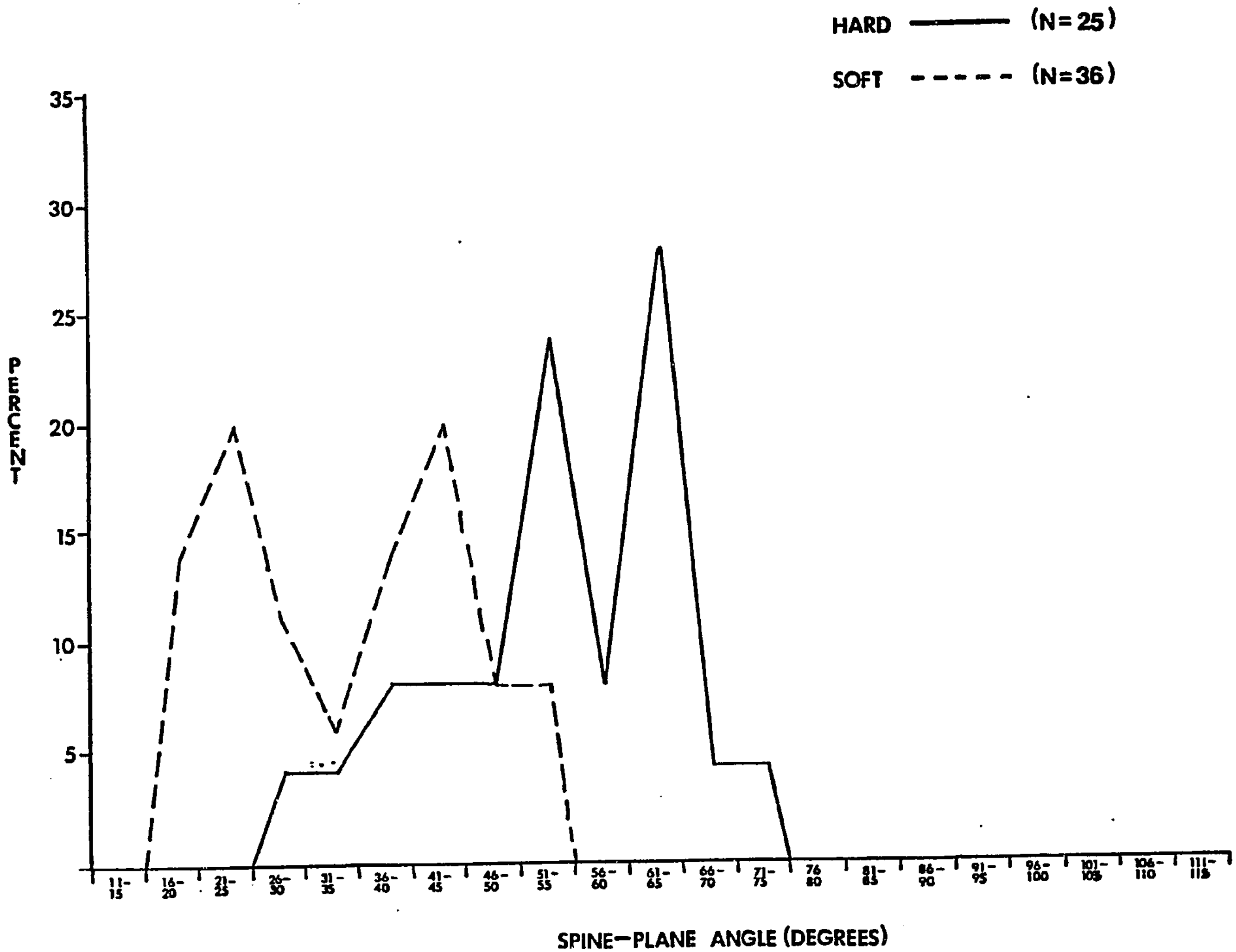

FIGURE 20. Site 8-208, range of spine-plane angles.

seven (78%) fit these larger size groups. In the hard category the flake weights vary from 4.30 to 12.08g and the mean is 7.43g. The range in the soft category is 0.62 to 14.39g and the average is 5.29g. For the retouched flakes the mean is 12.08g and the range is 1.11 to 38.00g.

For the attribute of tool edge length the mean for the retouched edges is 21mm and the range is 12 to 41mm. For the hard category the lengths vary from 8 to 27mm and the mean is 17mm. In the soft category the means 15mm and the range is 5 to 33mm.

The mean spine-plane angles for the hard and soft categories are 58 and 38 degrees. The ranges, as shown in Figure 21, are 22 to 106 degrees for the hard category and 20 to 64 degrees for the soft category. The edge angles for the retouched category vary from 49 to 85 degrees and the mean is to 68 degrees.

Site 8-245a has 67 percent of its debitage and 74 percent of its altered flakes in size groups 2 and 3. The mean weight of a flake in the hard category is 10.76g more than twice the mean for the soft group which was 4.70g. The range in the hard category is 1.15 to 20.81g, while for the soft category it is 0.49 to 16.53g.

For the hard category the mean edge length is 15mm and the range is 7 to 32mm. In comparison the range in the soft category is 5 to 33mm and the mean is 14mm.

The spine-plane angles at this site vary from 25 to 79 degrees in the hard category and 19 to 72 degrees in the soft. The mean angle in the hard category is 56 degrees and 36 degrees for the soft

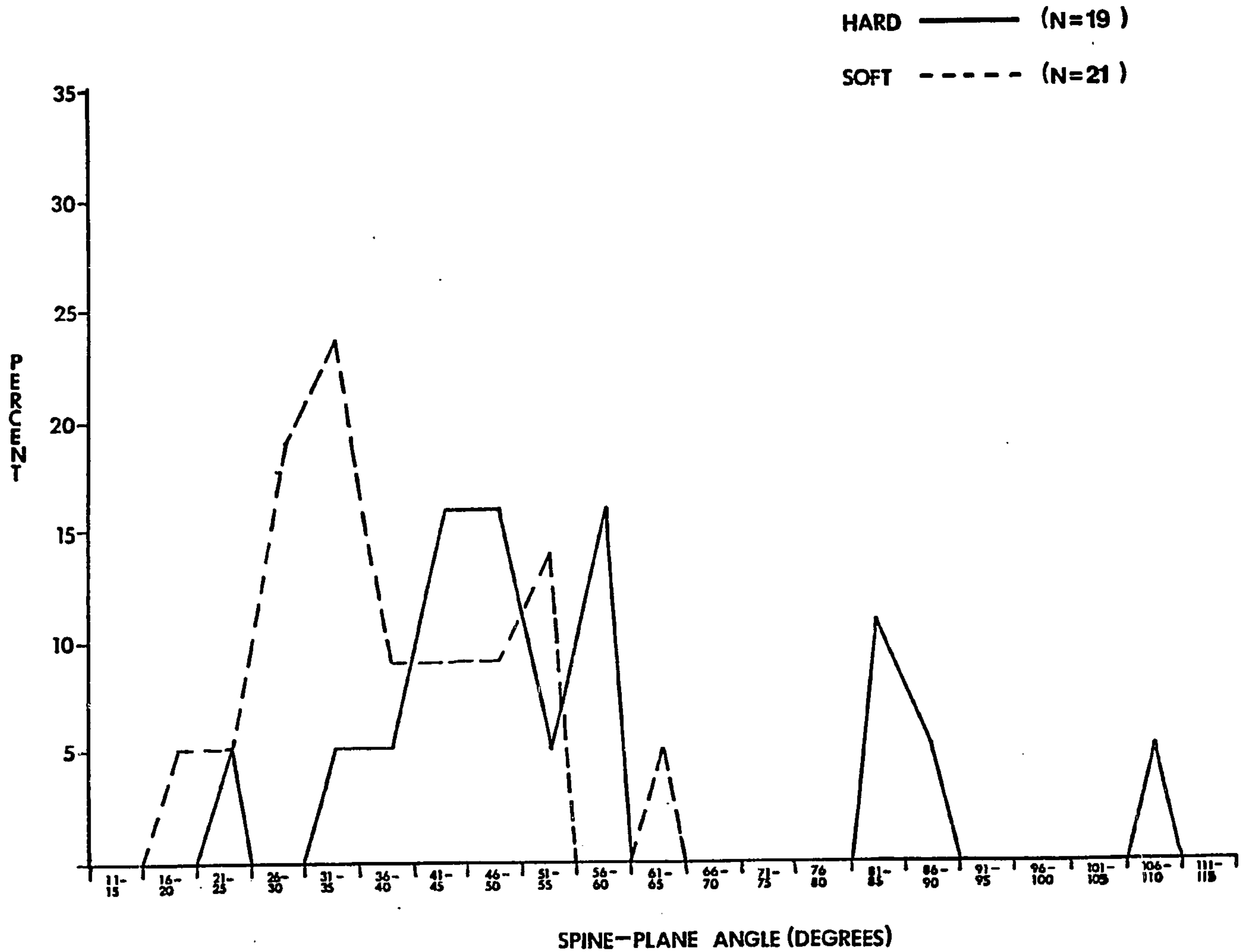

FIGURE 21. Site 8-211, range of spine-plane angles.

category. The distribution of the angles in these categories are shown in Figure 22.

Site 8-304a is a site almost wholely dedicated to the working of soft contact materials. Thirty-three of the 41 altered edges were used on soft materials. The range of spine-plane angles in this soft category is 21 to 59 degrees with a mean of 37 degrees. Figure 23 illustrates the distribution of the edges in both the hard and soft categories. The weight of flakes in the soft category range from 0.80 to 15.62g and the mean is 5.30g. The tool edge mean length is 17mm, with a range from 5 to 31mm.

Coastal cave 8-341 has 53 percent of its debitage and 69 percent of its edge altered flakes in size groups 2 and 3. The mean weight of the categories hard and soft are 4.26g and 4.10g. The range for the hard category is 1.68 to 11.52g and for the soft it is 1.06 to 11.52g.

The mean lengths of the altered edges are also close, with the mean for the soft category being 14mm and for the hard category 13mm. The range for the soft category is 5 to 36mm and that for the hard is also 5 to 36mm.

The hard category has a mean spine-plane angle of 46 degrees and a range of 24 to 90 degrees. The soft category has a range of 16 to 57 degrees and a mean of 30 degrees. The distribution of these angles for the categories hard and soft are shown in Figure 24.

Site 8-349a has small frequencies of altered edges (15) and obsidian debitage (6). Based on these small frequencies the range

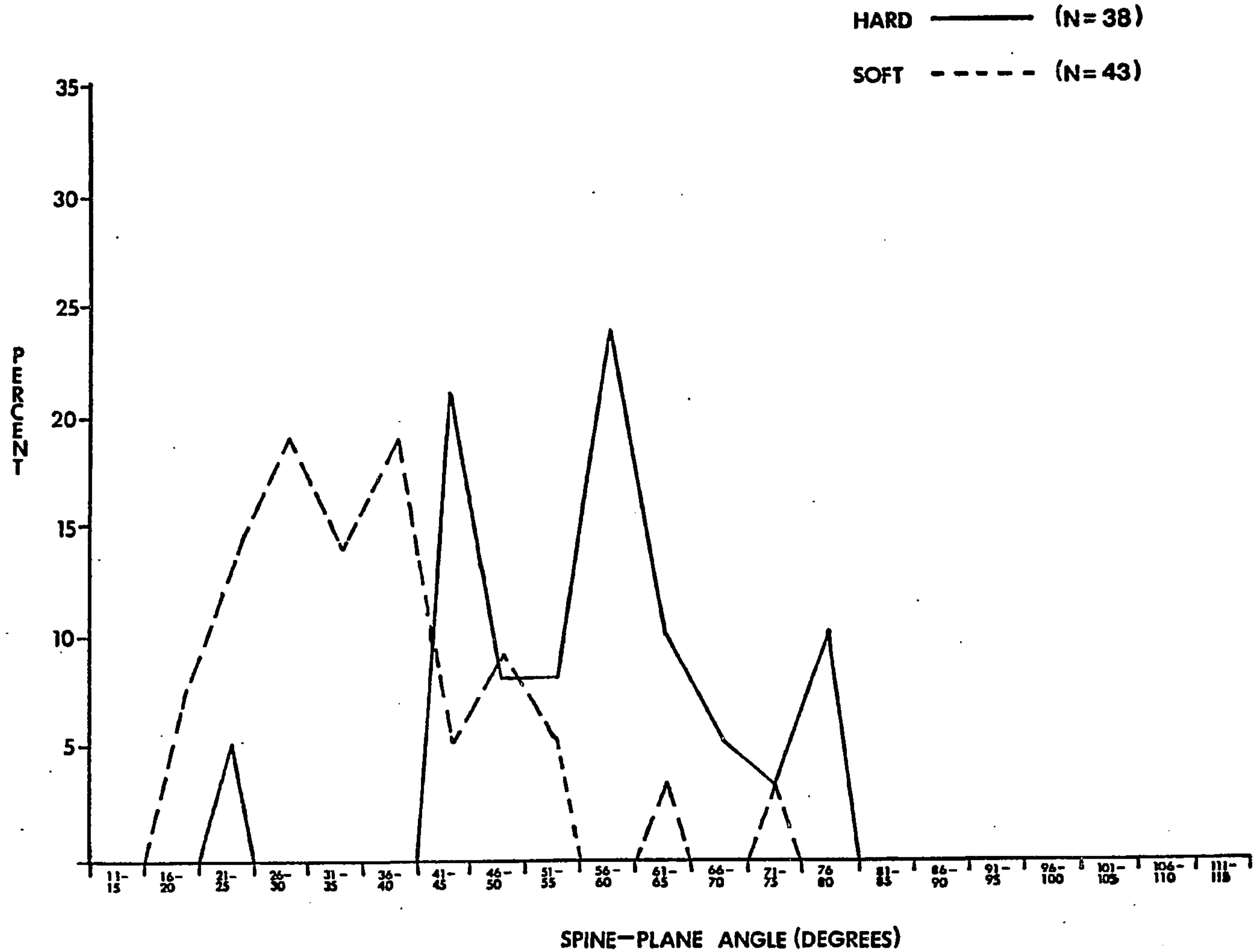

FIGURE 22. Site 8-245a, range of spine-plane angles.

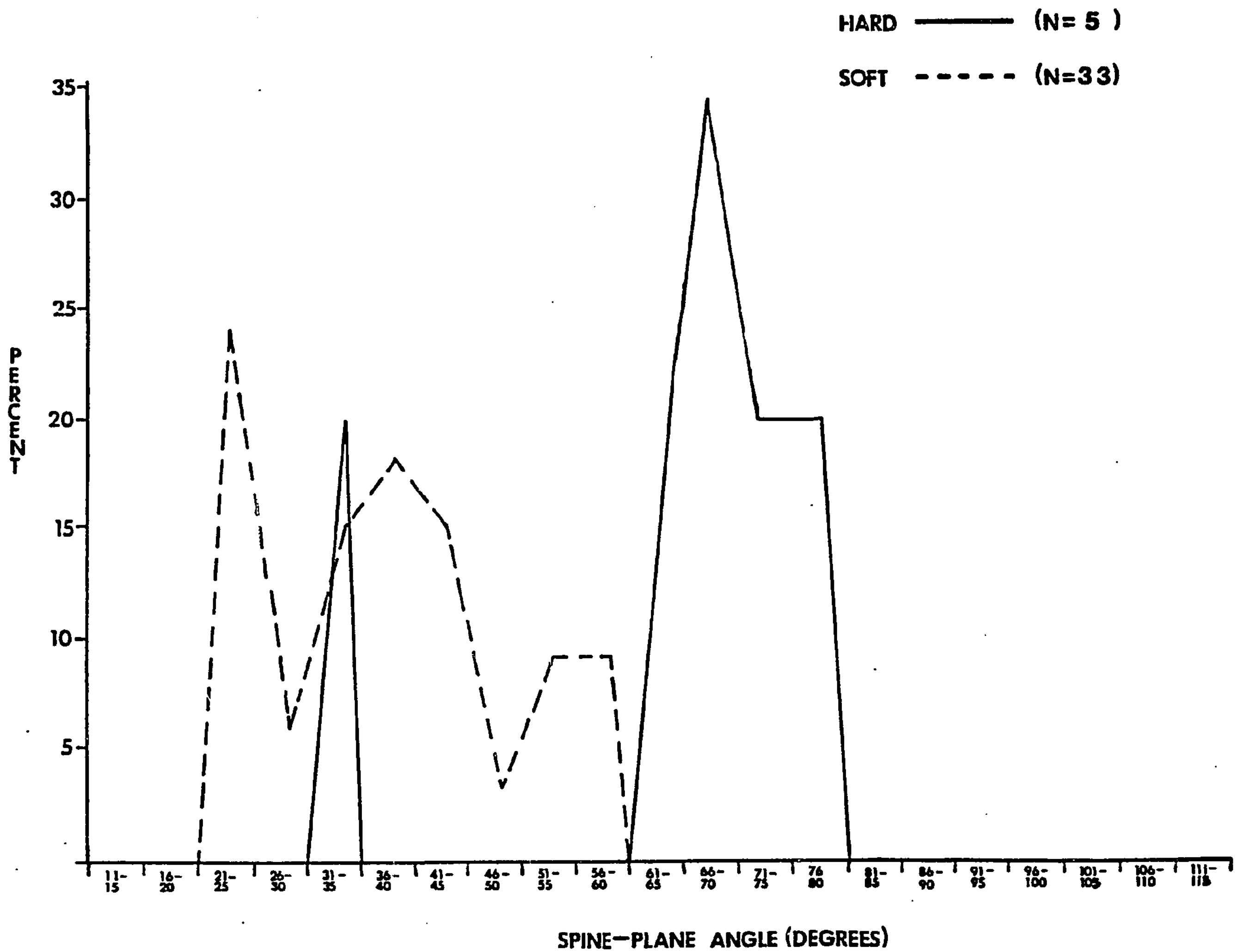

FIGURE 23. Site 8-304a, range of spine-plane angles.

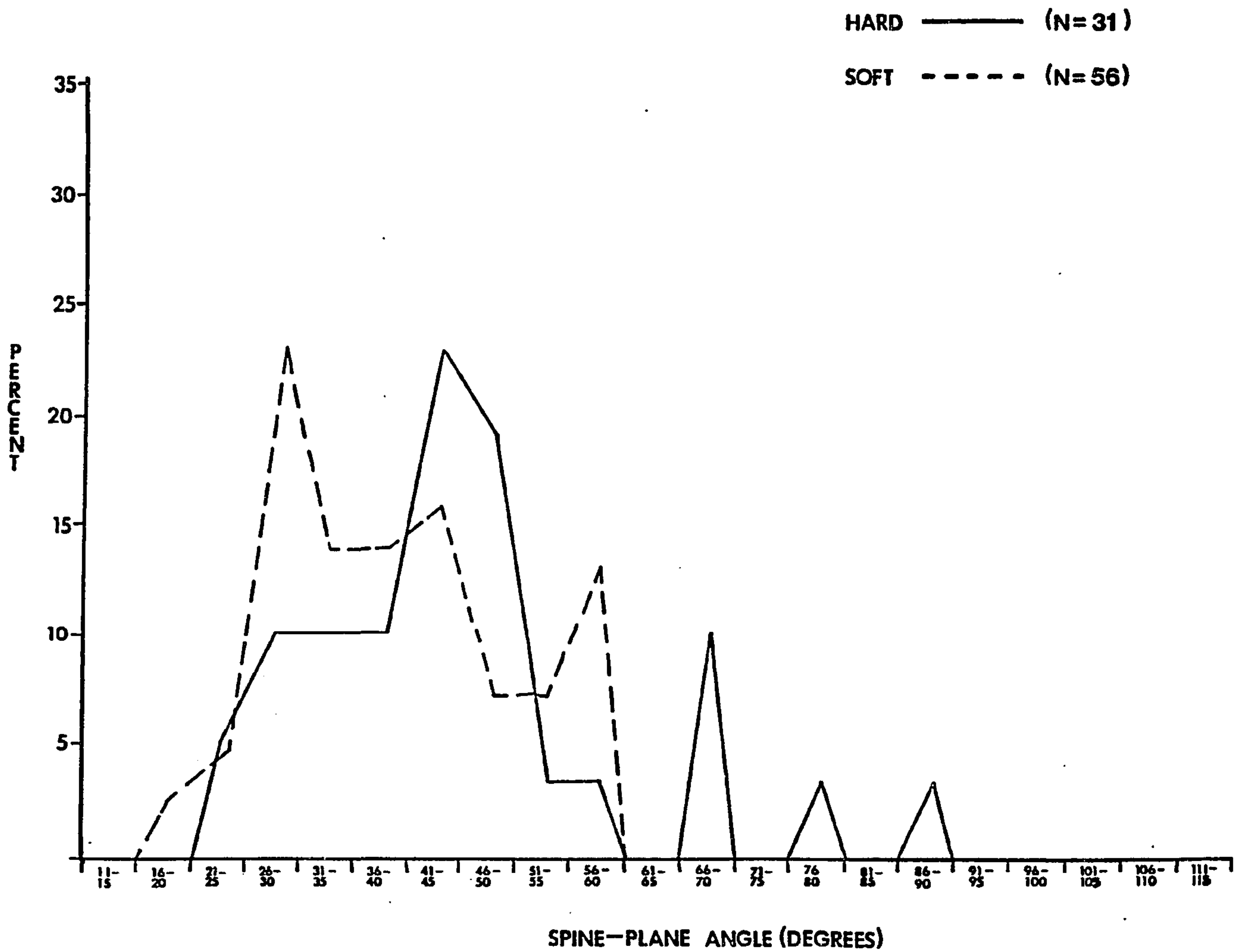

FIGURE 24. Site 8-341, range of spine-plane angles.

of flake weight is 1.31 to 6.91g in the hard category and 0.68 to 3.95g in the soft. The means are 3.48g for the former and 1.88g for the latter.

The length of the tool edge varies from 4 to 23mm in the hard category with a mean of 15mm. In the soft category the range is 5 to 24mm and the mean is 14mm.

Spine-plane angles vary from 26 to 99 degrees in the hard category and from 23 to 41 degrees in the soft. The mean angle for the hard category is 59 degrees and 39 degrees for the soft contact material category. Because there are so few examples in each category no figure is presented.

Forty-three percent of the edge altered flakes and 65 percent of the debitage from 8-353a fall into size groups 2 and 3. Flake weights vary little from category to category. For the hard category the mean weight is 4.01g and the range is 1.28 to 15.70g. In the soft category the range is 0.57 to 7.87g and the mean is 4.31g.

The mean tool edge lengths are also very close, 13mm for the hard category and 14mm for the soft. The range for the hard category is 5 to 27mm and for the soft category it is 5 to 25mm.

The hard category has a mean spine-plane angle of 56 degrees varying from 21 to 94 degrees. In contrast the soft category has a range of 15 to 51 degrees and a mean of 34 degrees. The distribution of these angles by category is shown in Figure 25.

With a total of 28 altered edges on 18 flakes site 8-375 has low frequencies in the hard and soft categories. The mean flake weight

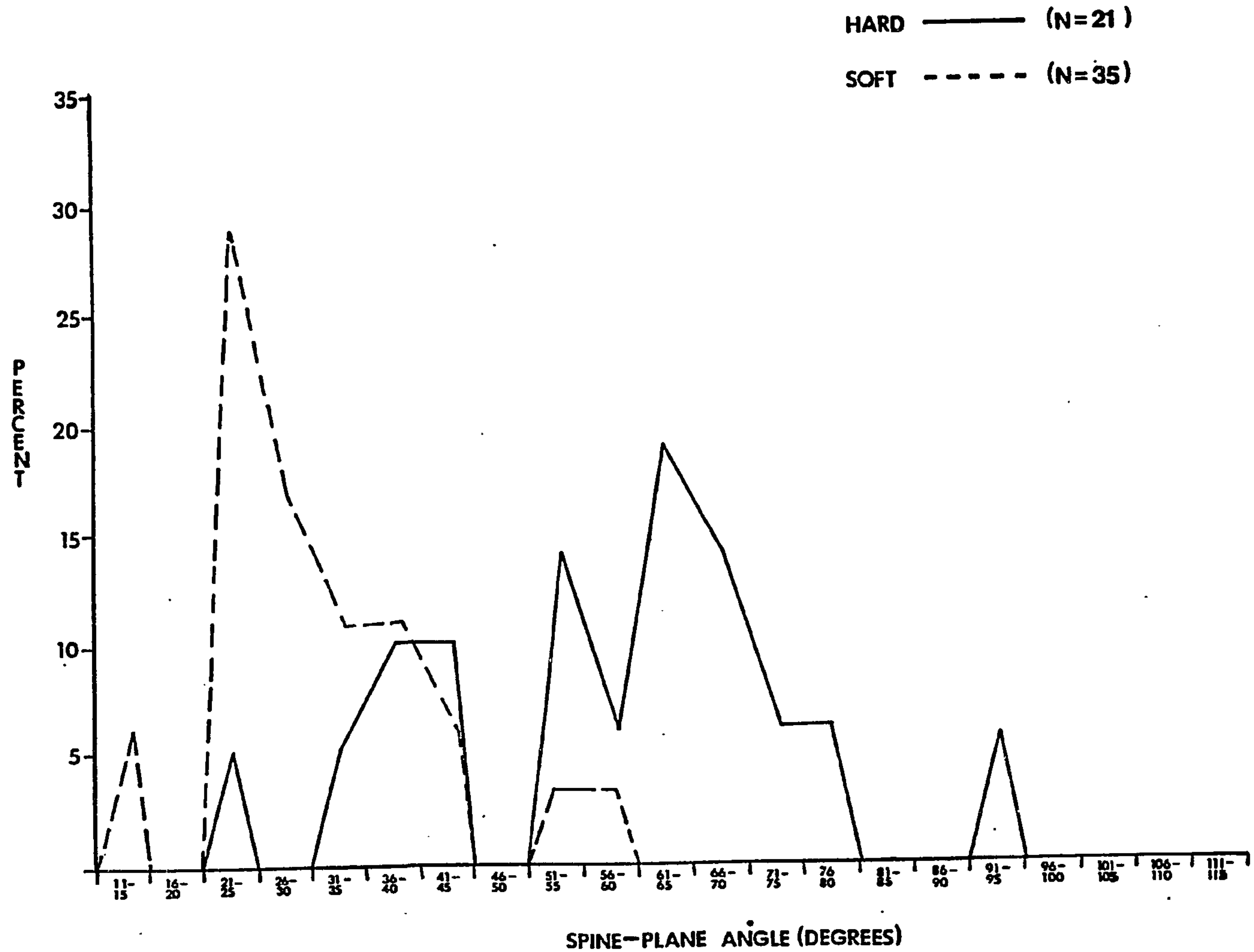

FIGURE 25. Site 8-353a, range of spine-plane angles.

in the hard category is 5.91g with a range of 1.07 to 9.81g. In the soft category the range is 0.39 to 6.44g and the mean is 2.28g.

The mean length of the tool edge is similar in both categories, 15mm in the hard category and 14mm in the soft. Edge length varied in the hard category from 8 to 20mm and in the soft category is varied from 7 to 22mm.

The spine-plane angles varied from 24 to 81 degrees in the hard category with a mean of 48 degrees. The soft category had a range of 17 to 53 degrees and a mean of 36 degrees. Figure 26 shows the overlapping distributions of the hard and soft categories.

