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Cogitating Prehistoric Archaeological Landscape With Pattern Recognition

Prakash Sinha

Department of Ancient History, Culture & Archaeology, University of Allahabad – 211002. e-mail: passinha@yahoo.com

Abstract

An attempt has been made in this paper to bring together the results obtained by the author, using quantitative method, from a number of case studies in temporal and spatial dimensions. Typological classification of artifacts helps in comparing two or more assemblages in totality but hardly leads us to understand the dynamic context or the structural correlation with the type of sites that created the archaeological landscape. The human brain works by extracting patterns of information from the senses and accordingly sets up models of what it perceives or imagines the world is like and models are continuously updated. The use of multivariate analysis does provide a pattern(s). Based on such generated pattern — grouping of tools, for example — brain starts setting up models. It seems that unless and until results are validated with the help of other pattern(s) of independent data, its reliability may remain questionable.

Key words: Pattern, archaeological landscape, temporal and spatial dimensions, Multivariate techniques, models, microwear, phytolith.

1 Introduction

A number of Stone Age sites have been reported from different parts of India. The context of these sites, especially those ranging from the Lower Palaeolithic to Upper Palaeolithic, have always been controversial. It is, perhaps, primarily because of their archaeological context. Most of them are open-air surface sites either located on the slopes of the hills or exposed geological deposits. Analysis of the physical condition of the assemblage of artifacts, indeed to some extent, help us to identify their context especially — primary or secondary. Typological classification of artifacts helps in comparing two or more assemblages in totality but hardly leads us to understand the dynamic context or the structural correlation with the type of sites that created the archaeological landscape. It is, therefore, necessary to find out ways of discovering the nature of this archaeological landscape and the factors that conditioned the deposition of artifacts (assemblages) differentially within it. Perhaps the answer lies in the fact that we require an interpreter i.e. bridging argument.

2 RAW DATA

The Dhanuhi Rock-Shelter, a late Upper Palaeolithic site in the Rewa District, Madhya Pradesh, India had been excavated for two seasons 1996 and 2002.[1] An exercise was carried out primarily on a number of assemblages excavated at Dhanuhi Rock-shelter in the first season — 1996 (see Fig. 1-3).

Figure-1: General view of Dhanuhi Rock-shelter, Adwa Valley, Rewa District, M.P., India.

Inventory of the artifacts/objects and the assemblages recovered from the excavations

[1] P Sinha, "Retrieving, recording and analyzing archaeological evidence: a modified approach," *Journal of Interdisciplinary studies in History and Archaeology,* Vol. I (1) (2004):119-129.

therein are presented through tables (see Fig. 4-5). The raw counts of artifacts/objects taken into account are from levels/spits - 9, 8 and 7 of grids (1x1 m) C-6, C-7, D-6, D-7 and D-8 (see Tab. 1); grids (1x1 m) B-4, C-6, C-7, D-6, D-7 and D-8 (see Tab. 2) and grids (1x1 m) B-4, C-6, C-7, D-6, D-7 and D-8 (see Tab. 3), respectively. Tables 4 and 5 show the inventory of raw counts of artifacts /objects and raw materials recovered from different assemblages, levels/spits (2-18) of grid C-6 (1x1 m). Two assemblages of grid C-6 labeled spit 17 and 18 contain raw count of artifacts recovered from baulk of spits 5 to 13 and spits 5 to 14, respectively.

Figure-2: Close up of excavated grids showing different levels/spits, Dhanuhi Rock-shelter, section facing South.

Figure-3: Close up of excavated grids showing different levels/spits, Dhanuhi Rock-shelter, section facing North.

3 QUANTITATIVE METHODS

A number of statistical techniques are available to us for quantitative analysis.[2] One of the basic issues in archaeology is which technique should be applied where and for what purpose or to which end. Various statistical techniques — basic to advance and univariate to multivariate have been applied in archaeology. This reflects the fact that different techniques are appropriate for different kinds of data, and different approaches in

Figure-4: Excavated Shaped, Modified and Waste Artifacts, Dhanuhi Rock-shelter.

Figure-5: Excavated hammer stones and anvil, Dhanuhi Rock-shelter.

[2] M. J. Baxter, *Exploratory Multivariate Analysis in Archaeology* (Edinburgh: Edinburgh University Press, 1994). M. J. Baxter, "Multivariate Analysis in Archaeology," in *Hand Book of Archaeological Sciences,* ed. D. R. Brothwell and A. M. Pollard (England: John Wiley & Sons Ltd., 2001), 685-694. M. J. Baxter and C. E. Buck, "Data Handling and Statistical Analysis," in *Modern Analytical Methods in Art and Archaeology,* ed. E. Ciliberto and G. Spoto (New York: John Wiley, 2000), 681-746. D. R. Brothwell, and A. M. Pollard Introduction to *Hand Book of Archaeological Sciences*, ed. D. R. Brothwell and A. M. Pollard (England: John Wiley & Sons Ltd., 2001), xvii-xx. R. D. Drennan, *Statistics for Archaeologists* (New York: Plenum Press, 1996). P. Sinha, *Model For Land-Use In Late Acheulian Tradition* (Satna District , Madhya Pradesh) (Allahabad: Prayag Pustak Sadan, 1991).

generating archaeological informative data that lead obviously to different data types.

The scope of this paper is neither to elaborate a comparative study of different statistical tools involving critical assumptions about the data, distribution of data, autocorrelations, sample size among the cases/assemblages, various transformations — percentage or ratio values, nor to discuss merits and demerits or practical applicability of these techniques in archaeological studies, but to understand 'for what' the technique has been used and this requires some explanations.

The human brain works by extracting patterns of information from the senses and accordingly sets up models of what it perceives or imagines the world is like and models are continuously updated. At a more pragmatic level, this would imply that there is some complex structural thinking process, which attempts to link this available perception or imagination of visual patterns. The basic question before us is how to identify these in archaeological evidence and then assign a rationale for it. This paper believes that the challenge in this regard is methodological.

Application of quantitative methods on archaeological variables hardly reveals cause and effect equations in the formation of archaeological landscape including inter-site and intra-site variations. It is true that several studies in Social Sciences and Natural Sciences were carried out on pattern analysis. The application of quantitative methods facilitates in generating pattern(s). In archaeology, like other sciences, an archaeologist is required to provide a rationale to the generated pattern(s) of data so as to test the validity and reliability of the same. In this regard perhaps the recovered pattern(s), if any, act as interpreter i.e. bridging argument.

In this paper, an attempt has been made to bring together the results obtained by the author, using quantitative method, from a number of case studies both in temporal and spatial dimensions.

4 ANALYTICAL PROCEDURE

The approach followed in this paper for pattern recognition is multivariate study in which normalized matrix is subjected to Singular Value Decomposition (Principal Component Solution).

In this exercise, raw counts of various assemblages/spits transformed by calculating *Chi-square* values for all cells in the matrix of rows (cases — assemblages/sites) and columns (variables — tool classes/objects). These transformed normalized values meet all the requirements of basic multivariate approaches. *Chi-square* values are measured deviations from the assumption that all cases are identical and only vary in size. While rows and columns totals are used to obtain the *Chi-square* values, the direction – plus and minus and the magnitude of the value measures quite directly the differences among the cases as evaluated from these totals. The *Chi-square* values normally distributed fulfill a typical assumption of multivariate technique. The normalized matrix thus obtained is then subjected to Singular Value Decomposition (SVD), the basic multivariate strategy standing behind Principal Component Analysis (PCA). A number of analytical steps are carried out with the aid of computer using statistical package — SPSS (version 14.01). In this process, two tables are generated. The first provides dimensional scores for the cases (assemblages/sites) and the second indicates the dimensional scores for the variables. The dimensions of SVD scores are positive (plus) or negative (minus) because of *Chi-square* values. The results are readable as inversely related suites of variables. The positive and negative sign identifies the character of the content of a case relative to the dimensions among which variables are distributed[3].

