Reprinted from *Mesolithic on the Move* (L. Larsson et al., eds.), pp. 253-261. Oxford: Oxbow Books (2003).

35. Liencres Revisited: the Significance of Spatial Patterning Revealed by Unconstrained Clustering

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This paper re-examines spatial data from the open air Mesolithic site of Liencres, Spain using unconstrained clustering augmented by a procedure devised to assess the strength of patterning. Unconstrained clustering (UC) uses cluster analysis to group grid squares based on the similarity of artifactual contents rather than their spatial locations. The most readily interpretable results of UC come when the analysis reveals sets of spatially contiguous units with similar compositions. As traditionally applied, a significant weakness of the method is that it can be difficult to evaluate the strength of the spatial patterning. Here, we offer a Monte-Carlo technique that makes it possible to assess the strength of spatial patterning detected by unconstrained clustering. The technique is applied to reveal and interpret robust patterns in the spatial distribution of artifacts at Liencres.

Introduction

Spatial analysis can be viewed as a process of searching for behaviorally meaningful structure in spatial data (Kintigh and Ammerman 1982:31). Inasmuch as archeological data is intrinsically spatial, such pattern searches have been fundamental to archaeology since its inception. Many classic works by early archeologists had strong spatial components, usually involving the intuitive interpretation of distribution maps (e.g., Childe 1929; Adams 1974).

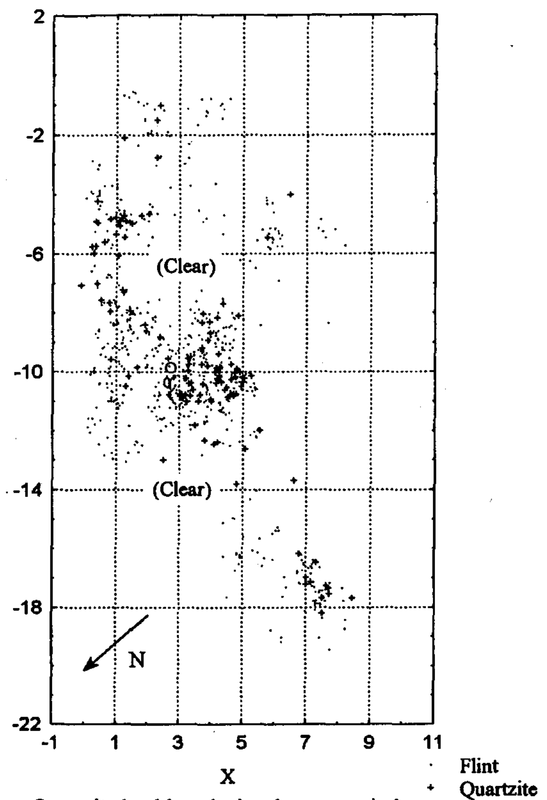
In the last few decades, there has been a growing interest in formal, mathematical methods of spatial analysis. This shift corresponds with our growing appreciation of the complexity of human behavior and with the quantity and precision of available archeological data. Although the human mind is adept at recognising spatial patterning, the complexity of some archaeological data defies intuitive interpretation. Formal methods can assist in untangling the intertwined behavioral and natural processes that produce the archeological record.

This paper uses a form of heuristic analysis to re-analyse spatial data from Liencres, an early Holocene site in Cantabrian Spain. The site represents a unique opportunity to examine the spatial organisation of a Mesolithic campsite. First, previous investigations of spatial patterning at Liencres will be reviewed. Next, Unconstrained clustering (UC) is used to explore the structure of the site. The results of this analysis are evaluated using Monte Carlo methods of probability estimation. The site is then interpreted and compared to archaeologically and ethnographically observed forager camps.

The Site of Liencres

Liencres is an open air site located on the coast west of the provincial capital of Santander and associated with the Asturian horizon of Cantabrian Spain. The immediate environs are characterised by heavily eroded limestone cliffs, stripped of vegetation by the action of wind and water. Sinkholes (*dolinas*) and other karstic phenomena are common. A survey of the area by Clark in 1969 revealed five aceramic lithic scatters in the process of being exposed by erosional processes. Four of these were characteristically Upper Paleolithic, but the fifth, called Liencres after a nearby town, was of Asturian affinity (Clark 1979a:249).