At site 8-459 52 percent of the debitage and 57 percent of the altered flakes fall into size groups 2 and 3. The mean weight of flakes in the categories hard and soft are very similar. For the hard category the mean is 3.13g and for the soft category it is 3.43g. The range for the hard category is 0.75 to 6.09g and for the soft category it varies from 0.75 to 10.48g.

The spine-plane angles vary from 21 to 90 degrees in the hard category and 22 to 46 degrees in the soft category. The mean for the hard category is 50 degrees and 32 degrees for the soft category. Figure 27 presents the distributions of the spine-plane angles for both of these categories.

Quadrangle 12

12-210

Runga Va'e, site 12-210 (RT2-ST1), is the only one from the

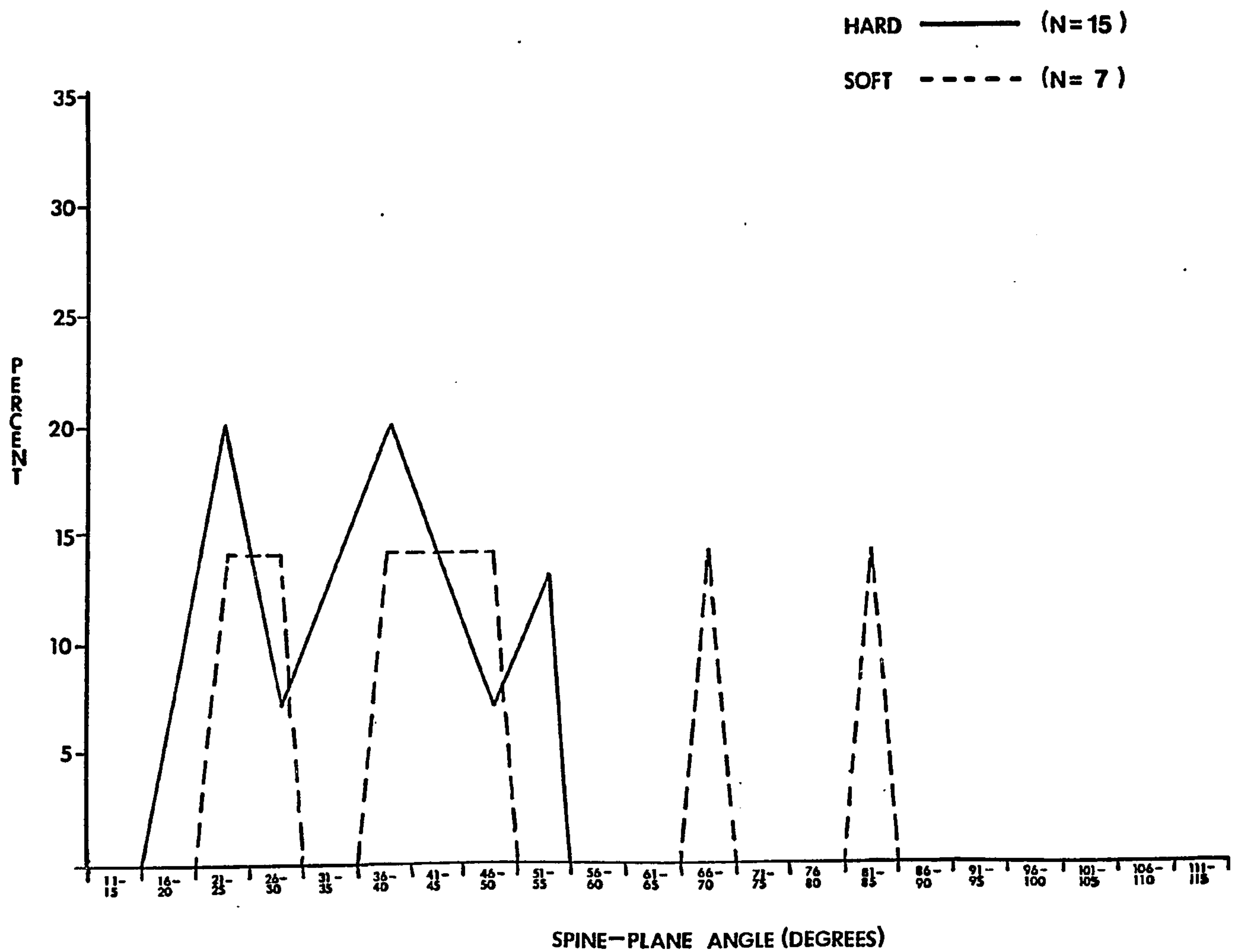

FIGURE 26. Site 8-375, range of spine-plane angles.

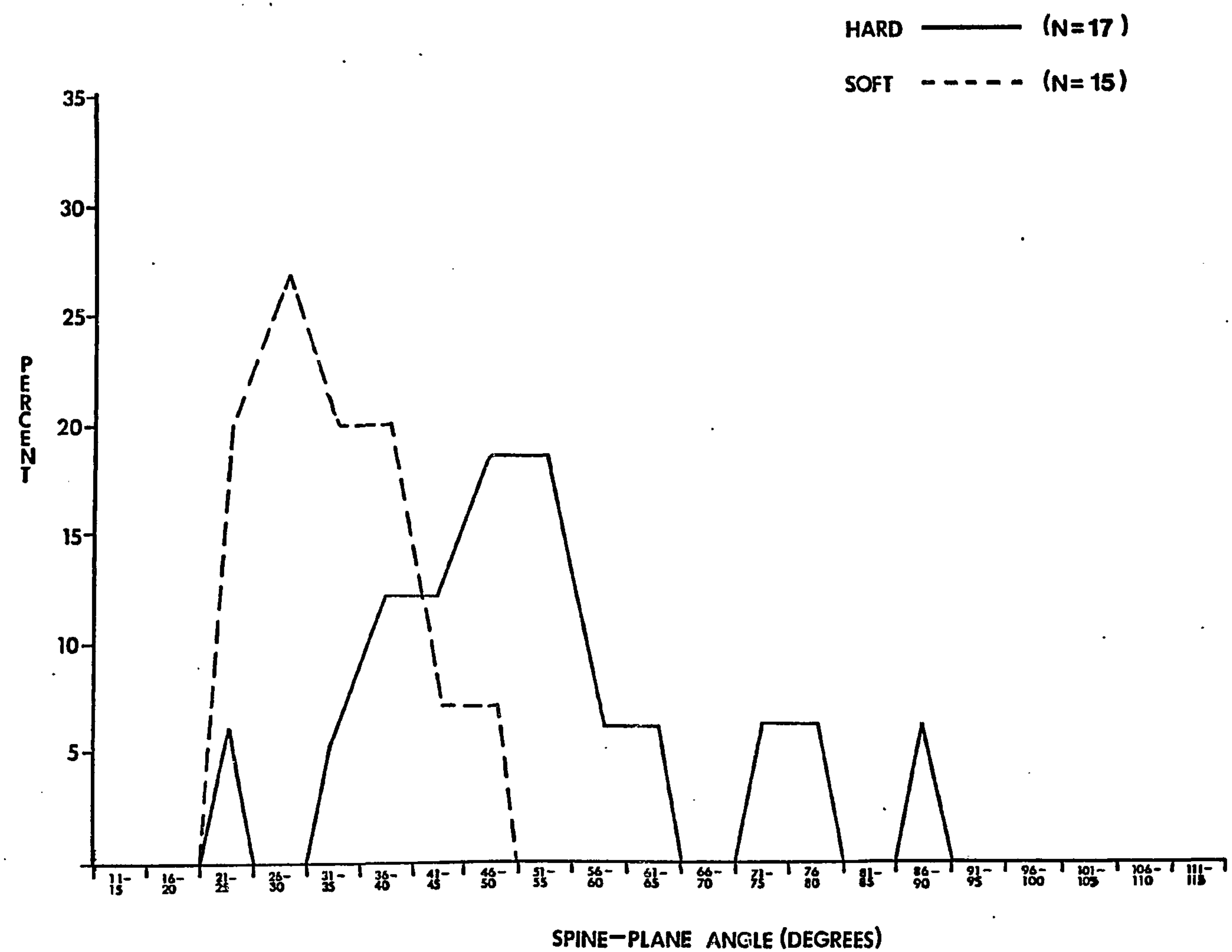

FIGURE 27. Site 8-459, range of spine-plane angles.

Maihiku Quadrangle discussed here (Figure 14). The site is a coastal cave covering about 25 square meters (Figure 28). Three test excavations penetrated more than one meter of buried midden. Within the excavations two floor levels were located as well as a stone pavement. Other features were one small taheta inside the cave and seven more on the top of the rock out crope above the cave roof. These taheta are depressions pecked into the stones surface to be used as storage, especially for water.

The nonhistoric artifact assemblege was comprised of seven bone needles, two fishhooks, 23 coral files, seven poro flakes, and 37 unworked basalt flakes. The obsidian component of the assemblege included seven mataa, seven drills, five abraders, two cores, 101 edge altered flakes, and 905 pieces of debitage.

The site has been dated by a single radiocarbon date and four obsidian hydration dates. The corrected radiocarbon date is A.D. 1655 ± 80. The obsidian dates range from A.D. 1493 to A.D. 1739. The depth of midden and the range of dates indicate the cave was used from the late fifteenth century to early contact times.

The internal stratigraphic succession of the midden can be divided into five layers which can be combined into two analytical units (see Chapter IV). Table 8 presents the basic data on edges, flakes and the altered edge categories. Note that Layers I and II, which are the most recent, have been combined.

The frequencies of the edge type groups are shown in Table 9. The most obvious trend in Table 9 is the increasing predominance

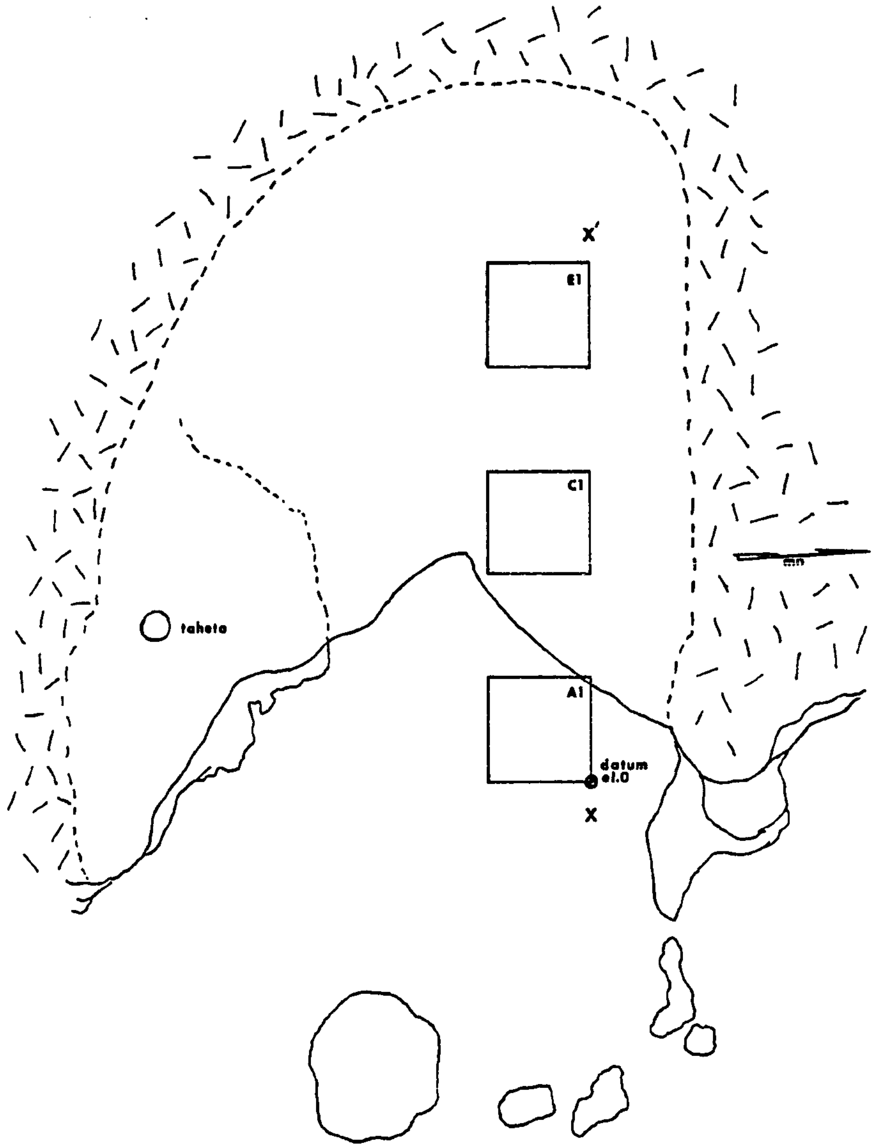

FIGURE 28. Site 12-210, Runga Va'e, plan view (after Ayres 1975).

TABLE 8. Site 12-210 Altered Edge Data

Layer	No. Edges	No. Flakes	Ave	Hard f	Hard %	Soft f	Soft %	Ret f	Ret %	Un f	Un %
Total	137	101	1.36	48	35	53	39	24	17	12	9
I+II	24	16	1.50	7	29	12	50	1	4	4	16
III	31	24	1.29	11	35	12	39	7	23	1	3
IVa	54	40	1.35	17	31	20	37	13	24	4	7
IVb	28	21	1.33	13	46	19	32	3	11	3	11

TABLE 9. Site 12-210 Edge Types

Layer	Edge Types 1/7 f	1/7 %	2/3 f	2/3 %	4/5 f	4/5 %
Total	61	45	35	25	41	30
I+II	14	58	2	9	8	33
III	12	39	7	22	12	39
VIa	23	42	15	28	16	30
IVb	12	43	11	39	5	18

of edge type Group 1/7 from Layer IVb to Layers I and II. Also of note is the decreasing use of edge type Group 2/3 from Layer IVb to Layers I and II.

Table 10 presents the relationship between the debitage and edge altered flakes. There is little change in Layers IVa and IVb in the debitage to altered flake ratio or the percentage of flakes that are altered. In contrast there are great differences between Layer III and Layers I and II in both of these categories.

TABLE 10. Site 12-210 Debitage and Flake Tools

Layer	No. Deb.	No. Tools	Ratio	Percent Flake Tools
Total	905	101	8.96:1	10
I+II	68	16	4.25:1	19
III	389	24	16.21:1	6
IVa	293	40	7.32:1	12
IVb	155	21	7.38:1	12

In comparing the categories hard and soft, the attributes of weight and spine-plane angle show some change while the attribute of length remains very stable. In Layer IVb the mean spine-plane angle for the hard category is 50 degrees and for the soft category the mean is 37 degrees. In contrast combined layers I and II have a mean spine-plane angle, in the hard category, of 41 degrees and in the soft category of 40 degrees. The overall distribution of the spine-plane angles for the categories hard and soft are shown in Figure 29.

The mean flake weight in the hard category in Layer IVb is 9.30g, some 6.57g heavier than the mean for the soft category which is 2.72g. The mean flake weight in Layers I and II for the hard category

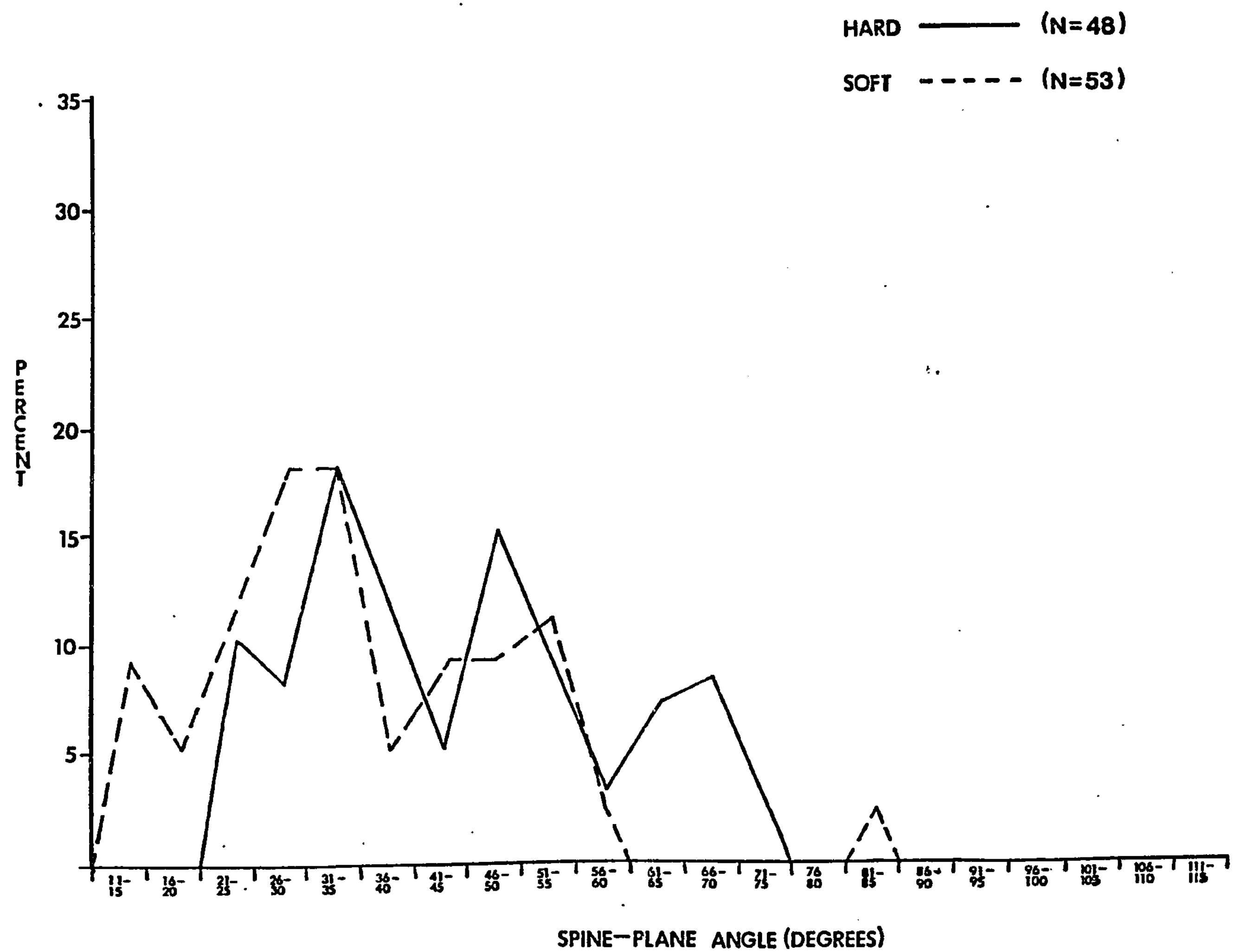

FIGURE 29. Site 12-210, range of spine-plane angles.

is only 2.75g and 3.29g in the soft category.

A look at the attribute of tool edge length in Layer IVb finds a mean of 15mm in the soft category and 13mm in the hard category. In combined Layers I and II the average length of the edge in the hard category is 13mm and 14mm in the soft category.

Quadrangle 14

The Tongariki Quadrangle encompasses the interior and coastal areas just south of Rano Raraku. Three sites were excavated in this region: two caves and a small hare paenga (Figure 30).

14-57a

Site 14-57a (RT2-ST1) lies 16 meters from the sea at an elevation of slightly more than 3.5 meters. This large 70 square meter cave was partly closed off by a rough wall of large boulders and smaller rock fill. A total of seven units were excavated at the site, five inside the cave and two outside of the cave mouth (Figure 31). Midden built up at the site was great enough to allow the identification of three stratigraphic layers. A single radiocarbon sample from square E9 provided a corrected date of 1450 ± 60 A.D.

Artifacts from the site represented a number of types. Seventy-three bone items were recovered; these were mostly needles and fragments of cut bone. A single one-piece shank fishhook was also found. Other artifacts included 26 coral files and 63 basalt tools.

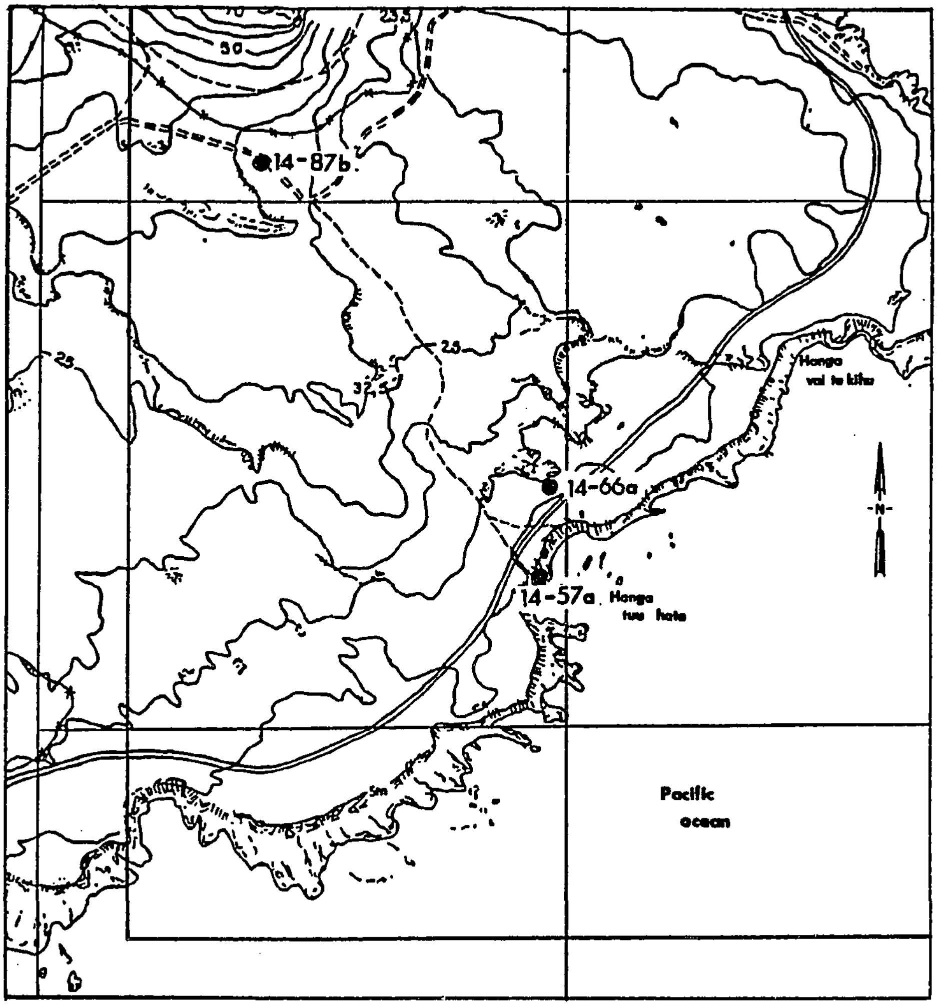

FIGURE 30. Quadrangle 14, site locations (after Ayres 1975).

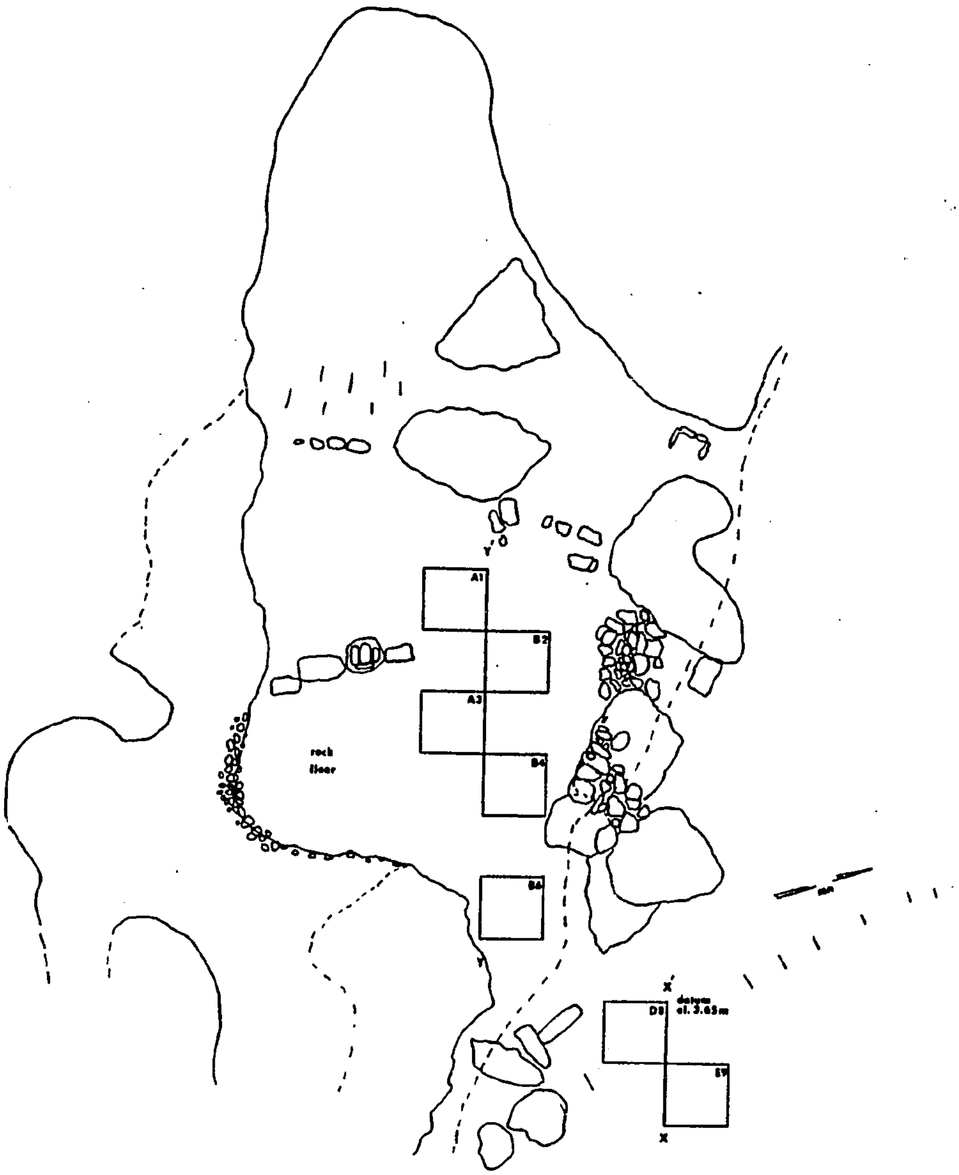

FIGURE 31. Site 14-57a, Hanga Tuu Hata, plan view (after Ayres 1975).

Obsidian artifacts included six files, 26 drills, 17 mataa, five cores, and one edge ground fragment. A total of 688 edge altered flakes was recovered as well as 2309 pieces of debitage.

14-66a

A small hare paenga measuring 2 by 12 meters is site 14-66a (FT1-STB). Set back slightly from the coast, the site is roughly 10 meters above sea level. Cultural debris was limited to one core, 17 edge altered flakes, and 158 pieces of debitage, all of which were obsidian. Based on obsidian hydration dates the site is estimated to have been in use during the early to mid-Expansion Phase.

14-87b

Site 14-87b (RT2-ST2) is a small, 12 meter square interior cave situated at an elevation of approximately 40 meters. A single test pit showed midden that contained small amounts of shell and bone. Found as well were two basalt adzes, an obsidian mataa, an obsidian core, four edge altered flakes, and five pieces of obsidian debitage.