5 ANALYSIS

An exercise of putting together results obtained from multivariate analysis on the above mentioned raw data is carried out in the following two steps. In all the cases, raw material/artifacts/objects is

[3] L. R. Binford, "Technology of Early Man: An Organizational Approach to the Oldowan", in *Debating Archaeology,* ed. L. R. Binford (London: Academic Press Limited, 1989), 437-463. P. Sinha, "Enhancing Understanding of Prehistoric Archaeological Landscape with Pattern Recognition" (paper presented at the National Seminar on 'Use of Quantitative Methods in Archaeology in India' for the Centre for Archaeological Studies & Training, Eastern India, Kolkota, India, November 5-7, 2008).

treated as variables (columns) while assemblages/sites/spits as cases (rows).

Step-I: To isolate spatial patterning, if any, during late Upper Palaeolithic Culture.

Step-II: To isolate Temporal patterning, if any, during late Upper Palaeolithic Culture.

STEP-I (Table: 1-3)

Analysis of data recovered from the excavations at Dhanuhi Rock-shelter was put to multivariate analysis by following the analytical procedure mentioned above. Three matrices were developed, one each for Spit-9, Spit-8 and Spit-7, primarily to understand the spatial pattern, if any.

SPIT-9 (Table: 1)

Data recovered from 1x1 m grids numbered C-6, C-7, D-6, D-7 and D-8 of the spit-9 was tabulated in rows (grids) and columns (artifacts/objects). The matrix was put to standardization and SVD, as mentioned in the analytical procedure.

Principal Component Solution for grids suggest that in dimension-1 only grid D-6 has plus values while the remaining have minus values. Grids C-6 and C-7 are heavily loaded in comparison to other grids D-6, D-7 and D-8 (see Tab. 6, Fig. 6). Dimensions 2 & 3 suggest that there is no significant change in D-7 over the period of spit-9, but for others there is inverse covariation. It seems that tools assisted activities of suites of tool classes having inverse covariation in dimensions 2 & 3, also performed in the grids C-6, C-7, D-6 and D-8.

Among all the assemblages, regardless of age or depositional condition, the great amount of systematic covariation is in opposition in dimension-1 between artifact/object classes (variables) indicate two groups. Group-1 with negative values consists of backed blade (convex, straight), backed blade fragments, lunate (symmetric), retouched/modified blade fragments and core rejuvenating (plunging) while the remaining artifacts with positive values (see Tab. 7, Fig. 7).

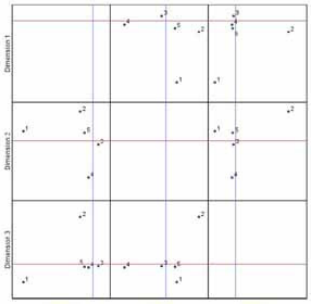

Figure-6: Principal Component Solution: Cases (grids), Spit-9, Dhanuhi Rock-shelter.

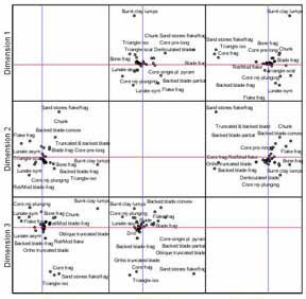

Figure-7: Principal Component Solution: Variables (Artifacts), Spit-9, Dhanuhi Rock-shelter.

Dimensions 2 & 3 suggest that there are two suites of tool classes with plus or minus values and the third group has inverse covariation between dimensions 2 & 3 (see Tab. 8). Group-1 with positive values consists of backed blade (convex, straight, partial), truncated & backed blade, blade fragments, flake fragments, core preparation (crested, long), chunks, hammer stone and ochre nodules. Group-2 with negative values comprises of drills, oblique truncated (blades, flakes), triangle (isosceles, scalene), retouched/modified (blades, flakes), backed blade fragments, flakes, core rejuvenating (transverse), cores (single platform-normal), core fragments, anvils and charred bone fragments.

The third group (Group-3) with inverse covariation includes denticulated blades, end scrapers, scrapers, lunate (asymmetrical), truncated & backed blade fragments, retouched/modified blade fragments, blades, core rejuvenating (plunging), cores (single platform-pyramidal), punch objects, sand stone flakes/fragments, bone fragments and burnt clay lumps.

In this process we isolated some interesting pattern — Group-1 represents cutting tool kits; Group-2 pointed and piercing tool kits; Group-3 represents

scraping tool kit; core preparation with Group-1; and core rejuvenation with Group-2. It is interesting to note that hammer stones are associated with core preparations (Group-1). Lithic work was going on along with other activities in all the grids as suggested by all the groups. Group-3 activities would have been carried out in all the grids — showing inverse covariation. Activies of Group-3 were plausibly craft activities as suggested by the presence of denticulated blades, end scrapers, scrapers, lunate (asymmetrical) and truncated & backed blade fragments — used in preparing objects on non-lithic material as bamboo, palm, etc. (analysis of phytoliths also support the presence of these materials in spit-9).

If loading plus and minus for cases (grids) has any relevance then it suggests that in grid C-7 Group-1, in grids D-6 and D-7 Group-2 and in grids C-6 and D-8 Group-3 activities would have been in currency.

SPIT-8 (Table: 2)

Analysis carried out on the objects recovered from grids B-4, C-6, C-7, D-6, D-7 and D-8 of spit-8 reveals that in dimension-1 for the cases (5 grids) here too as in spit-9 only one grid C-7 has positive values and the rest of the grids have negative values. However, grids with negative values are heavily loaded. Dimensions 2 & 3 show that the grids D-6, D-7 and D-8 hardly witness much variation in activities over the period of spit-8. However, in other three grids inverse covariation was recorded (see Tab. 9, Fig. 8).

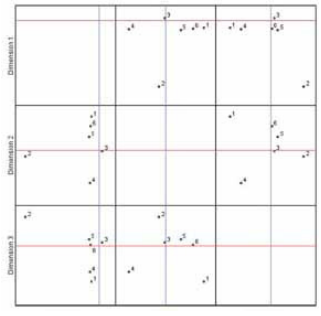

Figure-8: Principal Component Solution: Cases (grids), Spit-8, Dhanuhi Rock-shelter.

Among all the assemblages, regardless of age or depositional condition, the systematic covariation is in opposite in dimension-1 between artifact/object classes indicating two groups — Group-1 with only two artifact classes — blade fragments and chunks with minus values while the remaining tool classes (Group-2) have plus values. Further, analysis suggest that Group-1, in fact is similar to Group-1 of dimensions 2 and 3 with minus values (see Tab. 10-11, Fig. 9).

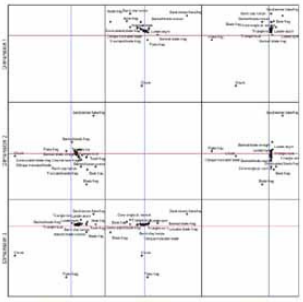

Figure-9: Principal Component Solution: Variables (Artifacts), Spit-8, Dhanuhi Rock-shelter.

Group-2 of dimensions 2 &3 with plus values consists of backed blades (partial), backed blade fragments, lunates (asymmetrical, symmetrical), triangles (isosceles, scalene), truncate & backed blades, percoirs, retouched/modified blades, retouched/modified blade fragments, flakes, core rejuvenation (plunging, transverse), core fragments and sand stone flakes/fragments.

Group-3 with inverse covariation between dimensions 2 & 3 comprises of awl, backed blades (convex, straight), denticulated blade fragments, end scrapers, notched blades, oblique truncated blades, truncated blade fragments, retouched/modified flakes, retouched/modified flake fragments, retouched/modified chunks, blades, cores (formless, double platform opposite plane, single platform-angle, single platform-normal), core rejuvenation (tablet), core preparation (crested), hammer stones, punch objects, ochre nodules, bone fragments, charred bone fragments, shell fragments and tooth fragments.

It seems that during spit-8, a lot of material — lithic and non-lithic, was brought in and processed (Group-3). There had been no change during spit-8 as far as Group-2 assisted activities are concerned — preferably piercing and cutting. Here too we noticed that there was covariation between denticulated pieces and end scrapers (scrapers) and hammer stones and core preparation.

Spatial distribution of activities in grids on the basis of loading suggest that activities assisted by

Group-1, Group-2 and Group-3 tool classes would have been carried more in grids D-6, D-7 and D-8, and B-4, C-6 and C-7, respectively.

