DRAFT

In November 1976 and June 1978 intensive investigations were conducted at archaeological site 109 on the island of Kaho'olawe by archaeologists under contract to the U.S. Navy. The research at 109 and the analysis of the data retrieved was part of the survey of the historic resources of Kaho'olawe sponsored by the Department of the Navy on partial fulfillment of its responsibilities under Federal Executive Order 11593, the National Historic Preservation Act of 1966 (as amended), and the Advisory Council on Historic Preservation's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800). For further information concerning the Kaho'olawe survey and its results, the reader is directed to the National Register of Historic Places Inventory--Nomination Forms for the 544 sites recorded during the survey, the National Register Multiple Resource Nomination Overview for the Historic Resources of Kaho'olawe (Hommon 1980b), "Kaho'olawe: A Cultural Resources Management Plan" (Ahlo and Hommon 1980), and Kaho'olawe: Final Report of the Archaeological Survey" (Hommon 1980a)

In 1976, when the Historic Sites Section, State Parks Division of the Hawaii Department of Land and Natural Resources was conducting the Kaho'olawe survey, feature A of site 109 was investigated by Dr. Robert J. Hommon (principle investigator), then Archaeologist of the Historic Sites Section; Mr. Farley Watanabe, then Historic Sites Specialist of the same agency; Dr. Maurice Morgenstein, Geologist and President of Hawaii Marine Research, Inc., (H.M.R., a private research firm headquartered in Honolulu); and Dr. Patrick McCoy, Archaeologist on the staff of the B. P. Bishop Museum (Honolulu). The remaining three features (B, C and D) of site 109 were investigated in June, 1978, after HMR had been contracted by the Navy to complete the survey of Kaho'olawe. The crew consisted of Mr. William Barrera (principle investigator), Dr. Morgenstein, Mr. Marcus Child (all of HMR) and Mr. Watanabe. The data and preliminary results of the 109A investigations are presented in an earlier report (Hommon 1979). In the present

document, the data from all four features are compared.

The four archaeological features of site 109, like most of the 892 habitation features of Kaho'olawe's inland zone are activity areas that have been extensively damaged by erosion. Little is known of the specific form and contents of such sites in Hawaii, or of their significance, since they have not been reported on the other Hawaiian islands. The purpose of the 109 investigations was to determine the nature and archaeological value of these features to contribute to an understanding of the eroded activity area of Kaho'olawe as a general type.

Setting

Kaho'olawe is the smallest of the eight major Hawaiian Islands, having a land area of 45 square miles (c. 116.6 square kilometers). The summit of the island, Lua Makika crater, rises to an elevation of 1477 feet (c. 450 meters). Kaho'olawe is the most arid of the main islands both because its low relief limits orographic rainfall and because it is situated in the rain shadow of Haleakala (elevation 10,023 feet or c. 3055 meters), the mountain that forms the eastern part of Maui, 7 miles (c. 11.3 kilometers) to the north.

Estimated average annual rainfall varies from less than 10 inches (c. 254 millimeters) at Kealaikahiki Point, at the western end of the island, to slightly more than 25 inches (c. 635 millimeters) at Lua Makika. The dominant vegetation on the island includes the exotic kiawe (Prosopis pallida) tree and various grasses, including pili (Heteropogon contortus), an indigenous species of grass that was used by the ancient Hawaiians as thatching material.

The soil mantle has been removed from about one-quarter of the surface of Kaho'olawe (c. 7,750 acrew or c. 3136 hectares), exposing saprolitic hardpan that is almost totally devoid of vegetation. Most of the eroded area is gentle sloping land above 750 feet (c. 229 meters) in altitude in what may loosely be termed the central plateau of the island.

