SPATIAL PATTERN AND STRUCTURE OF CHÂTELPERRONIAN OCCUPATIONS AT LES TAMBOURETS (HAUTE-GARONNE, FRANCE)[1]

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I. Introduction to the problem

Les Tambourets is an open-air Châtelperronian (earliest Upper Palaeolithic) site located in the Pyrenean foothills of southwestern France (Bricker and Laville 1977; Méroc and Bricker 1984; Laville et al. 1985). The general problem dealt with in this paper is how best to create approximations to stratigraphic samples in the absence of visible stratification within the archaeological level. It seems certain that Archaeological Level 1, the only Palaeolithic archaeological level at the site, is a palimpsest representing a minimum of two occupational episodes (and perhaps significantly more than two) that took place during the time of formation of a loess sheet. Traditional stratigraphic evidence suggests that two artificial structures whose traces have been discovered within Archaeological Level 1 are of different relative ages. Structure 2 is associated with an early occupational episode, shortly after the loess began to form; Structure 1 is associated with a later occupational episode, but it is not possible to specify how much later. Some of the artifacts recovered are almost certainly remains of the Structure 2 occupation, some are of the Structure 1 occupation, and some are probably of neither. The operational question is how to separate out earlier artifact scatters from later ones.

II. The first approaches

Various techniques were employed during the 1980s to test for the presence of nonrandom patterning. For most artifact classes, nonrandom patterning was shown to be present *for the palimpsest as a whole*.

A series of k-means cluster analyses of the sort discussed by Kintigh and Ammerman in their 1982 *American Antiquity* article was used for all major artifact classes at Les Tambourets. These analyses were two-dimensional analyses, using the raw, untransformed x and y coordinates of each artifact. The results were not very useful because they described the patterns of artifact clustering within the whole palimpsest, data that could not be related meaningfully to the artificial structures or the almost certain presence of multiple occupations. Some attempts at three-dimensional analysis, using the raw depth below site zero as the z coordinate, produced results that were completely unhelpful.

During this first attempt at interpretation, the separation of the palimpsest was accomplished with traditional back-plotting techniques, using the Cartesian coordinates of each artifact and the survey data on arbitrary and natural strata recognized during excavation (Figure 1). Under optimal conditions, these traditional techniques can be extremely accurate. Even at their best, however, they are extremely time-consuming, and computer graphics were employed to speed the task.

Apart from the time required for their use, the back-plotting techniques used in the first analysis of the Tambourets data had two disadvantages. First, the resultant plots were fairly easily interpreted

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when artifact-class samples were small or moderate (for example, scrapers or Châtelperron points), but large samples (for example, nuclei or burnt pieces) produced such cluttered charts that interpretation was very difficult. Second, the subjective nature of the decisions being made could not be ignored, and for large samples this subjectivity called into question the validity of the entire procedure.

The results of this first analysis were reported to an international symposium in 1987 (Bricker n.d.), but they were not published because of my dissatisfaction with the dependence on back-plotting to subdivide the palimpsest.

III. The reanalysis

Inspired by the publication of Koetje (1991) on the materials from Le Flageolet II, I reanalyzed the distributional patterns of several artifact classes from Les Tambourets. One specific goal was the comparison of the results of quantitative techniques for separating the palimpsest with the results of traditional back-plotting techniques. The four major steps in the analysis were: a) choosing the samples; b) "levelling" the stratum; c) defining the clusters; and d) interpreting the results and comparing them with previous analyses.

A. *Sample definition*

Because of soil acidity, only lithic artifacts are present from the original inventory of Châtelperronian material culture. Two kinds of artifacts were chosen for reanalysis. First, end-scrapers and side-scrapers, which attribute analysis has shown to be undifferentiated in the Châtelperronian industry of Les Tambourets, represent a numerically small, typologically defined class of artifacts heavily modified by retouch. Second, burnt flints--of all sizes and shapes, including retouched tools as well as unmodified *débitage* products--represent a more frequent class defined solely by a kind of post-manufacture and, for the most part, post-use accidental damage. The distributional patterns of both classes could provide useful information about prehistoric human behavior.