SPIT-7 (Table: 3)

Unlike Spit-9 and Spit-8 the dimension-1 for cases shows that only grids B-4 and C-7 have minus values while the rest have plus values (C-6, D-6, D-7 & D-8). In all the three dimensions grid B-4 is with minus values while the grid D-6 with plus values (see Tab. 12, Fig. 10). The remaining grids have inverse covariation in these dimensions. Activities assisted by suites of tool classes with plus and minus values continued without any significant change in the grids D-6 and B-4, respectively.

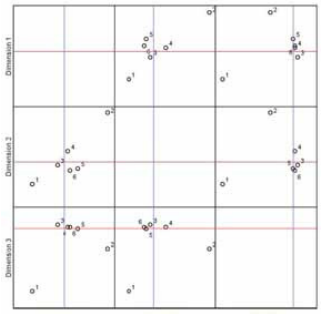

Figure-10: Principal Component Solution: Cases (grids), Spit-7, Dhanuhi Rock-shelter.

Among all the assemblages, regardless of age or depositional condition, the systematic covariation is in opposition for the variables (artifacts/objects) in dimension-1 (see Tab. 13, Fig. 11). Group-1 consists of backed blade fragments, triangles (scalene), oblique truncated blade, truncated blade fragments, retouched/modified flakes, flakes, blade fragments, flake fragments, chunks, sand stone flakes/fragments, bone fragments and burnt clay lumps. The remaining artifacts constitute second group of artifacts. Chips, waste and modified objects are the major components of Group-1.

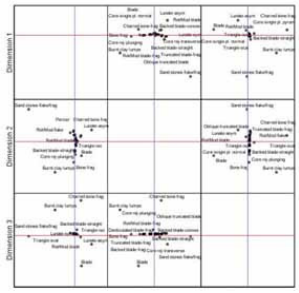

Figure-11: Principal Component Solution: Variables (Artifacts), Spit-7, Dhanuhi Rock-shelter.

Dimensions 2 & 3 generated for the variables (see Tab. 14) show a somewhat different pattern than to Spit-8. Artifacts with minus value is only blade (Group-1) while the artifacts with plus values (Group-2) are backed blades (convex, partial), triangles (isosceles, scalene), lunate (symmetrical), denticulated blade fragments, end scrapers, oblique truncated blades, truncated & backed blades, truncated & backed blade fragments, percoirs, retouched/modified flakes, flakes, blade fragments, flake fragments, core preparation (crested), cores (double platform opposite same plane, single platform-normal), core fragments, chunks, anvil cum hammer, charred bone fragments, shell fragments, tooth fragments, and potsherd.

It seems that the main activity during the spit-7 would have been those assisted by Group-2, which also has potsherds. Only a single piece marked the introduction of pottery at the site (C-7). Activities assisted by Group-2 plausibly reflect mixed activities — lithic work, cutting, piercing, scraping that normally require in replicating stone tools, non-lithic objects and food processing. The artifact classes of the third group — Group-3 (dimensions 2 & 3) having inverse covariation used variably. This group comprises backed blades (straight), backed blade fragments, drills, lunate (asymmetrical), retouched/modified blades, retouched/modified blade fragments, retouched /modified flake fragments, retouched/modified chunks, core rejuvenation (tablet, transverse, plunging), cores (double platform, double platform-right angle same plane, single platform-pyramidal), hammer stones, punch objects, sand stone flakes/fragments, color nodules, ochre color nodules, burnt clay lumps and bone fragments.

In the assemblages of Spit-7 too, we noticed an interesting pattern of covariation between

denticulated blade fragments and end scrapers and between core preparation and hammer stones.

STEP-II (Table: 4-5)

Multivariate analysis was carried out on all the assemblages (spits/levels) recovered in the excavation of the grid C-6 at Dhanuhi rock-shelter. This attempt was focused primarily to understand changes in pattern, if any, through time, i.e. temporal or chronological sequence. In this, the question would arise — could we generaliz results to understand history of activities at the site and to know whether there was any change in the provenance of raw material?

Tool Classes (Tables: 14-16, Fig. 12-13)

Dimension-1 of Principal Component Solution for cases (spits) suggests minus values from spit-7 to spit-2. It is interesting to note that pot shreds appear at the site for the first time in the spit-7 of grid C-7 and in the spit-6 of grid C-6 (only one potsherd). Spits-8 to spit-10, spit-11, spit-12, spit-13 to spit-15 and spit-16 have plus, minus, plus, minus and plus values, respectively (see Tab. 15, Fig. 12). The spit-17 and the spit-18 represent assemblages collected in the process of removing baulk and, therefore, represent assemblages of spit-5 to spit-14 and spit-5 to spit-13, respectively. There is inverse covariation between these two spits, spit-17 (minus values) and spit-18 (plus values).

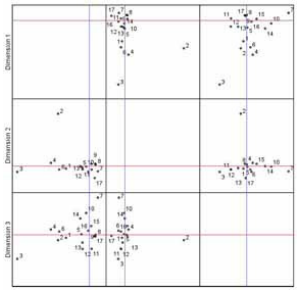

Figure-12: Principal Component Solution: Cases (spits), Grid-6, Dhanuhi Rock-shelter.

Nearly similar pattern with different combinations of spits were also reflected in the dimensions 2 & 3.

There is almost regular inverse covariation pattern between spits, suggesting temporal variation in the activities carried out in the grid C-6. This pattern is also collaborated by looking at patterns vertically obtained through multivariate analysis of spit-9, spit-8 and spit-7.

Among all the assemblages, regardless of age or depositional conditions, dimension-1 for variables (artifacts/objects) suggests that suites of artifact classes with minus values consists of backed blades (straight, partial) truncated & backed blades, truncated & backed blade fragments, lunates (asymmetrical, symmetrical), triangles (isosceles), burin, core rejuvenation (plunging), tooth fragments, shell fragments, ochre color nodules and hammer stones. Backed blades and its variants predominate this group — Group-1 and the associated activity was possibly cutting. The remaining artifacts with plus values constitutes Group-2 (see Tab. 16, Fig. 13).

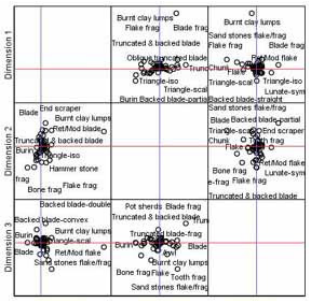

Figure-13: Principal Component Solution: Variables (Artifacts), Grid-6, Dhanuhi Rock-shelter.

Dimensions 2 & 3 suggest following suites of artifact classes (see Tab. 17):

Group-1 with negative values: awls, burins, percoirs, triangles (scalene), truncated & backed blades, truncated & backed blade fragments, scrapers, backed blade fragments, retouched/modified flakes, retouched/modified chunks, flakes, flake fragments, core rejuvenation (tablet, transverse), cores (single platform-normal), core fragments, chunks and bone fragments. This group is dominated by tools made by backing technique (primarily flint-napping, cutting activities).

Group-2 with positive values: backed blades (double), denticulated blades, denticulated blade fragments, end scraper, notched flakes, drills, oblique truncated blades, ortho truncated blades, truncated blade fragments, retouched/modified blades, retouched/modified flake fragments, blade fragments, cores (formless, double opposite - same plane, double right angle-same plane, single platform-normal), anvil cum hammer, color

nodule, charred bone fragments and bone fragments. Tools that were primarily used for lithic work, piercing, scraping, engraving (craft activities) dominate this group.

Group-3 with inverse covariation: backed blades (partial, convex, straight), lunate (asymmetrical, symmetrical), triangles (isosceles), retouched/modified blade fragments, blades, core rejuvenation (plunging), core preparation (crested), cores (single platform-pyramidal, double parallel), hammer stones, punch objects, sand stone flakes/fragments, ochre color nodules, shell fragments, tooth fragments, burnt clay lumps and pot shreds. Does this group correspond with Group-1 of dimension-1 with minus values? Does this group indicate outdoor activities? Because such artifacts usually show inverse covariation in both spatial (spit-7 to spit-9) and temporal (grid C-6 — all spits) dimensions. However, it is yet to be confirmed by multivariate analysis of sites in the region and micro-wear analysis.

