Archaeological Ceramics

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Introduction

This study concerns pottery found on excavated medieval sites in the south of France: in Provence, Comtat Venaissin, Languedoc, and Roussillon (Fig. 1). The ceramic material found on these excavations includes, for the period of the thirteenth to the fifteenth centuries, many imports of tin-glazed pottery from Italy and Spain.

We have decided to discuss here the problems involved in the attribution to the workshop of Malaga in southern Spain of a small group of imported pottery found in France. The pottery in question is tin glazed and decorated either with a luster or with a luster and blue lines.

The best-represented categories of Spanish imports found in France are the Catalonian and above all the Valencian productions. These are both characterized by a green and a brown decoration, but amongst the Valencian productions we also frequently find a luster painted ware with additional blue lines. Some of the earliest productions of the workshops of the region of Valencia resemble the latest productions of Malaga, to such an extent that the identification can be carried out only in the laboratory. It is obvious that this identification is crucial to our understanding of trade in the western Mediterranean, particularly that of the fourteenth century which was a period of important historical transformation. For our purposes here, the imported pottery from Malaga will serve above all as an example of the difficulties encountered in the determination of ceramic provenance.

The first stage of our research consisted in sorting out the medieval Spanish ceramics found in France which concern this present study. We have determined for each ceramic sample eight principal chemical elements: potassium, magnesium, calcium, aluminium, iron, manganese, titanium, and silicon. The analytical method chosen was the X-ray fluorescence method using a fusion technique. The classification of the results of the analysis was carried out according to the standardized variables using the clustering by average linkage method. We have thus been able to distinguish different groups amongst the imported medieval pottery. The provenance of several of these groups was easily determined by comparing them with reference samples from the Spanish production centers. In this way we have been able to identify ceramics from Catalonia, Aragona, Valencia, and Malaga. On analysis we distinguish these different groups as easily as we distinguish those of Valencia and Malaga on the dendrogram (Fig. 2).

Comparison of the Results

We now come to the problems of the attribution to the production center of Malaga of the small group

