26

Terrain modelling, deposit survival and urban archaeology

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26.1 Introduction

This paper describes an application of computers to urban site evaluation. It is based on work conducted during 1989–90 by the Department of Archaeology at York University in conjunction with civil engineering contractors Ove Arup for York City Council and English Heritage. The paper first describes the archaeological situation which provides the background to the problem, then looks briefly at the prediction of the deposit model; the rest of the paper concentrates on the computing aspects of the project undertaken in York.

The renewed pace of urban development in the late 1980s has led to considerable destruction of archaeological deposits, particularly in the historic cores of many British towns. In 1989 the bulldozing, or piling, of celebrated sites made the headlines in the local and national press, and questions were asked in Parliament. Amongst the most notable examples, recalling the 1954 scandal over the Walbrook Mithraeum, were the Rose Theatre, London, and the Queen's Hotel site, York. As was originally observed in the 1950's, when such cases are presented in the media as confrontation there are no winners. In each case, the developers were forced to meet considerable extra costs, and were portrayed in the press as the villains of the piece, despite the fact that they had originally agreed to fund archaeological work. The archaeologists were made to look incompetent for their apparent inability to predict the presence of significant remains and, in the eyes of the press, appeared to be implicated in the destruction of important sites.

Of course, excavators can never know exactly what they will find, although some attempt should be made to find out. Yet the speed of the required response and the nature of archaeological funding have combined to work against this. Urban units have often been forced to adopt an opportunist strategy. The scale of urban renewal has meant that they have had to be extremely selective in their choice of sites to excavate. All too often, this selection has been dictated by the availability of sites for which developer-funding was available, rather than by a research design taking account of the survival and quality of deposits likely to provide a rich information yield. Units have rarely been able to divert resources to an evaluation of urban centres as a whole, which would allow them to place the importance of individual sites in context. Such information is vital if well-informed decisions are to be taken on the research priorities in specific areas. It is particularly relevant with the introduction of contract archaeology and competitive tendering, when fixing the correct price for a job becomes doubly important.

Recent commentators, notably Martin Biddle (Biddle 1989, p. 760), have stressed the importance of conducting a full site evaluation before archaeological advice is given. English Heritage also now underline the need for full site evaluation before development is allowed to proceed (Wainwright 1989, p. 434). Archaeological site evaluation may soon be made a condition of planning consent in a number of cities. In the United States, it is widely accepted that there may be up to three stages of archaeological investigation before development (Burrow & Hunter 1990, p. 195). Phase 1 surveys are designed to establish if any cultural resources exist; Phase 2 surveys characterise the extent of the site, and demonstrate its significance. Preservation *in situ* will then always be the first option in the case of an important site. Only in a small number of cases will work proceed to Phase 3 operations, i.e. excavation, where it is not possible to avoid destruction of the deposit.

26.2 The deposit model

A major component of any site evaluation has to be an assessment of the depth of surviving archaeological deposits. This is not a particularly new science. Carver has frequently advocated the importance of site evaluation in urban archaeology (e.g. 1978, 1980, 1983, 1987). A number of techniques, including archival study, contour and cellar depth surveys, allow the production of a deposit model.

One of the best known archaeological evaluations was conducted for London at the height of the previous Rescue boom (Biddle & Hudson 1973). Maps showing the extent of known destruction from cellars, known thickness of deposits, and proposed developments provided graphic documentation of the threat to the capital's archaeology.

Carver, working on several West Midlands towns, including Shrewsbury, Worcester and Stafford, demonstrated the use of mapping to illustrate the survival of relict features. The first systematic deposit-mapping project sponsored by central and local government was undertaken by Carver in Stafford in 1977 (Carver *pers comm*).

26.3 The York Archaeology Assessment Project

The City of York is currently undergoing a development boom. High costs in London are forcing business to relocate in the provinces. York City Council is offering prime sites for redevelopment, many of them on land within the historic core of York. In 1989 they published a portfolio of 35 development sites which was widely circulated to national developers (York City Council 1989).

One of these developments was the now infamous Queen's Hotel site which was to be occupied by the headquarters of the new National Curriculum Council. The site had lain derelict for fourteen years. When limited excavation revealed that well-preserved Viking remains comparable to those uncovered at Coppergate overlay massive Roman masonry, interpreted by some as belonging to an Imperial Palace, there was enormous media interest, and national calls for development to be halted. In the event most of the archaeology had already been destroyed, and most of the rest went in the bulldozer's bucket, once the fuss had died down, although concrete piles were redesigned to allow some of the principle Roman walls to be preserved *in situ*.

Nevertheless there was concern that this situation should not be allowed to happen again, and a general feeling that it should have been possible to predict the existence of deep waterlogged archaeological deposits in advance.

In 1982 Gill Andrews had completed a survey of the archaeology of York, for the DoE as it then was (Andrews 1984). This included maps showing known sites and areas of known destruction, but there had been no attempt to provide a deposit model. The City Council and English Heritage now contracted civil engineers Ove Arup to look at possible engineering solutions, including imaginative foundation methods, to York's 35 development sites. Ove Arup sub-contracted the archaeological component of the project, including prediction of the deposit model, to the Department of Archaeology at York University.

