

Archaeological Collections: Invasive Sampling *versus* Object Integrity

Michael S. Tite

Professor of Archaeological Science

Research Laboratory for Archaeology and the History of Art,

University of Oxford

Introduction

In considering the question of invasive sampling versus object integrity, I start, and have always started, from the premise that archaeological material should be seen as a potential source of information rather than something that must remain totally unchanged after excavation. Therefore, I definitely favour invasive sampling over the preservation of complete object integrity. However, having said that, there is clearly a need for restrictions on the extent of invasive sampling.

When I started to investigate ancient technologies back in the 1960s, the attitude among scientists and curators was entirely different. Scientific examination was still something of a novelty. We were all uncertain as to what useful information could be provided by scientific methods. Both sides approached the archaeological material with a sense of adventure – of advancing into the unknown. With requests for samples being relatively rare, curators tended to be very relaxed, and I remember being provided with entire sherds from the Near East by one museum. Of course, there were occasional disasters. For example, there were rumours that a small group of silver coins could not be returned to their museum for several years because they had been made too radioactive by irradiating with neutrons prior to neutron activation analysis to determine their compositions.

However, quite correctly, such relaxed attitudes could not continue as the discipline of archaeological science expanded, and thus the requests for samples progressively increased. With the development of new scientific techniques, there were more and more requests requiring the repeated sampling of the same archaeological objects, either to obtain entirely new information or to improve the accuracy of previously obtained information. Curators therefore began to fear that their objects would not survive or, at best, end up looking rather like a sieve! Furthermore, because of the need to repeat measurements in order to achieve increased accuracy, curators tended to become more sceptical about the value of scientific examination and scientific data.

Fortunately, at the same time, scientists involved in the study of archaeological materials started to become ‘archaeological scientists’. There were still, as there are now, some scientists with a new scientific technique for which they are trying to find a problem to solve and which they consider to be ‘god’s gift’ to archaeology if only archaeologists were perceptive enough to appreciate it! However, aided by the establishment in 1976 of the Science-based Archaeology Committee within the Sci-

ence and Engineering Research Council, the majority of scientists became progressively better integrated into archaeology. This integration has continued, particularly during the 1990s with the creation of lectureship posts in archaeological science in most university archaeology departments and the teaching of archaeological science in most, if not all, archaeology undergraduate degree courses. As a result, archaeological scientists themselves now fully accept the need to take into account the problems associated with the risk of physical damage to the objects and the potential loss of object integrity when requesting and taking samples.

Criteria to be Satisfied Prior to Invasive Sampling

As a consequence of these developments, there has been considerable dialogue between curators and archaeological scientists on the sampling of archaeological materials, and generally agreed criteria for sampling have now been defined. First, the curator must decide whether the archaeological information that will be obtained by scientific examination would be of real value, and then whether the scientific method being proposed will really provide this archaeological information. In making the latter decision, the curator will need either to consult with an independent archaeological scientist or to rely on the integrity of the scientist making the application.

If the proposed research can be justified both archaeologically and scientifically, the next question is whether the scientific data required can instead be obtained in a non-invasive way, sampling only being appropriate if there is no alternative non-invasive method. The feasibility of using non-invasive methods depends on the scientific data being sought as well as the type of material being studied.

With the development of analytical methods using laser ablation, it is in principle possible to undertake both elemental and isotopic analysis of homogeneous materials without the removal of a sample. However, to use laser ablation for fully quantitative analysis, it is necessary to transport the object to the laboratory where the equipment is housed¹. For inhomogeneous materials, such as pottery and stone (other than flint or obsidian), it is necessary to remove a sample even for elemental analysis in order to ensure that a representative volume is analysed. Similarly, the use of microscopy to investigate the microstructure of materials almost always involves the removal of a small sample. The exceptions are when the entire object can be accommodated either under an optical microscope or within the scanning electron microscope chamber. But, even in this case, it will often be necessary to first remove surface weathering or contamination if valid scientific data is to be obtained and, again, the object will need to be transported to the laboratory.

