Towards a synthetic theory of archaeological stratigraphy

UB doctoral student in anthropology, fall 2003

Introduction

Archaeology is undergoing a revolution. As with any science, archaeologists separate their observations from their conclusions. For most of its history, archaeological observations have been recorded on paper. This has meant that excavation techniques developed in a manner which aims not at recording the material traces of human activities as they are found in the ground, but rather reducing what are often complex three-dimensional structures to two-dimensional planes which are easy to draw and photograph. As a result, archaeologists' understanding of the spatial dimension of their data has – apart from the limited (and often incorrect) context of the relative chronological sequence – been reduced by one dimension.

Computer technologies coupled with electronic surveying equipment now make the accurate recording of archaeological remains in three dimensions possible (Barceló et. al 2003), and the eventual development of three-dimensional Geographic Information Systems (GIS) will stimulate another significant line of development. GIS are databases linked to maps, designed to store and analyse geographical data. Because GIS was developed to analyse data in the geographic plane, archaeological use of GIS has largely focused on regional and landscape studies, locating sites relative to each other and to natural resources (Brandt et. al 1992; Kvamme 1989). But "archaeologists operate in a multi-dimensional world in which the addition of a third dimension, in the form of time, or depth, or height, are fundamentally interwoven within the archaeological analysis" (Harris and Lock 1995: 355). A within-site, three-dimensional GIS would enable the sort of spatial analyses which have made GIS applications such powerful tools for geographers, urban planners, ecologists, etc.

But before that can happen, archaeologists will have to reassess a number of its disciplinary foundations.

Research objectives

The overall research objective of the present study is the development of new tools for documenting archaeological stratigraphy. Strata (or layers) are the smallest analytical units in archaeological excavation, but this seemingly fundamental concept is badly flawed. Derived from geology, stratigraphy – the study of the strata formed by sedimentary rocks or soils – is an important tool for creating chronological sequences. Archaeology commonly follows geological practice, where strata are treated like envelopes, with everything inside one understood to belong together, having been deposited at the same time. "Lateral continuity dictates that no matter how extensive the upper and lower boundaries or interfaces of a stratum may be, the material enclosed by these boundaries is broadly the same age" (Dirkmaat and Adovasio 1997: 45). Thus relative

chronologies can be constructed by ordering layers from the oldest on the bottom to the youngest on top, and the contents from any one strata can be compared with those of any other.

This is a paradigm applicable in geology (where strata are static, discrete and mutually exclusive) since fossils don't move from one layer of rock to another. And although archaeologists have recognised that soils are dynamic, and that finds are sometimes transported across layer boundaries by roots, worms, frost, etc., such "intrusions" as – for example – a modern coin found on a Roman road, beneath medieval deposits (Barker 1998: 137-139), are often attributed either to mistakes made during excavation or to undefined "disturbance." There are numerous cases of finds discovered in places where they shouldn't be: stone tools in sterile (i.e. undisturbed by human actions) subsoil, or fragments of artifacts retrieved from different layers but which later are found to fit together, etc., which would not be problematic if archaeologists had a clearer concept of what strata are.

This is partly a problem of terminology. Just within British archaeology there are, for example, contexts, layers, strata, entities, features, structures, context-series, groups, stratigraphic and excavation units; fills and deposits and sediments, etc., many of which are synonymous or hierarchically differentiated (a structure may contain several features, and a feature may be composed of different contexts, depending on which system is being used), but not systematically applied, satisfactorily defined nor – quite often – supported by theory.

Thus one of the main goals of the present study is the development – using formal ontology (tools for ordering and defining terms in a classification system) – of a workable definition and theory of archaeological stratigraphy. The present situation in archaeology can be contrasted with that of the science archaeologists originally used as a model for their discipline, geology. When the Geological Society of London was inaugurated in 1807, for example, one of its aims was to induce geologists "to adopt one nomenclature." Besides meeting basic scientific needs, clear definitions and terminology are also necessary today for storing and analyzing data in databases. These are especially important for archaeology, since archaeological excavations produce vast quantities of data; often too much to process – or disseminate – in any other way. And taking the next step – actually linking database tables of descriptive attribute information recorded during excavation to photographs and to two- and three-dimensional digital drawings of stratigraphic units – would result in a GIS.

Besides being a powerful analytical tool, studies of the impact GIS has already had on wider society suggest how it could potentially effect archaeology. Part of this impact is due to the widespread availability of geographic information freely disseminated on the internet; online archaeological databases will provide access not just to interpretive reports but also to primary source data, thereby going a long way not only towards making results reproducible, but also simplifying the

synthesis of information obtained from different sites.

But before this can happen standards – and especially standardized terminology – must be established. GIS – with its concerns for metadata and data quality – also provides a roadmap for the standards and process to be followed.

Any attempts at developing such terminology, however, must recognise that there are two broad approaches to defining "strata," one which deals with structures and the other with contrasting sets of attributes.

Structurally, stratigraphy is a study of volumes (not the planes produced by the horizontal plans and vertical profiles of current two-dimensional documentation techniques) and their boundaries. Boundaries (cf. Harris 1989) are assumed in the above example of the Victorian coin on the Roman road (which actually can be traced back to Darwin [1896: 179]!), but aren't always clear, and are often made clearer by interpretive acts of simplification which ignore disturbances caused by roots, rodent burrows and the like.