Activities carried out with the assistance of the above two suites of artifacts, Group 1 and 2, seemingly were practiced during the whole occupation.

Raw Material (Tables: 17-18, Fig. 14-15)

Dimension-1 for raw material among cases (spits) suggests that there is inverse covariation. Spits with plus values are spit-2, spit-4, spit-6, spit-9, spit-11, spit-13 and spit-17 while those with minus values are spit-3, spit-5, spit-7, spit-8, spit-10, spit-12, spit-14, spit-15, spit-16 and spit-18 (see Tab. 18, Fig. 14). Does this pattern suggest different provenance of raw material or activities of different groups or change in the members of exploratory party, if any (see Tab. 19, Fig. 15).

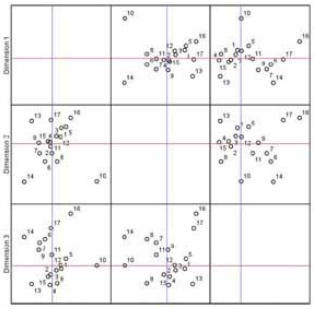

Figure-14: Principal Component Solution: Cases (spits), Grid-6, Dhanuhi Rock-shelter.

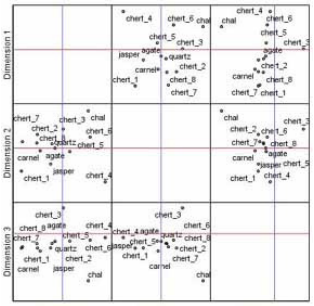

Figure-15: Principal Component Solution: Variables (Raw material), Grid-6, Dhanuhi Rock-shelter.

6 VALIDITY OF THE RESULTS

The use of multivariate analysis does provide a pattern(s). Based on such generated pattern — grouping of tool classes /types, the brain starts setting up models. Hence, it implies that it ignites some complex structural thinking process on the dotted lines, inferred from the pattern; and that led to reconstruction of past human behavior and recognition of the probable prehistoric landscape. All is usually done not merely considering pattern(s) indicated by multivariate analysis but most likely after taking into account other factors as well, such as — context of the site(s) and artifacts, physical condition of the artifacts, distance from natural resources, etc. Nevertheless, reliability of such reconstruction cannot enjoy the status of mathematically derived equation. Because of the fact that if sample size and variable numbers are adequate, multivariate analysis will necessarily provide clusters/groups whenever and whatever data is entered into the software package. Again here an important question arises as how to validate these emerging patterns(s)? It seems that unless and until results are validated with the help of other pattern(s) of independent data, its reliability may remain questionable. Ethnographical parallel, experimental archaeology, soil analysis, etc. may provide independent sets of data.

In the present study, two independent data sets are used to validate pattern(s) retrieved with the aid of multivariate analysis.

Microwear analysis carried out on lithic artifacts and compared with the results of microwear data

on Baghor-III[4] indicates that shaped tools like those of Baghor III were used a little more frequently on vegetative than on non-vegetative materials. To process vegetative materials bladelets are commonly used. These would have been, perhaps, components of expedient technology (Binford's terminology). A-type and B-type vegetative materials were commonly used, though C-type materials also used (see Fig. 16). It shows that inhabitants of Rock-shelters would have been collecting palm, grasses, bamboo and other plants for fuel, food and/or to manufacture objects like reeds, baskets, wooden shafts, arrow shafts, arrowheads, etc. This is corroborated by the presence of charred bones and burnt clay lumps, and by higher percentage of deep striations, whittling and cutting activities, and A-type and B- type polishes. Distribution pattern of such used artifacts closely matched with the statistical results. Consequently, it suggests that the pattern recognition regarding archaeological landscape in and around the Rock-shelter as derived from multivariate analysis would have been the case; and suggests that there would have been shifting in the activity areas in time and space (temporal — spatial patterning).

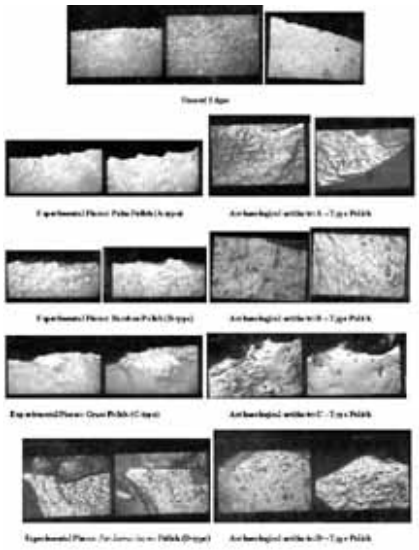

Figure-16: Microwear Plant Polishes (200x) on archaeological and experimental pieces.

Analysis of archaeological soil samples collected from different grids and spits in the course of excavation at Dhanuhi Rock-shelter, after due preparations in laboratory, were put to microscopic analysis to identify phytoliths on the basis of regional phytolith database developed by us[5].

[4] P. Sinha and Ian C. Glover, "Changes in Stone Tool Use in Southeast Asia, 10,000 Years Ago: A Micro-wear Analysis of Flakes with Used Gloss From Leang Burung 2 and Ulu Leang 1 Caves, Sulawesi, Indonesia," *Modern Quaternary Research in Southeast Asia* Vol.8 (1984):137-64. P. Sinha, "Report on the Project 'Research into the Micro-wear Characteristics of Prehistoric Flaked Stone Tools from Eastern Indonesia/West Bengal, India'", (submitted to *Royal Anthropological Institute of Great Britain and Ireland*, London, England, 1985). P. Sinha, "Behavioral Changes From Late Pleistocene to Holocene: A Micro-wear Testimony" (paper presented at the World Archaeological Conference, *The Pleistocene Perspective. Vol. 2* – Precirculated Papers, Southampton, England, September 1-7, 1986). P. Sinha, "Economic and Subsistence Activities at Baghor-III India: A Micro-wear Study," *Old Problems and New Perspectives in the Archaeology of South Asia, Wisconsin Archaeological Reports* Vol. 2 (1989): 47-53.

[5] D. K. Chauhan, D. K. Tripathi and P. Sinha, "Typological and Metrical Attributes of Phytoliths of Bamboos and Its Relevance in Archaeology" (paper at the 7th International Meeting on Phytolith Research & 4th South American Meeting on Phytolith Research, Session: Biology, Botany and Palaeobotany – *Circulated Abstract*, Mar del Plata, Argentina, South America, December 11-14, 2008). P. Sinha, D. K. Chauhan and D. K. Tripathi, "Phytoliths an Indicator of Temporal Shifting of Craft Activity Areas at Archaeological Site" (paper at the 7th International Meeting on Phytolith Research & 4th South American Meeting on Phytolith Research, Session : Archaeology – *Circulated Abstract*, Mar del Plata, Argentina, South America, December 11-14, 2008). D. K. Tripathi, P. Sinha and D. K. Chauhan, "Coprolite Study: Food Habit, Seasonality and Reconstruction of Palaeoenvironment" (paper at the 7th International Meeting on Phytolith Research & 4th South American Meeting on Phytolith Research, Session : Geology,Palaentology,Pedology, Environment and Palaeoenvironment – *Circulated Abstract*, Mar del Plata, Argentina, South America, December 11-14, 2008).

Figure-17: Phytoliths (400x) identified in the soil samples collected during excavations at Dhanuhi Rock-shelter.