Kaho'olawe has been divided into three settlement zones on the basis of the differential distribution of ancient archaeological sites: the coastal zone (zone I), a strip of land about 400 meters wide with its seaward boundary determined by the shoreline; the inland zone (zone III), an irregularly-shaped area on the upper slopes of Lua Makika, mostly above the 325 meter contour; and the intermediate zone (zone II), which includes the rest of the island. Sites tend to be clustered in the coastal zone, especially at the mouths of major gulches and in the inland zone and are very sparsely scattered in the intermediate zone (Hommon 1980b:47-48). In general, it has been suggested that the coastal zone represents an emphasis on marine exploitation, perhaps supplemented by cultivation of the lower stream terraces; and that the sites of the inland zone represent extensive dry-land cultivation of crops such as the sweet potato (Hommon 1980b:57-60). Each of the zones is divided into subzones, designated by letters (e.g. subzone III-B) for descriptive convenience.

A four-phase model of Kaho'olawe's pre-Contact history has been developed on the basis of information collected during the historic resources survey, including chronometric data derived from basaltic glass samples collected at 612 habitation features (Hommon 1980b:52-67). The tentative sequence developed in this model may be briefly summarized as follows: During Phase I (c. A.D. 1000-1400), the island was first colonized and the population of the coastal zone grew to a few hundred. Phase II (c. 1400-1550) saw the continued use of the inland zone and an expansion of accupation into the inland zone. The population of the island is roughly estimated at about 725 around the year 1500. Phase III (c. 1550-1650) is marked by apparent depopulation, especially marked in the inland zone. Geoarchaeological evidence indicates that the large-scale erosion of the inland zone that eventually resulted in the extensive environmental degradation is evidence today was initiated early in the 16th century. It is suggested (Hommon 1980b:60-65) that this degradation may have been

associated with the extensive agricultural clearing of the inland zone during phases II and III. Phase IV spans the period 1650 to 1779, the year that the Cook expedition established contact with the Western world. During this phase, the island's estimated population dropped form about 400 to about 60, largely, it is suggested, as a result of the continued degradation of the terrestrial and inshore environments. (Hommon 1980b:65-67).

Site 109 is situated at an elevation of about 330 meters on gentle sloping (about 6° grade) denuded saprolitic hardpan approximately 1.7 kilometers northeast of Kamohio Bay and 300 meters east of Kaneloa Gulch (Figure 1). The area of the site is totally devoid of vegetation, although kiawe (Prosopis pallida) trees and various grasses are found on nearby remnant soil hummocks.

Site 109 is one of the sites that define the southern boundary of settlement subzone III-B, to the south of which is the relatively broad expanse of subzone II-D where sites are sparse. Sites such as 109, 242, 115, 477, 474 and 615 form the scattered fringes of the inland zone. To the north and east of site 109, the archaeological features are relatively tightly clustered in large complexes such as 110, 111, 614, 616 and 618 (Figure 1). It is evident, however, in the case of such "fringe" sites as 109 that the conditions that resulted in the density of features nearer the center of the inland zone were only minimally operable. It was noted earlier that the hypothesis that seems to best explain clustering of sites in the inland zone is that the inhabitants of these sites were practicing dry-land agriculture on the upper slopes of the island. It has been suggested (Hommon 1980b:58) that the inland sites cluster in that part of the island where rainfall was highest. Most of the inland zone sites are concentrated in that portion of the island where estimated rainfall is at least 25 inches annually. It is further suggested that beyond the boundaries of the inland zone the agricultural techniques being used were insufficient to produce crops efficiently.

The inhabitants of site 109, then, may have cultivated crops at the very margin of the zone of extensive inland agriculture.

Description

Site 109 is triangular in shape and measures about 50 meters (east-west) by 135 meters (north-south) by 190 meters (northwest-southeast). Features A, C and B determine the east, west and north corners of the site and feature D is near the center of the triangle (Figure 2).

The four features are erosionally lagged; that is, the soil that once formed the stratigraphic context of the cultural items has been totally eroded away, leaving the items resting on the saprolitic hardpan. Each feature is a discrete cluster of such items. The items belong to four general categories: 1) angular fragments of unworked basalt; 2) unworked marine mollusc shells; 3) fragments of coral: 4) artifacts, flakes and cores of basalt; and 5) flakes and cores of basaltic glass.