For both scrapers and burnt flints, the reanalysis was limited to artifacts that were essentially flat-lying when encountered in excavation. Pieces found lying at a high angle or, in a few cases, objects for which this attribute had not been recorded, were excluded from the samples. (The exclusion of high-angle flints meant that the recognition of "dump" areas was essentially precluded, a problem to which further reanalysis would have to return.) The samples as finally defined include 87 scrapers and 142 burnt flints.

B. *"Levelling" the stratum*

The Châtelperronian archaeological horizon (Archaeological Level 1) occurs at the base of a loess sheet (couche B), which itself lies upon the eroded and somewhat weathered remnants of an interstadial soil (couche C) (Figure 2). The zone in the base of the loess within which the artifacts are concentrated vertically is usually about 8 cm thick. Both this zone and the surface of the fossil soil upon which the enclosing loess body accumulated slope gently and fairly regularly toward the southeast, at a rate that varies between 1 and 2.5 cm per meter. The trend of this slope cuts across the excavation grid system obliquely, creating distortion in back-plotting to both west-east and south-north survey lines. And, gentle as it is, the slope is enough to have rendered useless previous attempts at three-dimensional k-means clustering using raw depth measurements for the artifacts.

The analytic techniques discussed by Koetje assume "horizontality" of archaeological layers (1991:190-191), and if this horizontality does not exist at the site to be analyzed (as it does not at Les Tambourets), it must be "created" through the use of some sort of transformation technique. As suggested by Koetje (1991:191), trend surface analysis (Davis 1973; Hodder and Orton 1976) is an obvious technique to consider, and, in fact, it proved very useful for the Tambourets reanalysis.

The surface of the fossil soil (couche C) within the limits of the irregular excavation grid was best modelled by a first-degree or linear multiple regression equation,

$$DE = 153.8176 + .0104(WE) - .0154(SN) \quad ,$$

where DE is the depth coordinate in cm below site zero, WE is the west-east coordinate, and SN is the south-north coordinate. Using this equation, the location of the surface of couche C beneath each artifact was calculated from its WE and SN coordinates. The difference between the predicted or calculated depth of the fossil-soil surface and the measured depth of the artifact represents the *elevation* of the artifact above the surface of couche C. The use of this elevation instead of the depth measurement has the effect of "levelling" the stratum, as is required for further analysis.

C. *Defining the clusters*

The data on scrapers and burnt flints were prepared for three-dimensional k-means analysis by using the transformations and weighting suggested by Koetje (1991:189). Specifically, the locational coordinates (west-east, south-north, and elevation) were standardized by transforming them into z-scores, and the vertical dimension was emphasized by multiplying the elevation z-scores by five. The input data for the cluster analyses were, then, z_{WE}, z_{SN}, and $5z_{EL}$.

Using techniques suggested by Kintigh and Ammerman (1982), it was determined that the 87 scrapers were best grouped into five clusters. When the cluster centers (means and standard deviations expressed as z transformations) are plotted along the west-east and vertical axes (Figure 3), it can be seen that one cluster (Cluster 1, with 16% of the total sample) is very high (1.54 standard-deviation units above the global sample mean), one cluster (Cluster 4, with only 2% of the sample) is very low (2.50 standard-deviation units below the mean), and the other three clusters (Clusters 3, 5, and 2, with 82% of the sample) are more closely grouped around the mean.

The 142 burnt flints were grouped into seven clusters. The plot of these cluster means and standard deviations (Figure 4) shows that, with the exception of one very small cluster (Cluster 1, with only two pieces), the clusters are very evenly spaced vertically, from 1.33 standard-deviation units above the global sample mean (Cluster 4, with 18% of the sample) to 1.87 units below the mean (Cluster 3, with 6% of the sample).