The Asturian is a relatively well-known Mesolithic assemblage characterised by a crude industry in quartzite and dated to the late Boreal and early Atlantic phases (Clark 1976; González-Morales 1982). Radiometric dates for the Asturian range from *c.* 9300 to *c.* 6500 BP (mean of 7 dates from 5 sites is 7817±223 BP) (Clark 1989:590). Liencres probably dates to the Boreal Period (rather than to the Atlantic), when a climate similar to that of today prevailed in the region. Pollen analysis at the site indicates a vegetational configuration similar to that of the present (Clark and Menéndez-Amor 1975:67 pp). Liencres is the only open site so far recorded for this horizon, and is located significantly east of the main concentration of Asturian sites. Perhaps most important, Liencres is the only Asturian site known to date that has a collection large enough for detailed analysis (Clark 1979a:251 p).



Quartzite boulders depicted as open circles.

Figure 35.1 Liencres artifact locations.

When discovered in 1969, the site consisted of a scatter of lithic debris dispersed around the eastern edge of a large *dolina* situated on a rocky spine above an inlet. Surface materials consisted of quartzite and flint waste. Retouched flint tools, blades and bladelets were also common. Four large quartzite picks characteristic of the Asturian were also evident, and it is partly upon these that the association of the site with the Asturian horizon rests. Also noteworthy was a massive overturned quartzite grinding slab and a quartzite boulder in the middle of the site, both surrounded by chipping debris (Clark 1979a:250 p). The density of debris and the apparent lack of features suggest an occupation of short duration, possibly only a few days and probably for the specific purpose of exploiting the deposits of flint nearby (Clark 1979a:266).

The maximum surface scatter covered an area some 9 meters wide by 20 meters long, small enough for a sample approaching 100% to be collected. Although very sparse and sporadic, artifacts did occur up to 10 meters outside this area, these were of uncertain context and were not plotted on the final distribution maps (Clark 1979a:252). A total of 1,046 artifacts were recovered from the surface of the site. Of these, 249 were of uncertain context, were not plotted on the final distribution maps, and are thus not considered here. A list of all artifact types analysed in this paper with counts is presented in figure 35.2. A list of hypothetical functions for the stone tools and the materials they were used to work is also presented for heuristic purposes.

The distribution of all artifacts is given in figure 35.1, in which quartzite and flint have been differentiated. The quartzite boulders are depicted as open circles. It is evident that most of the artifacts are concentrated to the west of the quartzite boulders, almost as if someone had been sitting on them while knapping (Clark 1979a:263). Three smaller spatial clusters of artifacts are located east of the main concentration, in the upper portion of the map. Two conspicuous areas almost devoid of artifacts exist, centering at about X = 3, Y = -6 and southwest of X = 4, Y = -13. If Liencres is similar to many ethnographically observed camps, these areas might have been kept clear intentionally for the purposes of sleeping or resting and may even have been the locations of ephemeral structures.

Spatial Patterning at Liencres

It was immediately clear that the debris were highly structured, and numerous spatial analyses of the site contents have been conducted to elucidate that structure (Clark 1979a, 1979b). Clark's initial approach was to produce separate maps of different artifact classes, so that their distributions across the site could be compared visually. Although quartzite debris had a somewhat restricted distribution, flint and quartzite seem to have been knapped in spatially congruent or at least heavily overlapping areas. It also appeared that the secondary retouching of flint artifacts (resulting in tiny trimming flakes) was confined to the central portion of the site surrounding the cleared areas (Clark 1979a:263 pp).

Clark's next goal was to measure the degree of spatial aggregation within artifact classes, because he wanted to know if particular types were clustered. For this purpose, the Nearest Neighbour (NN) statistic was used to measure the spatial aggregation within artifact types. A complete description of this often useful but always problematic technique can be found in Blankholm (1991), Clark (1979a, 1979b), and Kintigh (1990). It was found that when, considered individually, many of the artifact classes under consideration were *not* strongly "clustered" in a way detectable by NN. Other artifact classes did exhibit degrees of spatial clustering, but the results were somewhat difficult to interpret.