Altered Edge Data

The following tables list the basic information on sites 14-57a and 14-66a. Site 14-87b is excluded because of the small number of cultural items recovered. The data for site 14-57a are presented by the overall totals as well as by the identified stratigraphic layers with Layer I being the most recent. Table 11 presents the altered edge data.

TABLE 11. Quadrangle 14 Altered Edge Data

Site	No. Edges	No. Flakes	Ave.	Hard		Soft		Ret.		Un.	
				f	%	f	%	f	%	f	%
14-57a Total	122	77	1.58	50	41	45	37	11	9	16	13
I	51	34	1.50	16	31	26	51	5	10	4	8
II	31	19	1.63	15	48	8	26	4	13	4	13
III	40	24	1.67	19	48	11	27	2	5	8	20
14-66a	25	17	1.47	8	32	7	28	10	40	0	0

Table 12 provides the edge type data by frequency and percentage.

TABLE 12. Quadrangle 14 Edge Types

Site	Edge Types							
	1/7		2/3		4/5		6	
	f	%	f	%	f	%	f	%
14-57a Total	62	51	36	30	22	18	2	2
I	28	55	16	31	7	14	0	0
II	17	55	8	25	5	16	1	3
III	17	42	12	30	10	25	1	3
14-66a	12	48	11	44	2	8	0	0

The relationship between the altered edges and debitage is shown in Table 13.

TABLE 13. Quadrangle 14 Debitage and Flake Tools

Site	No. Deb.	No. Tools	Ratio	Percent Flake Tools
14-57a				
Total*	1654	438	3.78:1	21
I	1020	226	4.51:1	18
II	224	62	3.61:1	22
III	410	150	2.73:1	27
14-66a	158	17	9.29:1	10

*The figures for this total are based only on the sample population and not the entire recovered collection.

Table 11 shows that the average number of altered edges per flake at 14-57a decreases slightly through time from 1.67 to 1.50. The overall average for the site is 1.58 while the average from 14-66a is 1.47.

Consideration of the altered categories for site 16-66a indicates an essentially even occurrence of specimens in the hard and soft categories and a very large percentage of retouched edges. The picture from 14-57a as a whole shows a fairly even occurrence of edges in the hard and soft categories with a small percentage of retouched edges.

While the overall distribution of the edges at 14-66a is fairly even there is a definite shift seen from Layer III to Layer I. Layer

III has a preponderance of edges in the hard category with much smaller frequencies in the soft and retouched categories. Layer I has very different frequencies in these categories with a statistically larger-than-expected number of edges falling into the soft category ($X^2 = 4.69$, α 0.10, 2 df).

The edge type information found in Table 12 shows that at 14-66a Groups 1/7 and 2/3 are dominant. At 14-57a edges in Group 1/7 are the most frequent in all three layers and increased by 13 percent from Layer III to Layer I. Although Group 2/3 remains constant through time those of Group 4/5 decrease by 11 percent from Layer III to Layer I.

Table 13 illustrates an extremely large ratio of debitage to edge altered flakes at site 14-66a. This feature is also seen by the small percentage of obsidian flakes used for tools.

At 14-57a change through time can also be noted for both categories. The ratio between debitage and flake tool increases by 65 percent from Layer III to Layer I. At the same time the percentage of flakes used for tools decreases by a little more than 33 percent form Layer III to Layer I.

At site 14-66a only 15 percent of the debitage falls into size categories 2 and 3, and 53 percent of the edge altered flakes do so. A two-variable chi-square test indicates a highly significant difference between the debitage and edge altered flakes in relation to size at the 0.01 level ($X^2 = 57.47$, 1 df). This difference is due mainly to a larger than expected frequency of altered edges in the size categories 2 and 3. This information is not available for site 14-57a.

For all three layers at 14-57a, the hard category has a wider range and higher mean spine-plane angle than does the soft category (Figures 32 and 33). In Layer III the range of spine-plane angles for the hard category is 21 to 78 degrees with a mean of 53 degrees. The soft category has a mean of 37 degrees and a range of 27 to 50 degrees. The range of angles in Layer I is 28 to 71 degrees for the hard category and 20 to 56 degrees for the soft category. The mean is 49 degrees for the hard category and 35 degrees for the soft category.

Within each layer the attribute of altered edge length varies little from the hard to soft categories. The hard category mean in Layer III is 15mm and the soft category mean is 14mm. The range for the hard category is 6 to 26mm and for the soft category it is 6 to 17mm. In Layer I the ranges are a bit greater, 7 to 27mm for the hard category and 5 to 38mm for the soft category. The means are 15mm in the hard category and 16cm in the soft category.

The larger mean flake weight shifts from Layer III to layer I. In Layer III the mean flake weight is 3.42g in the hard category compared to 2.10g for the soft. The ranges are quite different between the categories, for the soft category it is 0.70 to 4.25g while the hard category ranges from 0.99 to 14.67g.

For Layer I the opposite pattern holds true. The mean flake weight for the hard category is 3.16g which is smaller than the mean

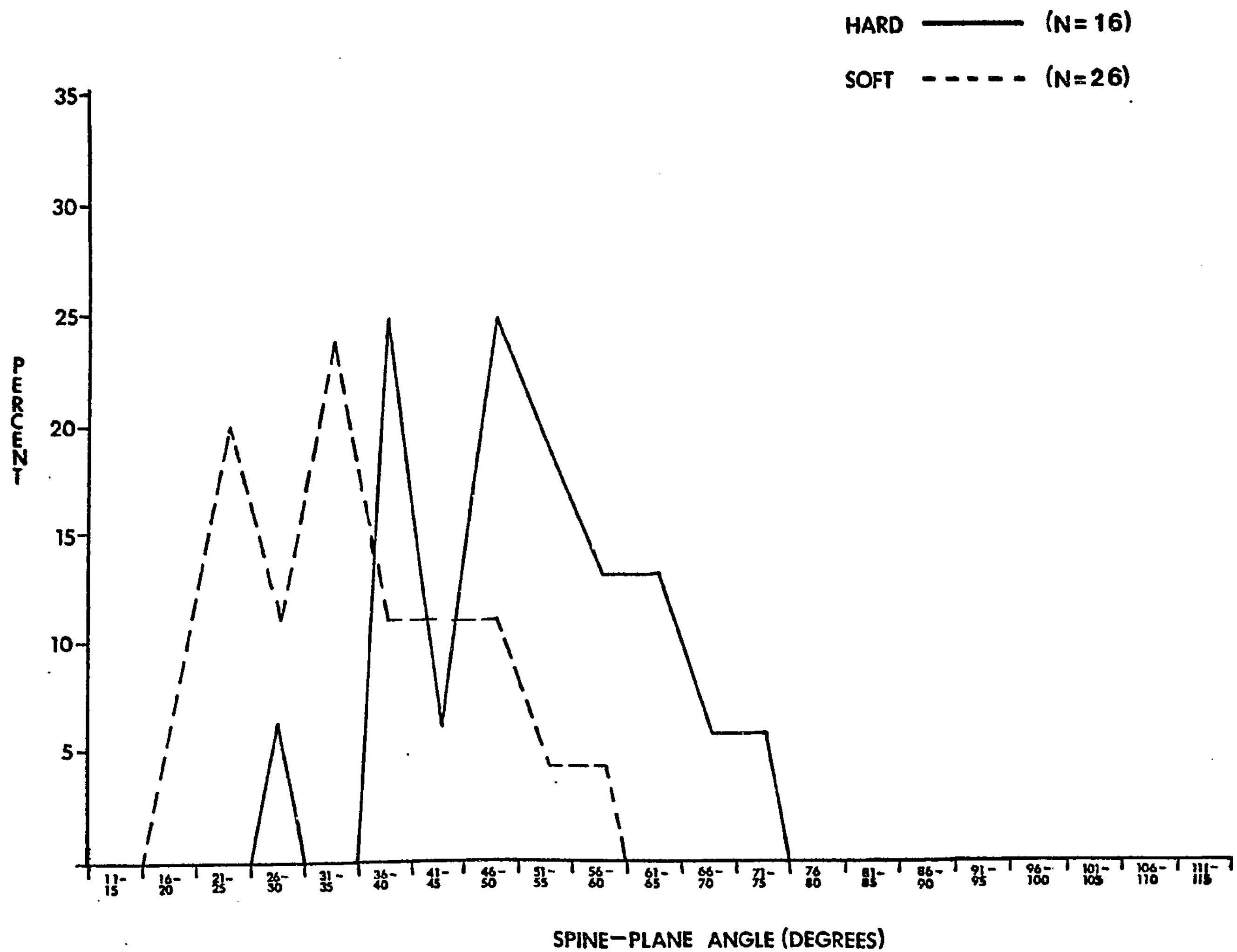

FIGURE 32. Site 14-57a, layer I, range of spine-plane angles.

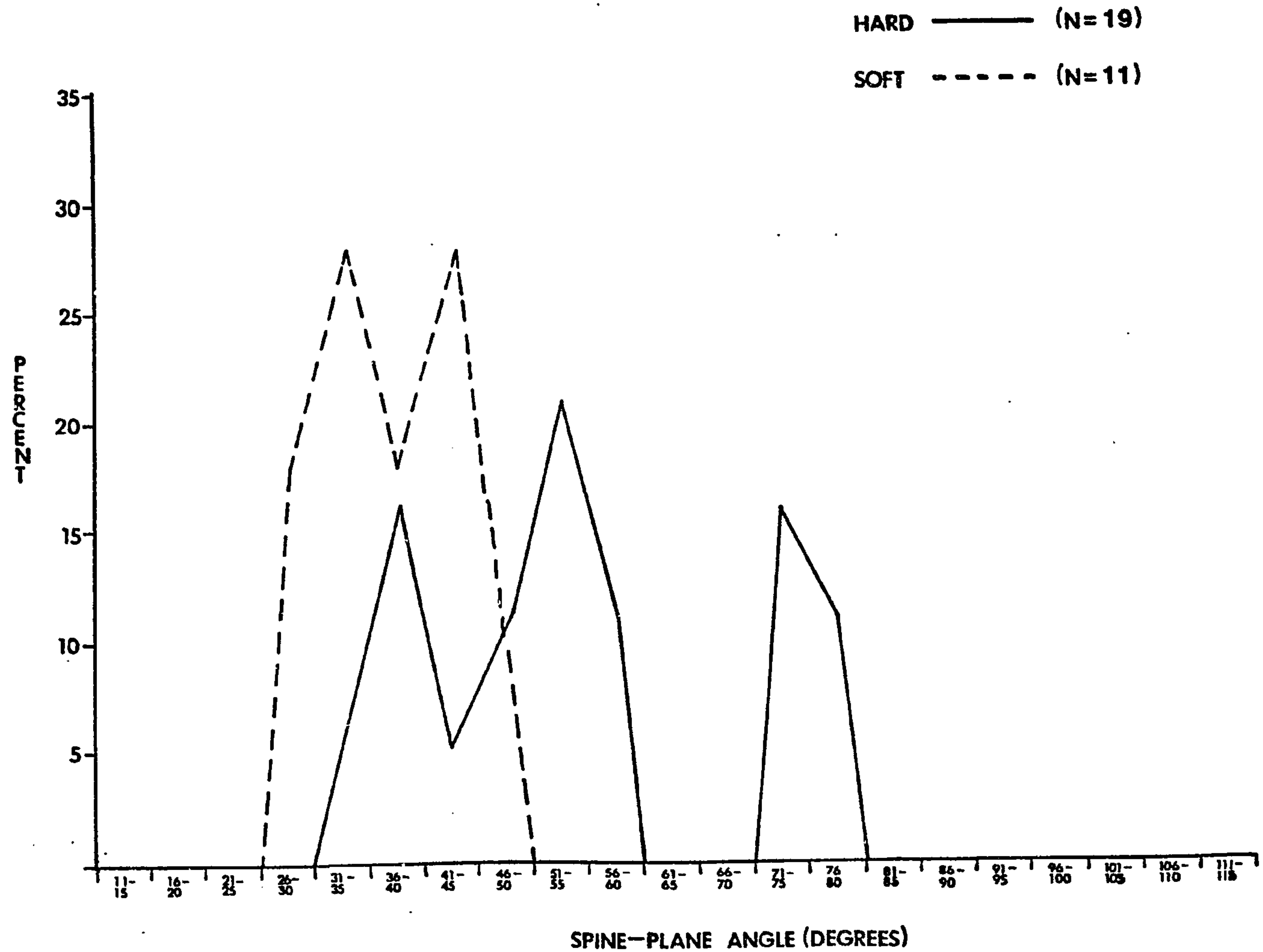

FIGURE 33. Site 14-57a, layer III, range of spine-plane angles.

of 4.02g for the soft category. The range for the hard category is only 1.06 to 4.39g while that for the soft category is 0.50 to 10.70g.

At site 14-66a the hard category dominates all three of the attributes spine-plane angle, length, and weight. For the spine-plane attribute the range for the hard category is 24 to 66 degrees, with a mean of 48 degrees. The range of angles in the soft category is 28 to 49 degrees with a mean of 34 degrees.

The length attribute ranges from 7 to 22mm in the hard category and 6 to 21mm in the soft. The mean for the hard category is 15mm, for the soft category it is 13mm.

The weight range of the soft category is 0.60 to 12.49g, the mean is 2.06g. The range in the hard category is 0.87 to 5.70g with a mean of 3.11g.

Quadrangle 34

34-1

Five sites were investigated in the Papa te Kena Quadrangle (Figure 34). Site 34-1 (RT2-ST2) is a large coastal cave (70 meters square) situated at an elevation of five meters. The recovered tool assemblage from the single test pit included one bone needle, a basalt adz, a core, one beaked graver, a possible mataa fragment, and a bifacial object. Edge altered flakes totaled 59 with 195 pieces of debitage. No construction was evident at the site and excavation found sterile papa rubble at 40cm. Based on five obsidian hydration dates the site is dated to the early to mid-Expansion Phase.

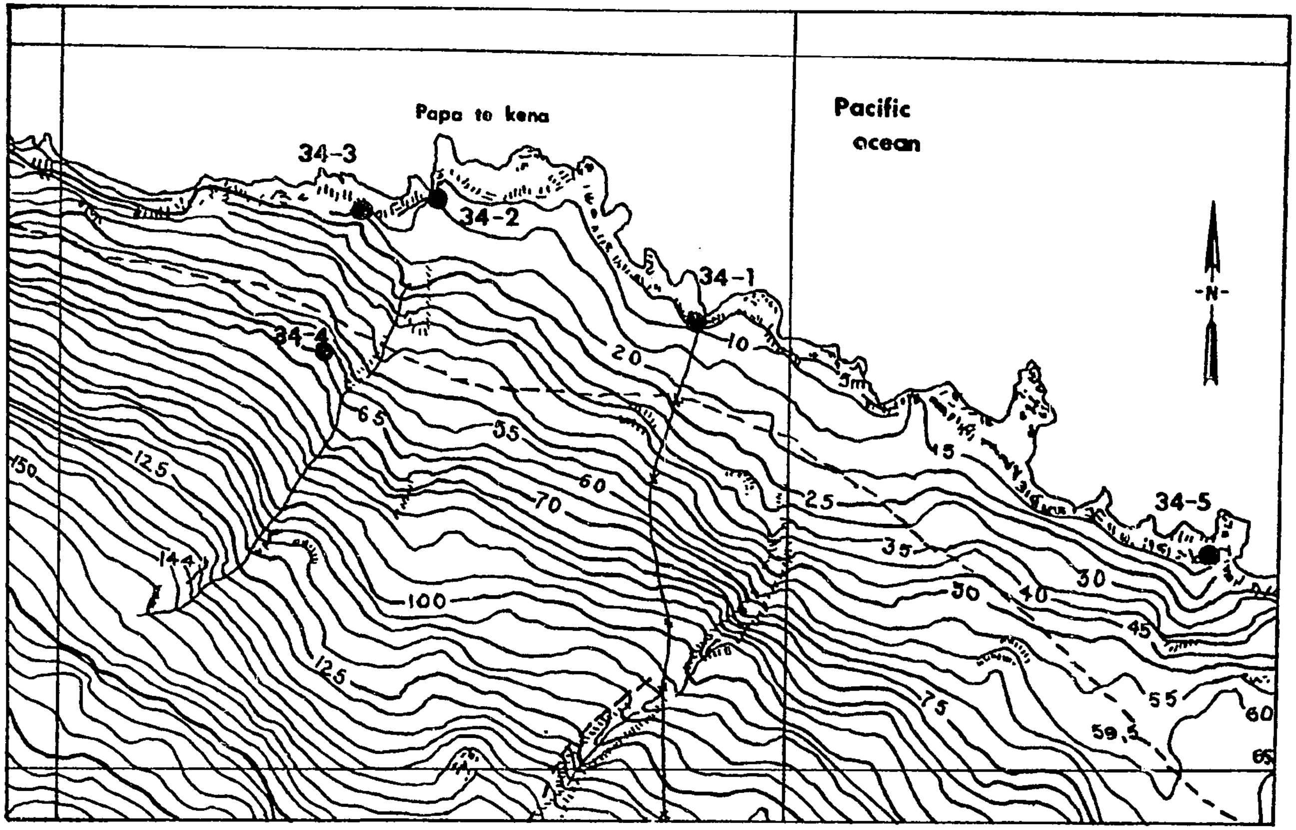

FIGURE 34. Quadrangle 34, site locations (after Ayres 1975).

34-2

To the west of 34-1 a second coastal site 34-2 (RT2-ST1) was fully excavated (Figure 35). This lava tube covers an area of 24 square meters and is 15 meters above sea level. Construction at the site included the partial covering of the broken roof of the tube with large stone slabs as well as some rough wall building near a side entrance.

No stratigraphic succession was present because the basalt floor was only 15 to 25cm below the modern ground surface. A total excavation of the lava tube produced 115 bone artifacts, mostly needles and cut bone. Two pendants, six punches, and ten fishhooks were found. Also recovered were 14 coral files, two scoria abraders, and 71 basalt artifacts, 49 of which were unworked flakes. Obsidian tools included 20 mataa, 18 drills, five files, three abraders, one bifacial object, 1,017 edge altered flakes, and 3,462 pieces of debitage. Obsidian hydration determinations date this site to the mid-fourteenth century. These dates place the site in the middle of the Expansion Phase.

34-3

A third coastal site, 34-3 (RT2-ST2), is a cave just west of 34-2. Located 15 meters above sea level this cave has an area of 16 square meters. A single test pit showed mainly loose, water-washed soil and some slight midden in the 20 to 50cm levels with sterile papa at 60cm. Only a small complement of cultural material

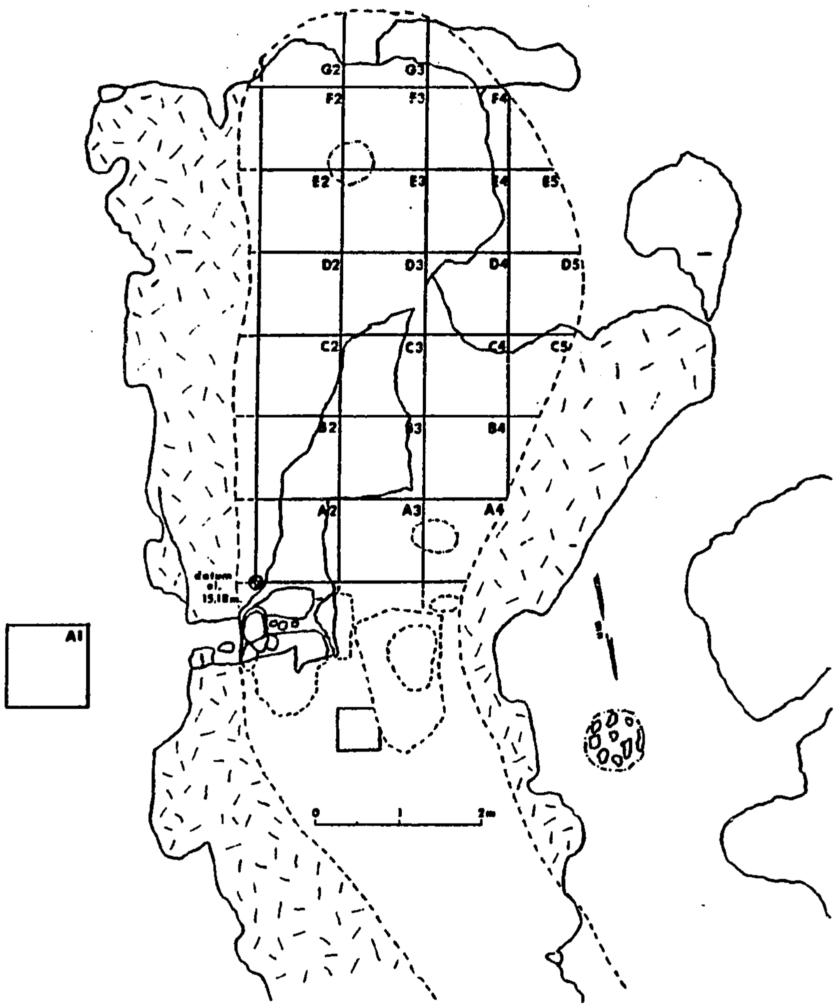

FIGURE 35. Site 34-2, Papa te Kena, plan view (after Ayres 1975).

was recovered; this included four bone needles, as well as an obsidian bipolar core, one obsidian drill, and one obsidian bifacial object. Edge altered flakes numbered 24 and debitage numbered 27.

34-4

Just south from 34-2 lies 34-4 (RT2-ST1), another coastal cave. A wall had once been constructed across the cave mouth blocking off its 80 square meter area. No great midden build up was evident in either of the two test pits although shell, bone, and obsidian were present. Artifacts from the site were all obsidian with the exception of nine bone needles, five basalt tools, and two small, rough stone images that were found on the surface of the cave. Other artifacts included three mataa fragments, four cores, 27 drills, 161 edge altered flakes, and 669 pieces of debitage.

34-5

The final site from Papa te Kena, 34-5 (RT2-ST2), is a small (12 square meters) coastal cave located some distance east of 34-1. The site is approximately nine meters above the sea and is filled with washed-in soil to a depth of 60cm. Only scattered midden was noted in the single test pit dug. Found in the excavation was an umu at 20 to 30cm. The only cultural debris recovered was 22 pieces of debitage and six edge altered flakes.

Altered Edge Data

The basic data presented below include all the sites except 34-5 because of the small number of cultural items recovered. Table 14 shows a range of averages for the number of altered edges per flake. Site 34-2 has the lowest average, 1.51, and site 34-3 has the highest with 1.79.

TABLE 14. Quadrangle 34 Altered Edge Data

Site	No. Edges	No. Flakes	Ave.	Hard f	Hard %	Soft f	Soft %	Ret. f	Ret. %	Un. f	Un. %
34-1	64	40	1.58	18	29	21	33	12	19	12	19
34-2	83	55	1.51	35	42	30	36	6	7	12	14
34-3	43	24	1.79	22	51	17	40	3	7	1	2
34-4	67	39	1.72	35	52	19	28	5	8	8	12

Both 34-1 and 34-2 have essentially even percentages of edges in the hard and soft categories, with 34-1 also having the largest percentage of retouched edges of all of the sites from Papa te Kena. The other two sites, 34-3 and 34-4, have their greatest percentages of edges in the hard category and both have low occurrences of retouched edges.

A one-variable chi-square test between the altered edge categories hard, soft, and retouched indicates no important difference at sites 34-1 and 34-2. For sites 34-3 and 34-4 there is a statistically significant difference in the contact material categories. Both sites have greater than expected frequencies of edges in the hard category and lower than expected numbers in the retouched category (Site 34-3: X^2 = 4.61, α 0.10, 2 df; Site 34-4: X^2 = 7.65, α 0.05 2 df).

A variety of edge type group distributions can be seen in Table 15. The percentages of the different edge types at site 34-1 are equal for the edge type Groups 1/7 and 2/3, while Group 4/5 is slightly larger at 39 percent. The pattern at 34-2 is quite different: here Group 1/7 is the most frequent (58%), followed by Group 2/3 (27%) and Group 4/5 (13%). Also present is a single type 6 edge (2%). Both sites 34-3 and 34-4 have substantially even distributions of edge type Groups 1/7 and 2/3 with Group 4/5 being the least frequent at both sites.

TABLE 15. Quadrangle 34 Edge Types

Site	Edge Types							
	1/7		2/3		4/5		6	
	f	%	f	%	f	%	f	%
34-1	18	30	18	30	23	39	0	0
34-2	45	58	21	27	10	13	1	2
34-3	15	35	17	39	11	26	0	0
34-4	30	45	26	39	11	16	0	0

Statistically sites 34-1, 34-3, and 34-4 have no significant difference in their overall distribution of edge types. Only site 34-2 has a significant distribution with an emphasis on Group 1/7 and a low occurrence of Group 4/5 (X^2 = 8.69, α 0.05, 2 df). Both the hard and soft categories show an emphasis on edge type Group 1/7, especially the hard category (X^2 = 4.70, α 0.10, 2 df).

Site 34-3 stands out from all the other sites in Table 16. At 34-3 the ratio between debitage and edge altered flake tools is very close to 1:1. The site also stands out because of the high percentage (47%) of flakes that were used for tools. All the other sites exhibit ratios exceeding 3:1. Also in contrast is the far lower percentage of obsidian material used for flake tools in these sites compared to 34-3.

TABLE 16. Quadrangle 34 Debitage and Flake Tools

Site	No. Deb.	No. Flakes	Ratio	Flake Tools
34-1	195	59	3.30:1	23
34-2	3462	1017	3.40:1	23
34-3	27	24	1.12:1	47
34-4	699	161	4.34:1	19

For site 34-1 there is an overall agreement in the flake size distribution between the debitage and the edge altered flakes. Forty-five percent of all the debitage was greater than or equal to flake size 2, the other 55 percent fit the smaller size categories. For the edge altered flakes, 40 percent were size 2 or larger and 60 percent were smaller than size 2. There is no distinction between the hard and soft categories and flake size.

Flake weight for edges worked on hard contact materials ranged from 0.89 to 9.64g, with a mean of 3.36g. For edges related to soft materials the range is 0.48 to 6.13g with an average of 2.23g.

The spine-plane angles for the hard and soft categories are also quite distinct. For the hard category the range of angles is 35 to 74 degrees, for the soft category the range is 14 to 55 degrees. For the soft category the mean is 34 degrees while that for the hard category is 49 degrees. The distribution of spine-plane angles for the hard and soft categories is shown in Figure 36.

The length of the utilized edge is very similar in both the hard and soft categories. The mean for the hard category is 13mm and for the soft it is 14mm. The ranges are also quite close, for the hard category the lengths vary from 8 to 26mm and the soft category varies from 5 to 26mm.

Retouched edges at this site were quite frequent, comprising some 19 percent of all the edges. The edge angle for the retouched edges ranges from 67 to 90 degrees with a mean of 77 degrees. The length of the retouched edges varied from 8 to 43mm and averaged 21mm. The weight of the retouched flakes tended to be greater than those flakes related to the soft or hard categories. For the retouched flakes the mean was 4.21g with a range of 1.09 to 14.26g.