Abundant evidence collected during the Kaho'olawe survey indicates that the angular unworked basalt stones found in these and other activity areas of the inland zone were fractured by heat in fireplaces and imu (underground ovens). In general, stones of any size are rare in the hardpan areas of the inland zone and much of the intermediate zone. It is probable that the unworked stones, like all other items in the erosionally-lagged features were carried in by the inhabitants of those features. Most of the more than 150 fireplaces presently being exposed by erosion in the inland zone contain angular unmarked stones. It is reasonable to suggest that virtually all of the angular unworked basalt stones found in the features of site 109 were once in fire places and/or imu. These stones will be referred to here as "fire-cracked rocks".

Most of marine mollusc shells are probably the remains of fresh food carried from the coast and eaten by the inhabitants of site 109. Although artifacts of shell have been found at other inland sites, none of the shells found at site 109 show any evidence of having been worked.

Coral occurs in Hawaiian archaeological sites as construction materials (unworked pebbles and cobbles used for walls and pavements), as a symbol of sanctity in shrines (usually large unworked branched fragments) and as artifacts (most commonly as files or abraders of various shape). The fragments of coral from 109 are badly weathered so that their original form cannot be discerned. Their rarity and small size suggest that they served neigher as construction materials nor as sacred symbols. It is likely that these items are abraders or waste products disposed of during the manufacture of abraders.

The basalt flakes, cores, and adz fragments are of a finer-grained basalt than are the firecracked rocks. Some of the flakes may have resulted from the trimming of adz preforms carried to the site from site 108 or one of the other adz quarries.

Small basaltic glass flakes about the size of a thumbnail were probably used by the ancient Hawaiians for a variety of tasks requiring a fine cutting edge. The Kaho'olswe chronology has been constructed primarily on the basis of hydration rind analyses of items of basaltic glass. The chronometric data derived from site 109 basaltic glass items are discussed in a later section.

The four erosionally-laggee activity areas of site 109 consist of those items that have survived the effects of erosion and weathering. Some of the original contents of these features have disintegrated and/or have been removed by overland runoff. Fragile material such as charcoal have been removed entirely by the action of water and wind. Observations of features in various stages of destruction by erosion during the survey indicate that the smaller, more-fragile marine mollusc shells, such as those of Nerita picea, are

weathered rather rapidly and disintegrate into fragments that are small enough to be washed or blown away. In features that have been exposed to the elements, only the largest and those with the thickest cross-sections survive.

What remain in the four features of site 109, as in all of the erosionally-lagged features of Kaho'olawe, are those items that are sufficiently durable and massive to have escaped disintegration and/or removal by the forces of erosion. These items have been removed from their original archaeological context, that is, their spatial relationships with each other with other items and materials that have perished and removed, and with the soil strata within which they once existed. As the soil matrix of these features eroded away the remaining contents were deposited on the hardpan, where they were exposed to further disturbance by wind and overland runoff.

Each of the four features is described below in terms of size and the nature and distribution of its contents (Figures 3, 4 and 5).

Feature A. Feature A, by far the largest of the site 109 features (measuring 31 meters by 22 meters), contains more items in all categories than do the other features. A sparse scatter of erosionally-transported cultural items, especially small ones is commonly found extending downhill from an erosionally-lagged feature. In the case of feature A, the scatter was found to extend at least 300 meters. Feature A includes cultural items in all of the categories discussed above.

Feature B. The extreme dimensions of feature B are 23 meters (north-south) by 21 meters, (east-west) within which are a concentration of cultural items measuring about 13 meters by 7 meters and areas to the north and south with sparsely scattered items. The feature consists almost entirely of fire-cracked rocks.

Feature C. This is the smallest of the features in site 109, measuring only 10 meters by 10 meters overall. It consists entirely of fire-cracked rocks which are concentrated primarily in the central portion of the feature, which measures 10 meters by 3 meters.

Feature D. This feature measures 28 meters (north-south) by 16 meters (east-west) overall, with the cultural items concentrated primarily in an area measuring roughly 10 meters by 9 meters at the north end. South of this concentration which consists almost entirely of fire-cracked rocks, is a large area in which items are sparsely scattered. Several items of basaltic glass were found within this southern area.

