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MEETING SUMMARY

The Identity and Future of Archaeological Science

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1. Introduction

It is now more than twenty years since the first symposium jointly organised by the Royal Society and the British Academy, under the title 'The Impact of the Natural Sciences on Archaeology'. The proceedings were promptly published (Allibone 1970a, 1970b) and give a clear picture of some of the outstanding preconceptions of the time. They constitute an interesting record for comparison with our present enterprise. The comparison is, I believe, a revealing one which can illuminate several aspects of the present state of our discipline.

In 1969 seventeen papers were presented of which eight were on the subject of dating. Five of these dealt with radiocarbon dating, the first of them by Willard Libby himself, whose pioneer work in that field (Libby 1949) must surely constitute the single most significant contribution in the field of archaeological science. There was one paper on statistics (more specifically on seriation, itself a technique directed toward dating), three on archaeological prospecting, and five on various aspects of the analysis of artefact materials.

If we compare that with the present programme, several obvious directions emerge. First, the life sciences, along with environmental archaeology, have now taken their place firmly alongside the physical sciences. Secondly, the sense of almost astonished novelty has gone: there is no longer a sense that natural sciences and archaeology are such separate spheres that their interaction is a matter of impact! The title of the present enterprise, 'New Developments in Archaeological Science', reflects the genuine effectiveness of the integration which I believe has now taken place. There has been at the meeting none of that separation, that feeling of a chasm dividing two disparate fields, which has sometimes characterised such gatherings.

Now it must be admitted that another feature of the present programme of speakers is that it contains not a single paper presented by an archaeologist. All the paper speakers may be classed either as scientists or as members of that new breed, archaeological scientists. But this was certainly not a deliberate decision by the Organising Committee, and I think it springs from the desire to describe new techniques rather than new applications. A more conscious wish was that questions of chronology should not be allowed to dominate this meeting as they have often done in the past. For that reason the Poster Session was devoted entirely to dating methods, and only dendrochronology was made the subject of a paper in the main session. But electron spin resonance and optical luminescence (a technique new to me) among others figure prominently among the posters.

The evolution of early hominids was another topic excluded from the present meeting since there will be another joint symposium of the Royal Society and the British Academy on that topic next year. But of course questions relating to the dating of fossil human remains were discussed by Dr. Hare in his treatment of amino-acid racemisation. And Professor van der Merwe gave us fascinating new insights into the diet and nutrition of Australopithecus.

On such an occasion it is of interest to gauge the composition of the participants. It seemed appropriate therefore to ask those present to raise a hand in order to identify their self-classification into one of the following categories:

i) archaeologist (about 40),

ii) archaeological scientist (about 60),

iii) scientist (about 40),

iv) other (about 25).

The figures suggest above all the extent to which the concept of 'archaeological science' has developed in recent years: it may be claimed that a new discipline has emerged.

In celebrating this new category of 'archaeological scientist' it is appropriate to look back to the origins of our discipline. The first period we may regard as ending in 1939 with the onset of the Second World War. It goes back as far as 1720, when Edmund Halley (a Fellow of the Royal Society) examined the stones of Stonehenge—although in the eighteenth century dolerite (whether spotted or otherwise) had not yet found its place in the terminology of petrology. From that time on, the sciences were occasionally applied to archaeology, especially in the appendices of excavation reports, for instance, those of Heinrich Schliemann. But archaeological science in the modern sense was a later development, seen for instance in the sustained researches in archaeometallurgy conducted by Richard Pittioni in the 1930's. And, of course, it was in the 1920's and 1930's that aerial photography, the first really productive technique of remote sensing, came into its own.