D. *Interpretation and comparison of results*

The earlier analysis of the distribution of scrapers dealt with a sample of 100, 72 end-scrapers and 28 side-scrapers, not just the 87 flat-lying scrapers in the re-analysis. The traditional back-plotting, accomplished with the aid of computer graphics, attempted to make a *minimal* division of the palimpsest, into just a high scatter and a low scatter. The results of the back-plotting indicated that ca. 29% of the scrapers could be assigned (usually confidently but sometimes questionably) to a high scatter, 68% belonged to a low scatter, and 3% had to be classified as indeterminate. These results for end-scrapers and side-scrapers were consistent with those for other artifact classes in indicating that low-scatter pieces were far more numerous than high-scatter ones.

The comparison of earlier results with those of the re-analysis is shown in Table 1. For example, in k-means Cluster 1, the stratigraphically highest of the five, 9 of the 14 scrapers had been assigned to the high scatter by back-plotting and another 2 had been considered as questionable but most likely high-scatter pieces. Two scrapers had been included in the low scatter, and one had been classified as indeterminate. It is obvious from the data of Table 1 that there is a broad measure of agreement here between the results of the two kinds of analyses. The only serious heterogeneity occurs in Cluster 3.

The situation is similar for burnt flint. The earlier back-plotting exercise assigned 34% of the pieces to a high scatter, 63% to a low scatter, and 3% to an indeterminate category. The object-by-object comparison for the 142 flat-lying pieces re-analyzed is shown in Table 2. Here the agreement between the two kinds of analysis is quite good except for two clusters, Clusters 6 and 2, covering approximately half a standard-deviation unit above the global sample mean. The lack of agreement is worst for Cluster 6, where approximately two-thirds of the pieces were assigned by back-plotting to the high scatter and approximately one-third to the low scatter.

From the comparisons made on scrapers and burnt flints, one may conclude that for the site of Les Tambourets the results of traditional back-plotting--a technique that is generally quite accurate but heavily dependent on subjective judgement about some objects and always time-consuming--may be very closely replicated using the much speedier techniques of trend surface analysis and three-dimensional k-means clustering. A strictly empirical conclusion from the comparisons now available is that at Les Tambourets a given cluster must have a mean value for the vertical dimension ($5z_{EL}$) equal to or greater than one standard-deviation unit above the global sample mean if that cluster is to be assigned to the high artifact scatter. As indicated in Tables 1 and 2, this relationship holds for scraper Cluster 1 and burnt flint Clusters 1 and 4. The tables show also that clusters with vertical-dimension means of about half a standard-deviation unit above the global sample mean are seriously "mixed" when compared with the results of back-plotting (scraper Cluster 3, containing about 30% of the scraper sample, and burnt flint Cluster 6, containing about 15% of the burnt sample). It is clear that some further efforts to reduce the uncertainty would have to be made if the original goal of the back-plotting--a *dichotomous* division only--were to be maintained.

The appropriateness of a dichotomous division (high scatter vs. low scatter) may be examined by plotting the results of the k-means clustering in original measurement units rather than z-scores. Such a plot of the seven burnt flint clusters is shown in Figure 5, which uses the graphic conventions employed by Koetje (1991:193, Fig. 4). Ignoring the very small cluster 1 (an error in excavation or stratigraphic assignment?), one can see that there is an overlap of the 2-sigma error bars for elevation between all adjacent clusters. In the much thicker Layer IX at Le Flageolet II, Koetje (1991:195) was able to use overlap of the vertical-dimension error bars to suggest the presence of "...approximately 10 discrete 'occupations' of the shelter" during the time represented by Layer IX. No such conclusions may be drawn for Les Tambourets, however, and a minimal separation of the palimpsest, into only two divisions, is an appropriately conservative tactic.

IV. Conclusions

Several of the techniques suggested by Koetje (1991) for "unpeeling" a palimpsest have, when adapted to the specific circumstances of the site of Les Tambourets, proved to be efficacious. The use of trend surface analysis has been particularly helpful in the context of a sloping archaeological

horizon. The techniques employed produce as many or more problematic or indeterminate cases as do traditional back-plotting techniques, but they are less time-consuming, less subjective, and completely replicable. For these reasons, they represent a better way to proceed.

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Table 1.--Three-dimensional (west-east, south-north, elevation) k-means clusters of selected scrapers in Archaeological Level 1 at Les Tambourets.