Methodology

The formal aspects of features such as those of site 109 have been both simplified and distorted by the effects of erosion. Not only has the soil matrix of the features been removed, along with all perishable evidence, but also any significant vertical relationships (such as stratification) that once existed have been entirely destroyed and all horizontal relationships between the individual elements of the feature have been disturbed.

A broad range of archaeological procedures, including excavation of soil matrix and recording vertical relationships were precluded by the nature of the features. It remained necessary to record the contents of each feature and the horizontal distribution of the various categories of cultural items. The general procedure that was followed in order to record these patterns of distribution was to impose a rectilinear grid on each feature with compass and tape and to collect and/or record all cultural items found within each square.

The grid imposed on feature A is oriented according to the cardinal magnetic compass directions, with lines at 2 meter intervals (Figure 3). The following description of the labeling system is taken from the report on feature A (Hommon 1979:4):

> Grid-lines were established by compass and tape. Each grid-square was assigned a letter and number designation indicating its direction and distance from an origin point established arbitrarily near the center of the feature. The first part of the grid-square designation indicates whether it is north (N) or south (S) of the origin point; the second indicates the distance from the origin point in 2 x 2 meter squares; the third indicates whether it is east (E) or west (W) of the origin; and the fourth indicates the distance from the origin point in 2 x 2 meter squares. Thus, grid-square N3W5 is in the third rank north of the origin point and the fifth row west of the origin point.

The grid-line interval in the other four features was one meter rather than 2 (Figures 4, 5 and 6). In these feature grids, the origin points were placed outside of the features, one axis was assigned numbers and the other letters so that square designations were letter-and-number combinations such as K6. The long axes of the grids of features B and D are oriented at 255° magnetic and that of feature C is oriented at 240°. The gridded area of feature B measures 13 by 7 meters; that of feature C, 10 by 3 meters: and that of feature D, 10 by 9 meters. Sparse scatters of cultural items outside of the main feature concentrations were labelled north south and southeast sections in feature B, north and south sections in feature C and south section in feature D.

All cultural items except the metal fragments in the four features and the unworked basalt from feature A were collected, labelled according to grid square provenience and removed to Honolulu for laboratory analysis. All items, including the unworked basalt from feature A, were counted. In addition, the unworked basalt from features B, C and D were weighed.

Analysis

Feature Contents

A total of 6913 items were recorded in the 123 grid squares (i.e. 492 square meters) of feature A. Of these 5650 were archaeological items deposited during the ancient Hawaiian occupation of the feature. They include 4759 pieces of unworked basalt, 626 basaltic glass flakes and cores, 125 items of worked basalt, 131 mollusc shells and shell fragments and 9 pieces of coral (Table 1). The remaining 1263 items were pieces of metal, all of which seems to fragments of ordnance deposited since 1941, when the island first became a target range.

Feature B contained a total of 1549 cultural items, of which 1529 were pieces of unworked basalt. The remaining 20 items included 19 mollusc shells and shell fragments and one basalt core. The distribution of unworked basalt is summarized by number and weight in table 2. The basalt core was found in square J-12. Sixteen of the mollusc shells and shell fragments were collected from the south section. These included one nearly complete example and 7 fragments of limpet (Cellana sp.) shells, two fragments of cowrie (Cypraea sp.) shells, one fragment of thais (Thais aperta) shell and five unidentified fragments of shells. In addition, one complete limpet (Cellana sp.) shell was collected from the north section and a single limpet shell fragment was recovered from both squares J-11 and J-14.

Feature C contained 157 cultural items, all of which were pieces of unworked basalt (table 3). Within the central gridded section of the feature, 77 (or about 49%) of the pieces were situated in the 13 1 by 1 meter squares (24% of the feature area) that contained 4 or more pieces each. The remaining 15 square meters of the gridded section of the feature contained 12 additional pieces and the north and south ungridded sections contained 61 and 7 pieces respectively.