After the Second World War, the scientific enterprise in this country, initiated earlier by Sir Mortimer Wheeler at the Institute of Archaeology in London, was redeveloped. One of the most thorough early treatments was F.E. Zeuner's *Dating the Past* (Zeuner 1946). The foundation in Oxford of the Research Laboratory for Archaeology and the sustained efforts there of E.T. Hall and of Martin Aitken was one of the developments which has had the most positive influence on the growth of the subject. *Archaeometry*, the journal of the Laboratory, was first published in 1958, and a few years later the first Archaeometry Conference took place. In Cambridge, at about the same time, the ecological approach promoted by Grahame Clark and furthered by Eric Higgs and his students, ensured that the environmental sciences were not overlooked. They have, however, sometimes seemed to be outside the field of "archaeometry", at least as this was defined through the work of the Oxford Laboratory, with its bias towards the physical sciences.

The 1969 Conference mentioned earlier well reflects the position where, not least through the continued efforts of our colleagues in the Oxford Research Laboratory, a coherent professionalism developed. A highly significant step in this direction (and one initiated by the Royal Society and the British Academy) was the decision, accomplished in 1977, to set up a Science-based Archaeology Committee, by which archaeological science could be funded through the Research Councils. It was decided to structure it as a committee within the framework of the Science and Engineering Research Council. The considerable success of this enterprise has recently been reviewed in a useful publication by Mark Pollard (1991). And so today we see the discipline firmly and securely based, with three established university chairs now devoted to archaeological science (in Oxford, Bradford, and Cambridge).

2. The future impact of archaeological science on archaeology

There can be no doubt of the significance of archaeological science for archaeology as a whole—at any rate in some senses. Chronological questions, which used to be at the nub of most archaeological discussions, can now, in large measure, be resolved by the application of radiometric methods for the older periods, and of tree-ring work in more recent times. To say this is, of course, to oversimplify somewhat. But the whole field of prehistory, for instance, has been transformed. So too have other aspects of the discipline.

It is remarkable, therefore, that archaeological science has had so little impact upon the conduct of archaeological excavation in the field. Remote sensing and survey methods certainly anticipate the excavation process. And all manner of 'post-excavation' analyses succeed it. But it is not inaccurate to say that for the great majority of field archaeologists, the actual praxis of digging has not been altered in any significant respect. Certainly most archaeologists will utilise sieving procedures and sometimes flotation procedures for the recovery of finer and lighter residues. And some now use computerised systems for recording data in the field. But otherwise the changes in excavation practice (for example, from Wheelerian grids or boxes to broadly open-plan work) have evolved quite logically and quite independently of any considerations deriving from the archaeological sciences.

Now this is not because there is no scope for appropriate new methods. I myself have excavated an eleven-metre stratigraphic sequence (in north Greece—effectively a tell mound), finding the succession of occupation floors, "destruction deposits", and considerable depth of "fill" intercut by "rubbish pits", which are the commonplace of all tell mounds and indeed of all urban sites also. But no archaeologist could claim that one has a clear understanding of precisely how these deposits were formed, or of what they represent. Dr. Marie-Agnès Courty, in her illuminating paper, offered us a glimpse of what might be gained by the consistent application of the technique of soil micromorphology to deeply stratified sites. Hitherto taphonomic issues have been debated mainly on palaeolithic sites (principally in caves and rock shelters). The palaeolithic archaeologist has become uneasy as to whether the materials under study are really the *in situ* product of human activity at all. Or are some of these deposits the result of non-human agencies —hyena dens and the like? In later prehistory such questions are less often relevant. But that is no reason to neglect the crucial relevance of taphonomy —of the understanding of site formation processes—to the proper interpretation of every archaeological site. The potential impact of soil micromorphological techniques to the practice of excavation is clearly very considerable. It may well be possible to give an accurate interpretation of the mode of formation of every half centimetre of soil in a stratigraphic succession. One can imagine, then, the wealth of information which a deeply stratified site could yield.

Is it too much to contemplate a vision of the future where archaeological science would be integrated fully within the sequence of prospection, excavation analysis and publication, with interpretations offered rapidly in the field, in such a way as actually to influence the course of the digging process? The following might be the sequence of events:

1. Satellite reconnaissance, with a pixel resolution of just one metre or less, allowing the techniques discussed by Ian Shennan to be deployed to full effect.