After completing the conventional application of NN, Clark used various significance tests to evaluate the spatial association (or co-occurrence) between pairs of artifact types in a procedure first suggested by Whallon (1974). This procedure is somewhat complex, and space prevents a summary here. Strong associations between individual artifact types indicated three kinds of "tool kits" at Liencres. These are primary and secondary tool manufacture, light cutting, slicing, and shaving of animal and vegetal matter, and core preparation and primary manu-

			Speculative Functions										Materials Worked						
Type (Qz. = Quartzite)	**n**	**Process**	**Raw Material**	**Hammer**	**Core Prep**	**Debris**	**Sec. Manufacture**	**Retouch**	**Cutting**	**Piercing**	**Sawing**	**Scraping**	**Stone**	**Nuts/Seeds**	**Wood, Antler/Bone**	**Vegetal Matter**	**Flesh**	**Hides**	**Other Uses**
Flint core	15	Primary	X	X															
Qz. core	6	Primary	X	X															
Qz. lg. cobble	3	Primary	X	X															
Qz. sm. cobble	9	Primary	X	X									X	X					
Qz. split cobbble	14	Primary		X	X								X	X					
Flint core reduction flake	5	Primary			X	X													
Flint decort. flake	264	Primary			X				X						X	X	X	X	
Flint trimming flake	92	Secondary				X	X	X											
Qz. trimming flake	19	Secondary				X	X	X											
Flint flake	209	Secondary					X		X						X	X	X		
Qz. flake	68	Secondary					X		X						X	X	X		
Flint blade	48	Secondary							X						X	X	X		
Flint knife	3	Tool							X							X	X	X	
Flint perforator	8	Tool								X					X			X	
Flint bec	4	Tool								X					X				
Flint denticulate	6	Tool									X				X	X			
Flint burin	8	Tool										X			X				
Flint notch	4	Tool										X			X				Shaft straightening
Flint endscaper	7	Tool										X			X				Expended cores?
Qz. Pick	3	Tool		X											X				Digging
Flint point	2	Tool															X		Hunting

Figure 35.2 Summary of the artifact classes recovered from Liencres.

facturing activities (Clark 1979a:136). Tool manufacture, edge renewal, and core preparation were confined mainly to the southeastern (upper left) portion of the site, whereas cutting, slicing and shaving activities were primarily found in the center of the site (Clark 1979b:139).

Although Clark's work gives us some ideas as to which activities or artifact classes were associated, it would be helpful to apply other methods to clarify or refine this interpretation. Given the complex nature of artifact distributions at Liencres, a simplified description of the site revealing what was happening where without becoming lost in incomprehensible detail would be highly desirable. For this purpose, the approach known as Unconstrained Clustering was used (Whallon 1984).

Unconstrained Cluster Analysis

Unconstrained clustering is more of an analytical strategy than a specific technique, as it offers many options at each stage of analysis (Gregg *et al.* 1991). First developed by Whallon (1984), the approach was designed to be more congruent with the kinds of questions archeologists ask than more traditional techniques. It was explicitly developed to focus on the patterns of joint distributions of different materials and is free from consideration of cluster shape, size and density.

The first step of Whallon's UC is to accumulate smoothed compositional data (a vector of proportions of artifact classes) from the vicinity of each data point or, alternately, from even intervals across the site surface. These compositional data associated with the particular locations are then clustered with no consideration given to the locational information. Thus, the composition (i.e. type proportions) of artifacts for a particular spot is what is being clustered, and the analysis is "unconstrained" by any previous notions of cluster size or shape.

UC has been described as "probably the fastest, cheapest, and most elegant way of displaying the general nature of a spatial distribution" (Blankholm 1991:78), but it does have weaknesses. Although it is successful at revealing compositions, individual activities (represented by individual tools) are tough to spot (Blankholm 1991:87). At Liencres, where many artifact types are involved, this would be difficult in any case. Another weakness of Unconstrained clustering is that it is unable to distinguish overlapping activity areas. In these situations, the overlapping areas are assigned to a new "mixed" cluster (Blankholm 1991:76 p). By the very act of distinction, all cluster analyses mask similarities between clusters and hide differences within them, a feature they share with language itself.

Sampling and Data Preparation

UC is highly compatible with both the nature of data at Liencres and the questions we wish to ask of them. Before raw data are analysed, however, they must be "filtered" to remove unusual or extreme situations which will dominate subsequent analyses and obscure more subtle differences. This always entails a loss of data and the procedure must be tailored to specific archeological data sets and the questions being asked of them. Thus, it cannot be automated, although automation allows the rapid comparison of different filtering procedures. Filtering is usually a mixture of guesswork and experimentation and represents the most serious weakness in human analytical processes (Kintigh and Ammerman 1982:34).