Phytoliths of Bamboo (*Bambusa striata, Bambusa vulgaris, Dendroclamus strictus*), Palm (*Palm — borassus, Phoenix sylvesris*) and grasses like Cymbopogon, *Eriocalis, Erogrostis, Cynodon, Paspalum, Paspalidium, Panicum, Dicanthium, Pennisetum* have been identified in the archaeological soil samples (see Fig. 17). It is interesting to note that the frequency of phytolith of Bamboo and Palm is higher than other plants in those grids, which have reported higher frequency of A-type and B-type polishes**.**

7 SUMMARY

The reliability and validity of the result in any scientific research depends upon how the raw data or samples have been retrieved, hence it requires a systematic sampling strategy and this is to be followed in archaeological fieldwork. Multivariate techniques must be used to develop components that would help us in recognizing patterns in archaeological evidence. Analysis of generated patterns in relation to archaeological context suggest behavioral and constructive activities, as well as the environmental factors that causes the clustering of cultural material in both temporal and spatial dimensions that plausibly gave rise to archaeological landscape. However, until results/patterns arrived at through the multivariate analysis are not validated with the help of other pattern(s) of independent data their reliability would remain questionable. The development of human behavior is not unilateral but multilateral, multi-structural and spiral both in terms of time and space.

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Table-1: Raw counts of artifacts/ objects at Dhanuhi Rock-shelter, Spit-9.

Grids of Spit-9	Lunate-sym	Lunate-asym	Triangle-iso	Triangle-scal	Backed blade-straight	Backed blade-convex	Backed blade-partial	Backed blade-frag	Denticulated blade	Oblique truncated blade	Ortho truncated blade	Truncated blade-frag	Drill	End scraper	Scraper	Truncated & backed blade	Truncated & backed blade-frag	Ret/Mod blade	Ret/Mod flake	Ret/Mod blade-frag	Blade	Flake	Blade frag	Flake frag	Core-single pl. normal	Core-single pl. pyram	Core frag	Core pre-long	Core pre-crested	Core rej-plunging	Core rej-transverse	Chunk	Bone frag	Charred bone frag	Sand stones flake/frag	Burnt clay lumps	Hammer stone	Punch object	Anvil	Ochre nodules
dnh_c6	1	2		1	6			1												1	14	66	27	35	4	1	1				1	23		1	12	30		2		1
dnh_c7			4		1			7		1	1								1		12	72	28	33			4					41							1	
dnh_d6	1			1		1		1								1				1	5	36	15	30	1					2		24							
dnh_d7				1		2	2	8								3		1		1	20	97	55	69	2			1	1	1		36			1		1			1
dnh_d8	1	1		6	4	1	3	19	3	1		2	1	2	3	3	2	2	1	2	42	255	105	148	2	3	2		1	8	1	145	6		25	1	1			

Table-2: Raw counts of artifacts/ objects at Dhanuhi Rock-shelter, Spit-8.

Grids of Spit-8	Lunate-sym	Lunate-asym	Triangle-iso	Triangle-scal	Backed blade-straight	Backed blade-convex	Backed blade-partial	Backed blade-frag	Denticulated blade-frag	Oblique truncated blade	Truncated blade-frag	Percoir	Awl	Notched blade	End scraper	Truncated & backed blade	Truncated & backed blade-frag	Ret/Mod blade	Ret/Mod flake	Ret/Mod blade-frag	Ret/Mod flake-frag	Ret/Mod chunk	Blade	Flake	Blade frag	Flake frag	Core-single pl. normal	Core-single pl. angle	Core-double opp same plane	Core-double parallel plane	Core formless	Core frag	Core pre-crested	Core rej-plunging	Core rej-tablet	Core rej-transverse	Chunk	Shell frag	Bone frag	Tooth frag	Charred bone frag	Sand stones flake/frag	Burnt clay lumps	Hammer stone	Punch object	Ochre nodules
dnh_b4																							1	4	1	2	2										1		2							
dnh_c6							1	4				1	1		1			2	1			2	21	91	21	36	3	1	1		1	3	1			1	48	1	10	14	9	43	27		2	1
dnh_c7																							1	4	1	4											4									
dnh_d6	3	3	1		2	1	1	14				1				6			1	1			32	160	81	108	4						1	5		1	71		6			4	3			1
dnh_d7				2	2	12	3	9		2		1			1	3		2	2		1		36	187	96	126	3		2	1		2		3	1	1	73		1		1	21				
dnh_d8	1			1		3	1	8	1		1	1		1	3	5	1	3					16	129	79	94	6							3		1	67					17		2		

Table-3: Raw counts of artifacts/ objects at Dhanuhi Rock-shelter, Spit-7.

Grids of Spit-7	Lunate-sym	Lunate-asym	Triangle-iso	Triangle-scal	Backed blade-straight	Backed blade-convex	Backed blade-partial	Backed blade-frag	Denticulated blade-frag	Oblique truncated blade	Truncated blade-frag	Percoir	Drill	End scraper	Truncated & backed blade	Ret/Mod blade	Ret/Mod flake	Ret/Mod blade-frag	Ret/Mod flake-frag	Ret/Mod chunk	Blade	Flake	Blade frag	Flake frag	Core-single pl. normal	Core-single pl. pyram	Core-double opp same plane	Core-double Rt same plane	Core-double parallel plane	Core frag	Core pre-crested	Core rej-plunging	Core rej-tablet	Core rej-transverse	Chunk	Color nodules	Shell frag	Bone frag	Tooth frag	Charred bone frag	Sand stones flake/frag	Pot sherds	Burnt clay lumps	Hammer stone	Punch object	Anvil cum hammer	Ochre nodules
b4																					4		5		2									1					7	3		1				
c6				1		2								1						3	25	5	7						1					10				1	5	1	69				
c7		1														1				4	8	1	3	1									3					1						
d6			1		1	3	3	13				2	1			2		5	2	1	32	145	58	59	4			1	1	1	1	6	1	2	60	1		4	1		24		1	1	2		2
d7			1	1		2	4	10							1	1			1		26	120	59	56	2		1			2	2	1			54		1				213					2	
d8	1			3		3	1	4	1	3	2	4		1	2		2	3			12	142	59	69	3	1				1		2			63				2		12		1		1		

Table-4: Raw counts of artifacts/ objects at Dhanuhi Rock-shelter, Grid C-6.

Spits of Grid C-6	Lunate-sym	Lunate-asym	Triangle-iso	Triangle-scal	Backed blade-straight	Backed blade-convex	Backed blade-double	Backed blade-partial	Backed blade-frag	Denticulated blade	Denticulated blade-frag	Oblique truncated blade	Ortho truncated blade	Truncated blade-frag	Percoir	Drill	Awl	Notched flake	End scraper	Scraper	Burin	Truncated & backed blade	Truncated & backed blade-frag	Ret/Mod blade	Ret/Mod flake	Ret/Mod blade-frag	Ret/Mod flake-frag	Ret/Mod chunk	Blade
2																													
3																													
4																													
5																										2			
6																													
7				1		2													1										3
8								1	4						1		1		1					2	1			2	21
9	1	2		1	6				1																	1			14
10	1	1	1	1	1			1	3										1		1	1	1	1		1			6
11	1							1									1		1			1			3				5
12			2	1	1	1			3			1												1	1	1			14
13		1		1		3			8	1	1	1	1						3					2		2			17
14		1		1	1	1		1	5						1	1		1								5			12
15	1			2	3	1		1	9						1					2	1				1	3	1		21
16	1				3			2	5						1				1		1		1						9
17				1				1				1							3					2		1			13
18					1		1	4	2			1		1											1	1	1		17

Spits of Grid C-6	Flake	Blade frag	Flake frag	Core-single pl. normal	Core-single pl. angle	Core-single pl. pyram	Core-double opp same plane	Core-double Rt same plane	Core-double parallel plane	Core formless	Core frag	Core pre-crested	Core rej-plunging	Core rej-tablet	Core rej-transverse	Chunk	Color nodules	Shell frag	Bone frag	Tooth frag	Charred bone frag	Sand stones flake/frag	Pot sherds	Burnt clay lumps	Hammer stone	Punch object	Anvil cum hammer	Ochre nodules
2		1																		1	6	1		15		4		
3	1			1												1		1	9	1		5	12			1		
4	1		1																		22		6	35				
5		1	2	7		1													7			9	9	40	1	4		
6	5		1													1			1			1	2	16		2		
7	25	5	7								1					10					1	5	1	69				
8	91	21	36	3	1		1			1	3	1			1	48		1	10	14	9	43		27		2		1
9	66	27	35	4		1					1				1	23					1	12		30		2		1
10	40	16	31	3												21		1		1	1	14		28	1	1		1
11	85	25	23	5	1	1					3		3	2	2	52			1		2	30		1				
12	55	47	38	2									1	1		25			1			10		6		1		
13	79	37	42	4				1			1				1	38	1		1			12						
14	93	44	48			1			1		1	1	2	2	1	50			1			22					2	
15	129	38	71				1		1			2			4	77						7						
16	49	17	35	2									1	1		32						3						
17	45	3	14	4							1	1				11			1	1		19						
18	47	9	20	5			1			1	2		4		1	19			2			7						

Table-5: Raw counts of raw material at Dhanuhi Rock-shelter, Grid C-6.