Where structural boundaries are unclear, strata are usually defined in terms of such attributes as colour, soil composition (sand/clay/silt), texture (course/fine), compaction (loose/compact), etc. Where there are no obvious boundaries, excavators must resolve the problem of deciding "where to draw the line," i.e. how to divide up some continuous gradation, and "unscientific" questions of subjectivity inevitably come into play. It is also difficult to determine which set of attributes should be given priority, since colour divisions may not coincide with composition, nor texture with compaction; soils may also contain concentrations of such discontinuous items as charcoal flecks or artifacts, etc.

Ideally, such attributes would be recorded separately, in ways which would allow post-excavation comparison of the distribution of (for example) a certain soil colour with a certain texture, and their distributions relative to finds and concentrations of charcoal. It would be almost impossible to perform this kind of analysis using traditional methods employing written (descriptions, interpretation and record of methods) and graphic (photos plus plan and profile drawings) media, but this is what GIS – with its different theme layers (layers in an urban GIS might include streets, property lines, commercial vs. residential use, etc.) – was designed to do.

The only problem is that GIS is still basically two-dimensional. Although interim links between databases and 3D computer graphics are possible (Nigro 1999), the current project focuses primarily on establishing a theoretical foundation for further research.

To summarise, the present study aims to develop new tools for documenting archaeological excavations. It will first show that the current geological model of stratigraphy is inappropriate in archaeological contexts. To find out how the

present situation was reached and what lessons might be learned from past mistakes, it examines the history of archaeology and its relation to geology. In an attempt to develop a synthetic theory of archaeological stratigraphy, it examines how archaeology, geology and soil science document layers. It uses formal ontology to compare different classification schemes used to define layers, with the aim of developing both a workable terminology and a database structure based on GIS models suited to the recording of archaeological stratigraphy.

Significance

This research is both important and necessary because of the fundamental role stratigraphy played in establishing archaeology as a scientific discipline, and the continued emphasis placed upon strata as the smallest analytical unit in archaeological recording. Archaeologists also need to develop scientific (and perhaps even legal) standards for excavation, given widespread recognition that the archaeological record is a limited resource in need of protection.

Related to both of these approaches is the simple need to bring stratigraphic theory into line with observed reality, and potential to re-establish archaeology on firmer scientific grounds.

Why Germany?

Research on the history of German excavation and documentation methods provide a comparative model to the Anglo-American standards which have been the subject of most studies to date. Dr. Stefan Altekamp of the Winckelmann-Institut, Seminar für Klassische Archäologie, Humboldt-Universität zu Berlin has been researching the history of German excavation techniques.

Barry Smith of the Philosophy Department at the University of Buffalo and the Institut für Formale Ontologie und Medizinische Informationswissenschaften at Universität Leipzig is working with formal medical ontologies for the European Union, providing a model for the sort of work which will eventually have to be done in archaeology (the present study is concerned only with terminology used in documenting excavations).

Gerhard Bersu, former director of the Römisch-Germanischen Kommission des Deutschen Archäologischen Instituts developed a unique “naturalistic” style of drawing archaeological remains, which could be useful to resolving the problems addressed in this project; archival research is necessary to understand just what Bersu was doing and how his illustrations can be interpreted.

In keeping with the German tradition for innovative technology, Arctron, a company located in Altenhann, has developed very interesting documentation software (computer graphics and databases) and tools for digital photogrammetry and surveying. Their system is being used by the Landesdenkmalämter of Baden-Württemberg and Rheinland Westfalen for recording archaeological

excavations, and I would like to evaluate its use in the field.

REFERENCES

Barceló, J. A., Castro, O. de, Travet, D., and Vicente, O.
2003 A 3D Model of an Archaeological Excavation. In *The Digital Heritage of Archaeology. Computer Applications and Quantitative methods in Archaeology*, edited by Doerr, M., and Sarris, A.. Hellenic Ministry of Culture.

Barker, P.
1998 *Techniques of archaeological excavation*. Routledge, London.

Brandt, R., Groenewoudt, B. J., and Kvamme, K. L.
1992 An Experiment in Archaeological Site Location: Modeling in the Netherlands using GIS Techniques. *World Archaeology* 24 (2):268-282.

Darwin, C.
1896 *The formation of vegetable mould, through the action of worms, with observations on their habits*. D. Appleton, New York.

Dirkmaat, D. C. and Adovasio, J. M.
1997 The Role of Archaeology in the Recovery and Interpretation of Human Remains from an Outdoor Forensic Setting. In *Forensic taphonomy: the postmortem fate of human remains*, edited by Haglund, W. D. and Sorg, M. H., pp. 39-64. CRC Press, Boca Raton.

Harris, E. C.
1989 *Principles of archaeological stratigraphy*. Academic Press, London.

Harris, T. M. and Lock, G. R.
1995 Towards an evaluation of GIS in European archaeology: the past, present and future of theory and applications. In *Archaeology and geographical information systems: a European perspective*, edited by Lock, G. and Stan≠i≠, Z., pp. 349-365. Taylor & Francis, London.

Kvamme, K. L.
1989 Geographic Information Systems in Regional Archaeological Research and Data Management. In *Archaeological Method and Theory*, edited by Schiffer, M. B., pp. 139-203. vol. 1, University of Arizona Press, Tucson.

Nigro, J.
1999 *The Swartkrans GIS Project: Using Geographic Information Systems to explore cave taphonomy*. MA thesis, University of Arkansas.