Feature D contained 947 cultural items, of which 929 were pieces of unworked basalt (table 4). The remaining eighteen items included 11 pieces of worked basaltic glass (5 flakes and 6 cores), five basalt flakes (two flakes in square) F6 and one each in E-5 I8 and E-5; one cowrie (Cypraea sp.) shell fragment and one unidentified mollusc shell fragment (square F8).

Unworked Basalt

The unworked basalt stones that constitute the great majority of cultural items at site 109 were of two general types: vesicular (containing numerous vesicles or cavities that resulted from gas bubbles present when the molten basalt solidified) and non-vesicular (containing few if any cavities). (See tables _____, _____ and _____).

The stones that were collected varied from 3 grams to 4.99 kilograms in weight. Total numbers of unworked basalt stones in recorded grid squares varied from 0 to as many as 74 per square meter in feature A, 71 in feature B, 14 in feature C, and 55 in feature D.

In Hawaii today vesicular stones are often preferred to nonvesicular ones for use in imu or underground ovens. It is believed that the cavities in vesicular stones allow them to withstand cracking and shattering when subjected to temperature changes. In an effort to determine whether vesicular

stones may have been selected by the inhabitants of site 109, the stones of both types found in each feature were tabulated according to both number and weight in Table _____. The average weight of each type and of all stones were also calculated. The total weights of both types of stone were estimated for feature A, using the mean figures for the other three features.

While no systematic survey was done in the vicinity of site 109, regarding the relative availability of vesicular and nonvesicular stones, general observation of Kaho'olawe's bedrock indicates that both types of stone were available to the inhabitants of site 109 in approximately equal quantities and could have been collected with the expenditure of approximately the same amount of effort. If it is assumed that vesicular and non-vesicular stones were equally available, features B, C and D do not seem to evidence strong preference for stones of either type (Table ____). Additionally, neither type of stones appear to be clustered within any feature. In Feature A, nearly 96% of the unworked stones were non-vesicular (Table ____), suggesting , given the assumption of equal availability, that nonvesicular stones were preferred over vesicular ones.

Spatial Distribution

The spatial distribution of the unworked basalt in each of the four features and that of other categories of items in Feature A are depicted in terms of numbers per grid square in Figures ____ through ____. The contour lines in each of these figures connect areas of equal density per square, as shown by the numerals on the contour lines. This treatment of the data graphically illustrates the locations and dimensions of the concentrations of items in contrast with the areas of altenuation. Each of the concentrations of unworked basalt is believed to represent at least one fireplace or imu.

Most of the concentrations exceed the expected dimensions of a fireplace (approximately 30 to 75 centimeters square) or an imu (approximately 30 to 75 centimeters square) or an imu (approximately 1 to 2 meters in length). Two factors are probably responsible. First, a single concentration may be the remnants of two or more fireplaces and/or imu that were close together laterally (either in the same or different strata). Second, as the soil matrix was eroded from the stones, it appears that the latter tended to spread outward laterally from the original center with a slight tendency to be displaced farther in the downhill direction.

Feature A includes two major concentrations of unworked stones near the northeast and northwest corners of the feature, and two minor concentrations southeast of the northwest major concentration (figure ____). In Feature A, items other than unworked basalt were numerous enough to be usefully depicted in contour diagrams. It is of interest to note that the concentrations of basaltic glass, basalt flakes and mollusc shell and coral are well within the boundaries of the feature as delineated by the concentration of unworked basalt. It appears, then, that the basaltic glass, worked basalt, coral and shell items have not been erosionally transported significantly greater distances than have the unworked basalt stones, despite the fact that the former are generally smaller and/or less massive than the latter. The main concentration of items of basaltic glass is about 60 square meters in extent in a roughly rectangular area from squares N3E2 and N3E4 on the north to S2E2 and S2E4 on the south. The main concentrations of both basalt flakes and coral and mollusc shells are situated within this 60 square meter rectangle. The main basalt flake concentration is bounded by squares N3E2 and N3E3 on the north and S1E2 and S1E3 on the south (32 square meters). The main concentration of coral

and mollusc shells is a 36 square meter area bounded by squares N1E2 and N1E4 on the north and squares S2E2 and S2E4 on the south.