Infrequent artifact classes can inordinately dominate many statistical analyses, and must be removed from the data to obtain robust results. Because there are no hard and fast rules for doing this, two different ad hoc rules were used here. In the first, all artifact classes with fewer than 3 objects were omitted. In the second approach, all artifact classes with frequencies less than 8 were omitted following Clark (1979). Although subsequent analyses were run on both data sets, the latter (all types < 8 occurrences omitted) gave the most interpretable results. It can be seen from figure 35.2 that this entailed the elimination of most classes of formal, retouched tools. Although the loss of data is always regrettable, this is a blessing in disguise. As Johnson persuasively argues, "we are more likely to obtain information about the spatial distribution of activities from waste products or expediently used tools than from tools that have been curated and used for a number of activities" (Johnson 1984:78).

On Grid Counts and Moving Templates

Before UC can begin, it is necessary to accumulate smoothed compositional data from across the site. Whallon (1984) originally advocated a "moving template" technique to smooth the data. Briefly, the technique moves a circular template from point to point, recording the local artifact composition (within a pre-set radius) for each point as percentages. Although the technique does smooth data, it can do so in a biased fashion. Some artifacts may count more than others in the density calculations. In a sparse area, this can have significant (and probably unpredictable) autocorrelative effects (Kintigh 1990:191).

While grid based approaches do entail some "blurring" of the data by the imposition of an arbitrary grid, it does remove these autocorrelative effects and is easily interpretable due to its simplicity (Kintigh 1990:196). As Blankholm puts it, "in most cases smoothing based on grid counts is to be preferred, both for clarity and simplicity" (1991:78). In grid analyses the contents of individual grid squares are statistically independent of each other, an enormous advantage. It will be argued that this property can be fruitfully exploited to evaluate the strength of clustering results.

The site was divided into a 1x1 meter grid, and the composition of each grid square was expressed as percentages. This was done in order to remove effects associated with artifact density. Some grid squares (especially those around the edges) had very low artifact counts. Because individual artifacts found in these low count squares were responsible for very high percentages relative to the other squares, they tended to dominate all subsequent analyses. Low densities are a ubiquitous problem in UC with two acceptable solutions. It is possible to increase the grid square size, but this entails a loss of resolution. It is also possible to exclude units below some threshold of counts per unit. The researcher is thus confronted with a three way trade-off between resolution, comprehensiveness, and robustness of results (Kintigh 1990:192). Because the size of the site and its potential for high-resolution results, it was decided to implement a density threshold. After some examination of the site maps and considerable experimentation, a minimum of 5 objects per grid square gave the most interpretable results.

K-Means Nonhierarchical Clustering

The next step was to cluster the grid square compositions using a clustering technique. Because the emphasis of unconstrained clustering is homogeneity of cluster composition, methods that minimise the sum of squared errors (SSE) and operate on Euclidean distances are appropriate. Whallon (1984) suggests Ward's Method, but k-means (Kintigh and Ammerman 1982) should work equally well or better for these purposes, and should usually give similar results (Blankholm 1991:81).

K-means analysis has the advantage of being intuitive and easy to understand because it is congruent with what our notions of what "clusters" are. The k-means program is a nonhierarchical divisive cluster analysis which attempts to minimise differences between members of the same cluster while maximising the differences between cluster centers. Mathematically, this entails trying to minimise the Euclidean distance from each point in a cluster to the cluster center, while maximising distances between clusters. In three or more dimensions, ideal clusters would appear as spherical concentrations of points. For a full discussion of k-means see Kintigh (1990) and Kintigh and Ammerman (1982).

K-means is a heuristic approach in that the appropriate clustering level (number of clusters) must generally be selected by the analyst from several choices. One reasonable way to proceed is to measure the distance from each point to the center of the cluster to which it is assigned, square these distances, and then add them together. This measure represents the global error of that clustering level and is called the sum of squared errors (SSE). Although the SSE must decrease as the number of clusters increases, clustering levels where the SSE lowers dramatically are good candidates. In the case of Liencres, no clear inflections existed and an alternative approach was used.