When a sample is taken, it is crucial, whenever possible, that after completion of the measurements proposed in the application, the sample is returned to the museum, which should take responsibility for storing it and for making it available to future investigators. Sample preservation and storage should not present any problems in the case of thin or polished sections used for microscopy. However, samples taken by drilling or abrasion for elemental and isotopic analysis are frequently dissolved in acid and vaporised during measurement, the principal exception being borate glass pellets prepared for X-ray fluorescence analysis.

A further factor that needs to be considered is the reputation of the archaeological scientist who has made the application. Have they been active in the particular research field for a reasonable length of time? Do they have a good record for the publication of the results of previous scientific examinations, and do these publications indicate that the laboratory in which the work is to be done has good quality control on its data? Furthermore, if the museum to which the application is made has previously provided samples to the same investigator, have they given the museum an adequate report of the results obtained, and have the samples been returned?

If all of the above criteria are satisfied, the final decision on whether or not to allow sampling must depend, first, on the risk of physical damage to the object during sampling and, second, on the importance attached to any loss in the integrity of the object as a result of sampling.

The decision based on risk of physical damage is undoubtedly the easier of the two to make. Thus, much material from archaeological sites is already in a fragmented state and can be readily sampled by drilling, abrading or cutting from a broken edge using, for example, diamond-impregnated tools. Similarly, even when archaeological objects appear to be complete, many have a damaged region from which samples can be easily removed by drilling, abrading or the application of pressure. Provided that such samples are taken with care by someone, such as a conservator, who is experienced in the handling of museum objects, there is minimal risk of physical damage to the objects during sampling. Obviously, in taking samples from such objects, it is important to avoid, as far as is possible, any loss to their characteristic form or decoration. Furthermore, a full photographic record of the object, before and after sampling, should be made.

In the case of genuinely complete objects, it would still normally be possible to remove a small sample by drilling or abrasion from a concealed part of the object, such as the base of a pottery vessel, without risk of physical damage to the object. However, it is certainly preferable to avoid any sampling of complete objects unless absolutely essential, for example, to establish the object's authenticity. Instead, one should try to sample comparable but damaged objects, whose link with the complete object can be confirmed by non-invasive qualitative analysis of the latter.

In deciding on the importance that should be attached to any loss of object integrity as a result of invasive sampling for scientific examination, one first needs to consider what is meant by object integrity. The state of any object in a museum is inevitably very different from its state when first produced in antiquity. In addition to any changes due to use and reuse of the object in antiquity, there are the changes that have occurred during burial as well as those occurring subsequent to excavation as a result of both the action of the post-excavation environment and any conservation processes to which the object has been subjected. In consequence, provided that there is minimal loss of an object's characteristic form or decoration, I believe that it is legitimate to question whether the removal of a small sample for scientific examination will have any significant impact on the overall integrity of an object.

The Basis for the Curator's Decision

Ultimately, the decision on whether or not to sample must rest with the curator, who needs to balance the cultural value of the object against the archaeological value of the information that could be obtained as a result of invasive sampling for scientific examination. In making their decision, the curator should, wherever possible, consult, first, with an independent archaeological scientist who will at least be able to judge the scientific validity of the proposed scientific examination. Second, consultation with conservators is essential regarding the possible risk of physical damage to the object during sampling. It can also be helpful, on some occasions, for a conservator to be present during, and perhaps assist with, sampling. However, it is not a conservator's role to pass judgement on either the cultural significance of an object or the extent to which it is important to maintain object integrity.

Third, the curator must consider the views of present and future generations of academics, and of the general public for whom the objects are ultimately being preserved. Since a majority of academics from across the humanities and sciences tend to see museum objects as sources of information, one would expect them in general to favour invasive sampling over object integrity, provided that the criteria outlined above have been strictly met. The wide range of TV and radio programmes and general books on all aspects of archaeology indicate the enthusiasm for the subject among the general public. Therefore, again, one would expect the general public to favour invasive sampling provided that it did not involve obvious physical damage to the object, and that the results of the scientific examination were presented in a manner that was generally understandable. However, in the present political climate, invasive sampling of material on which any indigenous peoples might have a *legitimate claim* should not be undertaken without their prior permission.