2. Ground survey, using tractor towed resistivity and ground radar survey methods of the kind indicated by Arnold Aspinall, along with magnetic techniques also, if a non-metallic tractor and engine were devised.

3. Tomographic interpretation of the data, so that the notional "peeling" of the stratigraphic sequence of the sites, without actually excavating, could first be accomplished.

4. Stratigraphic excavations of selected columns of material using soil micromorphology to investigate formation processes.

5. Area excavation of complete settlements following such stratigraphic elucidation, using computerised point plotting of artefacts, as well as screening and flotation recovery techniques for samples from each stratigraphic unit.

6. Rapid quantitative assessment of the artefact material from the site using measurement techniques of the kind outlined in his paper by Clive Orton.

7. Development of a chronology based in the first instance on radiocarbon and thermoluminescence determinations, backed up where possible by tree-ring measurements (as reviewed for us by Dr. Baillie) either on preserved wood, or on carbonised timbers, with the aim of providing a chronology measured in decades or even years rather than merely in centuries.

8. Reconstruction of the environment of the surrounding region through time, using the holistic approaches outline at the meeting by Professor Berglund.

9. Dietary reconstruction, taking into account (as advocated by Martin Jones) the entire food web, using data from bones, seeds, coprolites and preserved food residues, including lipid analysis of the kind so profitably explored by Richard Evershed *et al.*

10. Investigation of the ancestry and descent of the food plants and animals recovered, focussing upon the DNA in seeds and animal bones and using the biomolecular methods reviewed by Robert Hedges.

11. Investigation of the ancestry and descent of the human individuals for

whom bone or tissue is preserved (using comparable DNA-based methods), and investigation also of the specific genetic relationships between them.

12. Investigation of complete trading systems, using characterisation techniques, such as lead isotope analysis, for the sourcing of traded goods (in the manner outlined by Noel Gale). The investigation would aim also to follow up production of the materials at the area of origin, and consumption on the sites where they were ultimately used.

13. Investigation of the technologies used in the production of artefacts, using the range of techniques summarised by Paul Craddock and by Michael Tite for metallurgical and ceramic studies.

This sequence is, of course, a very incomplete one, deliberately referring only to the methods reviewed in the course of the Symposium itself. In addition one would wish to lay particular emphasis on the rapid publication of the material and indeed of the post-excavation analyses. And one would wish also to see undertaken some interpretation of why the observed changes took place. Here some attempt at the computer modelling of the culture system would be appropriate—simulation studies constitutes one of the more significant fields omitted from the programme of the Symposium.

It should be noted that the emphasis on post-excavation work would lie very much with the study of whole systems: the environmental reconstruction and the dietary reconstruction would benefit from the holistic approaches indicated by Berglund and Jones. The trading and technological-production studies would again consider the entire system in the manner indicated by Gale, and again by Craddock and Tite.

Perhaps the day is not far off that certain excavation projects will be conducted primarily by archaeological scientists seeking material relevant to their specialism.

3. A cautionary word

Sometimes archaeologists and, I am afraid, archaeological scientists, rather readily take the view that the conclusions offered by the application of the methods of the natural sciences carry with them more weight than do those deriving from archaeology as such.

It is pertinent, then, to remember that the findings of archaeological science have been reversed just as often. One very striking case was offered at the present Symposium. In 1923, the petrologist H.H. Thomas identified the 'bluestones' at Stonehenge as consisting of spotted dolerite, using the standard petrological technique of the microscopic examination of a thin section of the material. He showed that the only relevant source of this material was in the Prescelly Mountains of Wales, and concluded that the bluestones had been transported thence by human agency during the neolithic period (Thomas 1923).

Some ten years ago this view was questioned by Dr. Kellaway, who argued that the bluestones could have been transported to the Salisbury Plain by glacial action. His proposals attracted much media attention but did not find widespread acceptance—mainly, as I recall, because the weight of geological opinion was against the extension of the glacial flow in question so far to the east.