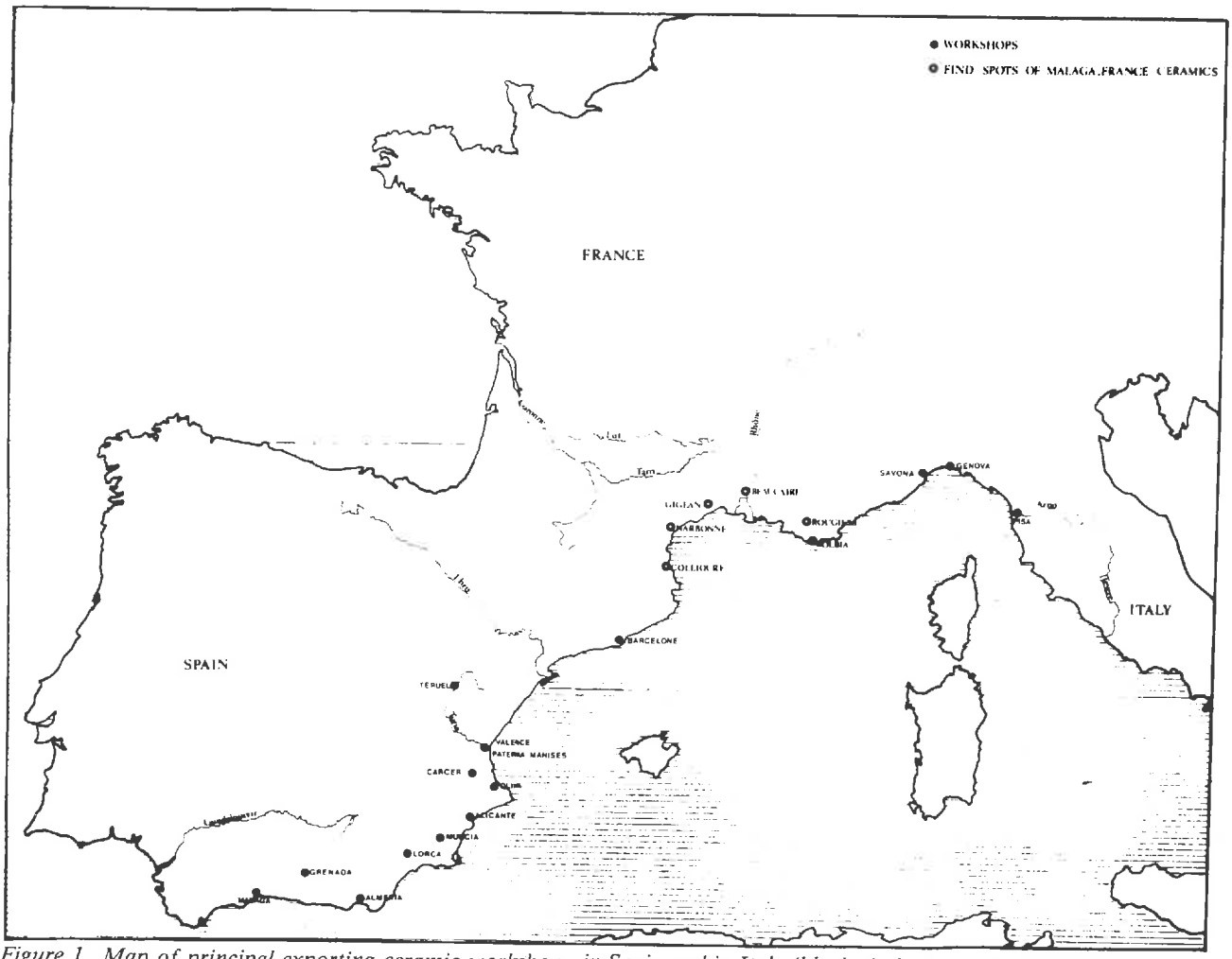

Figure 1. Map of principal exporting ceramic workshops in Spain and in Italy (black circles), and find spots of Malaga-France ceramics (stars).

