1A
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Feature E contained 157 cultural items, all of which were pieces of unworked basalt (Table 3). Within the central (or about 49%) gridded section of the feature, 77 (24% of the feature area) of the pieces were situated in the third 1 by 1 meter squares 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.

929
936

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), two basalt flakes (in squares F6 and one each in E-8, E-5 and I-8) and one cowrie (Cypraea sp.) shell fragment and one unidentified mollusc shell fragment (square F-8).

Feature A = 636 kg a cube (c. 1402 lbs
~~11.76~~ ~~88.5 78 cm on a side~~
containing 1,634,138.4 cc. = 117.78671 cm. on a side
1.634 cu. meter = 2.137 cu. yds

71
74 in A

1B

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Unworked Basalt

The unworked basalt stones that constitute the great majority of cultural items at site 107 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). ~~The numbers and weights of the unworked stones in the grid squares of features B, C and D are shown in~~ (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.

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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,

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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. ~~The above percentage figures in Table ___ appear to indicate that in Features B, C and D, when considered as a unit,~~

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 (~~see percentage figures~~ Table ___). Additionally, neither type of stones ~~does~~ appear to be clustered within any feature. In Feature A, nearly 96% of the unworked stones were non-vesicular (Table ___), suggesting, given the assumption ~~that if both types were equally~~ of equal availability, that nonvesicular stones were preferred over vesicular ones.

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~~stones were preferred over nonsiliceous ones.~~

Spatial Distribution

The spatial distribution of the unworked basalt in ~~in Feature A~~ each of the four features and that of other categories of items in Feature A in terms of numbers per grid square, are depicted 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 attenuation. Each of the concentrations of unworked basalt is believed to represent at least one fireplace or imu.

~~The illustrations~~

52,500

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spelling?

Most of the concentrations exceed the ~~usual~~ expected dimensions of a fireplace (approximately 30 to 75 centimeters square) or an imu (approximately 1 to 2 meters in length). Two factors ~~may be~~ are probably responsible. First, ~~the~~ ~~some~~ a single concentration may ~~be the remains~~ ~~rept~~ be the remnants of two or more fireplaces and/or imu that were close together laterally, either in the same or ~~and/or~~ ~~more~~ different strata ~~vertically (i.e. in various strata)~~. Second, as the ~~stones were removed from their original soil matrix~~ soil matrix was eroded from the ~~same~~ stones, ~~there~~ it appears that ~~was a tendency for~~ the latter ~~seem~~ tended to spread outward laterally from the original center, with a slight tendency to be displaced farther in the downhill direction. ~~While there~~ a slight tendency toward a greater ~~degree~~ attenuation of items in the downhill direction ~~is also~~ can be seen ~~in the~~

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~~figures~~, ¶ Feature A includes two major concentrations of unworked ~~stones and two minor ones~~ 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 contours diagrams ~~Fig~~. ~~It~~ 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. ~~Interesting that the items of basaltic glass, worked basalt, and shell and coral items~~ If it ~~seemed~~ that it appears, then, that the ~~item of~~ basaltic glass, worked

Rai (RAI)

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basalt, ~~and~~ coral and shell items have not been erroneously transported significantly ~~farther~~ greater distances than have the unworked basalt stones, despite the ~~fact~~ fact that the former are generally smaller and/or less massive than the latter. The main concentration of items of basaltic glass is ~~in an~~ about 60 ~~meter~~ 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 ~~in and~~ situated within ~~these~~ ~~60 sqs~~ 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 concen-

tration of coral and mollusc shells in 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 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, and two less dense concentrations to the northeast and a third at the southwest corner of the feature (Figure ——).

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An essential factor in the analysis of ~~the~~, 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 ~~fire~~ ash-represented by the fire-cracked rocks that remain. Such estimates have the potential of ~~making~~ contributing significantly to an understanding of the time-span, ~~&~~ degree of permanence, intensity of use and function of ~~such~~ these sites and features.