	Back-plotting results						Elevation z scores	
	HI	HI?	?	LO?	LO	N	mean	s.d. units*
Cluster 1	9	2	1	-	2	14	7.71	1.54
Cluster 3	8	-	1	7	10	26	2.40	0.48
Cluster 5	4	-	-	1	21	26	-1.52	-0.30
Cluster 2	2	-	1	-	16	19	-5.56	-1.11
Cluster 4	-	-	-	-	2	2	-12.50	-2.50

* NOTE: This value is the vertical-dimension ($5z_{EL}$) mean or cluster center for each cluster divided by the global standard deviation for the sample of scrapers.

Table 2.--Three-dimensional (west-east, south-north, elevation) k-means clusters of selected burnt flints in Archaeological Level 1 at Les Tambourets.

	Back-plotting results						Elevation z scores	
	HI	HI?	?	LO?	LO	N	mean	s.d. units*
Cluster 1	2	-	-	-	-	2	15.64	3.13
Cluster 4	25	-	-	1	-	26	6.65	1.33
Cluster 6	13	1	1	-	7	22	2.89	0.58
Cluster 2	6	1	2	-	22	31	0.19	0.04
Cluster 5	5	-	1	1	31	38	-2.95	-0.59
Cluster 7	-	1	1	-	12	14	-5.53	-1.11
Cluster 3	-	-	-	-	9	9	-9.36	-1.87

* NOTE: This value is the vertical-dimension ($5z_{EL}$) mean or cluster center for each cluster divided by the global standard deviation for the sample of burnt flints.

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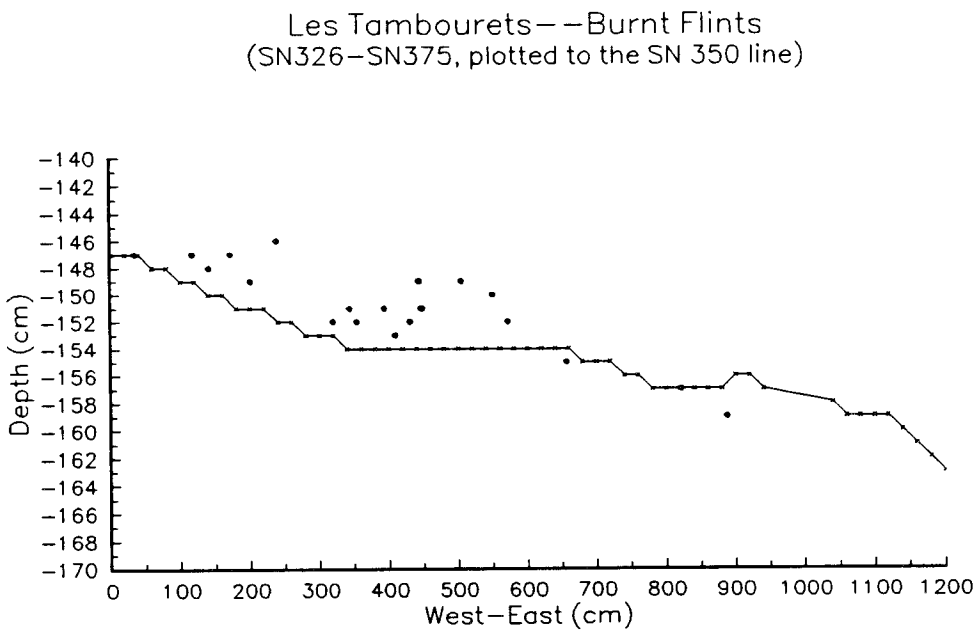

Figure 1.--Example of computer graphic used in artifact back-plotting. Burnt flints within 25 cm of the SN 350 line are projected to it. The graphed line is the surface of couche C, sloping from west to east in this projection.