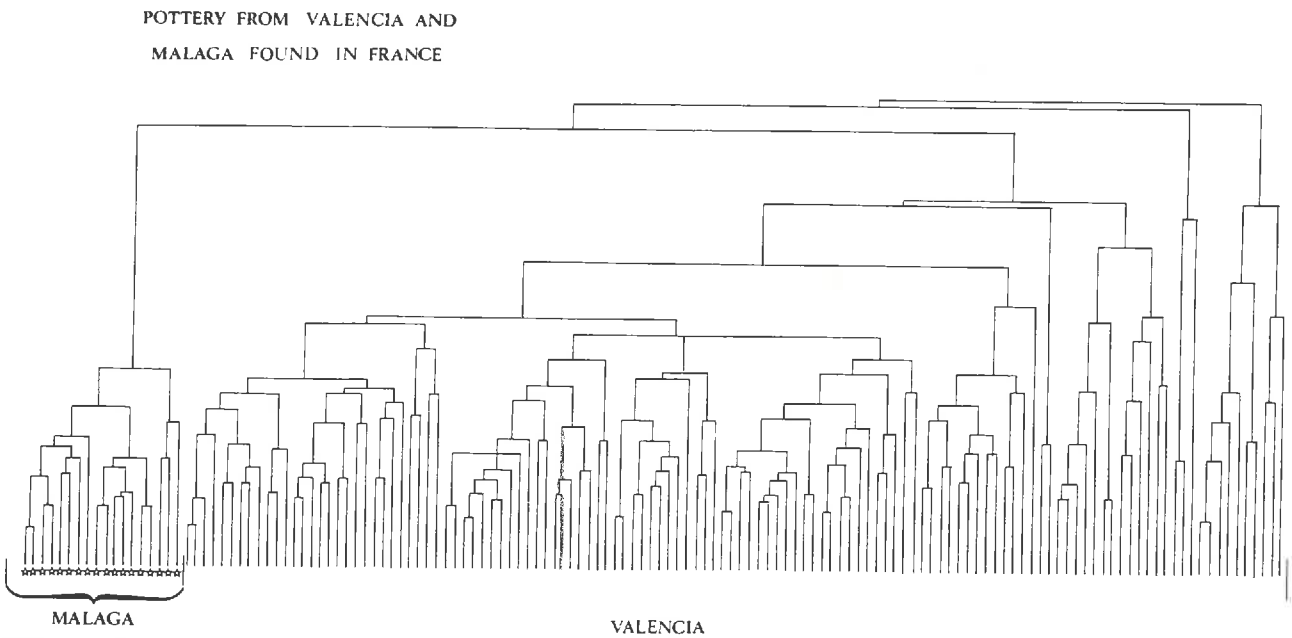

Figure 2. Cluster analysis of Spanish ceramics found in France originating from the region of Valencia and Malaga.

	CaO	Fe_2O_3	TiO_2	K_2O	SiO_2	Al_2O_3	MgO	MnO
Malaga-Spain group								
average	15.1	6.11	0.79	2.44	56.5	15.6	3.35	0.089
standard deviation	1.1	0.17	0.05	0.34	1.1	0.4	0.24	0.009
Malaga-France group								
average	15.1	6.10	0.83	2.10	56.1	16.3	3.41	0.089
standard deviation	1.3	0.16	0.02	0.48	1.2	0.4	0.14	0.008

of imported pottery situated on the left of the diagram in Figure 2. We shall therefore compare the eighteen sherds of this group with a selection of forty-six sherds from the excavations of Malaga, the purpose being to distinguish if both sample groups come from the same production center.

The forty-six sherds from Malaga come in fact from excavations of domestic structures, but in order to simplify matters we shall exploit them as if they came from the workshop of Malaga itself. For the same reason we shall give the name Malaga-Spain to the forty-six sherds from the excavations of Malaga, and the name Malaga-France to the eighteen sherds found in the south of France. We now propose to discuss the relationship of the Malaga-France group to the Malaga-Spain group.

The average composition of these two groups and the standard deviations of their distributions are shown in the table above.

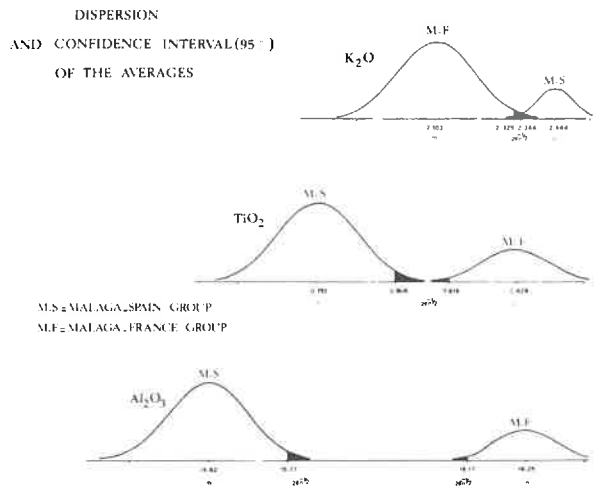

Figure 3. Dispersion and confidence interval (95%) of the averages of the Malaga-Spain and Malaga-France groups.