Spits of Grid C-6	Black chert (chert_1)	Grey chert (chert_2)	Brown chert (chert_3)	Green chert (chert_4)	Cream chert (chert_5)	Choclate chert (chert_6)	Orange chert (chert_7)	Other chert (chert_8)	Chalcedony	Agate	Carnelian	Jasper	Quartz
2 (1)	1												
3 (2)			1						2				
4 (3)	1								1				
5 (4)		2	3			1		4	3				
6 (5)	2		1						2		1		1
7 (6)	2	2	2	6	1	2	1	9	27				3
8 (7)	6	29	19	30	11	1	4	49	71	2	5	2	12
9 (8)	5	34	8	29	4	10		43	49				2
10 (9)	3	15	14	8	6	2	2	30	45	2		1	4
11 (10)	5	63	25	40	3	3	12	18	44		1		2
12 (11)	9	18	15	27	5	3	1	51	56	1		2	7
13 (12)	6	26	24	30	6	10	12	60	58	2	4		6
14 (13)	18	31	15	72	6	13	9	55	42	6	1		6
15 (14)	12	55	49	59	29	19	5	85	36	5	2	3	11
16 (15)	5	20	18	33	3	8	4	34	28	2	1		5
17 (16)	10	8	8	17		1	3	34	12		4	4	
18 (17)	11	19	7	31	1	3	1	39	16		4	4	3

Table-6:Dhanuhi Rock-shelter, Spit-9, Row Coordinates (Grids) for artifacts/objects.

Grid	Dimension-1	Dimension-2	Dimension-3
C-6	-5.514	.224	-.463
C-7	-1.000	.656	1.203
D-6	.423	-.082	-.047
D-7	-.343	-.819	-.081
D-8	-.665	.189	-.065

Table-7: Dhanuhi Rock-shelter, Spit-9, Column Coordinates of Dimension-1 for artifacts/objects.

TOOL	DIMENSION-1	TOOL	DIMENSION-1
Burnt clay lumps	4.462	Truncated & backed blade	.129
Sand stones flake/frag	1.357	Core pre-crested	.115
Chunk	1.055	Hammer stone	.115
Triangle-iso	.975	Triangle-scal	.094
Bone frag	.907	Oblique truncated blade	.081
Core frag	.653	Ret/Mod flake	.081
Blade frag	.591	Flake	.060
Core pre-long	.584	Core-single pl. pyram	.055
Denticulated blade	.304	Core rej-transverse	.043
Scraper	.304	Lunate-asym	.032
Ochre nodules	.281	Ret/Mod blade	.020
Ortho truncated blade	.254	Backed blade-partial	.015
Anvil	.254	Backed blade-straight	-.064
Truncated blade-frag	.189	Blade	-.124
End scraper	.189	Backed blade-frag	-.523
Truncated & backed blade-frag	.189	Ret/Mod blade-frag	-.614
Punch object	.182	Backed blade-convex	-.991
Core-single pl. normal	.175	Core rej-plunging	-1.050
Drill	.135	Flake frag	-1.684
Charred bone frag	.133	Lunate-sym	-1.866

Table-8: Dhanuhi Rock-shelter, Spit-9, Column Coordinates of Dimensions 2 & 3 for artifacts/objects.

Tool	Neg-Dimension-3	Tool	Pos-Dimension-2
Anvil	-.167	Backed blade-convex	.939
Backed blade-frag	-.048	Backed blade-partial	.187
Charred bone frag	-.009	Backed blade-straight	.628
Core frag	-.689	Blade frag	.572
Core rej-transverse	-.009	Chunk	1.161
Core-single pl. normal	-.024	Core pre-crested	.053
Drill	-.009	Core pre-long	.458
Flake	-.031	Flake frag	.795
Oblique truncated blade	-.071	Hammer stone	.053
Ortho truncated blade	-.167	Ochre nodules	.020
Ret/Mod blade	-.002	Sand stones flake/frag	2.646
Ret/Mod flake	-.071	Truncated & backed blade	.545
Sand stones flake/frag	-.722		
Triangle-iso	-.742		
Triangle-scal	-.027		
TOOL	**Neg-DIMENSION-2**	**TOOL**	**Pos-DIMENSION-3**
Anvil	-.289	Backed blade-convex	.311
Backed blade-frag	-.293	Backed blade-partial	.037
Blade	-.082	Backed blade-straight	.246
Bone frag	-.400	Blade	.048
Burnt clay lumps	-.441	Blade frag	.068
Charred bone frag	-.185	Bone frag	.149
Core frag	-.327	Burnt clay lumps	.297
Core rej-plunging	-1.056	Chunk	.159
Core rej-transverse	-.122	Core pre-crested	.011
Core-single pl. normal	-.356	Core pre-long	.050
Core-single pl. pyram	-.073	Core rej-plunging	.166
Denticulated blade	-.315	Core-single pl. pyram	.053
Drill	-.189	Denticulated blade	.089
End scraper	-.229	End scraper	.018
Flake	-.193	Flake frag	.101
Lunate-asym	-.091	Hammer stone	.011
Lunate-sym	-.498	Lunate-asym	.004
Oblique truncated blade	-.161	Lunate-sym	.155
Ortho truncated blade	-.289	Ochre nodules	.083
Punch object	-.217	Punch object	.017
Ret/Mod blade	-.144	Ret/Mod blade-frag	.002

Ret/Mod blade-frag	-.426	Scraper	.089
Ret/Mod flake	-.161	Truncated & backed blade	.043
Scraper	-.315	Truncated & backed blade-frag	.018
Triangle-iso	-.674	Truncated blade-frag	.018
Triangle-scal	-.240		
Truncated & backed blade-frag	-.229		
Truncated blade-frag	-.229		

Table-9: Dhanuhi Rock-shelter, Spit-8, Row Coordinates (Grids) for artifacts/objects.

Grid	Dimension-1	Dimension-2	Dimension-3
B-4	-.703	.850	-.201
C-6	-6.582	-.149	.164
C-7	.253	-.018	.019
D-6	-.849	-.819	-.147
D-7	-.930	.335	.036
D-8	-.796	.613	.006

Table-10: Dhanuhi Rock-shelter, Spit-8, Column Coordinates of Dimension-1 for artifacts/objects.

TOOL	DIMENSION-1	TOOL	DIMENSION-1
Burnt clay lumps	.851	Ret/Mod blade-frag	.201
Sand stones flake/frag	.777	Ret/Mod chunk	.190
Bone frag	.558	Core frag	.190
Backed blade-convex	.536	Punch object	.190
Blade frag	.536	Triangle-scal	.189
Tooth frag	.526	Backed blade-straight	.188
Charred bone frag	.381	Core pre-crested	.186
Hammer stone	.343	Ochre nodules	.186
Core-single pl. normal	.335	Ret/Mod blade	.185
Lunate-asym	.297	Awl	.178
End scraper	.295	Flake	.178
Blade	.280	Core-single pl. angle	.178
Oblique truncated blade	.256	Core formless	.178
Denticulated blade-frag	.248	Shell frag	.178
Truncated blade-frag	.248	Ret/Mod flake	.176
Notched blade	.248	Backed blade-partial	.148
Truncated & backed blade-frag	.248	Percoir	.141
Lunate-sym	.233	Core rej-transverse	.141
Ret/Mod flake-frag	.204	Truncated & backed blade	.136
Core-double opp same plane	.204	Core rej-plunging	.124
Core double pl plane	.204	Backed blade-frag	.025
Core rej-tablet	.204	Flake frag	-.160
Triangle-iso	.201	Chunk	-1.929

Table-11: Dhanuhi Rock-shelter, Spit-8, Column Coordinates of Dimensions 2 & 3 for artifacts/objects.