Feature B includes of a large concentration of unworked basalt stones at the center of the north side of the feature and two less dense concentrations to the southwest and east (Figure ____).

Feature C consists of a single concentration of unworked stones with a very low density of stones per square meter (Figure ____).

Feature D includes a major concentration of unworked stones in the southern half of the gridded area, two less dense concentrations to the northeast and a third at the southwest corner of the feature (Figure ____).

An essential factor in the analysis of erosionally-lagged features of the type that compose site 109 and many other sites and features on Kaho'olawe is the estimation of the number, size and type of fireplaces and imu represented by the firecracked rocks that remain. Such estimates have the potential of contributing significantly to an understanding of the time-span, degree of permanence, intensity of use and function of these sites and features.

As of this writing no useful data have been collected from Kaho'olawe sites other than site 109 itself that would be useful in arriving at estimates regarding the site 109 fireplace and imu remnants. It is expected that as intact and partially-intact fireplaces during management and research activities on Kaho'olawe such basic yet useful information as their size and form, their relationships with other archaeological data and the number, weight and size of the unworked stones in the fireplaces. For the present, a series of estimates of the number of fireplaces have been arrived at on the basis of data from site 109 itself and on general observations of fireplaces and imu in Hawaiian archaeological sites (Table ____).

Table ____ include two estimates of the maximum number of fireplaces in each feature and as many as three estimates of the maximum number of imu in each feature if the unworked basalt in each were the remnants exclusively of fireplaces or imu. The estimates of numbers of fireplaces are based on the assumption that feature B is the remains of no more than two fireplaces. Surface observations of intact fireplaces on Kaho'olawe suggest that the 23.142 kilograms of unworked basalt that constitute Feature B probably represent a single stone-lined fireplace, though it is possible that two small or incompletely-lined fireplaces are represented. The two columns of estimated numbers of fireplaces in each feature are based on the assumption that the fireplaces of site 109 contained an average of 23.142 kilograms or one half this quantity (11.571 kilograms).

The estimates of the maximum numbers of imu, if all unworked basalt stones were the remnants of imu, are based on the assumption that an imu contained an average of 50, 100 or 150 kilograms of stones.

Chronometric Analysis

Of the 637 basaltic glass items collected from site 109, a total of 65 items, including 54 from Feature A and all 11 items from Feature D, were subjected to hydration rind analysis to provide chronological information concerning the occupation of these two features. The theory of dating by hydration-rind analysis is summarized in the following excerpt from the Kaho'olawe Overview (Hommon, 1980: item 7, pp. 2-3):

> Hawaiian basaltic glass is similar to obsidian and was flaked by the ancient Hawaiians to make small, sharp cutting implements. Most of the basaltic glass flakes and cores used for dating Kaho'olawe features were collected from the surface where they had been redeposited after having been eroded from their primary cultural context. The date of each basaltic glass sample collected from a feature is usually assumed to fall within the feature's period of occupation.

The hydration rind dating technique is based on the fact that when the surface of basaltic glass is exposed to the atmosphere, a process is begun whereby the glass is chemically altered to become palagonite. This process proceeds inward toward the center of the sample at a very slow rate in a direction that is perpendicular to the surface. To determine the age of a particular glass surface, the microscopic thickness of the band of altered glass, called the hydration rind, is measured and a hydration rate factor is applied to the result. The number derived represents the number of years the dated surface has been hydrating. The event dated is assumed to be the exposure of a previously unhydrated ("fresh") surface as a consequence of human modification of the basaltic glass flake or core during tool manufacture.

While the basaltic glass chronometric data used in this document are usually referred to as "dates", it should be noted that the variation in the ten measurements of the rind thickness made on each sample and in other factors result in ranges that usually span 32 to 60 years. The "date" of a basaltic glass sample is usually written as the average year date followed by a plus or minus factor to indicate the date range. Thus, for example the date of the sample from feature 359H is 1647±25. The range within which the dated sample was flaked is 1622 to 1672.