Departures from randomised data are another helpful way to select the best clustering level. If the points under consideration are well clustered, the SSE of the actual data decreases much more rapidly than that of the randomised data (Kintigh and Ammerman 1982:46). Figure 35.3 shows the difference between randomised and actual data for the site of Liencres for 250 random runs. As can be clearly seen, this difference is greatest at the nine cluster level. Other clustering levels were

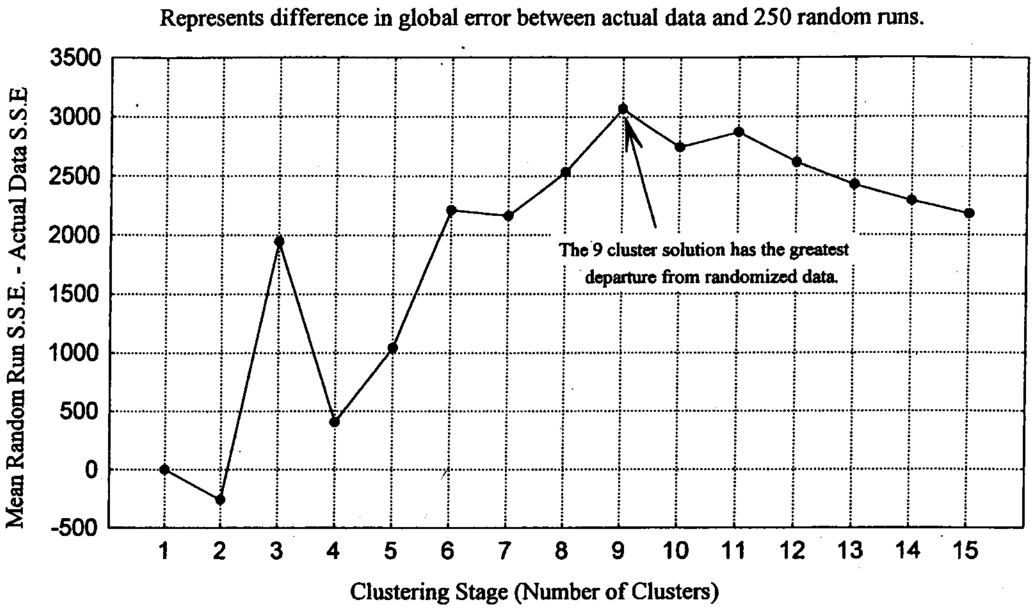


Figure 35.3 K-Means sum of squared errors difference plot.

Cluster compositons are expressed in average percentages

		Primary Manufacture				Secondary Manufacture				Tools		
Cluster	**N**	**Fl. Core**	**Qz. Sm. cobble**	**Qz. split cobble**	**Fl. decort. flake**	**Qz. trim. flake**	**Fl. trim. flake**	**Fl. flake**	**Qz. flake**	**Fl. blade**	**Fl. perforator**	**Fl. burin**
1	10	0.86	**1.6**	1.17	50.27	0.77	8.71	27.26	2.68	2.08	1.33	**3.27**
2	2	0	0	0	0	0	58.33	41.67	0	0	0	0
3	8	0.51	0.23	**3.03**	22.81	4.58	15.79	27.45	17.96	6.41	0.23	0.99
4	*1*	*0*	*0*	*0*	*16.67*	*0*	*0*	*16.67*	*0*	*50*	*0*	*16.67*
5	3	4.44	0	2.78	41.67	**5**	0	10	**33.33**	0	**2.78**	0
6	*1*	*14.29*	*0*	*0*	*0*	*28.57*	*0*	*28.57*	*14.29*	*0*	*0*	*14.29*
7	4	0	1.32	0	32.06	1.32	37.89	10.13	6.67	10.61	0	0
8	9	0.62	0	1.83	28.71	1.23	10.38	**42.98**	1.53	**11.76**	0.65	0.3
9	5	**10.86**	0	2.86	**60.19**	2.86	6.19	8.86	0	8.19	0	0

Clusters 4, 6 Italicized (not discussed)
Column Highs Bold
Row Highs Underlined

Figure 35.4 K-Means cluster compositions, 9 cluster solution.

considered, but the nine cluster solution gave the best compromise between resolution and interpretability.

The locations of grid squares are presented in figure 35.5, and the cluster compositions are presented in figure 35.4. Many other procedures gave roughly similar results, suggesting that this solution was detecting robust patterning in the data. There are two clusters which only occur once each – clusters 4 and 6. Examination of these grid squares revealed that they had very low counts (5 and 7, respectively). Their compositions are presented in figure 35.4, but they are dropped from subsequent analysis.