Use of the Average Compositions of Groups

Although the average compositions of the groups are closely related, there are important differences for aluminium, titanium, and potassium. One can say from a statistical point of view that the differences are significant, and are even highly significant (Fig. 3). This result does not permit us, however, to conclude that the two groups, Malaga-Spain and Malaga-France, do not come from the same production center. Indeed, these highly significant differences have little probability of being the result of a random sampling procedure carried out on the total production of a unique workshop. It is evident that we cannot consider a group made up solely of pottery from the workshop of Malaga and exported to France as being a representative result of a random sampling of the entirety of the Malaga production. Such a procedure does not take into account: *first*, the spatial and chronological evolution of the characteristics of clays supply to an important workshop; and *second*, the spatial and chronological evolution of the distribution circuits of this workshop, and more particularly of its long-distance trade. The group of exported pottery has a high probability of having characteristics which differ notably from the average characteristics of the entirety of the Malaga productions. In fact it is not rare to observe that between samplings carried out on ceramic production sites and those on domestic sites, there are differences which are often superior to those we have distinguished here. These differences can be further magnified by the sampling conditions on the workshop itself.

Thus, the difference in the averages of the two groups, Malaga-Spain and Malaga-France, does not justify on its own the conclusion that we are dealing with the productions either of different workshops or of a single workshop.

But if we had observed no significant difference between the average composition of the two groups, would we have been right in deciding that the two groups were identical? We would first of all point out that if the sampling conditions can separate the average compositions of the two groups, they can also bring them closer, thus perhaps hiding substantial differences. However, the probability that this would happen is very low. In any case, whether or not the average compositions of the groups present a signifi-

cant difference, the risks of going wrong by accepting the hypothesis of a unique workshop are about the same. This is true insofar as the difference is moderate, as it is between the Malaga-Spain and the Malaga-France groups. The risks of going wrong result from the possible existence of two or several workshops presenting very similar compositional characteristics. Now, the study in our laboratory of more than a hundred workshops has shown that such risks do exist, but that eventual confusion between either distant workshops or workshops installed in different geological contexts is very rare. On the other hand, when we are dealing with workshops of a similar geological environment the risks of confusion become important.

In conclusion, the comparison of the average compositions of the two groups Malaga-Spain and Malaga-France does not allow one to exclude the hypothesis according to which the ceramics of the second group could come (totally or partly) from a workshop other than that of Malaga in southern Spain. On the contrary, this comparison permits one to consider that the hypothesis of a production center far from southern Spain — for example, in Italy or in Tunisia — is unlikely. The archaeological data relative to the two groups renders such a hypothesis even more improbable. It would indeed be necessary to imagine, for example, an Italian or a Tunisian workshop which would have produced pottery typologically and chronologically similar to that produced at Malaga and which, by an incredible chance, would have been composed of clays having for their eight principal constituents average characteristics as close as those of the Malaga-Spain group.

One must remember, as we have already said, that besides this, the differences observed between the averages of the two groups do not exclude the hypothesis of a unique workshop.

Use of Distances between Groups

One can seek to quantify the dissimilarity which exists between two groups by using either Euclidean distance or the generalized Mahalanobis distance. But it is very much evident that whatever the methods of calculation used, and the conventions required for their application, the quantification of resemblances does not resolve any of the previous difficulties. The quantification will rid one of the imprecisions that are the result of a sampling procedure which in the majority of cases is not random. Nor does it resolve the unreliability resulting from the necessarily limited nature of the sampling. Above all, such a quantification does not reduce the risks of confusion which result from the possible existence of several workshops possessing largely identical compositional characteristics due to a similar geological environment. It is thus absolutely impossible to fix a limit below which one would be justified in considering that the two groups come well and truly from the same workshop.

Use of Individual Distances

Instead of comparing two groups, as has been done up until now, one can study the comparisons between the individual members of these two groups, or those between a group and the individual members of the other group. In the first case we will use a simple cluster analysis (Fig. 4). In the second case we can measure the Mahalanobis distances of all the individual members of the unidentified group with regard to the reference group; one can thus better visualize the interlocking of the two groups. If we examine our two groups, Malaga-Spain and Malaga-France (Fig. 5), we find that these comparisons (worked out using the Mahalanobis distance in relation to the Malaga-Spain group) contribute little that is new to permit us to remove the difficulties in the interpretation of averages. Obviously the possibility of observing resemblances between individual members belonging to different groups can lead us, in a certain number of limited cases, to consider as highly probable the likelihood of there being a single workshop. But in the majority of cases one cannot rid oneself of the imprecisions observed during the comparison of the averages.