The hydration rate of 11.77 microns per 1000 years has been used in all Kaho'olawe basaltic glass age-determinations. Ongoing research being conducted to determine the effect of such variables as the chemical composition of the basaltic glass from various sources and the effective temperature of archaeological contexts upon the rate of hydration have not yet produced useable results. The hydration rate of 11.77 microns per 1000 years has been shown to be at least as reliable in determining archaeological chronology as the radiocarbon method (Hommon, 1976:181-188; Morgenstein and Riley, 1975:153-156). This rate is considered useful for present purposes.

The chronometric information from Feature A is summarized as follows:

The dated basaltic glass samples are from eleven squares in the northeast-quadrant of the features. The dates range from A.D. 1406±16 to 1640±18. Twenty-one of the dated samples,

> including those with the earliest and latest dates, were recovered from square N1E2. The dated samples tend to cluster increasingly toward the late end of occupation at Feature 109A, as is indicated in Figure 1. For example, 43% of the sample medians date from the last 25% of the total occupation span as indicated by the sample medians; and fully 20% of the medians are found to date from the final 10% of the indicated occupation span, as compared with only 7% during the first 10% of the span. The date in hand seems to indicate that the intensity of working basaltic glass increased with time at 109A, and that this activity then ceased in the early 1600's (Hommon 1979:7).

The chronometric information from the eleven basaltic glass samples collected at Feature D are tabulated in Table ____. The dates range from 1593±19 to 1662±17, representing a span of about 69 years. If the median values of samples from both features are used, their occupation spans overlap for a period of 53 years.

It has been suggested elsewhere that if Feature A were occupied intermittently rather than continuously, the chronometric data from the basaltic glass samples may represent a minimum of six occupations. "This minimum figure is arrived at by determining the smallest number of year dates that would include some part of the ranges of all dated samples." (Hommon 1979:11). The six year dates were A.D. 1422, 1448, 1500, 1539, 1591 and 1625. If the same technique is applied to the chronometric data from Feature D, a minimum of two occupation years, about 1610 and about 1650, is obtained.

Conclusions

At this writing, site 109 remains the only Kaho'olawe site that has been subjected to intensive research. In the absence of detailed information about other sites of the Inland Zone with which the site 109 data could be compared, many of the conclusions discussed below are tentative in nature. Despite this fact the 109 research not only contributes significantly to our understanding of pre-Contact Kaho'olawe but also has proved extremely useful for designing future intensive research at Kaho'olawe sites, especially those in the inland zone. The site 109 data serve as a general guide to the nature and contents of the erosionally lagged sites, procedures that will prove useful in future work and to questions that can be profitably asked of the data that are collected.

Essential to an understanding of the erosionally-lagged features of site 109 and similar sites is an interpretation of the internal clusters of unworked basalt stones and other types of items. The factors that may have produced these clusters can be divided into two major categories: natural and cultural. The near-absence of unworked basalt stones on the hardpan outside of archaeological sites and features, and their strong tendency to cluster in these sites and features in association with artifacts and midden materials, demonstrate that these stones were brought to these sites and features by their inhabitants. Evidence discussed earlier indicates that most if not all the unworked basalt stones in site 109 and other Inland Zone sites were originally used to line or fill fireplaces and/or imu (underground ovens). Clearly cultural, rather than natural factors are responsible for the introduction of all of the items that constitute an erosionally-lagged feature. Such factors, involving human activities at the features, are also primarily responsible for the horizontal and

vertical pattern of these items as they existed before the removal of the soil matrix by erosion. This erosion, which took place for the most part after the abandonment of the feature, is responsible for the distortion of the spatial patterns that had resulted from cultural factors. Erosion has distorted the original pattern by disintegrating and removing some materials, by collapsing all vertical relationships within the feature so that all remnant materials now lie on the hardpan in a two-dimensional array; and by moving materials laterally from their original positions.