Contiguity and Interpretability

There is no straightforward way to evaluate the statistical significance of clustering results. Unlike some methods,

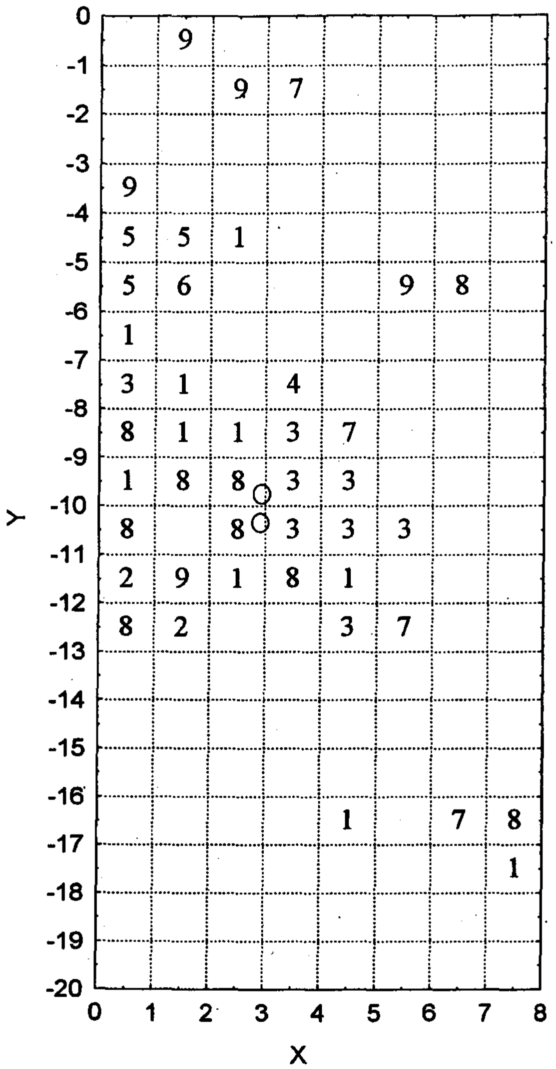


Figure 35.5 Nine cluster solution.

cluster analyses cannot fail. That is to say, they will always produce clusters regardless of the nature of the data to which they are applied. All cluster analyses impose their own order upon the data to a greater or lesser extent, a feature they share in common with language itself (Shennan 1988:228). In contrast to language, it is possible to develop formal methods that can evaluate the extent to which a particular classification is useful for interpretive purposes.

Aldenderfer argues that most cluster validation methods are best conceptualised as "methods which assess the compatibility of a clustering solution with a particular theoretical perspective on what constitutes a good classification" (1982:62). In this case, there is one independent criterion for evaluating UC results. As Whallon (1984:276) and Blankholm (1991:77) both note, there is no tendency inherent in the procedure to form spatially coherent clusters. "For interpretation, it makes sense to look for broader or larger areas of spatial integrity or homogeneity. Indeed, a kaleidoscopic pattern may be very hard to handle and interpret" (Blankholm 1991:81). Given human body size, most human activities simply take more than a square meter to perform, and this should be reflected in the distribution of artifacts across the site surface. Given that each grid square is an independent sampling unit, large areas of *contiguous* grid units assigned to the same cluster would indicate robust structure in the data. With our approach, the relative contiguity of data can be statistically evaluated. This approach thus compares the data to a context driven model.

Contiguity is easily quantifiable. For a given square assigned to a particular composition-based cluster, it is possible to simply count how many adjacent squares are of the same type. In our implementation, squares meeting only at the corner count as half an adjacency. Thus, a square completely surrounded by ones of the same type has a contiguity (C) of exactly six. These measurements can be simply added to produce both cluster specific and global results. Using a DOS program written by Kintigh for this purpose (CONTIG) and available over the internet *(http:www/pages.prodigy.net/keith.kintigh)*, the adjacency counts for each grid square were summed by cluster assignment. For the observed configuration the overall total is 1065. Then, the specific cluster assignments of the occupied squares were randomised holding constant the occupied grid locations and the number of squares assigned to each compositional cluster. By comparing the aggregate contiguity measure of a large number of random runs with the original data, it is possible to assess the likelihood of getting as high a contiguity measure as was observed by chance. That is, the randomly generated adjacencies can be expressed as a one-tailed (directional) probability p(C) which can be used to assess the significance of the observed clustering results. In addition to evaluating the strength of clustering results, this probability measure may also be used as a proxy for describing the relative dispersion or aggregation of a particular cluster.