Absolute Comparisons

If one wished to summarize the difficulties which have been pointed out concerning the attempt to attribute the Malaga-France group to the Malaga-Spain group, it would suffice to say that one always comes up against the same problem. This problem is the impossibility of deciding in an absolute way if the two groups correspond either to the productions of one (and the same) workshop, or to those of several workshops, the problem being the same whatever way one carries out the comparison between the two groups. In other words, it is impossible to determine in an absolute way the resemblance between two groups. This resemblance can in fact be interpreted only in relation to differences existing elsewhere. The important thing is (and that we shall discuss later on in connection with relative comparisons) that the characteristics of the Malaga-France group be closer to those of the Malaga-Spain group than to those of all the productions of the south of Spain, or that they be closer to those of clays found in the region of Malaga than to others found in the area under study.

The theoretical and practical consequences of such an attitude will be discussed later on, but it is already clear that such results will not lead to a lightening of

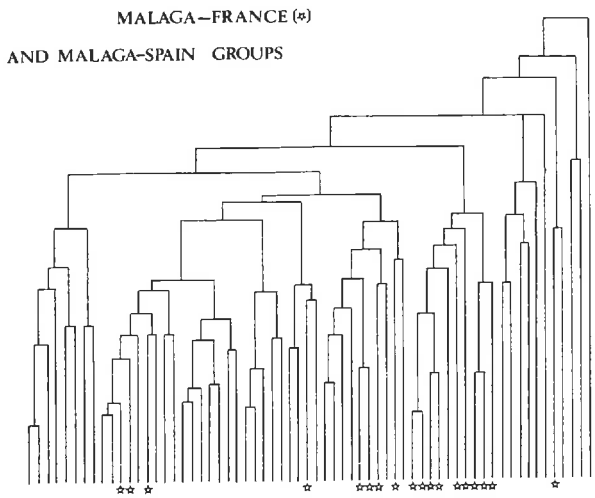

Figure 4. Cluster analysis of Malaga-France (stars) and Malaga-Spain ceramics.

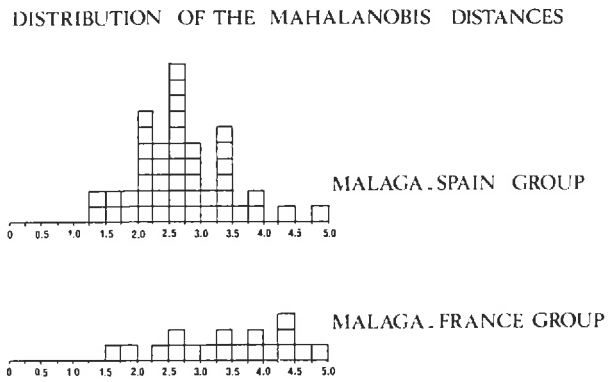

Figure 5. Histogram of the Mahalanobis distances in relation to the Malaga-Spain group of the two groups.

the workload. It can be understood under such circumstances that one is led to ask oneself if there exist other techniques capable of distinguishing the characteristics of ceramics in such a way that one could be sure, except under very exceptional circumstances, of not running the risk of confusing productions which don't belong to the same workshop. If such a method existed, nothing, or nearly nothing, would stop one's being able to decide that the two groups, Malaga-France and Malaga-Spain, came from the same workshop, if indeed this be the case here. Such a decision would take into account only the laboratory measured characteristics of these two groups. This is why we shall now examine what an increase in the number of elements to be analyzed (fingerprint theory), and the introduction of qualitative characteristics (mineralogical and petrographic analyses), can bring us in the way of results.