TOOL	Neg-DIMENSION-3	TOOL	Pos-DIMENSION-2
Blade frag	-.054	Backed blade-frag	.186
Chunk	-.264	Backed blade-partial	.005
Flake frag	-.458	Core frag	.005
		Core rej-plunging	.049
		Core rej-transverse	.006
		Flake	.001
		Flake frag	.041
		Lunate-asym	.065
		Lunate-sym	.057
		Percoir	.006
		Ret/Mod blade	.025
		Ret/Mod blade-frag	.020
		Sand stones flake/frag	.609
		Triangle-iso	.020
		Triangle-scal	.005
		Truncated & backed blade	.035
TOOL	**Neg-DIMENSION-2**	**TOOL**	**Pos-DIMENSION-3**
Awl	-.001	Awl	.016
Backed blade-convex	-.055	Backed blade-convex	.015
Backed blade-straight	-.005	Backed blade-frag	.027
Blade	-.111	Backed blade-partial	.014
Blade frag	-.493	Backed blade-straight	.016
Bone frag	-.256	Blade	.013
Burnt clay lumps	-.210	Bone frag	.041
Charred bone frag	-.023	Burnt clay lumps	.018
Chunk	-.041	Charred bone frag	.023
Core formless	-.001	Core formless	.016
Core pre-crested	-.005	Core frag	.018
Core rej-tablet	-.010	Core pre-crested	.016
Core-double opp same plane	-.007	Core rej-plunging	.018
Core double pl plane	-.010	Core rej-tablet	.015
Core-single pl. angle	-.001	Core rej-transverse	.015
Core-single pl. normal	-.210	Core-double opp same plane	.015
Denticulated blade-frag	-.052	Core double pl plane	.015
End scraper	-.066	Core-single pl. angle	.016
Hammer stone	-.100	Core-single pl. normal	.059
Notched blade	-.052	Denticulated blade-frag	.016
Oblique truncated blade	-.033	End scraper	.019
Ochre nodules	-.005	Flake	.016
Punch object	-.003	Hammer stone	.018
Ret/Mod chunk	-.003	Lunate-asym	.031
Ret/Mod flake	-.020	Lunate-sym	.024
Ret/Mod flake-frag	-.010	Notched blade	.016
Shell frag	-.001	Oblique truncated blade	.006
Tooth frag	-.058	Ochre nodules	.016
Truncated & backed blade-frag	-.052	Percoir	.015

Truncated blade-frag	-.052	Punch object	.016
		Ret/Mod blade	.021
		Ret/Mod blade-frag	.020
		Ret/Mod chunk	.016
		Ret/Mod flake	.014
		Ret/Mod flake-frag	.015
		Sand stones flake/frag	.112
		Shell frag	.016
		Tooth frag	.024
		Triangle-iso	.020
		Triangle-scal	.016
		Truncated & backed blade	.018
		Truncated & backed blade-frag	.016
		Truncated blade-frag	.016

Table-12: Dhanuhi Rock-shelter, Spit-7, Row Coordinates (Grids) for artifacts/objects.

Grid	Dimension-1	Dimension-2	Dimension-3
B-4	-10.486	-2.181	-1.944
C-6	14.346	4.914	-.627
C-7	-2.166	-.297	.118
D-6	1.307	1.067	.043
D-7	4.582	-.654	-.008
D-8	2.037	-.828	.039

Table-13: Dhanuhi Rock-shelter, Spit-7, Column Coordinates of Dimension-1 for artifacts/objects.

TOOL	DIMENSION-1	TOOL	DIMENSION-1
Lunate-asym	11.927	Hammer stone	.612
Blade	4.676	Tooth frag	.545
Charred bone frag	4.303	Ret/Mod flake-frag	.412
Ret/Mod blade	4.050	Lunate-sym	.378
Core-single pl. normal	1.965	Denticulated blade-frag	.378
Core-single pl. pyram	1.415	Core rej-plunging	.278
Core frag	1.020	Truncated & backed blade	.153
Backed blade-convex	1.019	Core rej-transverse	.119
Pot sherds	.900	Ochre nodules	.119
Core-double opp same plane	.892	Ret/Mod blade-frag	.081
Shell frag	.892	Percoir	.041
Backed blade-partial	.864	Backed blade-frag	-.152
Core pre-crested	.845	Blade frag	-.222
Triangle-iso	.841	Triangle-scal	-.239
End scraper	.763	Truncated blade-frag	-.343
Punch object	.727	Ret/Mod flake	-.343
Anvil cum hammer	.705	Chunk	-.593
Backed blade-straight	.612	Flake frag	-.760
Drill	.612	Bone frag	-.797
Ret/Mod chunk	.612	Oblique truncated blade	-1.031
Core-double Rt same plane	.612	Flake	-3.246
Aty_134	.612	Burnt clay lumps	-14.148
Core rej-tablet	.612	Sand stones flake/frag	-32.951
Color nodules	.612		

Table-14: Dhanuhi Rock-shelter, Spit-7, Column Coordinates of Dimensions 2 & 3 for artifacts/objects.

TOOL	Neg-DIMENSION-3	TOOL	Pos-DIMENSION-2
Blade	-.811	Anvil cum hammer	.056
Lunate-asym	-.232	Backed blade-convex	.210
Ret/Mod blade	-.041	Backed blade-partial	.189
Sand stones flake/frag	-.018	Blade frag	1.002
		Charred bone frag	.988
		Chunk	1.036
		Core frag	.149
		Core pre-crested	.352
		Core-double opp same plane	.122
		Core-single pl. normal	.090
		Denticulated blade-frag	.582
		End scraper	.036
		Flake	1.418
		Flake frag	1.757
		Lunate-asym	1.873
		Lunate-sym	.582
		Oblique truncated blade	1.598
		Percoir	1.120
		Pot sherds	.111
		Ret/Mod blade	.777
		Ret/Mod flake	1.072
		Sand stones flake/frag	5.168
		Shell frag	.122
		Tooth frag	.646
		Triangle-iso	.140
		Triangle-scal	.135
		Truncated & backed blade	.291
		Truncated blade-frag	1.072
TOOL	**Neg-DIMENSION-2**	**TOOL**	**Pos-DIMENSION-3**
Backed blade-frag	-1.665	Anvil cum hammer	.044
Backed blade-straight	-.636	Backed blade-convex	.042
Blade	-2.247	Backed blade-frag	.031
Bone frag	-3.298	Backed blade-partial	.042
Burnt clay lumps	-4.890	Backed blade-straight	.042
Color nodules	-.636	Blade frag	.038
Core rej-plunging	-2.069	Bone frag	.032
Core rej-tablet	-.636	Burnt clay lumps	.682
Core rej-transverse	-1.509	Charred bone frag	.934
Core-double Rt same plane	-.636	Chunk	.053
Core-double pl plane	-.636	Color nodules	.042
Core-single pl. pyram	-.127	Core frag	.042
Drill	-.636	Core pre-crested	.043
Hammer stone	-.636	Core rej-plunging	.038
Ochre nodules	-1.509	Core rej-tablet	.042
Punch object	-.540	Core rej-transverse	.040
Ret/Mod blade-frag	-1.349	Core-double opp same plane	.043
Ret/Mod chunk	-.636	Core-double Rt same plane	.042
Ret/Mod flake-frag	-.423	Core-single pl. normal	.016

		Core-double pl plane	.042
		Core-single pl. pyram	.152
		Denticulated blade-frag	.045
		Drill	.042
		End scraper	.043
		Flake	.065
		Flake frag	.057
		Hammer stone	.042
		Lunate-sym	.045
		Oblique truncated blade	.052
		Ochre nodules	.040
		Percoir	.047
		Pot sherds	.044
		Punch object	.042
		Ret/Mod blade-frag	.041
		Ret/Mod chunk	.042
		Ret/Mod flake	.048
		Ret/Mod flake-frag	.042
		Shell frag	.043
		Tooth frag	.044
		Triangle-iso	.043
		Triangle-scal	.045
		Truncated & backed blade	.044
		Truncated blade-frag	.048

Table-15: Dhanuhi Rock-shelter, Grid C-6, Row Coordinates (Spits) for artifacts/objects.