~~As yet~~, As of ~~this~~ this writing ~~of this report~~, no useful data have been collected, from Kaho'olawe sites other than site 109, that would be useful in arriving at ~~estimates~~ estimates ~~of the~~ regarding the site 109 ~~features~~ fireplace and ash remnants. It is expected that as intact and partially-intact fireplaces are excavated ~~during or during the management~~

during management and research activities on Kaho'olawe such basic yet useful information as ~~to~~ their size and form of ~~fireplaces~~, their relationships with other archaeological data and ~~size and~~ the number, ~~and~~ weight and size of the unworked stones in the fireplaces. For the present, a series of estimates of the number of fireplaces ~~have~~ have been arrived at ~~#~~ on the basis of data from site 109 itself and on ~~extens~~ ~~rough estimates~~ general observations of fireplaces and imu in Hawaiian archaeological sites (Table ___).

~~In Table ___, the estimate~~
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

~~Steve Spence~~

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the unworked basalt in each were the remnants ~~each feature consisted~~, exclusively of fireplaces or imu. ~~The~~ 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).

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

626
11
637

54
11
65

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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):

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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.

Student to Simple Source

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. (Hommon, 1980: item 7, pp. 2-3).

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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 1600s (Hommon 1979:7).

Indent & Single Space

The ~~eleven~~ chronometric information from the eleven basaltic glass samples collected at Feature D are tabulated in Table ___. The ~~median~~ dates ~~from~~ range from 1593± 19 to 1662 ± 17, representing a span of about 69 years. If the ~~and~~ median values

Table X

1662 − 1593 = 69 ; 1640 − 1593 = 53 ; overlap: 53 yrs.

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~~are used~~ of samples from both features are used, the occupation spans overlap for a period of ~~about~~ 53 years.

~~In the report on early reports~~

It has been suggested elsewhere that if Feature A were ~~not~~ occupied ~~continuously~~ intermittently rather than continuously, the basaltic glass ~~fragments~~ 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.

~~Having the same techniques The minimum~~
If the same technique is applied to the chronometric data ~~Using Applying the same reasons~~ from Feature D, ~~a~~ a minimum of two occupation years, ~~is obtained. 1610 and~~ about 1610 and about 1650, is obtained.

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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 usefulness of the zone site 109 data~~ The site 109 data serve as a general guide to the nature ~~lies both in the context lies both in the research questions~~ and contents of the erosionally lagged sites, to ~~useful pro-~~ ~~that they are raised, and in~~ cedures that will prove useful in future work and to questions that can be profitably asked of the data that are collected.

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Essential to an understanding of the features of site 109 and similar sites is an interpretation of the internal clusters of unworked basalt, 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 the 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 ~~vine~~ (underground

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owners). 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; ~~such as charcoal and certain mollusc shells~~; 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 distorted 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 ~~shell~~ 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

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It is suggested that earlier in this report, these concentrations 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. ~~On the basis of present evidence, differential deposition of the midden and artifactual materials as compared with unworked basalt stones~~

The fact that the concentration of the artifactual and midden materials remains well within the boundaries of Feature A as determined by the distribution of unworked basalt stones

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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 ~~about~~ 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 features erosionally on the basis of surface observations.

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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. ~~Both the fact that~~ 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. ~~Whether the suggested intensity of use~~ Whether

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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 suggesting small-scale, short term use of the latter. Feature C, Feature A ~~also~~ 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, ~~but the working of basaltic glass evidently was not worked at the larger feature. The presence of the~~ fine basalt

suggesting that the former may have been used more intensively ~~or~~ 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 ~~functioned~~ was utilized in a way that differed from ~~that~~ both Features A and D.

~~The formal variation in the four features may reflect some degree of functional specialization.~~

The chronometric data from Features A and D, ~~and~~ 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, ~~and its~~ stones,

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a relatively large proportion of which are vesicular may be primarily the remnant of ~~a single~~ 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 ~~contained all~~ other activities of the local group: the preparation and use of lithic tools, eating and sleeping. ~~The high proportion of non-vesicular stones in Feature A may evidence the selection a succession of fireplaces rather than imu~~

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