At site 34-2 slightly more than 27 percent of the debitage falls into the size categories 2 or greater and the remainder fit the smaller size groups. For the edge altered flakes 36 percent fit the size

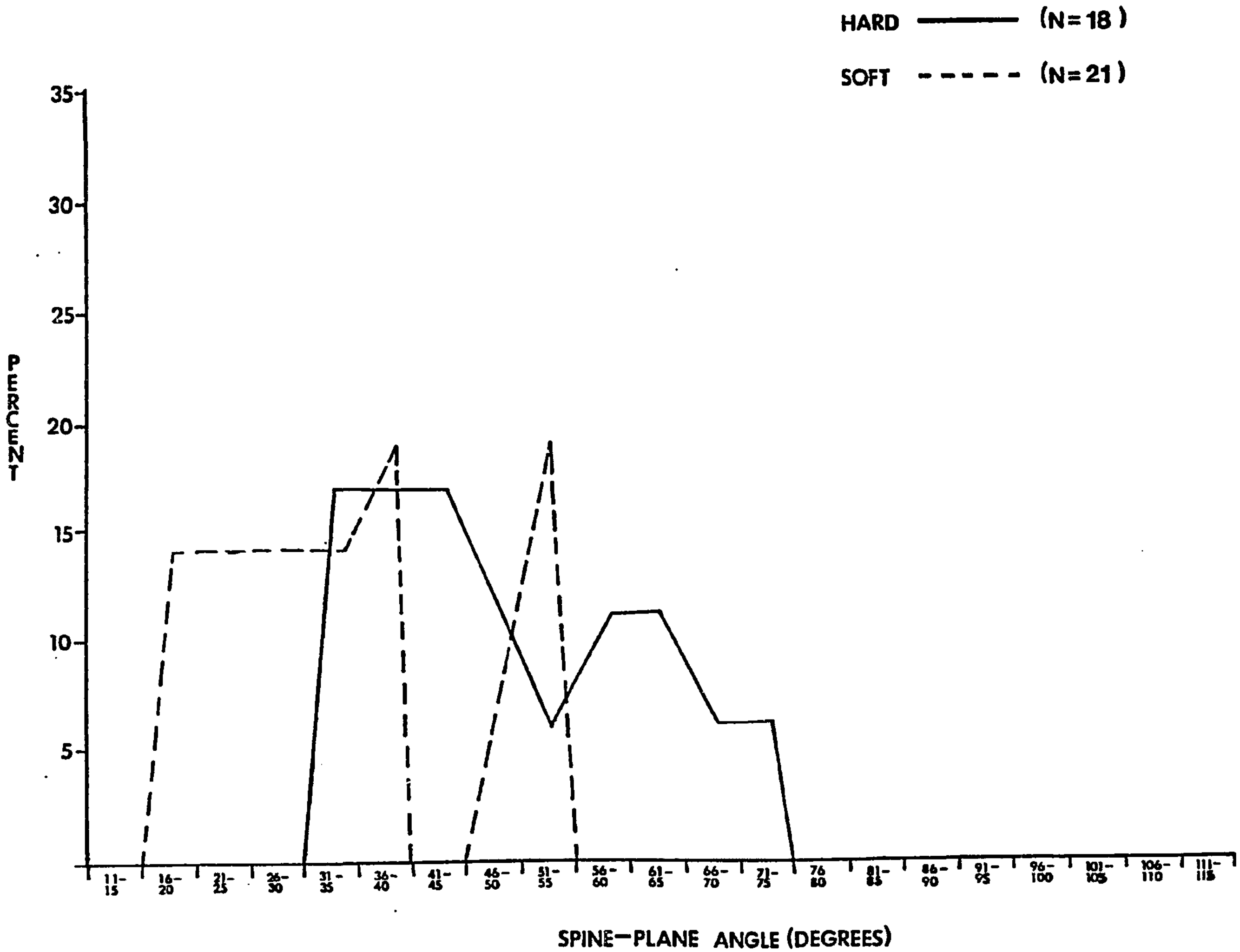

FIGURE 36: Site 34-1, range of spine-plane angles.

groups smaller than 2 and 64 percent fall into size group 2 or larger. A two-variable chi-square test of the sizes and frequencies of the debitage and edge altered flakes finds, at the 0.01 level, a highly significant pattern indicating size selection for the altered flakes (X^2 = 39.79, 1 df).

The weights of the flake tools show no distinction between the hard and soft categories. For the hard category the weight range is 0.50 to 43.23g with a mean of 7.33g. The mean for the soft category is 6.94g with a range of 0.81 to 19.29g.

There is also no difference between the hard and soft categories and length of tool edge. For the hard category the range is 6 to 30mm, for the soft category the range is 7 to 26mm. For both categories the mean is 14mm.

Figure 37 illustrates the distribution of the hard and soft categories in relation to spine-plane angles. For the hard category the range of angles is 20 to 90 degrees with a mean of 59 degrees. In the soft category the mean is 36 degrees and the range is 23 to 55 degrees.

At site 34-3 there is no distinction between debitage and edge altered flakes in regard to size. The weight of the flake tools varies only slightly between the categories hard and soft. The range of weight in the hard category is 0.62 to 11.47g with a mean of 4.06g. The soft category has a mean of 4.68g and ranges from 0.40 to 11.47g.

For the attribute of tool edge length the soft category does

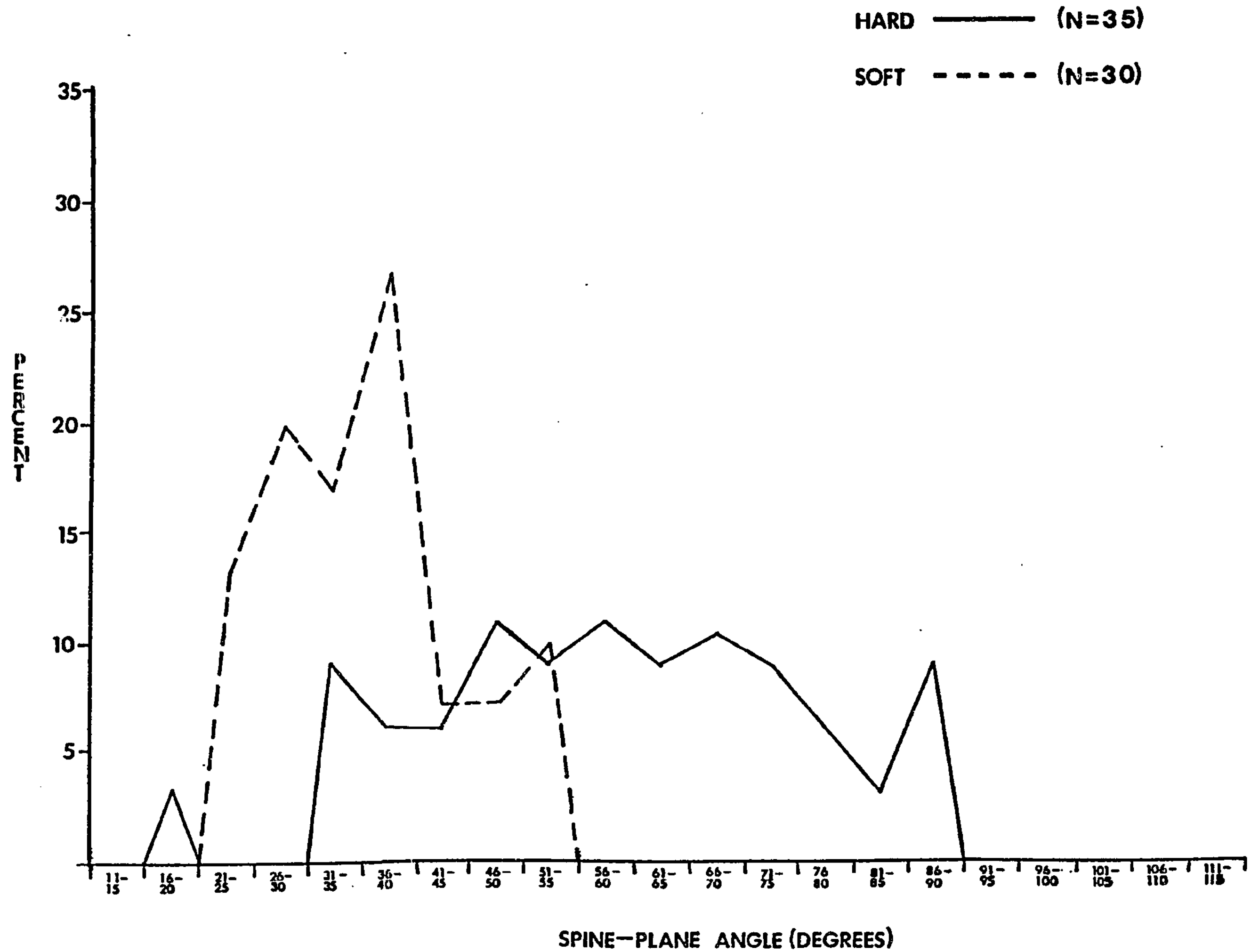

FIGURE 37. Site 34-2, range of spine-plane angles.

have a greater average length than the hard category. The range of lengths in the soft category is 8 to 23mm with a mean of 16mm. The range in the hard category is 6 to 35mm and the mean is 13mm.

The mean spine-plane angle for the hard category is 51 degrees with a range of 24 to 71 degrees. The soft category has a range of 13 to 57 degrees and a mean of 45 degrees. The distribution of these spine-plane angles is presented in Figure 38.

At site 34-4 26 percent of the debitage fits into size categories 2 and 3 while the remainder falls within the smaller size groups. For the edge altered flakes, 46 percent fit into size groups 2 and 3 and 54 percent can be placed into the smaller size groups. The chi-square test comparing the debitage and edge altered flakes indicates a statistically significant difference at the 0.01 level ($X^2 = 8.09$, 1 df).

There is a noticeable difference in the mean weight of flakes used on hard versus soft contact materials. For the hard category the range is 1.76 to 12.33g with a mean of 4.98g. The range for the soft category is 0.74 to 21.14g with a mean of 3.48g.

The mean length of the utilized edges is only slightly different for the hard and soft categories. The range of the hard category is 5 to 27mm, for the soft category it is 6 to 24mm. For the former the mean is 14mm and for the latter it is 15mm.

Figure 39 displays the range of spine-plane angles related to both the hard and soft categories. Hard category spine-plane angles range from 25 to 96 degrees, with a mean of 58 degrees. For the soft

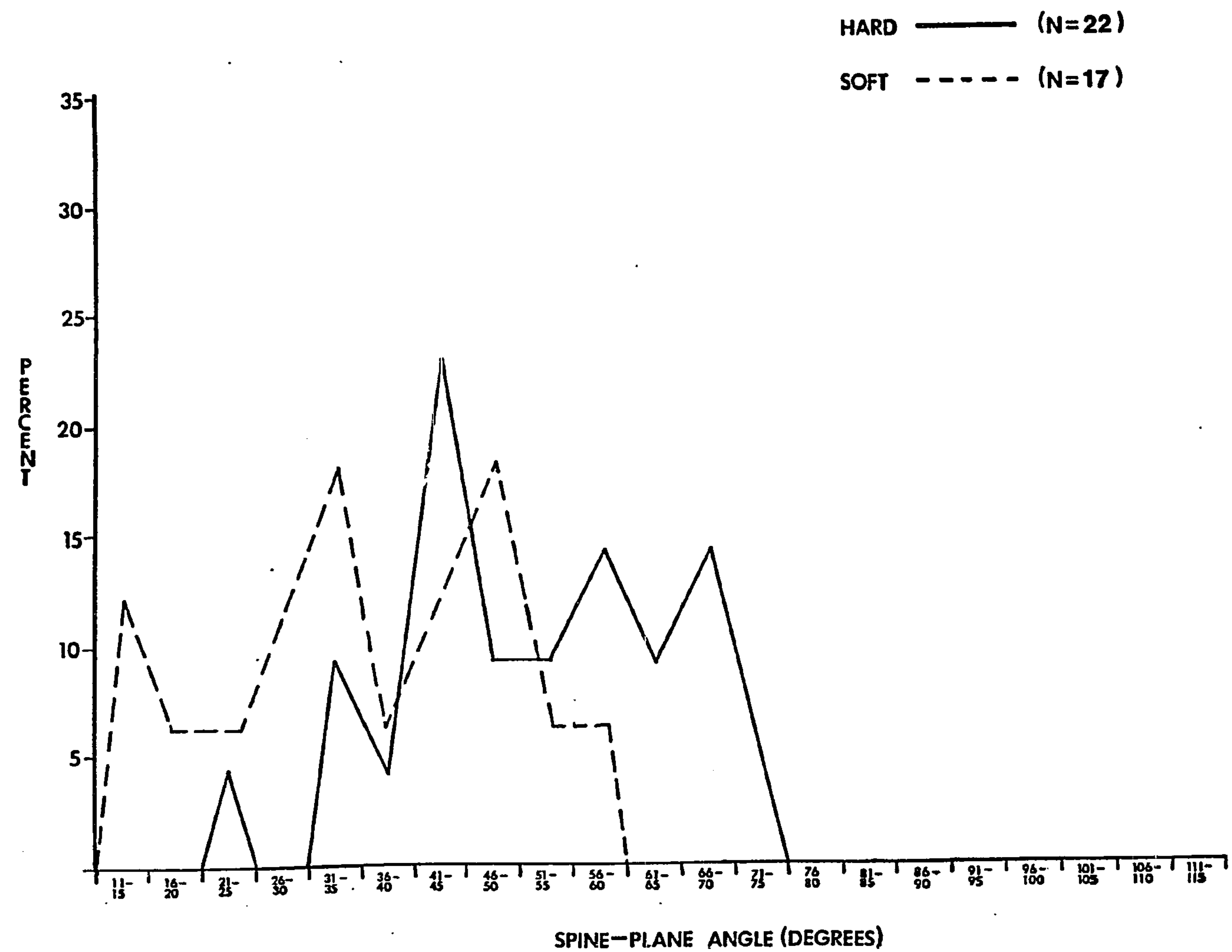

FIGURE 38. Site 34-3, range of spine-plane angles.

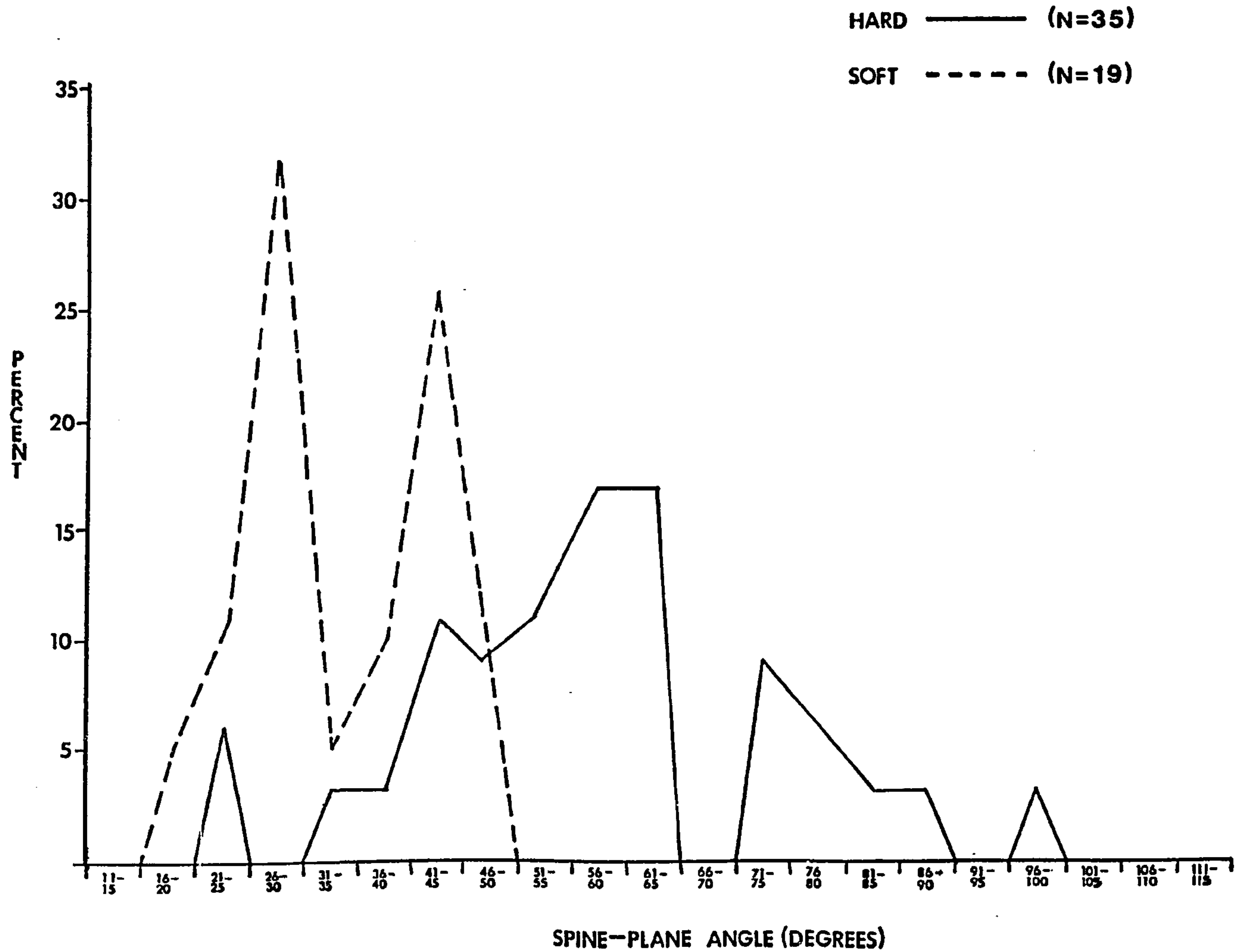

FIGURE 39. Site 34-4, range of spine-plane angles.

category the range is 18 to 50 degrees with a mean of 35 degrees.

Quadrangle 35

35-1

Figure 40 shows the nine sites used in this work from the Anakena Quadrangle. Site 35-1 (RT2-ST2) is a coastal cave some four meters above sea level. Within this 36 square meter cave a single test pit cut through midden extending 43cm to a sterile orange gravelly deposit. Historic debris was found in the first 30cm. A second test pit unit was placed just outside the cave and excavated to a depth of 50cm, with little cultural material recovered. Non-obsidian artifacts from 35-1 included one bone needle and a coral file. Obsidian cultural debris consisted of two mataa, 8 drills, 42 edge altered flakes, and 145 pieces of debitage.

Set back from the coast 0.05km, site 35-2 (RT2-ST1) is known as Ana Kena (Figure 41). The cave is located at an elevation of 30 meters and is 25 meters square. The cave had once been walled off by a number of stones including cut stones from a hare paenga. Total excavation was carried out with 22 units most of which ended at a solid rock floor at about 20cm. The two cultural features encountered were both fire pits.

Cultural material at the site included shell, cut bone, bone needles (18), two coral tools, and one scoria statue. Basalt artifacts were four adzes, one hammerstone, and 20 other items. Obsidian tools consisted of eight mataa, one chisel, six cores, eight drills, 551

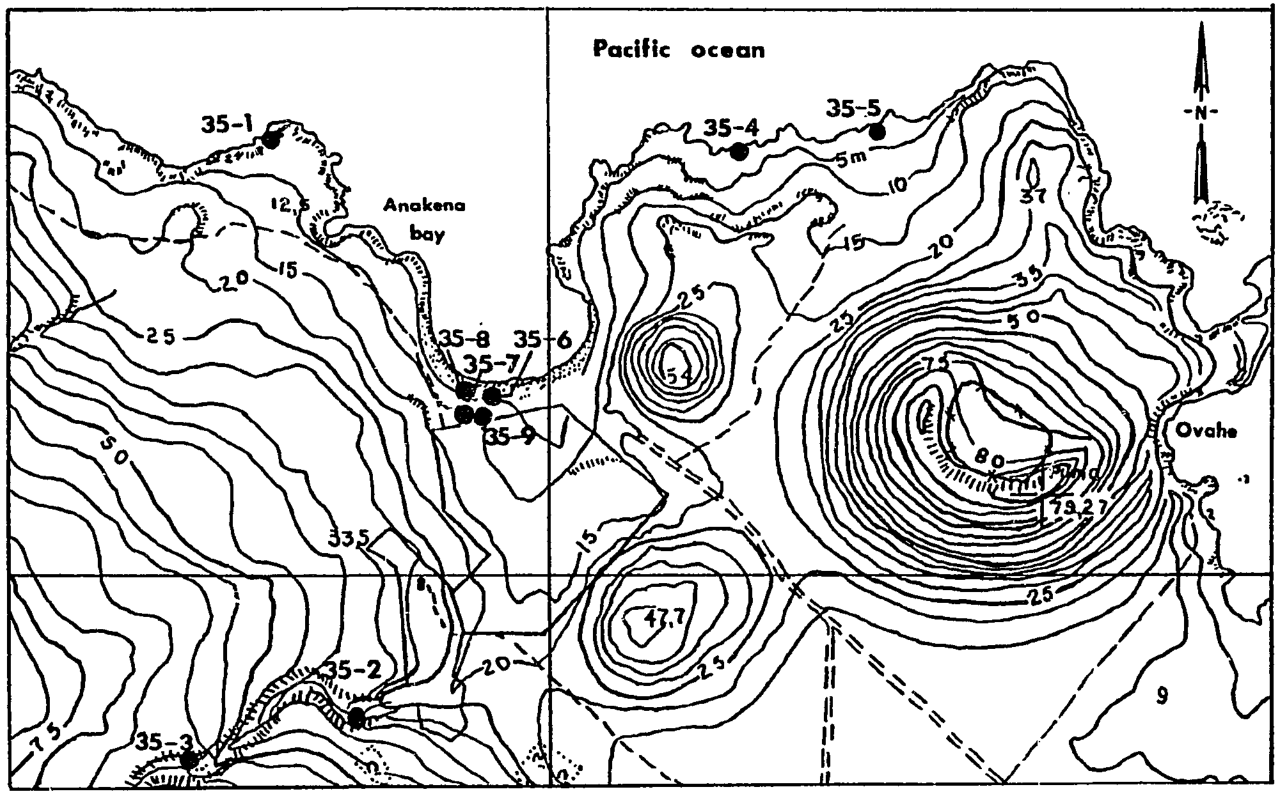

FIGURE 40. Quadrangle 35, site locations (after Ayres 1975).

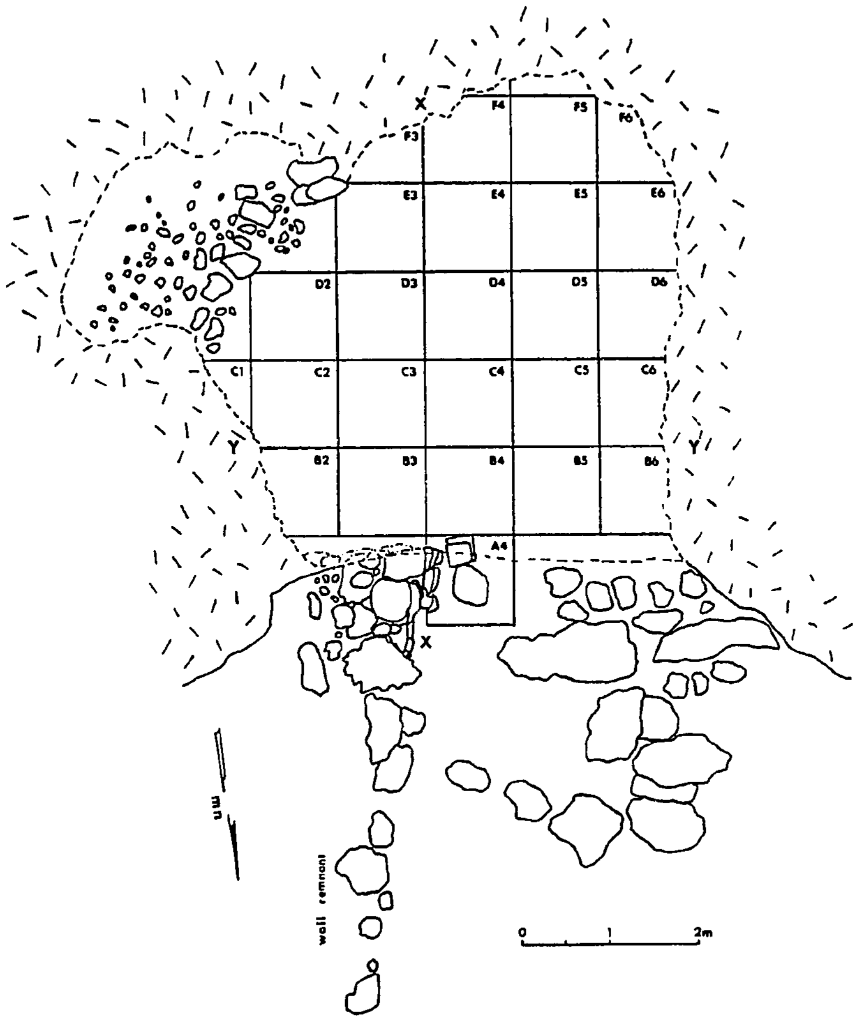

FIGURE 41. Site 35-2, Anakena, plan view (after Ayres 1975).

edge altered flakes, and 2,049 pieces of debitage.

35-3

A second interior cave, 35-3 (RT2-ST1), was closed off by a stacked slab stone wall across its front and had an interior wall constructed along its north side. The cave is 20 meters square and is located 60 meters above sea level. One test pit was dug near the interior wall and hit papa at 20cm. Only very slight midden was encountered along with three edge altered flakes and three pieces of debitage.

34-2

Site 35-4 (RT2-ST2) is a coastal lava tube of some 20 square meters. Excavation of two test units revealed a solid rock floor at a depth of 20 to 30cm. A dense concentration of midden included shell and bone. Recovered artifacts included two bone nnedles, one coral file, two basalt adzes, and one hammerstone of basalt. The obsidian cultural debris included one file, two mataa, two cores, 25 drills, 28 edge altered flakes, and 423 pieces of debitage.

35-5

A small 15 square meter cave, 35-5 (RT2-ST2), was located east of 35-4 at an elevation of eight meters. A single test pit found very little cultural debris prior to ending at 30cm. A single edge altered flake and 14 pieces of debitage were recovered in the test unit.

35-6

Site 35-6 (RT2-ST2) is also a coastal cave that contained little cultural material. The single test unit placed in this 27 square meter cave produced only five edge altered flakes and 13 pieces of debitage.

35-7

Site 35-7 (RT2-ST1) is a small cave (16 square meters) located on Anakena beach at an elevation of six meters (Figure 42). Construction at the site was apparently restricted to a rough wall across the cave entrance. Excavation included the entire cave interior and four one meter square units outside the cave mouth.

Nonstone artifacts were comprised of three fishhooks, 28 needles, 23 pieces of cut bone, and 12 coral files. Basalt debris included two adzes, four hammerstones, five adz chips, and 48 other pieces of basalt. The obsidian material included 16 <u>mataa</u>, four files, 20 drills, nine cores, two eye pieces, 553 edge altered flakes and 2,309 pieces of debitage.

35-8

Site 35-8 (FT1-STB) is a large-boat shaped <u>hare paenga</u> located adjacent to 35-7 on a low, narrow terrace at an elevation of five meters (Figure 43). Incorporated in this site were several <u>paenga</u> in the foundation, remains of a <u>poro</u> pavement, and an associated <u>umu</u>.

A wide variety of tool classes were recovered from the site.