The results of this analysis are presented in figure 35.6 for 1000 random runs. In only three out of a thousand runs (mean 1047) did the overall contiguity match or exceed that of the original data (1065). This indicates a very high likelihood that our clustering results are robust and do reflect some aspects of the site's structure. Contiguity varies widely from cluster to cluster. Three clusters (2, 3 and 5) are highly contiguous, whereas two seem dispersed (clusters 7 and to a lesser extent, 9). In order to understand these differences, it is necessary to consider their relationship to the compositions of the clusters.

Interpretation of Cluster Compositions

Now that we are confident that our analysis has revealed significant aspects of the site's structure, we may move

1000 Random Runs

Cluster	Count (C)	Observed Contiguity	Mean Random	Std. Random	Min. Random	Max. Random	Estimated Prob. p(C)
All	43	1065	1046.77	0.16	1033	1071	**0.003**
1	10	7	6.73	0.1	0	21	0.478
<u>2</u>	2	1	0.15	0.02	0	2	<u>0.097</u>
3	8	16	4.29	0.08	0	17	**0.001**
4	1	0	0	0	0	0	1
5	3	5	0.44	0.03	0	5	**0.004**
6	1	0	0	0	0	0	1
7	4	0	0.98	0.04	0	8	1
8	9	8	5.55	0.09	0	19	0.214
9	5	1	1.63	0.05	0	11	0.697

Probability estimations < 5% are in bold type.
<u>Probability estimations < 10% are underlined.</u>

Figure 35.6 Grid contiguity computation for the nine cluster solution.

towards detailed interpretation of those results. We will begin by considering the center of the site and will work out towards the periphery. The two large open areas in the center of the site may have been intentionally kept clear for the purposes of resting or sleeping. Ethnographically observed forager camps often consist of a prepared area where a wide variety of tasks are carried out. Work which causes uncomfortable amounts of debris is carried out just outside this area (Spurling and Hayden 1984:232). Also, larger chipping debris is obnoxious, and tends to get "scuffled" towards the edges of prepared areas (Stevenson 1982, 1991).

Cluster One conforms closely to the edges of the clear areas and has a composition consistent with this interpretation. It can be characterised as consisting primarily of flint flakes with a smattering of other artifact types. Cluster one has the highest proportion of burins (3.3%) and small quartzite cobbles (1.6%) at the site. It also has a relatively high proportion of perforators, and is thus rich in all tool types that require extensive retouch (e.g., not blades). In ethnographic accounts, the fringes of intentionally cleared spaces are likely to be chosen for the caching of finished tools – where they are handy but out of the way (Carr 1991:241).

Various knapping episodes can be distinguished in the spaces between the cleared areas. It is likely that *Cluster Three* and *Eight* represent the overlapping debris from several chipping events. Although both are highly contiguous and consist primarily of knapping debris, cluster three has a significantly higher proportion of quartzite. It is of note that the interface between these clusters coincides with the final locations of the quartzite boulders. One could speculate that the knappers sat upon them and chipped quartzite facing west during a single or very few episodes. Because flint was worked more frequently at the site it does not show this restricted distribution. In contrast, *Clusters Two* and *Five* seem to represent spatially segregated individual knapping episodes. Both form discrete spatial clusters, and cluster five corresponds exactly to a spatial cluster of quartzite artifacts identified by Clark (1979a:262).

Finally, messy or obnoxious activities seem to have been carried out on the periphery of the site. This is also consistent with many ethnographically observed forager camps, where cooking, butchering, and some knapping (especially the initial stages of production) are carried out well away from cleared areas (Spurling and Hayden 1984:232). The spatial distributions of *Clusters Seven* and *Nine* support this general interpretation. These clusters are generally dispersed in discrete spatial clusters at the periphery of the site. Cluster seven is actually much less contiguous than would be expected by chance (p(C) = 0.98). Contiguity is one kind of spatial pattern, but not the only one. Dispersal represents a different kind of spatial patterning that is measured only indirectly with this method.

The compositions of these clusters also support this interpretation. Cluster seven has relatively high proportions of flint trimming flakes, flint decortication flakes, and blades. Blades found in these locations, and decortication flakes themselves, may have been used for butchery. Phosphate analyses at the site indicate concentrations of organic substances consistent with food preparation (Butzer and Bowman 1979). Finally, *Cluster Nine* clearly represents areas where the primary reduction of flint took place frequently and to the relative exclusion of other activities (Figure 35.4). This cluster has the highest relative abundance of flint cores and decortication flakes, which together comprise over 70% of all artifacts.