Increase in the Number of Analyzed Elements

The assumption at the origin of the fingerprint theory is that on increasing the number of chemical elements to be measured one considerably reduces the risks of confusion. The problem is that of the definition of the potential risks of confusion that can be minimized, or even ignored. If it's a question of the accidental confusion of two workshops whose geological environment is not the same, but whose ceramics show the same compositions for the principal elements analyzed, it is certain that on increasing the number of elements to be analyzed one will likewise increase the chances of finding some differences between the productions of the two workshops. This of course results from the fact that no reason, other than that of luck, is in any way responsible for the accidental correspondence noticed between the principal constituents. However, such cases are in fact extremely rare, as we suggested earlier on when advancing the hypothesis that the Malaga-France group could come from Tunisia or Italy. The most frequently encountered risks correspond to those cases where the possible confusion is not due to chance, but due to the fact that the workshops have the same geological environment. It is in such cases that it would be necessary to know whether on increasing the number of elements to be analyzed one could succeed, or not, in avoiding such confusion. It is clear that such a success would constitute a most definite advantage.

Unfortunately, it does not seem that one has taken sufficient care to demonstrate the validity of the assumption behind the fingerprint theory using well-chosen and sufficiently numerous examples. The comparisons that have been carried out for us, and the information that can be gleaned from different publications, seem indeed to contradict this basic assumption. We in fact encounter more or less the same difficulties when distinguishing different workshops whatever the number of elements analyzed (provided, of course, that one uses a minimum of about ten), especially when dealing with workshops whose geological environment is similar — and this we stress is a particularly frequent case. It is absolutely necessary for the integrity of our discipline that we get together and agree to study, using different and complementary analytical techniques, a certain number of cases where the risks of confusion seem evident when using one technique or another. In the meantime we must

assume a very prudent position and adopt a suitable attitude which takes into account the potential sources of error. In conclusion, one can say that if an increase in the number of chemical elements to be analyzed is of use in the case of certain well-defined comparisons, it does not seem to be so in every case, and in particular when comparing workshops of a similar geological environment.

Introduction of Qualitative Characteristics

The important thing here is not that the characteristics one is dealing with be qualitatives, but that their variety be very wide. One could be tempted to consider petrographic and mineralogical characteristics as being inferior to chemical characteristics because they are most often used only on a presence and absence basis. Such an approach would present a serious handicap in comparison with the numerical possibilities of chemical analysis, if the variety of the petrographic and mineralogical observations did not largely compensate for this disadvantage.

In the case of the ceramics of the Malaga-Spain group, the examination of a thin section reveals the presence in the paste of different varieties of schist, often closely associated with some finely granulated quartzites. Many larger grains of quartz, associated sometimes with schists and quartzites as well as with ferruginous elements, present a marked cataclastic structure. These characteristics, as well as a few others (e.g., dimensions of the grains, appearance of the clay matrix), might not be the same over a large geographic area. One can also consider that the probability of finding the same characteristics in regions far from Malaga is virtually nonexistent. As we observe these characteristics in the ceramics of the Malaga-France group we can be sure that the two groups come from the same region. But we cannot affirm, on the sole basis of laboratory data, that we are dealing with the same workshop.

Thus, the study of the petrographic characteristics leaves us confronted with the same sort of situation encountered earlier on with that of the chemical characteristics. There can without doubt be risks of confusion, serious or not, depending on which characteristics one studies, but here also there is a lack of comparative studies. In the case of the Malaga productions we would be tempted, taking into account the local geology, to believe in the superiority of petrographic characteristics. Unfortunately, too many categories of pottery have a fine paste which presents an obstacle only overcome with great difficulty when one wishes to distinguish the petrographic characteristics of the ware in question. What is more, the fine wares are most often those that were most widely exported, and they must therefore be studied in the laboratory. Besides, the sorting of a complicated material is often more supple and quicker using chemical data than when using mineralogical and petrographic data. However one must not ignore the value of mineralogical and petrographic data which often provide us with precise and irreplaceable geological information.