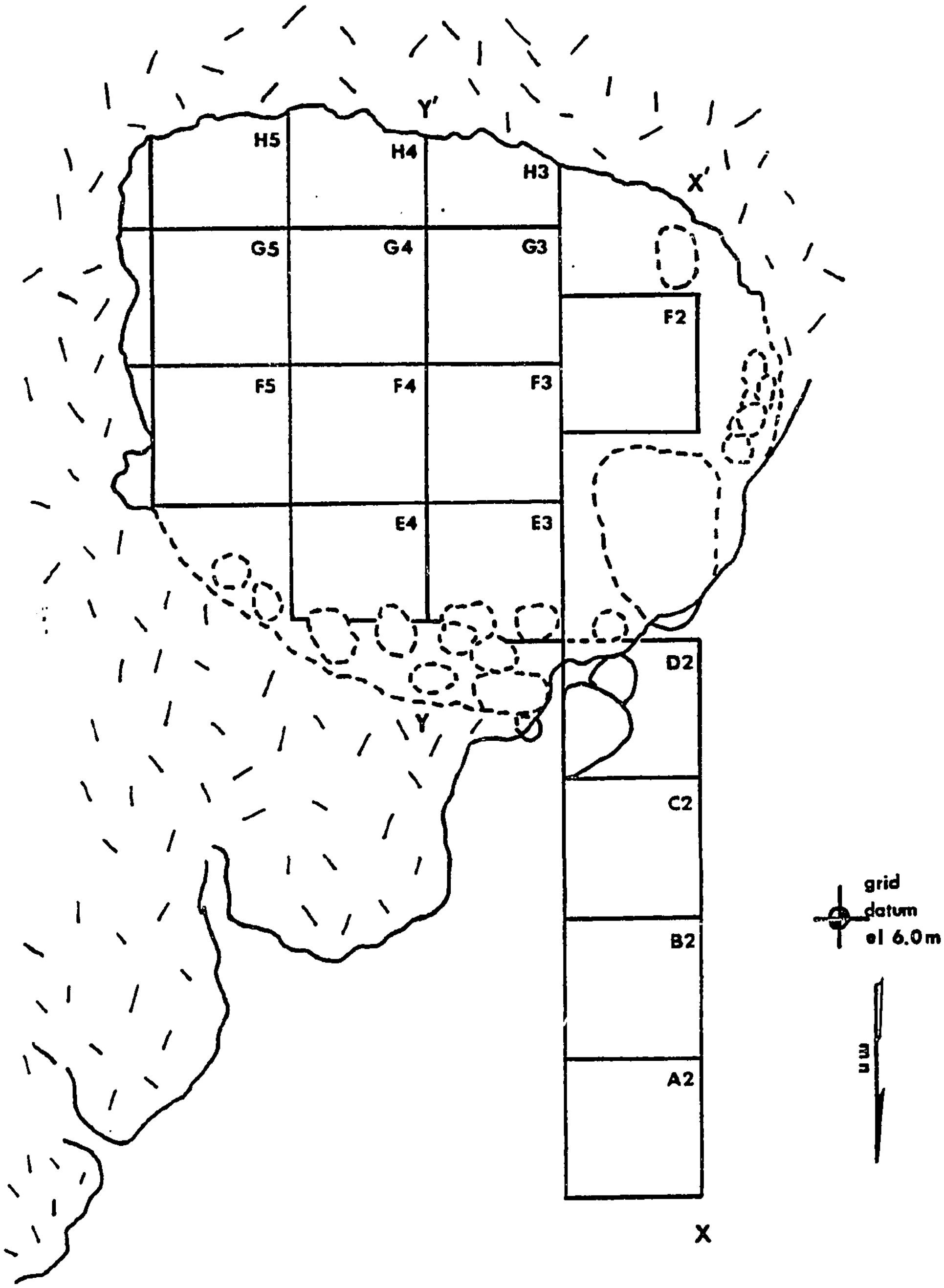

FIGURE 42. Site 35-7, Anakena, plan view (after Ayres 1975).

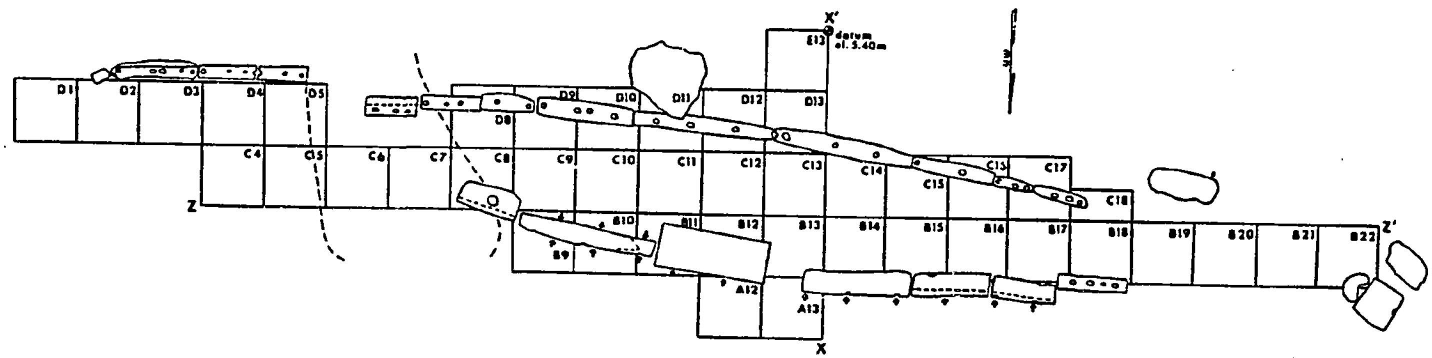

FIGURE 43. Site 35-8, Anakena, plan view (after Ayres 1975).

Thirty-three bone artifacts were found, including 17 needles and four fishhooks. Seven coral abraders, one scoria statue, and one scoria abrader were also found. Basalt artifacts included five adzes, one axe/adz blank, two hammerstones, eight adz chips, one sinker, two knives, one fishhook, and 269 flakes. Obsidian artifacts included 12 mataa, seven files, 4 drills, two choppers, 26 cores, 929 edge altered flakes, and 4,522 pieces of debitage.

35-11

The final site, 35-11, was one of two exploratory trenches dug in the central part of the Anakena sand area approximately 50 meters inland from the beach. Within this 16 meter long trench numerous small pits and two deep narrow holes were found, but no architectual remains. The cultural remains were confined to one drill, 16 edge altered flakes, and 37 pieces of debitage, all of which are obsidian.

Three of these nine sites have been dated with obsidian hydration. Site 35-2 has dates that fall around the middle and end of the sixteenth century, or during the Expansion Phase. Site 35-7 is divided into two cultural layers, the first of which is associated with the Protohistoric and Historic Phases. The second layer is dated from the late fourteenth to the late seventeenth century which runs from the middle of the Expansion Phase to the beginning of the Decadent Phase. The date from 35-8 indicates a relatively late period of construction during the mid to late seventeenth century. This occupation encompasses the late Expansion and Decadent Phases.

Altered Edge Data

Table 17 is the first of four to present the basic data on six of the nine sites discribed above. Sites 35-3, 35-5, and 35-6 are excluded from these tables because of the small number of cultural items recovered from each of them. Site 35-7 is shown both by its data layers and its overall totals.

TABLE 17. Quadrangle 35 Altered Edge Data

Site	No. Edges	No. Flakes	Ave	Hard		Soft		Ret.		Un.	
				f	%	f	%	f	%	f	%
35-1	61	42	1.45	35	57	15	25	4	7	7	11
35-2	82	58	1.41	34	42	31	38	6	7	11	13
35-4	100	61	1.64	46	46	31	31	7	7	16	16
35-7											
Total	91	55	1.65	41	45	39	43	3	3	8	9
I	53	35	1.51	27	51	19	36	2	4	5	9
II	38	20	1.90	14	37	20	53	1	3	3	8
35-8	59	47	1.25	15	25	27	46	9	15	8	14
35-11	35	16	2.19	14	20	15	43	2	6	4	11

Both RT2-ST2 sites, 35-1 and 35-4, have large percentages of edges in the hard category in contrast with the RT2-ST1 sites which show essentially even percentages in the hard and soft categories. The house foundation site 35-8 shows a large percentage of edges in the soft category and the largest percentage of retouched edges of any of the sites in this Quadrangle. At 35-7 Layer II has an emphasis on the soft category (53%) that drops to a smaller percentage (36%) in Layer I. For the hard category the opposite holds true, a shift is evident from Layer II (37%) to Layer I (51%).

The occurrence of the edge type groups for the six sites is presented in Table 18. Sites 35-1, 35-2 and 35-4 all have the largest percentage of edges in type Group 1/7. In contrast sites 35-8 and 35-11 have their largest percentages occurring in edge type Group 2/3. Site 35-8 again shows a shift from one layer to another. In Layer II Type Group 2/3 has the largest occurrence of edges, in Layer I the largest percentage is found in Group 1/7.

TABLE 18. Quadrangle 35 Edge Types

Site	Edge Types 1/7		2/3		4/5		6	
	f	%	f	%	f	%	f	%
35-1	29	47	23	38	9	15	0	0
35-2	44	54	22	27	14	17	2	2
35-4	56	56	26	26	15	15	3	3
35-7								
Total	38	42	37	41	16	17	0	0
I	27	49	18	37	8	14	0	0
II	11	29	19	50	8	21	0	0
35-8	19	32	24	41	16	27	0	0
35-11	12	34	15	43	8	23	0	0

Table 19 presents the statistically significant results derived from one-variable chi-square tests used to examine the contact material and edge type categories.

TABLE 19. Summary of Statistical Significance Quadrangle 35

Site	Altered Edge Chi-Square	Sign. Level	Edge Type Chi-Square	Sign. Level
35-1	9.15	0.05	----	----
35-2	6.66	0.05	6.03	0.05
35-4	9.22	0.01	9.28	0.01
36-7 Total	----	----	----	----
I	6.79	0.05	----	----
II	5.39	0.10	----	----
35-8	----	----	----	----
35-11	----	----	----	----

Table 20 shows the data on the relationship of the debitage and edge altered flake tools.

TABLE 20. Quadrangle 35 Debitage and Flake Tools

Site	No. Deb.	No. Tools	Ratio	Percent Flake Tools
35-1	145	42	3.45:1	22
35-2	2049	551	3.72:1	23
35-4	423	281	1.50:1	40
35-7 Total	2309	553	4.17:1	19
I	1459	351	4.16:1	19
II	850	202	4.21:1	19
35-8	4522	929	4.87:1	17
35-11	37	16	2.31:1	30

At site 35-1 38 percent of the debitage fits size groups 2 and 3 while 62 percent fall into the smaller size gorups. In comparison the edge altered flake tools fall into the smaller size groups only 40 percent of the time and 60 percent of the time they fit size groups 2 and 3. A two-variable chi-square was used to test the relationship of the debitage and edge altered flakes to size. This test found a statistically significant difference between the actual and expected frequencies at the 0.05 (X^2 = 6.41, 1 df).

In relation to the attribute of weight the hard category has a range of 1.21 to 14.76g while the range for the soft category is 0.79 to 15.07g. The mean weight for a flake used on hard material is 5.64g, that for the soft category is 4.26g.

The mean length of the tool edge is longer in the soft category where the mean is 17mm while that for the hard category is 15mm. The range for the soft category is 9 to 40mm and for the hard category it is 4 to 30mm.

Figure 44 shows the distribution of the spine-plane angles in the hard and soft categories. The range of the spine-plane angles in the hard category is 30 to 73 degrees, with a mean of 52 degrees. The mean for the soft category is 33 degrees and the range is 17 to 48 degrees.

At the inland cave site 35-2 slightly more than 21 percent of the debitage fits the size gorups 2, 3, and 5 and 79 percent fits the smaller size groups. Sixty-four percent of the edge altered flakes fit these size categories and only 36 percent fit into the

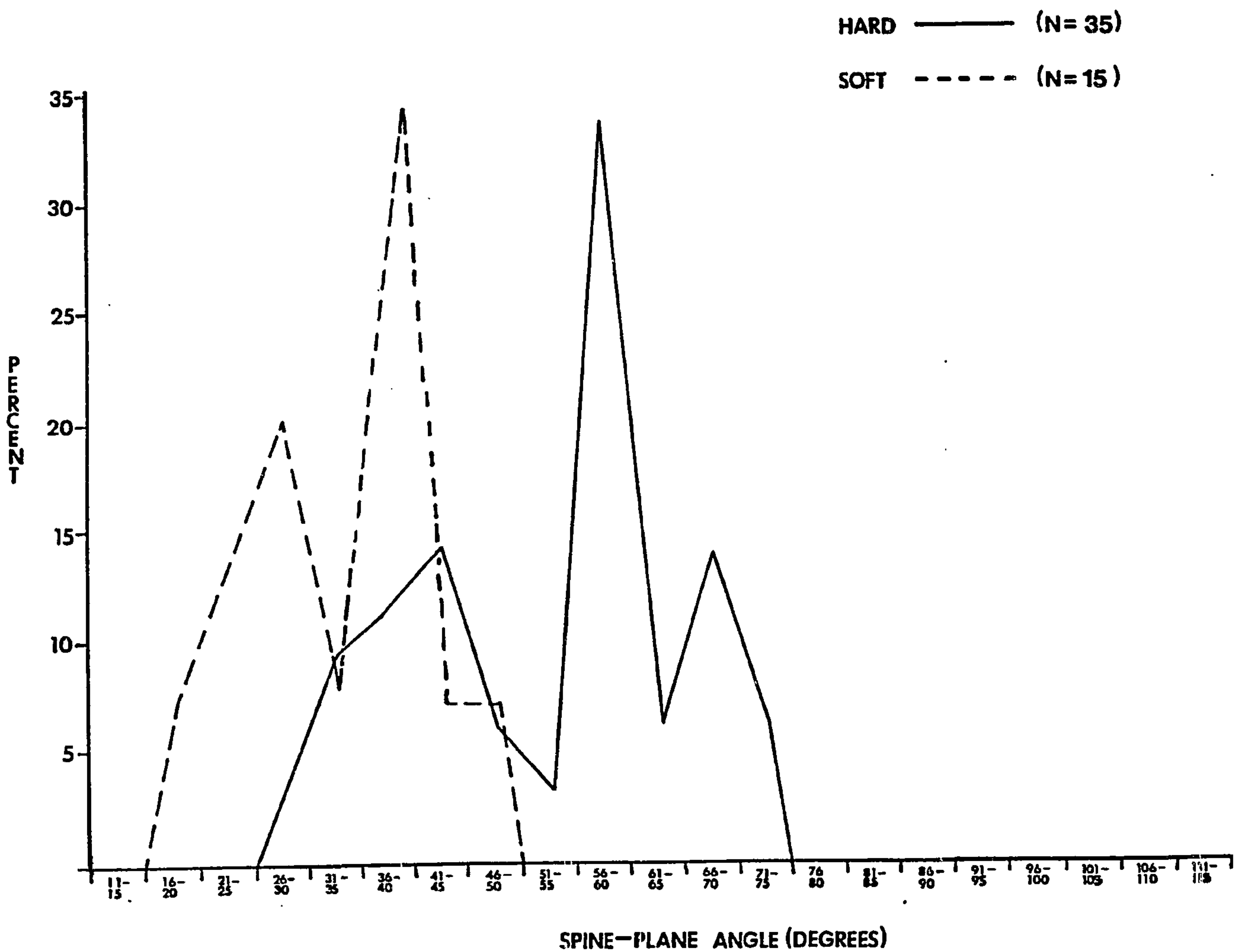

FIGURE 44. Site 35-1, range of spine-plane angles.

smaller groups. Like 35-1, a two-variable chi-square test on these size data indicated a highly significant chi-square statistic at the 0.01 level (X^2 = 70.44, 1 df).

The mean flake weight is slightly greater in the hard category at 5.59g than the 4.62g found in the soft category. The range in the hard category is 0.97 to 29.24g and the range in the soft category is 0.53 to 24.40g.

For the attribute of tool edge length the means for the categories hard and soft are even at 14mm. The range for the hard category is 8 to 25mm and that for the soft category is 6 to 31mm.

Figure 45 illustrates the distribution of the spine-plane angles for the hard and soft categories. The range of angles for the hard category is 23 to 84 degrees with a mean of 52 degrees. The soft category has a mean 36 degrees and a range of 17 to 59 degrees.

At 35-4 the distribution of the edge altered flake tools and debitage in relation to the size groups is basically the same. Thirty-nine percent of the debitage and 44 percent of the altered flake tools fit size categories 2 and 3. The remaining percentages in both categories fall into the smaller size groups. A two-variable chi-square test was performed on these data and no statistically significant difference was discovered.

The mean spine-plane angle in the hard category is 55 degrees, ranging from 28 to 90 degrees. In the soft category the mean angle is 31 degrees with a range of 12 to 55 degrees. Figure 46 percents the distributions of both of these categories.

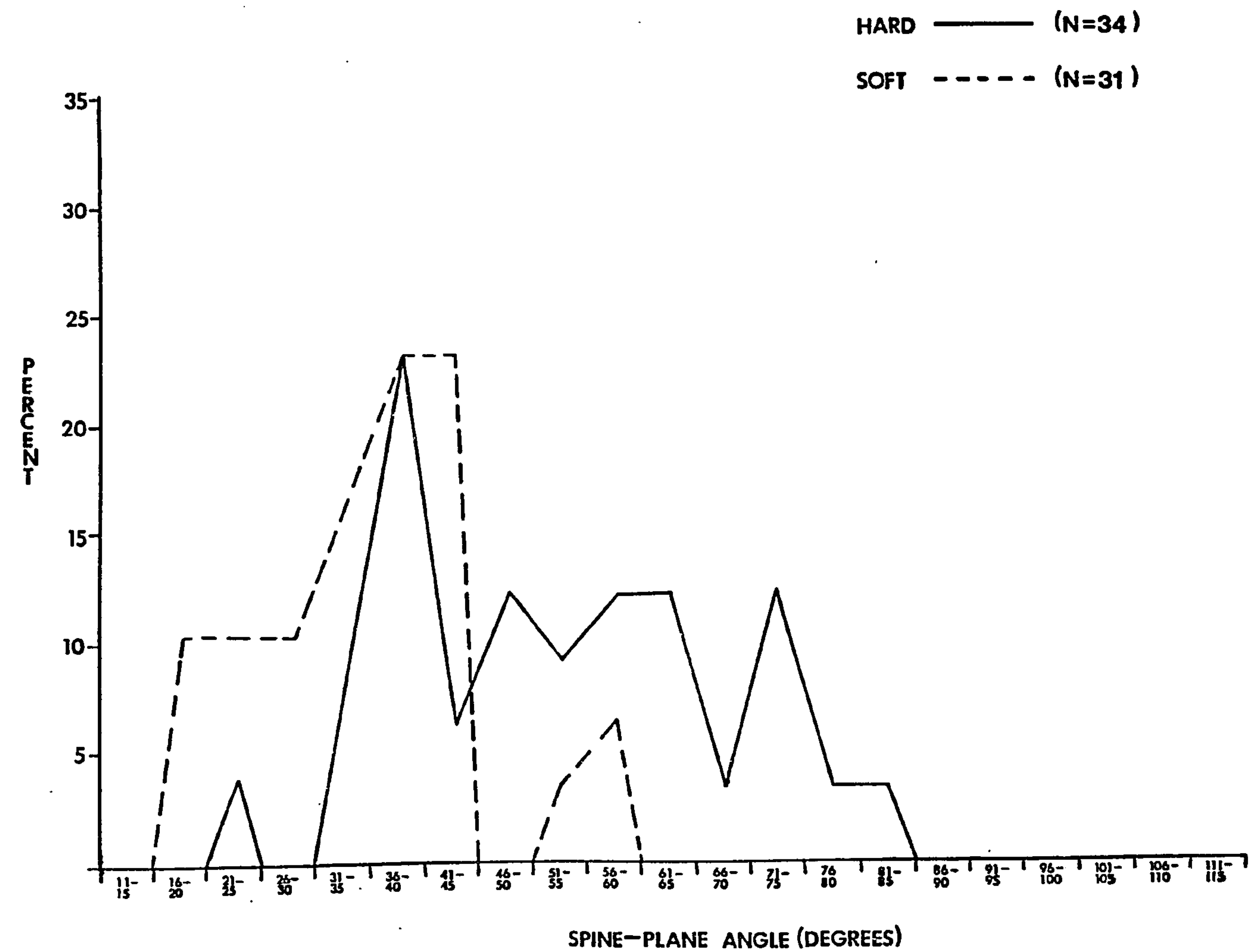

FIGURE 45. Site 35-2, range of spine-plane angles.

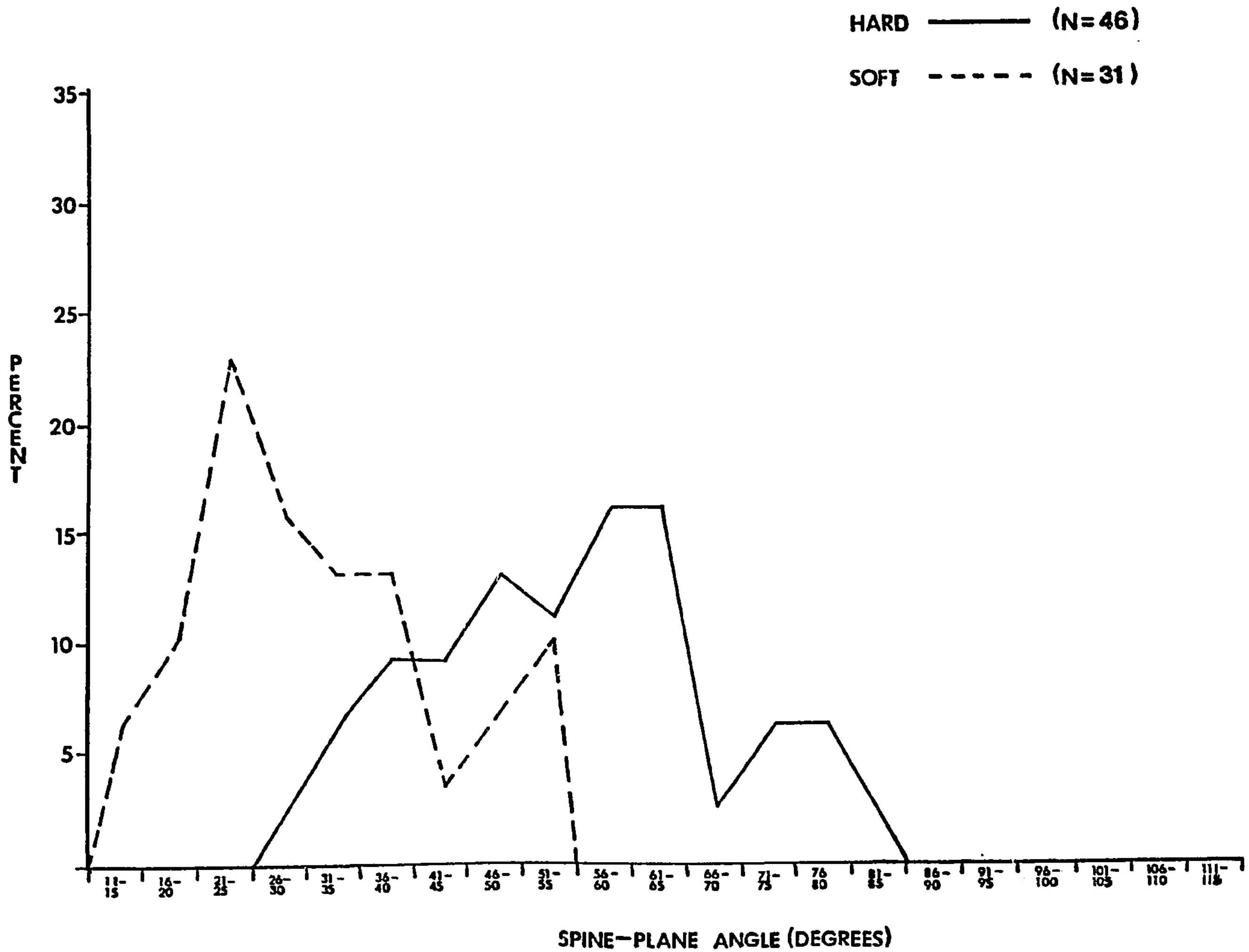

FIGURE 46. Site 35-4, range of spine-plane angles.

The weight of flakes in the hard category vary from 0.66 to 16.60g, with a mean of 4.60g. For the soft category the range is 0.91 to 12.35g and the mean is 3.18g.

The mean tool edge length is greater in the soft category than that found in the hard category. For the soft category the range is 6 to 26mm with a mean of 14mm. The hard category has a mean of 12mm and a range of 6 to 25mm.

The distribution of debitage and flake tool sizes at 35-7 shows the same pattern in both its layers. In Layer I 49 percent of the flake tools fit size groups 2 and 3 and 51 percent fit the smaller size groups. Only 24 percent of the debitage in this same level fit these larger size groups while 76 percent fall into the smaller size groups. In Layer II 60 percent of the flake tools fit size groups 2 and 3 and 40 percent fit the smaller size groups. For the debitage in this level, 75 percent falls into the smaller size groups and 25 percent fits size groups 2 and 3. Both layers at 35-7 have statistically significant differences between the actual and expected frequencies at the 0.01 level (Layer I: $X^2 = 10.64$, 1 df, Layer II $X^2 = 12.95$, 1 df).

The spine-plane attribute shows the same pattern in both layers. In Layer I the range of spine-plane angles in the hard category was 24 to 90 degrees, with a mean of 54 degrees. In Layer II the range was 25 to 85 degrees with a mean of 49 degrees. In the soft category the range of angles in Layer I was 26 to 50 degrees and in Layer II the range was 21 to 54 degrees. The associated means are 38 degrees for Layer I and 34 degrees for Layer II. Figures 47 and 48 show the distribution of the spine-plane angles for Layers I and II.

In Layer II the length of the tool edge tends to be larger in the hard category. Within this category the range of edge lengths is 7 to 28mm with a mean of 15mm. For the soft category the range is 5 to 23mm, with a mean of 13mm. The means of these two categories fall closer together in Layer I. For the hard category the mean is 12mm while for the soft category the mean is 13mm. The range for the hard category is 5 to 23mm, for the soft it is 7 to 32mm.

For Layer I flake weights tend to be larger in the hard category than in the soft. The mean for the hard category is 4.60g with a range of 1.01 to 10.56g. In the soft category the range is 0.34 to 6.54g with a mean of 2.90g.

In Layer II the mean weight is slightly greater in the soft category, for the soft category the mean is 3.17g and for the hard category the mean is 2.72g. The range of the soft category is 0.74 to 7.72g and for the hard category it is 0.74 to 5.68g.

Only 17 percent of the debitage of the hare paenga site 35-8 falls into size groups 2, 3 and 5, with the other 83 percent falling into the smaller size categories. In comparison, 51 percent of the edge altered flake tools fall into these larger size categories and 49 percent fit the smaller size groups. The two-variable chi-square test found a highly significant difference between the expected and actual frequencies at the 0.01 level (X^2 = 33.67, 1 df).