Spit	Dimension-1	Dimension-2	Dimension-3
2	-3.881	-.506	-.157
3	-5.193	10.470	-.283
4	-11.957	-1.161	-1.283
5	-6.383	.643	.284
6	-1.322	-.158	.031
7	-4.996	-.685	.175
8	1.413	-1.052	1.982
9	1.028	.308	.007
10	.967	.457	-.092
11	-.542	-.095	1.164
12	.369	-.699	-.744
13	-1.127	-.671	-.754
14	-1.150	-.398	-.411
15	-1.502	-.027	.872
16	.303	.440	.471
17	-.195	-1.139	.223
18	.877	-2.394	-.052

Table-16: Dhanuhi Rock-shelter, Grid C-6, Column Coordinates of Dimension-1 for artifacts/objects.

TOOL	DIMENSION-1	TOOL	DIMENSION-1
Burnt clay lumps	14.444	Core-single pl. angle	.379
Sand stones flake/frag	2.467	Core pre-crested	.365
Charred bone frag	2.436	Core rej-transverse	.342
Pot sherds	2.014	Oblique truncated blade	.298
Chunk	1.777	Percoir	.204
Punch object	1.468	Triangle-scal	.195
Flake	1.407	Ret/Mod flake-frag	.195
Backed blade-frag	1.390	Core frag	.185
Flake frag	1.220	Bone frag	.179
Blade frag	1.070	Core-double opp same plane	.161
Anvil cum hammer	1.064	Ret/Mod chunk	.113
End scraper	1.052	Core formless	.102
Core-single pl. normal	.833	Core-single pl. pyram	.097
Ret/Mod blade-frag	.731	Backed blade-double	.039
Core rej-tablet	.711	Truncated blade-frag	.039
Denticulated blade	.675	Core rej-plunging	-.015
Denticulated blade-frag	.675	Tooth frag	-.200
Ortho truncated blade	.675	Lunate-sym	-.277
Core-double Rt same plane	.675	Backed blade-partial	-.459
Color nodules	.675	Shell frag	-.546
Ret/Mod flake	.672	Burin	-.729
Scraper	.635	Ochre nodules	-.911
Drill	.621	Triangle-iso	-.941
Notched flake	.621	Hammer stone	-1.015
Backed blade-convex	.543	Truncated & backed blade	-1.079
Ret/Mod blade	.532	Lunate-asym	-1.102
Core-double parallel plane	.440	Truncated & backed blade-frag	-1.543
Blade	.383	Backed blade-straight	-3.072
Awl	.379		

Table-17: Dhanuhi Rock-shelter, Grid C-6, Column Coordinates of Dimensions 2 & 3 for artifacts/objects.

TOOL	Neg-DIMENSION-3	TOOL	Pos-DIMENSION-2
Awl	-.200	Anvil cum hammer	.078
Backed blade-frag	-.615	Backed blade-double	.547
Backed blade-partial	-.086	Backed blade-partial	.938
Blade	-.279	Blade	1.696
Bone frag	-.305	Blade frag	2.405
Burin	-.025	Burnt clay lumps	1.527
Burnt clay lumps	-.438	Charred bone frag	.157
Chunk	-1.797	Color nodules	.110
Core frag	-.297	Core formless	.219
Core pre-crested	-.003	Core pre-crested	.177
Core rej-plunging	-.303	Core rej-plunging	1.272
Core rej-tablet	-.342	Core-double opp same plane	.084
Core rej-transverse	-.085	Core-double Rt same plane	.110
Core-single pl. angle	-.200	Core-single pl. normal	.565
Flake	-.786	Denticulated blade	.110
Flake frag	-1.320	Denticulated blade-frag	.110
Percoir	-.133	Drill	.002
Ret/Mod chunk	-.044	End scraper	1.613
Ret/Mod flake	-.770	Notched flake	.002
Sand stones flake/frag	-2.720	Oblique truncated blade	.598
Scraper	-.084	Ortho truncated blade	.110
Tooth frag	-1.198	Ret/Mod blade	1.128
Triangle-scal	-.014	Ret/Mod flake-frag	.213
Truncated & backed blade	-.093	Sand stones flake/frag	1.644
Truncated & backed blade-frag	-.025	Tooth frag	.695
		Truncated blade-frag	.547
TOOL	**Neg-DIMENSION-2**	**TOOL**	**Pos-DIMENSION-3**
Awl	-.079	Anvil cum hammer	.474
Backed blade-convex	-.085	Backed blade-convex	.504
Backed blade-frag	-.565	Backed blade-double	.152
Backed blade-straight	-2.211	Backed blade-straight	.018
Bone frag	-1.657	Blade frag	2.006
Burin	-1.389	Charred bone frag	.515
Chunk	-.773	Color nodules	.416
Core frag	-.071	Core formless	.097
Core rej-tablet	-.329	Core-double opp same plane	.093
Core rej-transverse	-.225	Core-double parallel plane	.142
Core-double parallel plane	-.071	Core-double Rt same plane	.416
Core-single pl. angle	-.079	Core-single pl. normal	.086
Core-single pl. pyram	-.234	Core-single pl. pyram	.048
Flake	-.214	Denticulated blade	.416
Flake frag	-1.694	Denticulated blade-frag	.416
Hammer stone	-1.122	Drill	.274
Lunate-asym	-.881	End scraper	.242
Lunate-sym	-.690	Hammer stone	.511
Ochre nodules	-.839	Lunate-asym	.421
Percoir	-.479	Lunate-sym	.014
Pot sherds	-1.447	Notched flake	.274

Punch object	-.009	Oblique truncated blade	.173
Ret/Mod blade-frag	-.099	Ochre nodules	.375
Ret/Mod chunk	-.011	Ortho truncated blade	.416
Ret/Mod flake	-.111	Pot sherds	.167
Scraper	-.128	Punch object	.046
Shell frag	-.676	Ret/Mod blade	.084
Triangle-iso	-.120	Ret/Mod blade-frag	.006
Triangle-scal	-.070	Ret/Mod flake-frag	.089
Truncated & backed blade	-1.468	Shell frag	.321
Truncated & backed blade-frag	-2.167	Triangle-iso	1.363
		Truncated blade-frag	.152

Table-18: Dhanuhi Rock-shelter, Grid C-6, Row Coordinates (Spits) for raw material.

SPIT	Dimension		
	1	2	3
2 (1)	1.032	1.382	-.132
3 (2)	-.190	-.238	-.389
4 (3)	.454	.671	-.199
5 (4)	-.250	.145	-.844
6 (5)	1.570	1.484	.306
7 (6)	-.812	-1.546	1.185
8 (7)	-1.406	-.836	1.024
9 (8)	.542	-1.555	-.767
10 (9)	-1.498	.082	.700
11 (10)	4.997	-3.287	.012
12 (11)	-.050	-.826	.479
13 (12)	.937	.601	.020
14 (13)	-2.291	2.038	-.802
15 (14)	-3.114	-3.325	1.278
16 (15)	-.473	.211	-.478
17 *(5-14)* (16)	2.103	2.311	2.297
18 *(5-13)* (17)	-.133	2.124	1.662

Table-19: Dhanuhi Rock-shelter, Grid C-6, Column Coordinates for raw material.

Raw Material	Dimension		
	1	2	3
Black_chert (chert_1)	-.738	-.699	-.553
Grey chert (chert_2)	-.451	.417	-.547
Brown chert (chert_3)	.015	.578	.976
Green chert (chert_4)	.772	-1.024	-.150
Cream chert (chert_5)	.132	-.104	-.283
Choclate chert (chert_6)	.499	.337	-.248
Orange chert (chert_7)	-.720	.198	-.501
Other chert (chert_8)	-.461	.156	-.379
Chalcedony	.465	1.134	-1.791
Agate	-.134	.001	-.299
Carnelian	-.399	-.080	-.661
Jasper	-.212	-.482	-.545
Quartz	-.187	.133	-.371