Relative Comparisons

We now propose to go back to the original problem we presented, namely, that of the localization of workshops. We have at our disposal a reference group, the Malaga-Spain group, which we take for granted as originating from Malaga. The determination of the provenance of the Malaga-France group ought to consist, if the group in question does really come from Malaga, in showing that the two groups have certain characteristics which could assure us as to their having a common origin. However we have already seen that if we take into account only these two groups there exists no laboratory study of ceramics, however complicated, that could permit us with our present knowledge to state positively the common origin of the two groups. Indeed, nothing indicates that there might not exist in southern Spain another workshop using clays of the same characteristics as those of Malaga. We know that such cases do exist, and that they are even frequent and can be found at a considerable distance, but unfortunately such cases have rarely been studied. Likewise, we have seen that as long as one limits investigations to the reference group and to the group of undetermined origin, nothing allows one to conclude as to the likelihood of a separate origin when faced with the differences between the two groups.

We must therefore accept the idea that the laboratory methods for the study of ceramics are imperfect, this in itself a banal statement for all experimental research. Nonetheless, the fact that these methods are generally less imperfect than the traditional approach to pottery studies in no way justifies their use without taking into account their imperfections.

If we wish to consider the flaws in these methods in order to minimize their drawbacks, the only logical procedure which would allow one to assert that the Malaga-France pottery was produced at Malaga would be to stop estimating the degree of resemblance between the two groups in an absolute way, and henceforth to estimate in a relative way. We intend to show, as has already been pointed out, either that the characteristics of the Malaga-France group are closer to those of the Malaga-Spain group than to those of any other productions in southern Spain, or that they are closer to clays existing in the region of Malaga than to any other clays existing in the area

under study. If it turned out that the characteristics of the Malaga-France group were found virtually unchanged over a long distance, the determination of the provenance would be relatively imprecise, but the knowledge of this imprecision would prevent the mistaken attribution of workshops.

The putting into practice of such a procedure necessitates the setting up for the region under study of what we shall call a network of localized data, which also brings us to the idea of an a priori probability. We now propose to discuss in greater detail the role of these two complementary themes.

The Network of Localized Data

Taking into account all we have said so far, it is easy to understand that generally the value of the determinations of ceramic provenance carried out in a laboratory depends above all on the density of the information that one has been able to gather concerning the clays of the region under consideration. It is the assemblage of this information that constitutes the network of localized data. The problems of localization being above all geological, one can make do with a loosely structured network where one is sure that certain geological formations would not have been the source of the raw material used by the potters. On the other hand, the network ought to be relatively tightly structured in zones where the formations might have been exploited for ceramic production. The construction of the network will involve the use of results obtained from the study of clay samples, as well as those from the study of regional ceramic workshops of all periods. The importance of the latter will be seen later on. Sometimes the assemblage of the network of localized data cannot be easily carried out, notably because the location of certain references is not the result of direct, incontestable observations. One is indeed often obliged to resort to information provided by ceramic comparison material whose localization is based on archaeological or other such methods of cross-checking. Such a procedure can be at the origin of many mistakes. We shall therefore point out that the procedure followed for the determination of ceramic provenance does not generally call directly on the nature of the observed or measured characteristics of the ceramics and the clays. In fact, we can use any method of characterization. This is all the more valid if certain methods are seen in practice to be of little discriminatory value and thus difficult to use. This deficiency would not lead one into error but only lead to a greater imprecision as to the localization of the ceramic source. The essential concern is to recognize and define the imprecision.