The weights of the flake tools are essentially the same for the

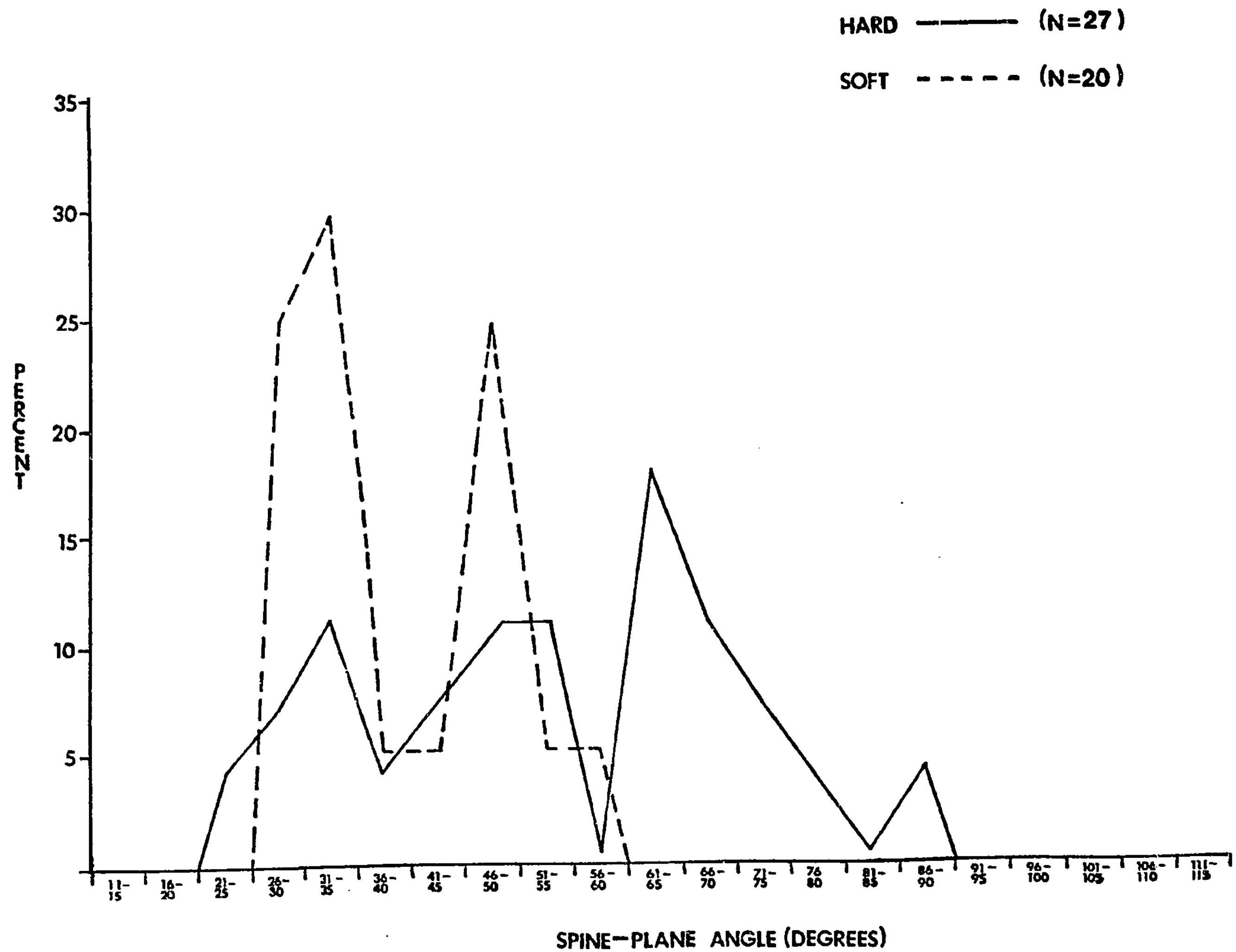

FIGURE 47. Site 35-7, layer I, range of spine-plane angles.

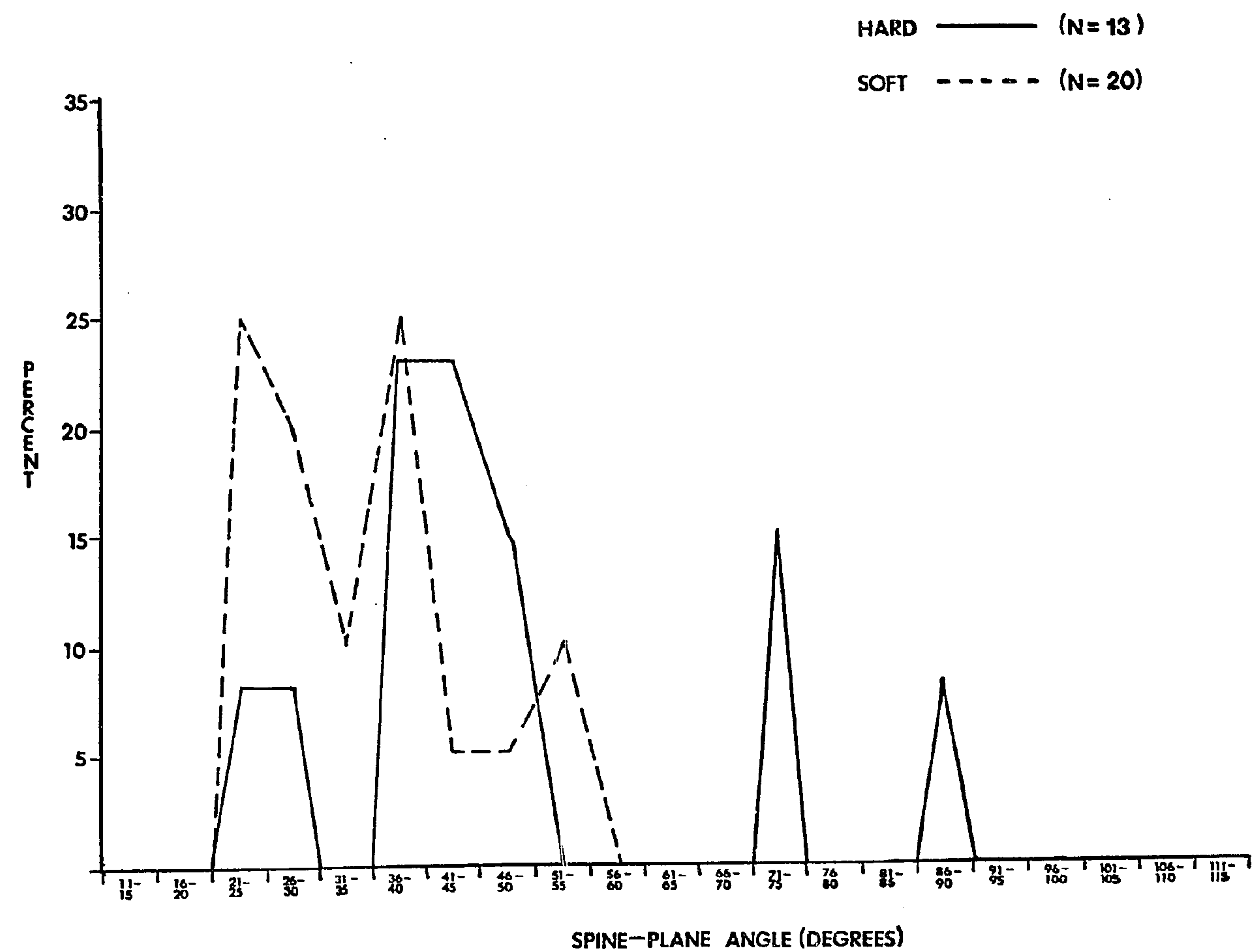

FIGURE 48. Site 35-7, layer II, range of spine-plane angles.

hard and soft categories. The range of weights in the hard category is 0.64 to 5.85g and for the soft category it is 0.43 to 8.99g. The mean for the hard category is 2.82g and for the soft it is 2.73g.

In the hard category the length of the tool edge ranges from 5 to 25mm with a mean of 16mm. The mean for the soft category is 13mm and the range is 4 to 27mm.

For the attribute of spine-plane angle the hard category has a range of 20 to 72 degrees and a mean of 50 degrees. In comparison the range of angles in the soft category is 20 to 64 degrees with a mean of 39 degrees. The distribution of the spine-plane angles is presented in Figure 49.

The trench excavated on the beach at Anakena (35-11) produced only the larger size flakes. Ninety-two percent of the debitage and 100 percent of the edge altered flakes fit into size categories 2, 3 and 5. Flake weight shows a trend toward heavier flakes in the hard category. The range of flake weights in the hard category is 3.12 to 56.07g, with a mean of 20.34g. The range of the soft category is 4.28 to 23.42 with a mean of 12.34g.

The mean tool edge length of 20mm is the same for both the hard and the soft categories. The range of the hard category is 9 to 47mm and for the soft category it is 10 to 35mm.

Figure 50 illustrates the distribution of the spine-plane angles for the hard and soft categories. The mean angle for the hard category is 53 degrees with a range of 32 to 73 degrees. In the soft category the range is 21 to 53 degrees and the mean is 37 degrees.

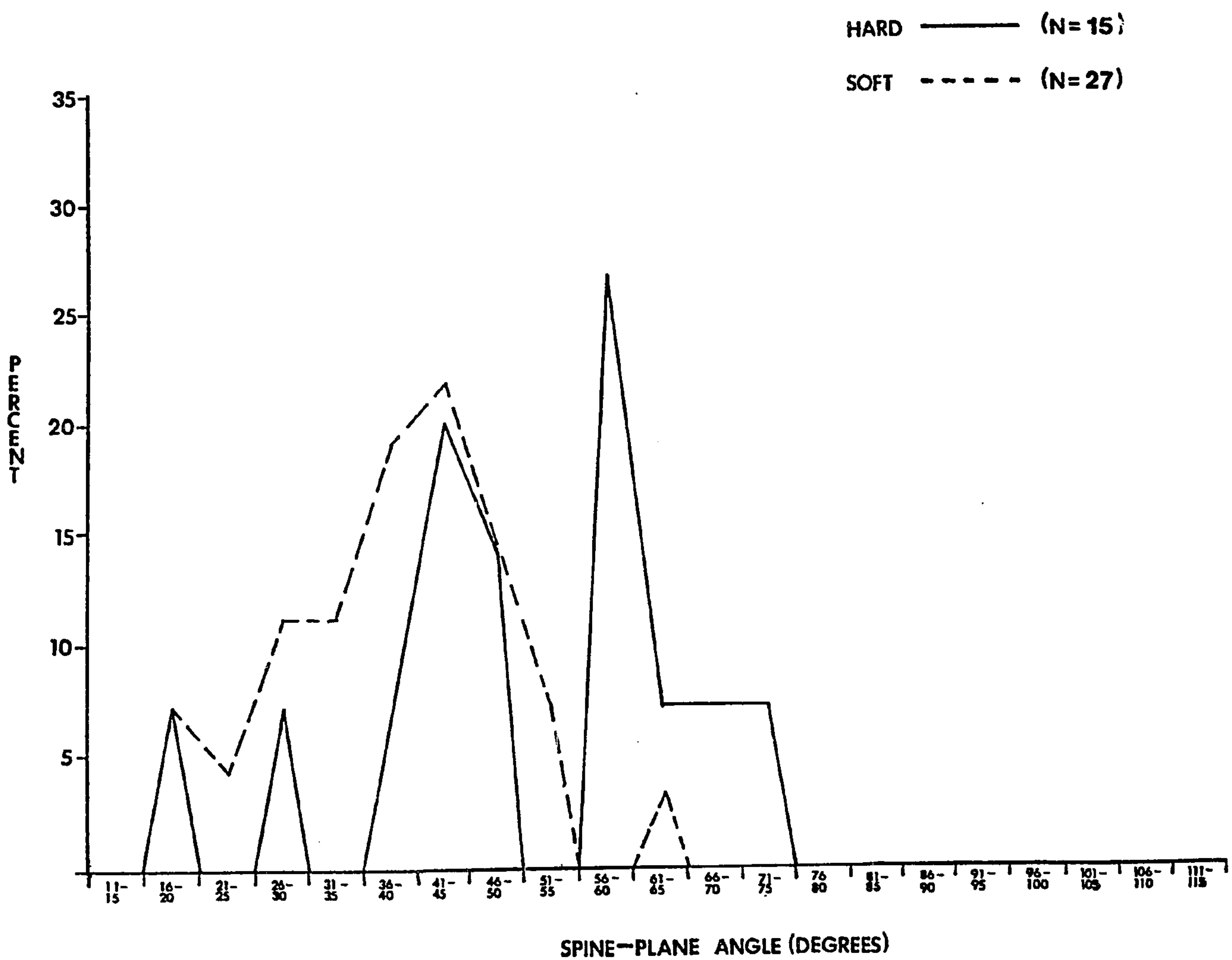

FIGURE 49. Site 35-8, range of spine-plane angles.

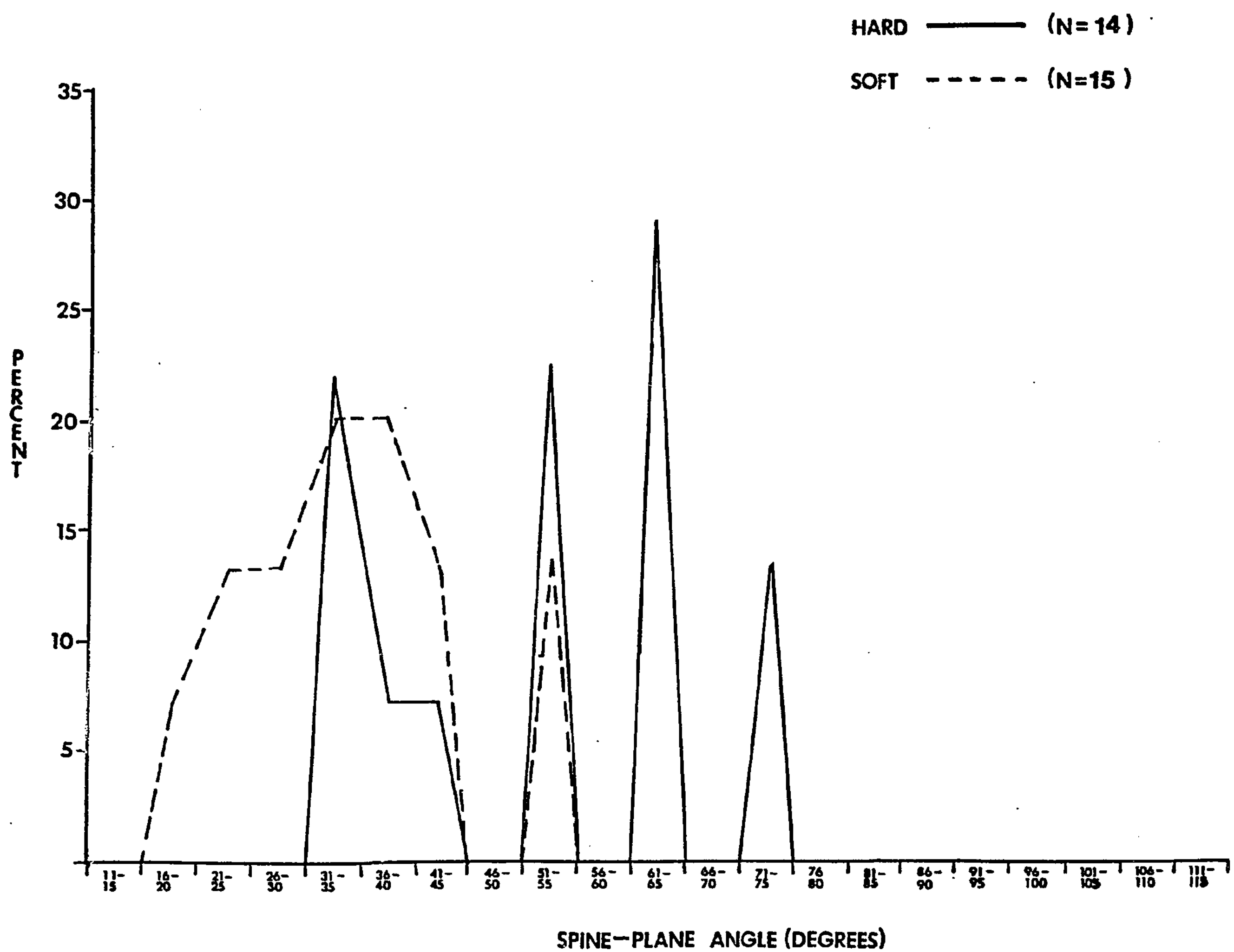

FIGURE 50. Site 35-11, range of spine-plane angles.

CHAPTER IV

DISCUSSION

The amorphous obsidian flake tools from Easter Island were found to be amenable to low-power use-wear analysis. The results of this analysis were successfully applied to the settlement pattern questions proposed earlier.

The initial research question addressed the issue of whether the tool-use activities carried out in archaeological sites in this study could be identified through lithic studies that focused on use-wear analysis. The application of the chi-square test to the data in the altered edge categories showed no consistency according to site types. Of the 16 sites that had statistically significant chi-squares seven were Sub-Type 1 rockshelters, eight were Sub-Type 2 rockshelters and one was an oven house. The one variable chi-square test did indicate that the occurrence of intentionally retouched edges was lower than expected by chance.

The edge type data also showed no pattern among site types. Of the twelve sites with statistically significant chi-square values, seven were Sub-Type 1 rockshelters and five were Sub-Type 2 sites. In most cases the significant chi-square indicated a higher than expected occurrence of straight and irregular edges.

Of the 2,138 altered edges that were completely analyzed only 81 were used in a cutting or sawing motion and the remainder were used in a scraping or shaving motion. Such a low frequency of edges used as knives is somewhat surprising. The use of flaked and ground basalt knives may in part account for the low frequencies of obsidian knives (see, e.g., Metraux 1940:280). Secondly, most of the cutting activities which used obsidian knives involved soft materials such as fish and plants. Such contact materials create very little if any use-wear that may be noticed through the low-power approach.

The spine-plane angle mean has been shown to be consistently larger in the hard category than in the soft category. Only two sites had means that were within ten degrees of each other. This pattern indicates that altered edges used on hard materials are generally more obtuse than edges used on soft materials. This conclusion is consistent with those derived by other researchers.

Semenov (1964) and Wilmsen (1968) were among the first to argue that different edge angles may be associated with different tool functions. In Hawaii, the interpretation of the obsidian materials from the Waimea-Kawaihae sites has also applied the concept that certain edge angle ranges were used for certain tasks (Schousboe et al. 1983). For Easter Island, McCoy (1973) relied on edge angles as well as use-wear to interpret the activities carried out at house site 1-187. Previous work on three different Easter Island sites found that at all three, edges used on hard contact materials were closer to obtuse than edges worked on soft materials (Ayres and Spear n.d.; Spear n.d.a.).

The altered edge data in Table 21 allows the sites to be

TABLE 21. Altered Edge Percentages

Site	Site Type	Hard	Soft	Ret.	Unknown	Site Emphasis
1-185	FT2	30	30	26	14	Equal
1-193	FT3	39	26	17	18	Hard
3-72	ST2	21	51	14	14	Soft
3-85	ST1	43	47	5	5	Equal
3-98	ST1	35	44	6	14	Equal
7-571	ST1	34	40	16	10	Equal
8-82	ST2	26	48	11	14	Soft
8-88	ST2	37	32	14	17	Equal
8-133	H.U.*	27	52	8	13	Soft
8-208	ST2	33	48	5	13	Soft
8-211	ST1	35	38	18	9	Equal
8-245a	ST1	39	44	4	13	Equal
8-304a	ST2	12	80	3	5	Soft
8-341	ST2	32	57	2	9	Soft
8-349a	RT1	47	33	7	13	Hard
8-353a	ST1	30	50	6	14	Soft
8-375	ST2	25	54	11	11	Soft
8-459	RT1	40	36	14	10	Equal
12-210	ST1	35	39	17	9	Equal
14-57a	ST1	41	37	9	13	Equal
14-66a	STB	32	28	40	0	Equal
34-1	ST2	29	33	19	19	Equal
34-2	ST1	42	36	7	14	Equal
34-3	ST2	51	40	7	2	Hard
34-4	ST1	52	28	8	12	Hard
35-1	ST2	57	25	7	11	Hard
35-2	St1	42	38	7	13	Equal
35-4	ST2	46	31	7	16	Hard
35-7	ST1	45	43	3	9	Equal
35-8	STB	25	46	15	14	Soft
35-11	Trench	20	33	6	11	Soft

*H.U. is an oven house (hare umu).

characterized by the use-wear analysis. Overall, 15 of the sites reflect an even working of hard and soft contact materials, the work done at six sites emphasized hard materials and work at ten sites focused on 10 soft materials. Five Type 2 rockshelters, 14-87b, 34-5, 35-3, 35-5, and 35-6 are excluded from this table because of the low frequency of edge altered flakes found at these sites.

These site use-wear characterizations can be applied to McCoy's (1973) site typology. This typology was basically designed around the presence of various architectural elements and cultural features. By using the presence of architectural features such as wall building and house planview, 35 of this study's 36 sites were placed within McCoy's site typology. The only site that did not fit into McCoy's typology was 35-11 which was a test trench dug into the beach at Anakena. Each of these types are discussed below, with the lithic data previously developed evaluated against McCoy's site typology.

Type 2 Rockshelters

Of the 30 rockshelter sites in this study two are Type 1 rockshelters (*karava*) and 28 are Type 2 rockshelters (*ana*). For this analytical stage the RT1 sites are excluded. Of the 28 Type 2 rockshelters, 13 fall into Sub-Type 1 (ST1) and 15 fit into Sub-Type 2 (ST2).

Within Sub-Type 1, 12 of the 13 Type 2 rockshelters have sufficiently large frequencies to assess the altered edge categories. Of these 12 sites, nine (75%) have approximately equal percentages in both hard and soft categories. The work at one (8%) site focused on hard material and the work at two (17%) sites focused on soft material. In contrast, of the 11 ST2 sites with sufficient frequencies for anlaysis three (27%) show an equal focus on working both the hard and soft materials while eight (73%) sites show an emphasis on either hard (N=3) or soft (N=5) materials. Table 22 summarizes this information.

TABLE 22. Type 2 Rockshelters (by Sub-Type)

ST1			ST2		
Site	Geo. Loc.	Cont. Mat. Emphasis	Site	Geo. Loc.	Cont. Mat. Emphasis
3-72	C	Soft	3-85	C	Equal
3-98	I	Equal	8-82	C	Soft
7-571	C	Equal	8-88	I	Equal
8-211	I	Equal	8-208	I	Soft
8-245a	I	Equal	8-304a	C	Soft
8-353a	I	Soft	8-341	C	Soft
12-210	C	Equal	8-375	C	Soft
14-57a	C	Equal	14-87b	I	----
34-2	C	Equal	34-1	C	Equal
34-4	C	Hard	34-3	C	Hard
35-2	I	Equal	34-5	C	----
35-3	I	----	35-1	C	Hard
35-7	C	Equal	35-4	C	Hard
			35-5	C	----
			35-6	C	----

As reflected in the contact material data, the large majority (75%) of Sub-Type 1 sites have an equal emphasis on working soft and hard contact materials. The ST2 data show just the opposite pattern where 73 percent of the sites show an emphasis on either the hard or soft categories. By using the variables of site type and equal or unequal emphasis in regard to the altered edge categories, an exact probability figure of 0.03 was calculated. This figure is well below the 0.10 level of significance and indicates that the pattern of site usage in relation to contact materials is not random.

The dissimilarity of ST1 and ST2 sites is shown in Figures 51 and 52. The data used in the ternary plots are based on the recalculation of the percentage of edges in the altered edge categories hard, soft, and retouched while excluding the unknown category. Figure 51 illustrates the tight clustering of most of the Sub-Type 1 sites.

In Figure 52 a much different clustering is evident. Because Sub-Type 2 sites are typed by McCoy as temporary, such a pattern might be expected if the sites were functionally specialized.

The distinction between the sub-types is also evident in relation to surface area. Figure 53 presents the size distribution of both of the sub-types. As is evident in this figure, the 13 Sub-Type 1 sites range in size from 16 to 80 square meters. Fifty-four percent of the ST1 rockshelters are smaller than 40 square meters while 46 percent are larger than this figure.

Figure 53 shows a range of 12 to 70 square meters for the Sub-Type 2 sites. However, of the 15 sites 80 percent occur in caves less than 40 meters square. The pattern indicated by these data suggests that Type 2, Sub-Type 2 sites have a strong tendency to be located in smaller rockshelters.

The distinction between the two sub-types also appears in the data regarding edge altered flakes and debitage. Table 23 has two columns; the first is the percentage of obsidian material, excluding formalized tools such as mataa or drills, that was used as edge altered tools. The second column indicates the ratio of debitage to edge altered

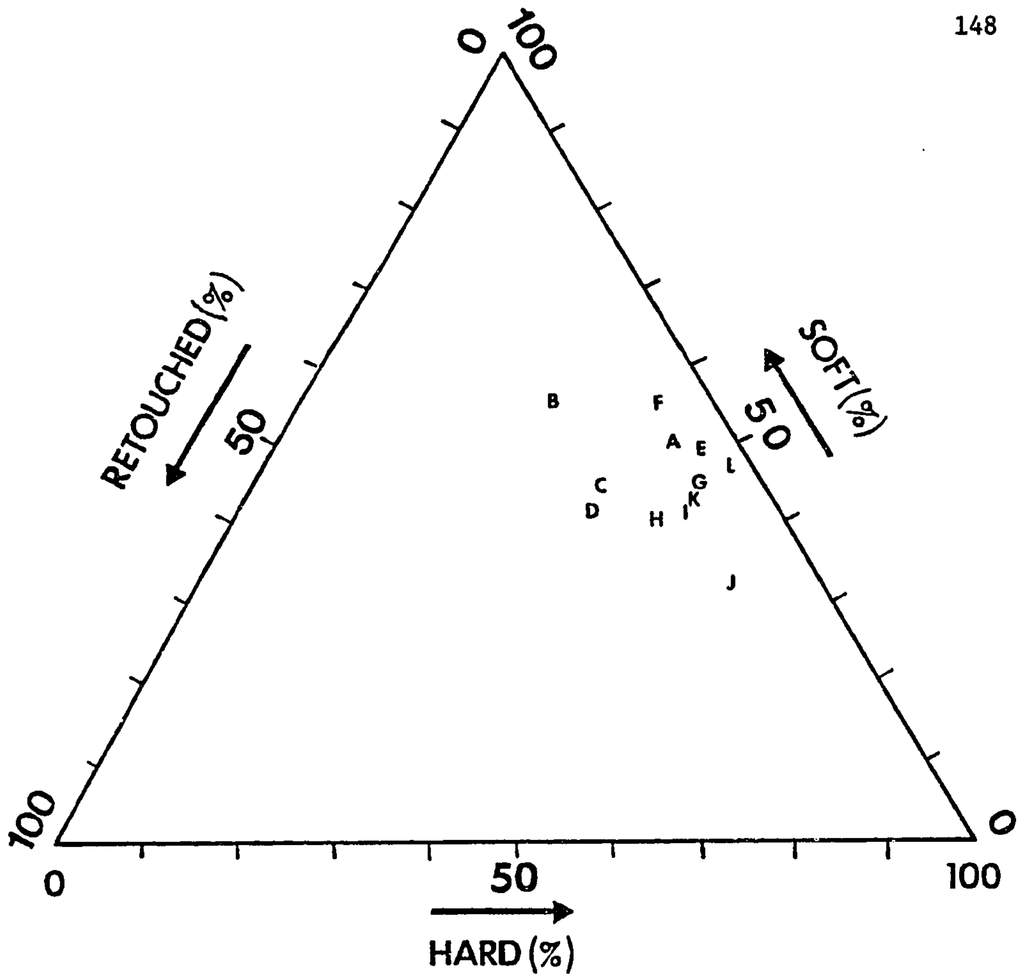

FIGURE 51. Type 2 rockshelter, sub-type 1, Ternary plot.