Two of these types of distortion can be dealt with only superficially in the absence of comparative data from intact Inland Zone features. The materials lost from site 109 almost certainly included charcoal from each of the fireplaces and the smaller and lighter mollusc shells such as those of the nerite, Nerita picea. In the Inland Zone, shells of this species are found only in and near soil deposits that are currently being eroded (such as site 203), and not in erosionally lagged features, where only the larger more massive shells remain. Little can be learned from the study of site 109 alone concerning the original vertical pattern that collapsed to form the present two-dimensional one. It is expected that future research conducted at intact Inland Zone sites will provide useful information concerning quantity and lateral distribution of cultural materials in a single stratum, and the nature of stratification in such sites.

Regarding the third factor, lateral distortion, the investigations of site 109 provide somewhat more information. As noted previously, the contour diagrams of the four features (Figures _____) suggest that clusters of unworked basalt stones and other materials have been dispersed laterally, with an apparent tendency in some cases to be displaced somewhat greater

distances in the downslope direction. It is suggested that each of the clusters of unworked basalt stones in site 109 represents the remnants of one or more fireplaces and/or imu. More generally, it is suggested that the spatial patterns of unworked basalt stones observed at most erosionally lagged sites on Kaho'olawe are due largely to cultural rather than natural factors, though these patterns have been subsequently distored by erosion. Exceptions to this generalization may be found to be those sites situated on slopes significantly steeper than that of site 109.

Of the four features of site 109, only Feature A contained sufficient artifactual and midden materials to address the problem of spatial distribution of items other than unworked basalt stones. The clustering of flakes and cores of basaltic glass, basalt flakes, fragments of coral and mollusc shells has been noted earlier in this report. It is suggested that these conclusions represent one or more functionally specific areas, where tasks such as the production of lithic tools took place, and/or a refuse area where debris was deposited.

Data from Features A and D, the only features for which chronometric data are available suggest that the quantity of unworked basalt stones in a feature may be roughly correlated with the total occupation span of the feature. Feature A, evidently occupied for approximately 234 years, contained an estimated 636 kilograms of unworked basalt stones. Feature B, which contained only 66.22 kilograms of unworked basalt stones yielded basaltic glass dates that spanned only 79 years. While the observed correlation is by no means precise, the site 109 research provides a rule of thumb for obtaining rough estimates of occupation spans of erosionally features on the basis of surface observations.

Chronometric data from Feature A indicates that its occupation spanned Phases II and III, during which the utilization of the Inland Zone grew to a maximum extent and then declined. The dated samples from Feature A tend to cluster around the end of its occupation span. This, together with the apparent contemporaneity of Features A and D (c. A.D. 1593-1640) may indicate that site 109 was more intensively used at the end of its occupation span than at its beginning.

The four features of site 109 differ from one another in a number of respects. Feature A contains about 28 times the weight of unworked basalt stones of stones in Feature C suggesting small-scale, short term use of the latter. Feature A contains a very small proportion of vesicular unworked stones as compared with non-vesicular ones, unlike the more equal proportions found in the other features. The working of basaltic glass appears to have been an intensive and/or a long term activity at Feature A and an infrequent activity at Feature D. Feature B contains about 4.5 times the weight of unworked basalt found at Feature D, suggesting that the former may have been used more intensively and/or for a longer period of time than was the latter. Yet the absence of basaltic glass and the near absence of worked basalt at Feature D suggests that it was utilized in a way that differed from both Features A and D.

The chronometric data from Features A and D, the relative proximity of the four features and their formal variability may indicate that two or more of the features were functionally specific elements of a small local settlement cluster. For example, Feature B, with its large cluster of unworked basalt stones, a relatively large proportion of which are vesicular may be primarily the remnant of an imu or succession of several imu. Feature B, then, may have been a hale imu or cooking house. Feature A, on the other hand may have been the locus of most other activities of the local group: the preparation

and use of lithic tools, eating and sleeping. In such a feature, fireplaces for warmth light and the cooking of small parcels of food may have been used rather than imu. The high proportion (c. 95%) of non-vesicular stones at Feature A may reflect a preference for such stones for fireplaces rather than imu