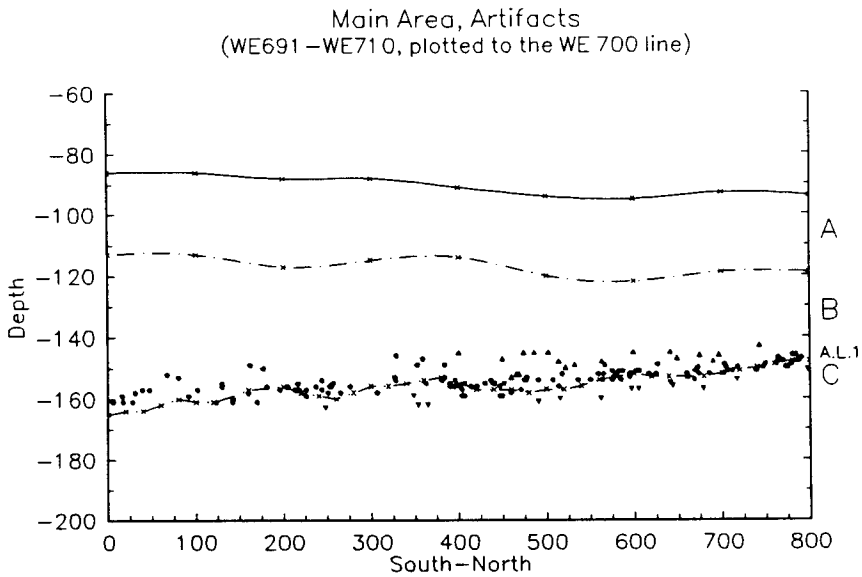

Figure 2.--Section through the middle (WE 700 cm line) of Trench V in the Main Area at Les Tambourets, showing the surveyed boundaries of stratigraphic units and the locations of artifacts within 10 cm of that line as projected to it. Upward-pointing triangles = artifacts in couche B(Basal); solid circles = artifacts in Archaeological Level 1; downward-pointing triangles = artifacts in couche C.

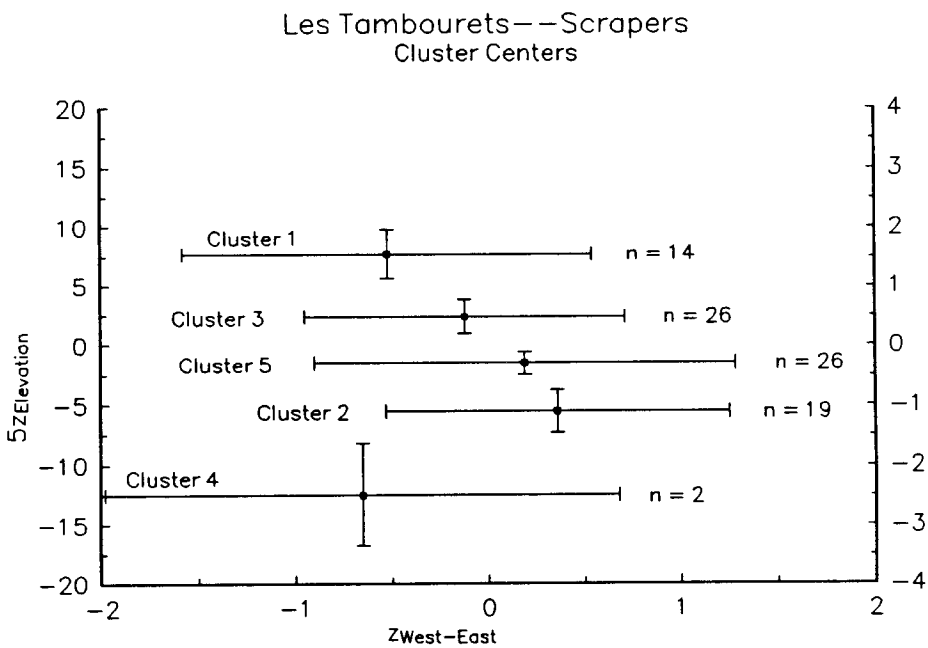

Figure 3.--Five-cluster solution for selected scrapers. Cluster centers (means and standard deviations expressed as z transformations) are plotted along the west-east and vertical axes.