Conclusions

It appears that the deposition of artifacts during the brief use life of Liencres were structured in several important

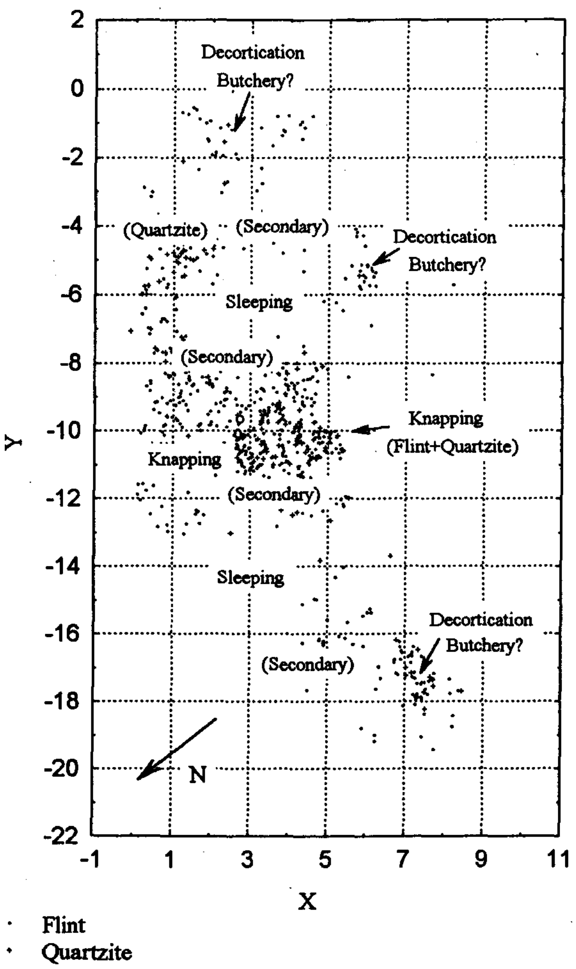


Figure 35.7 Activity areas at Liencres.

ways (Figure 35.7). The two large open areas may have been kept clear for the purposes of resting, creating a halo of "scuffled" artifacts and cached tools. Various overlapping knapping episodes can be distinguished in the spaces between the open areas. The quartzite boulders in the center of the site also structured the use of space, as evidenced by the differences between Clusters Three and Eight. Finally, messy or obnoxious activities seem to have been carried out on the periphery of the site. This overall interpretation is congruent with that forwarded for Pincevent by Leroi-Gourhan and Brézillon (1972), and supported by Carr (1991) and Lang (1992). It is also consistent with a many ethnographically observed short term forager camps (Brooks and Yellen 1987).

Unconstrained clustering has proven itself capable of quickly and easily isolating key aspects of pattern in the Liencres data. Like all analyses of any kind, this one entailed some subjective decisions. Subjective elements exist in all archaeological interpretation, and hypotheses should be tested independently whenever possible. In this case, independent assessments of clustering results were accomplished through the use of context driven models and simulation. Although they lack the sophistication and elegance of classical techniques of significance testing, Monte Carlo estimations are easy to conceptualise and are robust in that they make fewer *a priori* assumptions about data structure.

Optimistic early studies in spatial analysis made significant headway, but quickly encountered a past more complex than expected. Some researchers have used these difficulties to argue that all spatial analysis is doomed to failure. This is, in the words of George Cowgill, "logically akin to the drunk who loses his keys in a dark section of the street but hunts for them under the streetlight, because the light is better there" (Cowgill 1993:560).

Others have resisted formal techniques in general for philosophical reasons. These critics have been useful for pointing out biases in quantitative archaeology, but seemingly fail to realise that many of their objections apply to all forms of description. Quantitative techniques are themselves description and expression, and share characteristics in common with all symbols. In contrast to language, formal techniques can be invented, changed, or dismissed freely to suit the purposes of a community of researchers. Their utility lies in the strategically chosen and explicit nature of this description.

As Roy Rappaport noted, the very characteristics of language that provide the basis for humanity's astounding adaptive flexibility also give birth to confusion, and "threaten with chaos and babel the orders that groups do establish" (Rappaport 1979:202). Attempts within anthropology to define such ubiquitous concepts as "culture" or "household" clearly demonstrate how tricky even verbal description can be (cf. Hammel 1984). The greatest utility of quantitative methods is perhaps that they allow us to create new forms of description while forcing us to be precise about what we mean.

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