It was fascinating, then, to hear the case for glacial action so persuasively put by Dr. Williams-Thorpe. But although I was impressed by the coherence of her arguments, it does seem a strange stroke of fate that should lead an ice sheet to uproot so many bluestones from the Prescelly Mountains, and then proceed to deposit them in considerable quantity in so localised a part of the Salisbury Plain. Whatever the merits of the case, we see here archaeological science in conflict with archaeological science. Either in 1923 or in 1991 an erroneous conclusion has been offered.

A second famous case which comes to mind is that of Glozel. The late Glyn Daniel always considered the entire site and all its products to be monstrous fakes, and he had sound archaeological reasons for his suspicions (Daniel 1975). It was with some astonishment, then, that one contemplated the thermoluminescence dates offered by the Oxford Laboratory, by Dr. Mejdahl in Copenhagen and by Dr. McKerrell in Edinburgh, all suggesting that the site was of very considerable antiquity (McKerrell *et al.* 1974). At Professor Daniel's request I read his paper to the annual Archaeometry conference in Oxford in 1974 (Renfrew 1975). And well I remember the confidence with which the assembled archaeological scientists dismissed his evaluation of the position. But I have not, for many years, met a reputable scholar (whether archaeologist or scientist) who would maintain that the Glozel finds were other than fakes. Glyn Daniel was right and the archaeological scientists were wrong. Yet what is even more disquieting is that there has been no subsequent publication to show precisely where the thermoluminescence measurements went astray, or what was wrong with them. So far Emile Fradin, the discoverer of the site and for long the proprietor of the site museum, has had the last laugh.

Another justly celebrated case of scientific fallibility is offered by Willard Libby's comparison of the Egyptian historical dates for certain organic samples from ancient Egypt and the radiocarbon dates for the same specimens. The historical dates were systematically older than the radiocarbon dates. Did Libby suggest that the radiocarbon dates might be in error? Not a bit of it. He concluded "This plot of the data suggests that the Egyptian historical dates beyond 4,000 years ago may be somewhat too old, perhaps five centuries too old at 5,000 years ago ... it is noteworthy that the earliest astronomical fix is at 4,000 years ago, that all older dates have errors and that these errors are more or less cumulative with time before 4,000 years ago". (Libby 1963, 279).

Later it was discovered that fluctuations in the radiocarbon time scale necessitated the calibration of radiocarbon dates by means of dendrochronology. The Egyptian historical dates were found to be right, and the radiocarbon dates once calibrated fell into line with them.

At about the time of the first Royal Society/British Academy meeting in 1969 there occurred the first international conference on the volcanology and archaeology of Thera, that remarkable island in the Aegean destroyed by a volcanic eruption more than three thousand years ago. At that conference the consensus of scientific opinion was with Professor Spyridon Marinatos that the eruption of Thera was responsible for the destruction of the Minoan palaces of Crete around 1450 BC. By the time of the second congress in 1978, it was felt that the date of the eruption was somewhat earlier, perhaps around 1500 BC, and that it preceded by some decades the palace destructions. Yet at the third conference, held two years ago, whose proceedings are being published this very day (Hardy 1991), the radiocarbon evidence was being interpreted to support a date for the eruption of 1628 BC, obtained from the study of the Irish dendrochronological sequence. Nor is the matter yet settled, for the ice core dates from Greenland would appear to contradict the tree ring dates from which they differ by some twenty years.

Such controversies, when uncharitably drawn in this way to the attention of archaeological scientists, sometimes cause vexation. Indeed, to speak too loudly of Glozel is still considered bad form in some quarters. But in reality they should be as much a cause for satisfaction as for embarrassment. For is it not, these days, a defining characteristic of real science that it is testable? If we follow a refutationist definition of this kind, in the tradition of Sir Karl Popper, we should not be surprised if we encounter a few refutations! That archaeological science should sometimes give the wrong answers, and that these can later be shown to be indeed erroneous, must be counted one of the subject's greatest strengths. It is a sign of the growing maturity of the discipline that these reverses can be contemplated with equanimity (or at least near-equanimity). Archaeological science has certainly now come of age, and can take in its stride such differences of opinion as these as a characteristic feature of scientific progress.

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