<u>Sites</u>:	A - 3-72	G - 12-210
	B - 3-98	H - 14-57a
	C - 7-571	I - 34-2
	D - 8-211	J - 34-4
	E - 8-245a	K - 35-2
	F - 8-353a	L - 35-7

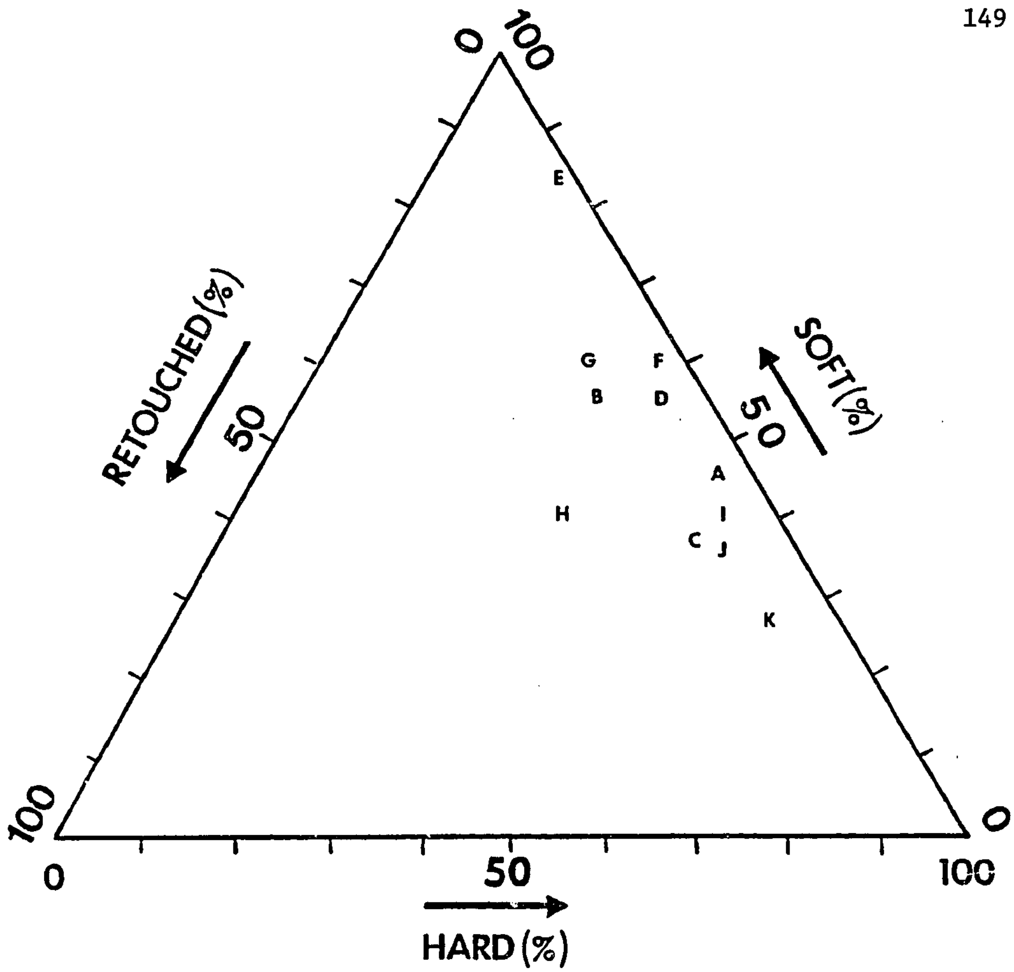

FIGURE 52. Type 2 rockshelter, sub-type 2, Ternary plot.

Sites:

A - 3-85	G - 8-375
B - 8-82	H - 34-1
C - 8-88	I - 34-3
D - 8-208	J - 35-1
E - 8-304a	K - 35-4
F - 8-341	

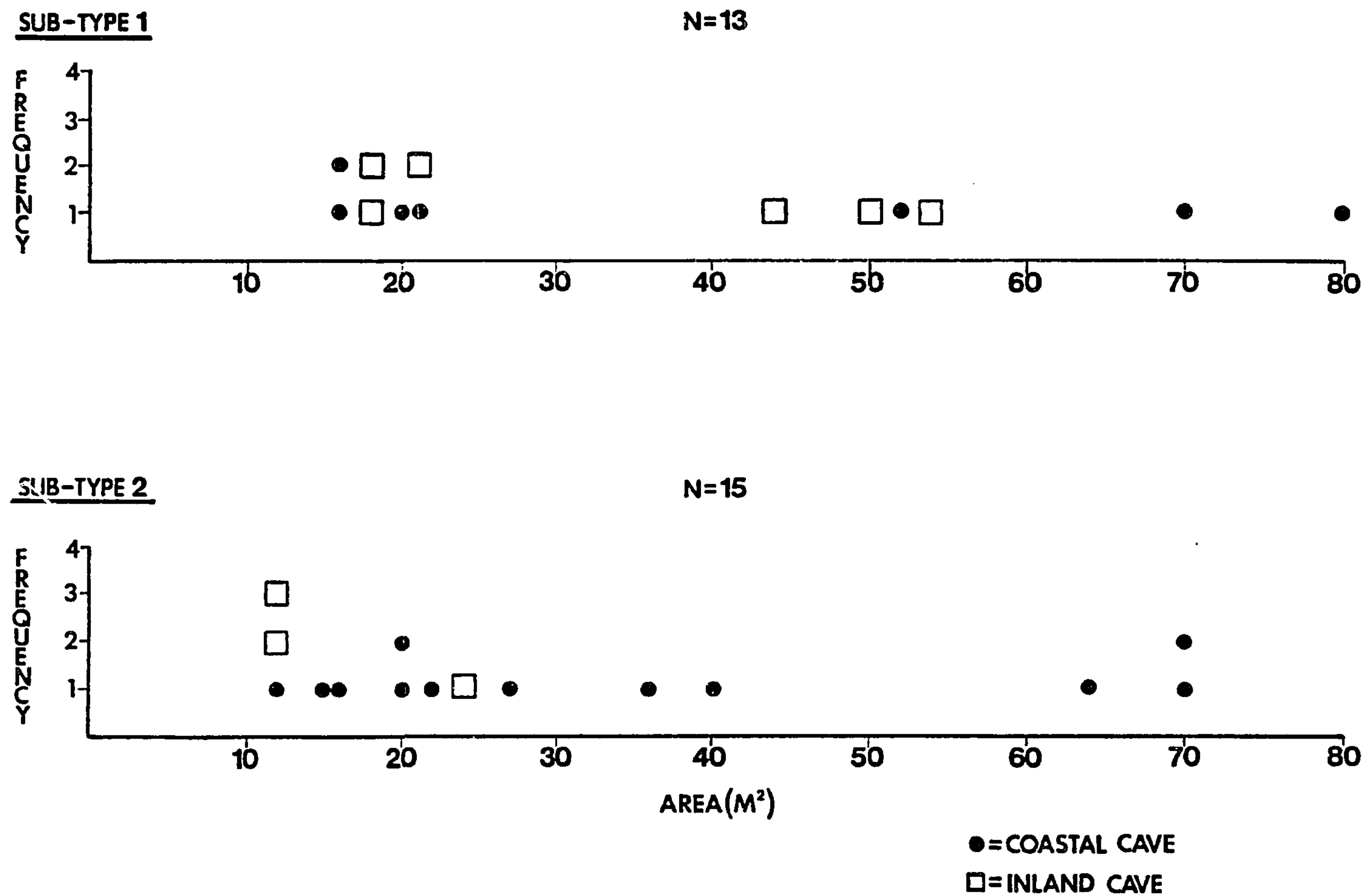

FIGURE 53. Type 2 rockshelters sizes (square meters).

TABLE 23. Relationship of Edge Altered Flakes and Debitage

	ST1			ST2	
Site	Percent Obs.	Deb./EAF Ratio	Site	Percent Obs.	Deb./EAF Ratio
3-72	31	3.36:1	3-85	45	1.20:1
3-98	39	1.56:1	8-82	70	0.43:1
7-571	27	2.67:1	8-88	70	0.42:1
8-211	83	0.21:1	8-208	78	0.28:1
8-245a	61	0.64:1	8-304a	82	0.21:1
12-210	10	8.78:1	8-375	47	1.11:1
14-57a	23	3.36:1	14-87b	--	----
34-2	23	3.40:1	34-1	23	3.30:1
34-4	19	4.34:1	34-3	47	1.11:1
35-2	21	3.72:1	34-5	--	----
35-3	--	----	35-1	22	3.45:1
35-7	19	4.36:1	35-4	40	1.50:1
			35-5	--	----
			35-6	--	----
	--	----		--	----
Ave.	35.00	3.08:1		54.54	1.21:1

flakes. For example, for Site 3-72 the ratio of debitage to edge altered flakes is 3.36:1 while for Site 8-82 the ratio is 0.43:1.

Taken as a whole, Sub-Type 1 sites have a considerably smaller use rate of obsidian than do Sub-Type 2 sites. ST1 sites have an average of 35 percent of their obsidian flakes used so that edge altering results, while ST2 sites have 54.54 percent of their obsidian material in the edge altered category.

The average Sub-Type 1 ratio of debitage to edge altered flake is 3.08:1. This ratio is considerably larger than the 1.21:1 ratio found for ST2 sites.

Type 1 Rockshelters (karava)

The Type 1 rockshelter (RT1) is represented by two examples. Both sites are rockshelters located toward the interior of the Tahai Quadrangle (8). Sites 8-349a and 8-459 both contain small material culture assemblages. Of the edge altered flakes recovered from 8-349a, seven were used on hard and five on soft materials. At 8-459 the frequency of edges in the hard (N=17) and soft (N=15) categories are also almost equal with 14 percent (N=6) of the edges being retouched. Given the small numbers involved, especially at 8-349a, it is still interesting to note that these two sites have two of the three largest ratios of debitage to edge altered flakes in the Tahai Quadrangle. These sites also stand out because they have two of the three smallest percentages of obsidian used for edge altered flakes.

House Foundations

Four open-air house foundations form part of the data base. Two sites fall into site type FT1, which are elliptical, boat shaped structures. The two sites are 14-66a and 35-8 and both are sub-type B (STB) structures. Site type FT2, a circular stone foundation, is represented by Site 1-185 while Site 1-193, a rectangular stone foundation, fits type FT3.

All four of these sites are dated by absolute means. Site 1-185 appears to be the oldest and has obsidian hydration dates indicating a fourteenth century age; this places it in the early Expansion Phase. Site 14-66a is dated to the mid-Expansion Phase by a series of hydration dates. Based on radiocarbon and hydration dates, sites 1-193 and 35-8 appear to have been constructed after the end of the Expansion Phase (Ayres 1975).

Table 24 presents the data on the various foundation sites by type, contact material categories, debitage to altered flakes ratio (Deb/EAF Ratio) and percentage of obsidian used as edge altered flakes (Obs %).

TABLE 24. House Foundation Data

Site	Type	Altered Edge Categories								Deb/EAF Ratio	Obs %
		Hard		Soft		Ret.		Un.			
		f	%	f	%	f	%	f	%		
1-185	FT2	13	30	13	30	11	26	6	14	4.31:1	19
1-193	FT3	25	39	17	26	11	17	12	18	3.39:1	23
14-66a	FT1	8	32	7	28	10	40	0	0	9.29:1	10
35-8	FT1	15	25	27	46	9	15	8	14	4.87:1	17

All of these sites also show a relatively large percentage of edges in the retouched category. The mean debitage to edge altered flake ratio is 5.46:1 while the average percent of obsidian used for edge altered flakes is 17.25. These two figures most closely compare with those of the Sub-Type 1 rockshelters. The ternary plot, Figure 54, illustrates the relationships among all four foundations and is based on the percentage of edges in the altered edge categories hard, soft and retouched.

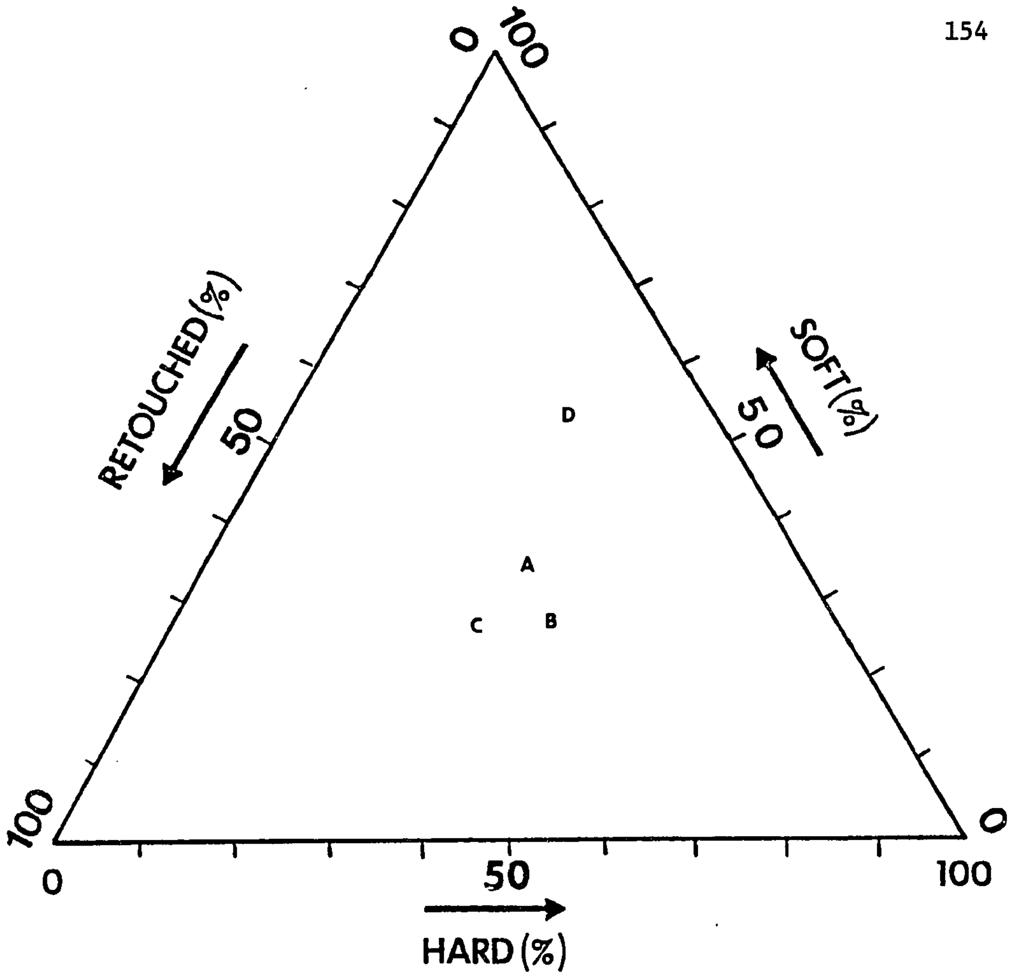

FIGURE 54. House foundations Ternary plot.

<u>Sites:</u> A - 1-185
B - 1-193
C - 14-66a
D - 35-8

Oven House (*Hare Umu*)

The only one of its type in the sample, site 8-133 had a large complement of edge altered flakes. The emphasis at the site is on the working of soft materials (52%) and there were few intentionally retouched edges (8%). Eighty-three percent of the obsidian was used as edge altered flakes and the ratio, then, between debitage and the flake tools was 0.21:1. Although these figures stand out from all the other site types they are closest to the Sub-Type 2 (*ana*) rockshelter sites.

Test Trench

Site 35-11 is located on the sandy beach area of Anakena. The small collection of cultural debris produces a ratio of obsidian debitage to edge altered flakes of 2.31:1. Thirty percent of the obsidian was used for flake tools. These figures are most similar to those of the ST1 sites.

Stratified Sites

Of the 36 sites in this study only three have sufficiently stratified lithic deposits to allow for intrasite comparison. Runga Va'e (12-210) has five dated stratigraphic layers extending from before A.D. 1493 to post A.D. 1750. The dates for the three stratified layers from 14-57a range from A.D. 1440 to the early nineteenth century. Site 35-7 has obsidian hydration dates that range from the middle of the fourteenth century to the early eighteenth century.

Site 12-210

Each of these three sites has a different occupational history as reflected by the stratigraphic data. The five layers at Runga Va'e can be collapsed into two analytical units: Unit 1, comprised of Layers III, IVa, and IVb, represents the Protohistoric and Historic phases, and Unit 2, comprised of Layers I and II, fits into the Expansion Phase. Table 25 provides the data on the altered edge categories based on the collapse of the five stratigraphic layers into two analytical units.

TABLE 25. Site 12-210 Altered Edge Data

	Altered Edge Categories							
	Hard		Soft		Retouched		Unknown	
	f	%	f	%	f	%	f	%
Unit 1	7	29	12	50	1	4	4	16
Unit 2	41	36	41	36	23	20	8	7

Immediately apparent is the shift away from the even distribution of edges in the hard and soft categories in Unit 2 to an emphasis on the soft category in Unit 1. Also of interest is the large decline in the percentage of retouched edges between Unit 2 and Unit 1.

The edge types at 12-210 also show a shift through time. The data in Table 26 present the information on the frequency of edges in the various edge type categories.

A chi-square test of the relationship between these two units

TABLE 26. Site 12-210 Edge Type Categories

	1/7		2/3		4/5	
	f	%	f	%	f	%
Unit 1	14	58	2	9	8	33
Unit 2	47	42	33	29	33	29

indicates a statistically significant difference at the 0.10 level (X^2 = 4.93, 2 df). The major difference between Units 1 and 2 is the smaller than expected frequency of edges in edge type Group 2/3. While both units have a predominance of edges in the 1/7 Group, Unit 2 has an equal distribution of edges in Groups 2/3 and 4/5. This pattern shifts in Unit 1 where there is a very small percentage of edges in the 2/3 Group.

The data relating to edge altered flakes and debitage also suggest a change in the use of Runga Va'e. In the earlier Unit 2, 11 percent of the obsidian material was used as edge altered flakes; in Unit 1 the percentage climbs to 19 percent. The ratio of debitage to edge altered flakes also changes: for Unit 2 the ratio is 10.30:1 and for Unit 1 the ratio declines to 4.25:1.

Runga Va'e is interpreted here as a permanent or semi-permanent habitation largely owing to the depth of the midden deposit. Based on the previous discussion, the two analytical units represent two different occupational periods. Unit 2, dated to the Expansion Phase, saw the use of the cave as a permanent or semi-permanent shelter. A variety of tasks were performed that included the working of hard and soft materials. The use of more specialized retouched flakes was also prevalent. Near the end of the Expansion or the Decadent Phase the cave ceased to be used as a regular habitation possibly owing to limited living area because of the considerable midden build up.

Unit 1 is represented by a small number of edges. Based on the available data, this unit is dated to the Protohistoric or Historic times. The use of the site at this time was that of a task-specific locale that focused on the working of soft contact materials.

Site 14-57a

Site 14-57a, called Ana Tuu Hata, has three identified layers. Layer I is related to the Protohistoric and early Historic Phases and Layer III is associated with the Expansion Phase. Layer II is a thin band which appears to be highly mixed and of little analytical value for this study (Cheatham and Ayres n.d.). Table 27 presents the basic contact material data for Layers I and III (Layer II is excluded).

TABLE 27. Site 14-57a Altered Edge Data

	Altered Edge Categories							
	Hard		Soft		Retouched		Unknown	
	f	%	f	%	f	%	f	%
Layer I	16	31	26	51	5	10	4	8
Layer III	19	48	11	27	2	5	8	20

The difference between the layers in the categories hard and soft is quite large. A two by two chi-square test of the edge frequencies in the hard and soft categories finds a statistically significant difference between the two layers at the 0.05 level (X^2 = 4.46, 1 df). The percentage of retouched edges remains relatively small from layer to layer.

Both layers are dominated by edge type Group 1/7. Layer III shows an essentially even occurrence of Groups 2/3 and 4/5 as well as a small percentage of the pointed Type 6 edges. In contrast, Layer I has no Type 6 edges and emphasizes edge type Group 2/3 over Group 4/5.

The percentage of obsidian material used for edge altered flakes decreases from 27 percent in Layer III to 18 percent in Layer I. The ratio of debitage to edge altered flakes also shows some change; in Layer III the ratio is 2.73:1 and in Layer I it increases to 4.51:1.

Some change in activities at the site is suggested by the analysis. The most distinct of these is in the altered edge categories where a shift from the working of hard materials to soft materials is evident.

Site 35-7

Site 35-7 can be divided into two layers; Layer I is associated with the historic period and Layer II is associated with prehistoric times. The altered edge data presented in Table 28 indicate a shift in the emphasis of the kind of contact materials worked. Layer II has 53 percent of its altered edges used on soft materials but in Layer I this category declines to 36 percent. As at 14-57a retouched edges have a very minor place in the altered edge categories.

TABLE 28. Site 35-7 Altered Edge Data

	Altered Edge Categories							
	Hard		Soft		Retouched		Unknown	
	f	%	f	%	f	%	f	%
Layer I	27	51	19	36	2	4	5	9
Layer II	14	37	20	53	1	3	3	8

The shift seen in the contact material is also reflected in the edge type data. Table 29 shows that in Layer II edge type Group 2/3 is dominant with the other two groups being roughly equal. In Layer I edge type Group 1/7 is dominant, with Group 2/3 being second most frequent and Group 4/5 being third.

Table 29. Site 35-7 Edge Type Data

	1/7		2/3		4/5	
	f	%	f	%	f	%
Layer I	27	49	18	37	8	14
Layer II	11	29	19	50	8	21

Unlike the other two stratified sites, 35-7 has remarkable stability in its debitage to edge altered flake relationship. For both levels, 19 percent of the obsidian material was used for edge altered flakes. In Layer II the ratio of debitage to edge altered flake is 4.21:1; this changes little in Layer I where the ratio is 4.16:1.

Obsidian remained easily available at Site 35-7 in both the prehistoric and historic periods. However, the contact material data suggest a shift from the working of soft to the working of hard materials over time.

General Discussion

It is evident that McCoy's site typology and site characterization by use-wear analysis can be informatively joined together. Use-wear analysis was done on artifacts associated with several of McCoy's site types including karava (Type 1 rockshelters), ana (Type 2 rockshelters), three different house foundation types, and a hare umu (oven house). One site, 35-11, a beach test, did not fit the McCoy site typology.

With the exception of the Type 2 rockshelters, all of the site types in this sample were limited in number. For the Type 2 rockshelters two sub-types were present in sufficient numbers to allow comparisons. When the variables of sub-type and equal or unequal emphasis on the altered edge categories were related a probability of 0.03 was determined with the Fisher's exact test. This figure strongly indicates that these two sub-types were quite different with regard to their characterization by use-wear analysis. Figures 51 and 52 illustrate the difference between the two sub-types.

Other data that support the difference between the two sub-types are seen in Figure 53. This figure shows that Sub-Type 1 sites are found in a variety of different sizes while a large majority (80%) of

Sub-Type 2 sites are found in relatively small rockshelters.

Table 23 presents the data on edge altered flakes and debitage. This information shows that Sub-Type 1 rockshelters have much larger ratios of debitage to edge altered flakes (3.08:1) than do Sub-Type 2 sites (1.21:1). It was also found that 35 percent of the obsidian in Sub-Type 1 sites was used as edge altered flakes compared to almost 55 percent of the obsidian being so used at the Sub-Type 2 sites.

In addressing the question of whether a coastal-inland site dichotomy actually exists on Easter Island the analysis initially relied on 30 rockshelter sites, two karava (RT1), and 20 ana (RT2). Of these sites, 19 are considered coastal and 11 are designated inland. The 19 coastal caves range in interior surface area from 12 to 80 square meters and average slightly less than 38 square meters. The 11 inland caves range from 6 to 54 square meters and have an average area of just less than 25 square meters.

Of the 16 coastal cave sites with altered edge frequencies sufficient for analysis, seven have roughly equal percentages of edges in the hard and soft categories, and nine sites tend to favor either the hard or soft category. Within the coastal cave group, then, no pattern is discernable when the altered edge categories hard and soft are considered.

Of the 11 inland caves, eight have sufficiently high edge frequencies for analysis. Six of these sites have fairly equal frequencies of edges in the hard and soft categories and two sites emphasize the soft category.

Based simply on the geographical split of coastal versus inland, the altered edge data suggest that coastal caves were used in various ways. Some sites focused on the working of either hard or soft materials while others have an equal emphasis on both. For the inland caves the small sample indicates that a large majority, 75 percent, had an equal emphasis on the working of soft and hard contact materials.

By combining data on site location and site type a more complete picture of the coastal-inland dichotomy can be seen (see Table 22). Note that the two interior karava shelters (RT1) are not included in the table.

Based on the sample of sites shown in Table 22, the following pattern emerges. Permanent and semi-permanent sites (Sub-Type 1) have an equal chance of being located on the coast or the interior. However, these sites seen as temporary (Sub-Type 2) are found on the coast in 12 out of 15 cases. By calculating the relationship of these site types against geographic location a probability figure of 0.07 can be derived. This figure is below the 0.10 level that is considered statistically significant and indicates that the location of the sites types is not random.

Comparisons with other Polynesian coastal-inland settlement patterns are useful in assessing the Easter Island site distribution. In the Hanatekua Valley of the Marquesas, Bellwood found that the settlement pattern showed differential use of the valley from the coast toward the interior (1972:39). Bellwood summed up this pattern as follows:

> Lower Valley (seaward end): plantations, religious structures, few dwellings.
> Middle Valley and inland end of lower valley: many dwellings, breadfruit plantations, storage pits, the pa and the most elaborately constructed me'ae
> Upper Valley: root-crop terraces, few paepae and one small me'ae. (Bellwood 1972:39)

Bellwood's interpretation of the settlement data was that the regular, full-time dwellings were located in the middle valley area and that the structures on the coast were not regular dwellings (Bellwood 1972:38-39).

Four different case studies of Hawaiian settlement patterns illustrate both the underlying regularities and the variation found in the distribution and arrangement of sites (Kirch 1985:273). Apple (1965) also discusses the basic Hawaiian unit of land, the ahupua'a, and he shows that different site types are located in different sections of this land division.

The significance of the 0.07 probability figure is that it supports the concept of a coastal-inland dichotomy. For Easter Island the permanent and semi-permanent Type 2 rockshelters occur in approximately equal numbers on the coast and inland. It is the location of the temporary sites on the coast, in 12 out of 15 examples (80%), that creates the geographic dichotomy between the permanent and temporary habitations.

For Easter Island the difference between the Type 2 rockshelter sub-types is seen as a difference in site function or specialization. Returning to Table 22 and combining the data on site type, geographic location, and altered edge emphasis, it is apparent that Sub-Type 1 permanent habitations are found both on the coast and inland and in 75 percent of the instances there is an equal emphasis on the working of hard and soft contact materials. These sites are considered to be functionally generalized. For the temporary Sub-Type 2 habitations 73 percent emphasize the working of either hard or soft contact materials and 80 percent of these sites are found on the coast. These sites are viewed as functionally specialized.

Table 23 presents the data on the relationship of the edge altered flakes and debitage. This table shows that Sub-Type 1 sites have larger debitage to edge altered flake ratios and smaller percentages of obsidian used for flake tools than do Sub-Type 2 sites. An explanation for these sub-type differences lies in site function.