Additional factors that the curator needs to consider include, first, whether there is some more appropriate source of material for scientific examination, other than that in their museums, and second, whether scientific research on the objects should be deferred until some entirely non-invasive analytical technique has been developed. Obvious alternative sources of material for scientific examination are current archaeological excavations. However, it is frequently not possible, outside Europe, to remove even the small samples required for scientific examination from their country of origin. Therefore, the material collected from past excavations outside Europe, and now held in museums in Europe and the USA, is often the only material available for scientific examination. In consequence, without access to this material, the possibilities for the scientific examination of archaeological material from outside Europe will be severely limited, and progress in the archaeological understanding of early technology and trade will be seriously hampered.

Awaiting the development of an all-powerful, non-invasive analytical technique again is not a realistic option. In addition to the consequent delay in the progress of archaeological research into early technology and trade, it is doubtful whether a non-invasive technique that can provide high resolution compositional and microstructural profiles to depths of several hundred microns below the surface of an object will be developed, at least in the foreseeable future. In addition, much of the impetus for the modification of analytical techniques for the specific study of archaeological

material comes from the need for results that go beyond those already obtained with established techniques. Therefore, without a succession of ongoing scientific projects to stimulate development, it is unlikely that appropriate new techniques would emerge.

A final barrier that must be borne in mind is that requests for invasive sampling can add significantly to the many demands that already exist on both curators' and conservators' time. Thus, the objects for analysis must be collected together, any possible impact on them must be assessed, and if the application is approved, then time must be set aside for the actual sampling. Conversely, curators should remember that scientific examination is itself a very time-consuming activity, and therefore, archaeological scientists tend to be as parsimonious as possible in their requests for samples.

Conclusions

Finally, one needs to consider how satisfactory the present situation regarding access to samples for scientific examination is in the UK. Over the past few years, I have applied for samples to the Ashmolean Museum, Oxford, The British Museum and the Petrie Collection, UCL. In each case, I have been asked to complete an application form that aimed at ensuring that the criteria for permitting invasive-sampling, outlined above, would be met. So far, my applications have generally been successful, although I have not always been allowed to take samples from the full range of objects requested in my application.

In spite of this comparative success in obtaining samples, there is no doubt that it is becoming both more difficult and more time-consuming to obtain samples than it was, say, 10 years ago. This partly reflects the ever increasing demands on curators' and conservators' time in the more bureaucratic world in which we all now work. But, I also feel that, at least in some museums, the emphasis put on object integrity is unnecessarily restrictive, especially when the requests are for samples from industrial debris surviving in considerable quantity. It is not clear to me, however, whether this increased emphasis on object integrity comes from curators or from conservators. Interestingly, even though (or perhaps because!) the UK has tended to be at the forefront of archaeological science, it is now often easier to obtain samples for scientific examination from museums in the US and some other European countries than it is from museums in the UK.

If the current trend in the UK continues, I fear that progress in archaeological research into early technology and trade could be seriously hampered. Therefore, I would urge that the balance between invasive sampling and object integrity is not pushed any further in favour of the latter. In conclusion, let us always remember that objects are primarily sources of information and not 'holy relics'.

Endnote

¹ Recently semi-portable equipment for laser induced breakdown spectroscopy has been developed for the non-invasive analysis of archaeological objects by the Foundation for Research and Technology Hellas in Heraklion, Crete. However, the analytical data obtained using this technique is only qualitative or, at best, semi-quantitative. Therefore, although potentially a very valuable diagnostic tool, this technique is not a substitute for fully quantitative analysis by laser ablation ICP-MS, for which the objects must be brought to the laboratory.