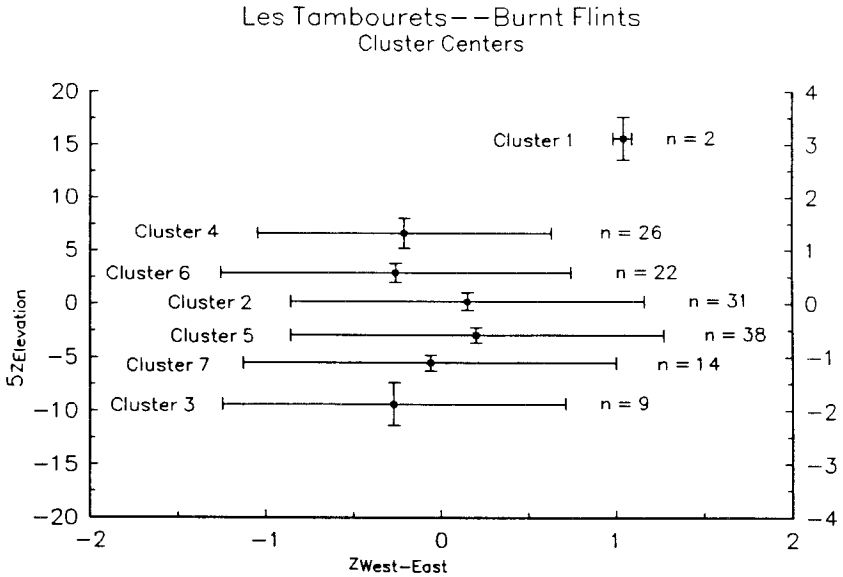

Figure 4.--Seven-cluster solution for burnt flints. Cluster centers (means and standard deviations expressed as z transformations) are plotted along the west-east and vertical axes.

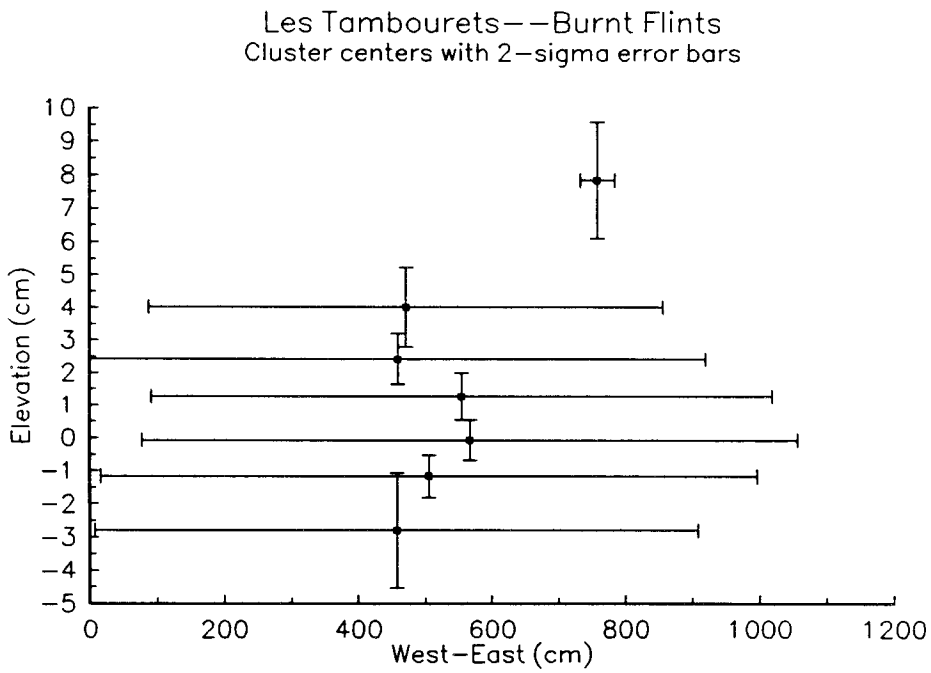

Figure 5.--Seven-cluster solution for burnt flints plotted in original measurement units, using the graphic conventions employed by Koetje (1991:193, Fig. 4).