Obsidian cores of two types were produced on Easter Island: block cores for mataa manufacture and discoidal cores for the production of domestic tools (Stevenson et al. 1984:121). These researchers believe that mataa manufacture was generally carried out at the quarry but that discoidal cores were probably prepared at the quarry and carried back to the village (Stevenson et al. 1984:121-122).

It is proposed here that discoidal core reduction was one of the common activities carried out at the Sub-Type 1 permanent habitations. Such activity would explain the large ratio found between the debitage and edge altered flakes and the smaller percentage of obsidian used for edge altered flakes. In contrast, the Sub-Type 2 temporaty sites are interpreted as only infrequently being the site of core reduction. The large percentage of edge altered flakes indicates that much of the obsidian present was intended for use specifically as tools rather than just being core reduction biproducts.

The above discussion has shown that there is a geographic, coastal-inland pattern to the Type 2 rockshelters as defined by McCoy (1973). Permanent and semi-permanent habitation sites (ST1) are located on both the coast and inland and tasks carried out at these sites were varied. Rockshelters labeled temporary (ST2) in McCoy's typology are viewed as being functionally specialized.

Intra-Island Discussion

This pattern can also be seen when attention is focused on only the north or west coast of Easter Island where the large majority of samples examined in this study are found. On the west coast, Quadrangles 3 (Hanga Piko) and 8 (Tahai) are located only one kilometer apart and are used as one sample; this includes 12 Type 2 rockshelters (RT2). On the north coast, Quadrangle 34 (Papa te Kena) and 35 (Anakena) together provide a sample of 12 RT2 sites.

Based on the data in Table 23, the western Sub-Type 1 sites have an average debitage to edge altered flake ratio of 1.27:1 but the ratio for the ST2 sites is 0.57:1. For the Sub-Type 1 sites the percentage of obsidian used for edge altered flakes is 55.6 and for the ST2 sites it is 68.7 percent.

The north coast sites have the same relationships between the sub-types but the numbers are quite different. Sub-Type 1 sites have a debitage to edge altered flake ratio of 3.96:1 and the percentage of obsidian used for edge altered flakes is only 20.5. The percentage for ST2 sites is 33.0 and the ratio is 2.34:1. Table 30 presents the debitage to edge altered flake ratios and the percentages of obsidian used for edge altered flakes for both the north and west coastal areas.

TABLE 30. North and West Coast Site Data

	West		North	
	ST1	ST2	ST1	ST2
Ratio Obs.	1.27:1	0.57:1	3.96:1	2.34:1
Percent	55.6	68.7	20.5	33.0

The north coast sites have larger ratios and smaller percentages for both sub-types when compared to the west coast sites. Two explanations for these figures can be offered; the first considers access to the obsidian.

McCall has suggested that island resources such as obsidian, red ochre, and construction stone came from specific areas and these ares were controlled by local groups. This resource control was used by the local groups so that access to them could be traded for products of other groups (McCall 1981:32). Based on maps in Routledge (1919: 222) and Métraux (1940:8), the obsidian resources appear to have been controlled by members of the Haumoana ramage.

Differential access to obsidian may have been granted to the people in the Papa te Kena and Anakena region for two, perhaps interconnected, reasons. First, this northern area, controlled by the Miru ramage, is directly associated with the ariki mau, the highest chief of the island (Métraux 1940:132). While this alone may have provided special access to the obsidian resource, the north coast Miru also had fish to trade.

Ayres (1981) has shown that the north coast had a greater emphasis on offshore fishing than did other areas of the island. This contrast, combined with relatively poorer fishing on the west (Ayres 1981) and south (McCall 1981:32) coasts, would have given the Miru an important exchange resource.

A second but less well supported explanation for the figures in Table 23 may lie in the idea that different site activities are reflected in these numbers. Direct support for this explanation can be found in Table 22. Of the 12 Type 2 rockshelters in the Tahai and Hanga Piko Quadrangles on the west coast, seven have been associated with the working of soft contact materials and none emphasize hard materials. For the north coast sites all of those associated with a particular contact material are related to the working of hard materials.

It is clear then, that all of the research questions asked could be addressed through use-wear analysis. Such analysis has distinguished differences between and within site types as well as within stratified sites. Further, the lithic analysis has indicated important differences between two separate locations of Easter Island.

CHAPTER V

CONCLUSION

Analysis of amorphous flake tools from 36 archaeological sites yields new insights into Polynesian and Easter Island settlement patterns and site-specific activities. Initially the question was asked whether these flake tools could be usefully analyzed in terms of use-wear. A range of flake tool attributes was recorded which focused primary analysis on the altered edge itself rather than the entire flake. By combining this analytical approach with experimental use-wear data, the function of the flake stone tools was determined through analogy.

Four categories were used to group the edge altered flakes; these categories were labeled hard, soft, retouched, and unknown. The categories hard and soft both refer to the general class of contact material that the flake edge was worked against. The basis of this categorization was the analysis of the edge use-wear microchipping. By comparing this use-wear with experimental data the archaeologically derived specimens were categorized as having been used on hard or soft materials through the use of analogy. A large majority of the analyzed edges fall into these two categories at all sampled sites. The retouched category, defined as an edge that was intentionally modified, was present at every site but usually in small frequencies. Not all edges that were altered only through use fit the hard or soft categories; these edges were placed in the unknown category.

After establishing the altered edge categories, each site was described within this framework. Sites that had differences between the hard and soft categories of no more than 10 percent were interpreted as having an equal focus on the working of soft and hard contact materials. Sites producing differences greater than 10 percent were characterized as having an accent on the working of the larger category. With this technique, sites were characterized by use-wear analysis. Once the sites were so described, three other primary research questions addressed the issues of site typology, site specialization, and geographic location.

The site typology defined by McCoy (1973) was examined by comparing his site types with the use-wear characterizations. The most frequently represented site type in this sample is the Type 2 rockshelter which totaled 28, including two ana kionga. This site type was in turn divided into two sub-types: permanent or semi-permanent (ST1) and temporary (ST2). When these sub-types were related to the site use-wear descriptions they were found to be significantly different.

Other data that support this sub-type difference were found in the relationship between the edge altered flakes and the debitage. Sub-Type 1 sites were found to have smaller percentages (35%) of obsidian appearing as edge altered flakes than did Sub-Type 2 sites (55%). The ratio of debitage to edge altered flakes was also quite different; for the Sub-Type 1 sites the ratio was 3.08:1 and for the Sub-Type 2 sites it was 1.21:1.

Interior site surface area also distinguished the two sub-types. Sub-Type 1 sites range from 16 to 80 square meters in area and are roughly equally represented on either side of a value of 40 square meters while 80 percent of the ST2 sites are smaller than this surface area.

Other site types were part of this study sample, but only in small frequencies. The four house foundations tested were found to most closely compare with the Sub-Type 1 rockshelter habitations. In contrast, the hare umu (oven house) site is most like the Sub-Type 2 temporary habitations in the kinds of use-wear represented. Flakes at this site show an emphasis on the working of soft contact materials.

The three stratified sites all illustrate/document a functional change through time. Runga Va'e (12-210) was a permanent or semi-permanent habitation during the Expansion Phase. Wear analysis indicated that a variety of activities were carried out at the site including the working of soft and hard contact materials. A second, later, occupation during Protohistoric or Historic times was interpreted as being a specialized, task-specific use of the site which involved the working of soft contact materials.

Sites 14-57a and 35-7 both saw changes in site use-wear through time. Site 14-57a (Ana Tuu Hata) shows a shift from working hard materials to a later emphasis on soft materials. Site 35-7 provides just the opposite picture with a shift from working soft to hard contact materials.

It is clear that site use-wear examination adds another dimension to McCoy's (1973) site typology. In doing so the differences both within and between sites and site types can be more finely tuned. This approach leads to the questions of site specialization. Type 2 rockshelters are labeled as permanent or semi-permanent (ST1) or temporary (ST2) (McCoy 1973:47). These labels do not indicate how the site was used, only the duration or intensity of their use. By characterizing sites in terms of use-wear they can be interpreted as being functionally generalized or functionally specialized. For Type 2 rockshelters the permanent or semi-permanent habitations are viewed as being functionally generalized. In contrast, temporary (ST2) caves are considered functionally specialized or task specific. Each of these sub-types is viewed as having their own spatial and functional place in the overall settlement pattern.

Geographically, the Type 2 rockshelters can be related to the well known Polynesian high-island settlement pattern of radial land divisions. McCoy (1973:171) has said that the coastal-inland settlement dichotomy found on the high-islands did not hold for Easter Island because of its small size and environmental uniformity. Analysis of site location and site type, however, suggests that there was indeed a coastal-inland dichotomy. Sub-Type 1 rockshelters within this sample were found to have an equal chance of being located either on the coast or inland. Sub-Type 2 habitations, on the other hand, are located on the coast in 12 out of 15 cases.

The pattern indicated by these data is that permanent or semi-permanent sites which are functionally generalized are identified with both locales. However, specialized, task specific sites typed as temporary habitations have a strong tendency to be situated on the coast itself.

The marriage of amorphous obsidian flake tool studies and use-wear analysis achieved here was thus successful in addressing the initial research questions posed. Further, the issue of lithic resource availability and control was raised as one possible explanation for the variations in the north and west coast data.

However promising the results of the analysis are, they must be tempered by certain facts. The original work of Ayres (1975), from which this research material comes, was not designed to explore the research questions addressed in this dissertation. Ayres' interest in examining sites from a variety of locations on the island led to a widely distributed sample. Excavations within most of the sites were often limited to one or two test units. Both of these factors may have influenced the analytical results of this research.

To test the results of this research as well as to examine other questions raised, larger samples are needed both in terms of excavation volumes and numbers of sites sampled within the various site types. Ideally, one or more land strips (kainga) could be defined in order to determine the variety and number of the different site types. Following this work, analysis of the site types sampled would establish functional differences between them. In turn, such analyses done at different points on the island would test for regional and island-wide patterns.

Even with these sampling limitations, however, it is evident that analysis of the amorphous flake stone industry on Easter Island promises to generate new and important data which will expand our understanding of the island's prehistory. No doubt similar analysis carried out on other Pacific islands such as New Zealand and Hawaii would be similarly beneficial.

APPENDIX A

SAMPLE SIZES

Site	Total*	Sample Size (Frequency)	Sample Percentage
1-185	32	32	100
1-193	43	43	100
3-72	85	59	70
3-85	35	35	100
3-98	30	30	100
7-571	275	54	20
8-82	102	50	50
8-88	47	47	100
8-133	76	46	60
8-208	116	58	50
8-211	43	43	100
8-245a	179	54	30
8-304a	28	28	100
8-341	58	58	100
8-349a	12	12	100
8-353a	82	41	50
8-375	18	18	100
8-459	28	28	100
12-210	101	101	100
14-57a	688	77	11
14-66a	17	17	100
14-87b	4	4	100
34-1	59	40	68
34-2	1017	55	5
34-3	24	24	100
34-4	161	39	25
34-5	6	6	100
35-1	42	42	100
35-2	551	58	10
35-3	3	3	100
35-4	281	61	22
35-5	1	1	100
35-6	5	5	100
35-7	553	55	10
35-8	929	47	5
35-11	16	16	100

*This column lists the total count of edge altered flakes recorded for each site.

REFERENCES CITED

Anderson-Gerfaud, P.
1928 Contributions Méthodologiques à l Analyse des Microtraces d'utilisations sur les Otils Préhistoriques. Thése de 3éme cycle no. 1607, Institute du Quaternaire, Université de Bordeaux I, Talence.

Ayres, W. S.
1971 Recent Radiocarbon Dates from Easter Island. Journal of Polynesian Society 80:497-504.

1973 The Cultural Context of Easter Island Religious Structures. Ph.D. dissertation, Department of Anthropology, Tulane University.

1975 Easter Island: Investigation in Prehistoric Cultural Dynamics. Unpublished manuscript. Columbia, South Carolina.

1981 Easter Island Fishing. Asian Perspectives 22:61-92.

Ayres, W. S., B. Saleeby, and C. B. Levy
n.d. Late Prehistoric-Early Historic Easter Island Subsistence Patterns. Recent Easter Island Archaeology, edited by W. S. Ayres. University of Oregon Anthropological Papers, Eugene. In Press.

Ayres, W. S., and R. L. Spear
n.d. Easter Island Artifacts: Typology and Use-Wear. Recent Easter Island Archaeology, edited by W. S. Ayres, University of Oregon Anthropological Papers, Eugene. In Press.

Baker, P. E.
1967 Preliminary Account of Recent Geological Investigations on Easter Island. Geological Magazine 104:116-122.

Bandy, M. C.
1937 Geology and Petrology of Easter Island. Geological Society of American Bulletin 48:1589-1610.

Bellwood, P. S.
1969 Excavations at Skippers Ridge, Opito Bay, Coromandel Peninsula, North Island of New Zealand. Archaeology and Physical Anthropology in Oceania 4:198-221.

1972 A Settlement Pattern Survey, Hanatekua Valley, Hiva Oa, Marquesas Islands. Pacific Anthropological Records, no. 17. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, Hawaii.

Brink, J. W.
1978 An Experimental Study of Microwear Formation on Endscrapers. National Museum of Man, Archaeological Survey of Canada, Mercury Series. Ottawa. Paper no. 82.

Cheatham, R. D., and W. S. Ayres
n.d. Use-Wear Patterns on Obsidian Flakes and Functional Inference: A Case Study From Site 14-26, Easter Island. Recent Easter Island Archaeology, edited by W. S. Ayres, University of Oregon Anthropological Papers, Eugene. In Press.

Clark, M.
1975 Age, Chemistry and Tectonic Significance of Easter and Sala y Gomez Islands. Master of Science thesis, Department of Geology, University of Oregon, Eugene.

Coqueugniot, T.
1983 Analyse Tracéologique d une Série de Grattoirs et Herminettes de Mureybet, Syrie. Traces D'utilisation sur les Outlis Néolithiques du Proche Orient, edited by M-C Cauvin, pp. 163-72. Maison de l'Orient, Lyon.

Curwen, E. C.
1930 Prehistoric Flint Sickles. Antiquity 4:179-86.

1935 Agriculture and the Flint Sickle in Palestine. Antiquity 9: 62-66.

Del Bene, T.
1979 Once Upon a Striation: Current Models for Striation and Polish Formation. Lithic Use-Wear Analysis, edited by B. Hayden, pp. 243-57. Academic Press, New York.

n.d. Microanalysis of Lithic Materials from Aniganigaruk. Unpublished manuscript, Department of Anthropology, Washington State University, Pullman.

Englert, P. S.
1948 La Tierra de Hotu Matu'a: Historia' Ethnologia, y Lengua de La Isla de Pascua. Santiago, Chile: Padra de Casas.

Evans, J.
1872 The Ancient Stone Implements, Weapons and Ornaments of Great Britain. New York: Appleton.

Ferdon, E. N., Jr.
1961 Sites E-4 and E-5. Reports of the Norwegian Archaeological Expedition to Easter Island and the East Pacific, Vol. 1, edited by T. Heyerdahl and E. N. Ferdon, Jr., Santa Fe.

Flenley, J. R.
1979 Stratigraphic Evidence of Environmental Change on Easter Island. Asian Perspectives 22:30-40.

Flenley, J. R., and S. M. King
1984 Late Quaternary Pollen Records from Easter Island. Nature 307: 1-4.

Geiseler, Capt. Lieutenant
1883 Easter Island. A Site of Prehistoric Culture in the South Sea. Report by the Captain of H. M. Gunboat "Hyne" (Hyena). Lieutenant Geiseler on the Ethnological Investigation of Easter Island to the Chief of the Imperial Admirality. [Translated and ed. by W. S. Ayres]

Glover, I.
1978 Microliths in Indonesian Flaked Stone Industries: An Anomalous Elaboration or Mainstream? Paper presented at the I.P.P.A. Symposium: Recent Advances in Indo-Pacific Prehistory. Poona, December.

Gould, R. A.
1971 The Archaeologist as Ethnographer: A Case from the Western Desert of Australia. World Archaeology 3:143-177.

Greenwell, W.
1865 Notices of the Examination of Ancient Gravehills in the North Riding of Yorkshire. Archaeological Journal 22:95-105.

Greiser, S. T., and P. D. Sheets
1979 Raw Material as a Functional Variable in Use-Wear Studies. Lithic Use-Wear Analysis, edited by B. Hayden, pp. 289-296. Academic Press, New York.

Haber, A., and R. P. Runyon
1969 General Statistics. Addison-Wesley Publishing Company, Reading, Massachusetts.

Hayden, B.
1978 Stone Tool Functions in the Western Desert. Stone Tools as Culture Markers, edited by R. V. S. Wright, pp. 178-188. Australian Institute of Aboriginal Studies, Canberra.

1979 Lithic Use-Wear. Academic Press, New York.

Hayden, B., and J. Kamminga
1973 Gould, Koster and Sontz on Microwear: A Critical Review. Newsletter of Lithic Technology 2:3-14.

1979 An Introduction to Use-Wear: The First CLUW. Lithic Use-Wear Analysis, edited by B. Hayden, pp. 1-13. Academic Press, New York.

Heyerdahl, T., and E. N. Ferdon
1961 Reports of the Norwegian Archaeological Expedition to Easter Island and the East Pacific. Vol. 1, Santa Fe.

1965 Reports of the Norwegian Archaeological Expedition to Easter Island the East Pacific. Vol. 2, Santa Fe.

Kamminga, J.
1977 A Functional Study of Use-Polished Eloueras. Stone Toools as Cultural Markers, edited by R. V. S. Wright, pp. 205-12. Australian Institute of Aboriginal Studies, Canberra.

1979 The Nature of Use-Polish and Abrasive Smoothing on Stone Tools. Lithic Use-Wear Analysis, edited by B. Hayden, pp. 143-57. Academic Press, New York.

Keeley, L.
1974 Technique and Methodology in Microwear Analysis: A Critical Review. World Archaeology 5:323-36.

1976 Microwear on Flint: Some Experimental Results. Second International Symposium on Flint, edited by F. Engelen, pp. 49-51. Nederlande Geologische Vereniging, Maastricht.

1977 The Functions of Paleolithic Flint Tools. Scientific American 237:108-26.

1978 Microwear Polishes on Flint: Some Experimental Results. Lithics and Subsistence: The Analysis of Stone Tool Use in Prehistoric Economies. Vanderbilt University Publications in Anthropology no. 2, edited by D. Davis, pp. 163-78. Vanderbilt University, Nashville.

1980 Experimental Determination of Stone Tool Uses: A Microwear Analysis. University of Chicago Press, Chicago.

Keller, C.
1966 The Development of Edge Damage Patterns on Stone Tools. Man 1:501-11.

Kirch, P. V.
1979 Subsistence and Ecology. The Prehistory of Polynesia, edited by J. D. Jennings, pp. 286-307. Harvard University Press, Cambridge, Massachusetts.

1984 The Evolution of Polynesian Chiefdoms. Cambridge University Press, Cambridge.

1985 Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory. University of Hawaii Press, Honolulu.

Leach, H. M.
1978 Mind Within Matter: Discovering the Technological Knowledge of Early New Zealanders. Paper presented at the 43rd Meeting of the Society of American Archaeology. Tucson, Arizona, May 5.

McCall, G.
1981 Rapanui: Tradition and Survival on Easter Island. University of Hawaii Press, Honolulu.

McCoy, P. C.
1973a Easter Island Settlement Patterns in the late Prehistoric and Protohistoric Periods. Ph.D. dissertation, Department of Anthropology, Washington State University, Pullman.

1973b Excavation of a Rectangular House on the East Rim of Rano Kau Volcano, Easter Island. Archaeology and Physical Anthropology in Oceania 8:51-67.

1978 Stone-Lined Earth Ovens in Easter Island. Antiquity 52:204-16.

Métraux, A.
1940 Ethnology of Easter Island. Bernice P. Bishop Museum Bulletin 160. Honolulu.

Michels, J. W., C. M. Stevenson, I. S. T. Tsong, and G. A. Smith
n.d. Hydration Rates for Easter Island. Recent Easter Island Archaeology, edited by W. S. Ayres. University of Oregon Anthropological Papers, Eugene. In Press.

Moss, E.
1983 Some Comments on Edge Damage as a Factor in Functional Analysis of Stone Tools. Journal of Archaeological Science 10:231-42.

Moss, E., and M. Newcomer
1982 Reconstruction of Tool Use at Pincevent: Microwear and Experiments. Recent Progress in Microwear Studies. Studia Prehistorica Belgica 2: Edited by D. Cahen, pp. 289-312. Musee royal de l Afrique centrale, Tervuren.

Mulloy, W.
1966 The Archaeological Heritage of Easter Island. A Report Prepared for the United Nations Educational Scientific, and Cultural Organization.

1970 Preliminary Report on the Restoration of Ahu Vari Uri Easter Island. The Easter Island Committee, International Fund for Monuments Inc., Bulletin 2, New York.

1973 Preliminary Report of the Restoration of Ahu Huri a Urenga and Two Unnamed Ahu at Hanga Kio'e, Easter Island. The Easter Island Committee, International Fund for Monuments Inc., Bulletin 3.

Mulloy, W., and G. Figueroa
1978 The A Kivi-Vai Teka Complex and Its Relationship to Easter Island Architectural Prehistory. Asian and Pacific Archaeological Series Number 8. Social Sciences and Linguistics Institute, Honolulu.

Neuville, R.
1934 Les débuts de l'agriculture et al faucille préhistorique en Palestine. Etrait du Recueil de la Société Hébraique d'Exploration et d'Archéologie Palestinieene, Jerusalem.

Nilsson, S.
1838-1843 Skandinaviska Nordens Urinvanare. Lund: Berlingska Boktryckeriet. (English edition: The Primative Inhabitants of Scandinavia, 1868, London.)

Odell, G.
1977 The Application of Microwear Analysis to the Lithic Component of an Entire Prehistoric Settlement: Methods, Problems and Functional Reconstructions. Ph.D. dissertation, Department of Anthropology, Harvard University, Cambridge, Massachusetts.

1978 Préliminaries d' une analyse fonctionnelle des points microlithiques de Bergumermeer (Pays-Bas). Bulleting de la Societe Prehistorique Francaise 75:37-49.

1981 The Morphological Express at Function Junction: Searching for Meaning in Lithic Tool Types. Journal of Anthropological Research 37:319-42.

1982 Emerging Directions in the Analysis of Prehistoric Stone Tool Use. Reviews in Anthropology 9:17-33.

Odell, G., and F. Odell-Vereecken
1980 Verifying the Reliability of Lithic Use-Wear Assessments by Blind Tests: The Low-Power Approach. Journal of Field Archaeology 7:87-120.

Pookajorn, S.
1984 The Technological and Functional Morphology Analyses of the Lithic Tools from the Hoabinhian Excavation at the Ban Kao Area: Kanchenaburi Province, Thailand. Faculty of Archaeology, Silpakorn University, Bangkok, Thailand.

Randall E.
1970 Easter Island: An Ichthyological Expedition. Oceans Magazine 3:48-59.

Ronquillo, W. P.
1981 The Technological and Functional Analysis of the Lithic Flake Tools from Rabel Cave. Anthropological Papers no. 13. National Museum, Manila, Philippines.

Routledge, C. S.
1919 The Mystery of Easter Island. Hazel, Watson and Viney, Ltd., Loncong.

Runyon, R. P., and A. Haber
1980 Fundamentals of Behavioral Statistics. Addison-Wesley Publishing Company, Reading, Massachusetts.

Schousboe, R., M. F. Riford, and P. V. Kirch
1983 Volcanic-Glass Flaked Stone Artifacts, Report 12. Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawaii: An Interdisciplinary Study of an Environmental Transect, edited by J. T. Clark and P. V. Kirch. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, Hawaii.

Semenov, S. A.
1964 Prehistoric Technology. Cory, Adams and MacKay, London.

Shawcross, W.
1964 Stone Flake Industries in New Zealand. Journal of the Polynesian Society 73:7-25.

Skjølsvold, A.
1961 House Foundations (Hare Paenga) in Rano Raraku. Reports of the Norwegian Archaeological Expedition to Easter Island and the East Pacific, vol. 1, edited by T. Heyerdahl and E. N. Ferdon, Jr., pp. 291-294. Santa Fe.

Skottsburg, C.
1928 The Vegetation of Easter Island. The Natural History of Juan Fernandez and Easter Island, vol. 2, part 4, no. 17. Uppsala.

Smith, C. S.
1961 The Maunga Auhepa House Site. Reports of the Norwegian Archaeological Expedition to Easter Island and the East Pacific, vol. 1, edited by T. Heyerdahl and E. N. Ferdon, Jr., pp. 277-286. Santa Fe.

Sonnenfeld, J.
1962 Interpreting the Function of Primitive Implements. American Antiquity 28:56-65.

Spear, R. L.
1980 A Brief Discussion of Obsidian Use-Wear Experiments. Lithic Technology 9:38-39.

n.d.a. An Analysis of Easter Island Obsidian Flake Tools. Unpublished manuscript, Department of Anthropology, University of Oregon, Eugene.

n.d.b. An Analysis of Sites from the Tahai Region, Easter Island. Unpublished manuscript, Department of Anthropology, University of Oregon, Eugene.

Spurrell, F. C. J.
1892 Notes on Early Sickles. Archaeological Journal 49:53-59.

Stevenson, C. M.
1984 Corporate Descent Group Structure in Easter Island Prehistory. Ph.D. dissertation, Department of Anthropology, Pennsylvania State University.

Stevenson, C. M., L. C. Shaw, and C. Cristino
1984 Obsidian Procurement and Consumption on Easter Island. Archaeology in Oceania 19:120-124.

Thomas, D. H.
1976 Figuring Anthropology: First Principles of Probability and Statistics. Holt, Rinehart and Winston, New York.

Thomson, W. J.
1889 Te Pito te Henua, or Easter Island. U. S. National Museum Annual Report for 1889, pp. 447-552.

Tindale, N. B.
1965 Stone Implement Making Among the Nakako, Ngadadjara and Pitjandjara of the Great Western Desert. Records of the South Australian Museum 15:131-64.

Tringham, R., G. Cooper, G. Odell, B. Voytek, and A. Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. Journal of Field Archaeology 1:171-96.

Vaughan, P. C.
1985 Use-Wear Analysis of Fkaked Stone Tools. University of Arizona Press, Tucson.

Vayson, A.
1919 Faucille Préhistorique de Solferino. L'Anthropologie 23:303-422.

1920 La Plus Ancienne Industrie de Saint-Acheul. L'Anthropologie 32:1-38.

White, J. P.
1969 Typologies for Some Prehistoric Stone Artifacts of the Australian New Guinea Highlands. Archaeology and Physical Anthropology in Oceania 4:18-46.

1972 Ol Tumbuna: Archaeological Excavations in the Eastern Central Highlands, Papua New Guinea. Department of Prehistory, Australian National University, Canberra.

White, J. P., and D. H. Thomas
1972 What Mean These Stone Tools? Ethnotaxonomic Models and Archaeological Interpretations in the New Guinea Highlands. Models in Archaeology, edited by D. Clarke, pp. 275-308. Methuen, London.

Williams, F.
1968 Reasoning with Statistics. Holt, Rinehart and Winston, New York.

Witthoft, J.
1967 Glazed Polish on Flint Tools. American Antiquity 32:383-88.

Wright, C. S., and C. Diaz V.
1962 Soils and Agricultural Development of Easter Island. Quarterly Report, Supplement 1. Santiago.