A Priori Probabilities

When one reads publications, including our own, that deal with the determination of ceramic provenance, it is clear that the procedure we have just described is rarely used. One can say that if the tightly structured network of localized data is rarely encountered, this is because laboratories nearly always accept that the data relevant to the problem of provenance includes a certain number of limitations which are more or less explicit. Indeed, certain possible locations can be considered a priori as being more probable than others. The existence of these a priori probabilities allows us, if not to get by without the network of localized data, at least to use a highly simplified version of the network. Such a simplified network can be used wherever we consider that a problem of provenance can be limited to a certain number of possible localizations. In using such a method, we accept that the sites proposed at the beginning as being the only likely ones present a certain probability of being the location one is looking for, whereas all other sites are of a zero probability. However, in the majority of cases it is not possible to be so categorical. Nevertheless it is evident, when one seeks to identify the origin of a group of pottery from a given region, that the workshop one is looking for has more chances of being situated at certain places and sites than at others. Bearing this statement in mind, we can construct a simplified network where all points have a high probability of being the location in question. Such a network necessitates the bringing together of the evidence of archaeology (workshops, domestic sites, markets, communication networks), ethnography (the study of modern production sites whose interest resides in the often noticed chronological continuity of artisanal production, technical traditions, and so on), and geology (clay sources and their suitability for certain ceramic productions). This simplified situation is represented on the map of southern Spain (Fig. 6).

If, in our search for the production site of a group of ceramics, we can show not only that their composition very closely resembles that of one of the high probability points on our network of localized data, but also that all the other high probability points have radically different compositions, we would be right in considering this first point as being that of the ceramic production source. One can above all accept that the probability of another production site's existing would be low, all the more so as greater care will have been taken in the inventory of the high probability points in the region under consideration.

It is clear that the principal difficulty encountered in the determination of ceramic provenance results

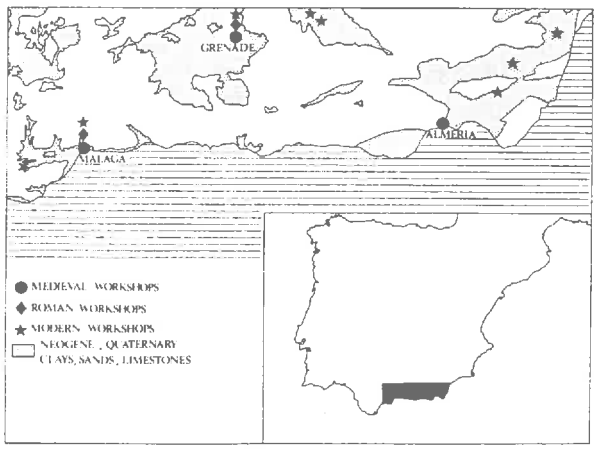

Figure 6. Simplified map of clay deposits and ceramic workshops, ancient and modern, in southern Spain.

from the fact that an accurate distinction of the role of the laboratory and that of the different a priori probabilities is rarely carried out. The a priori probabilities which justify the use of a very simplified network are often not very clear, often implicit, and when they are explicit they are badly assessed, underestimated, and even more often overestimated.

Even in the relatively simple case of the Malaga-France group where we conclude, as indeed is the case, that the group does originate from Malaga, it must not be forgotten that though the laboratory has well and truly confirmed the attribution of the pottery to the Malaga region, the attribution to Malaga itself is more the result of historical evidence and therefore of certain a priori probabilities.

This reinstatement of geological, historical, archaeological, and ethnographic evidence in the conclusions reached by the laboratory ought to provide us all with food for thought. We are agreed that it is not so much a true reinstatement, as the realization of the exact role played by historical evidence (using the idea of a priori probabilities) in the general conclusions reached by work in the laboratory.

One can finally ask oneself if the construction of the network of localized data is not too long and costly an enterprise. But, apart from the fact that it seems difficult to dispense with such a network without running the risk of coming to false conclusions, it should be emphasized that it is not possible to count on luck alone in the localization of ceramic production sites. The surest, and in the long run the most economic, procedure for discovering these points is the use of the simplified network where, in priority, one takes into account the zones of high probability.

We hope that this reflection will contribute to the discussion which enlivens present-day research in ceramology.