26.4 The UNIRAS mapping system

In order to provide an evaluation of the archaeology of York the first task was to compile a database of known archaeological observations. The major source was the archive of the York Archaeological Trust (YAT), including information from excavations and from the numerous watching briefs conducted by YAT staff. Further information was extracted from the City Engineer's bore hole data, as well as from a variety of published sources, including the Royal Commission for Historical Monuments volumes for York. Data were collected on standardised pro-forma and later input to a PC using dBaseIII+. The choice of database software was largely determined by the need for compatability with the City Council, who would take a copy of the database at the end of the project. The database will eventually provide the basis for the archaeological element of a Geographic Information System in the City Planning Department.

Data were collected for five major period divisions: Natural, Roman, Anglian, Anglo-Scandinavian and Medieval. Recording fields included easting, northing, height and thickness of deposit, and information affecting quality of deposits, such as moisture content, degree of disturbance, residuality, anaerobic levels and so on. More information was stored as free-format text, including full description, comments and source data. By the end of the data gathering stage 1087 records had been entered on computer (Price 1989).

The main aim of this aspect of the project was the production of a series of five period maps of York, showing the topography at the end of the Prehistoric, Roman, Anglian, Anglo-Scandinavian and Medieval periods.

Within the University the UNIMAP package from UNIRAS was chosen as the most appropriate mapping package for the job (ISG 1988). UNIMAP combines interactive development of maps with powerful two-, three- and four-D mapping techniques. Its default values allow the rapid generation of results, but with further work the package can be customised to specific user requirements. Within York, full colour maps can be developed and displayed at a graphics terminal; A3 full colour output is available on an ink-jet plotter; larger scale line maps may be plotted on an A1 Calcomp plotter. In addition, the interpolation procedures, having been developed for the oil exploration industry, were thought to be sufficiently robust to deal with the sparse York data.

Fixed length data files were output from dBase and input to UNIMAP. The first stage was simply to plot the data values, which cover an area slightly larger than the medieval walled city. UNIMAP allows the user to impose a grid, of any size, over the data, without interpolation. Interpolation may then be used to draw contours. The default UNIRAS method uses a refinement of the bi-linear method (cf. Haigh & Kelly 1987). If the original data points are posted, the black dots give some indication of the reliability of the contours. It is essential to remember the distribution of the original data throughout, as contours will be interpolated even when data is sparse, or non-existent. The maps can be upgraded, however, as more information is added to the database.

26.5 Preliminary results and discussion

In this section, the production of the Roman map will be examined in some detail, as a case study, before briefly presenting the other period maps.

A number of features can be identified on the Roman period map, including the influence of the natural topography on the position of the Roman road system, bridge across the River Ouse, and legionary fortress (Fig. 26.1). It should be noted that this map was produced by combining the data for the depth of natural, and the depth of Roman levels; in effect adding the Roman deposits to the natural landscape. This technique was used for each of the period maps. If Roman points only were used then a less adequate representation is derived (Fig. 26.2).

If a three-D wire-frame model is preferred the view is easily changed (Fig. 26.3). UNIMAP allows the user to select the angle and height of view, and nature of the projection. Archaeologists have long recognised the benefits of presenting survey data in the form of three dimensional surfaces (e.g. Lock 1980); these benefits extend to the study of historic landscapes (Reilly 1988). Users can use a topographic colour scale if they prefer; or define their own.

Other variables in the data file, such as the moisture level of deposit, can be plotted as a fourth dimension on a three-D surface. In practice, wetness of deposit appeared to be a rather localised variable, not susceptible to interpolation. More informative maps were derived simply by plotting the data points, coded, for example, according to whether they were anaerobic or not (Fig. 26.4). Other features, such as the Roman fortress walls and road network, can also be overlaid on the on the three-D topographic model of the Roman ground surface (Fig. 26.5).

When a number of data sets are compared, the development of York through the ages can be studied as a sequence of maps (Fig. 26.6, Fig. 26.1, Figs. 26.7–26.9) which can be overlaid on the modern street plan. Dumping and landscaping is revealed, and the areas of concentrated human activity are identified. Thus one can observe the pattern of the shifting urban topography, from the prehistoric landscape to Eboracum to Eoforwic to Jorvik, as York develops from the Roman capital to Anglo-Saxon entrepot to Anglo-Scandinavian metropolis. Finally, the likely archaeological impact of developments can be assessed by studying the depth of deposits in specific areas (Fig. 26.10). The maps therefore provide a predictive terrain model. Solid colour output is the most visually striking, but the illustrations accompanying this paper demonstrate that useful monochrome output can also be produced. The figures are UNIRAS-generated PostScript files which have been printed on a laser printer.

Nevertheless, UNIMAP is a large and expensive mainframe mapping system which was chosen for its power. There are a number of PC-based mapping systems which may be adequate for some applications. For instance, a similar series of two-D maps was produced using the PC-based system, SURFER on an IBM PS2/50, as a pilot study for the York project. SURFER also allows the user to generate 3-D wireframe views.

Finally, it is worth emphasising that the York data is not exceptional in its quantity or quality. It should be possible to produce deposit survival maps for many historic centres that have been the subject of extensive archaeological study. As I have attempted to show, the future development of urban archaeology is dependent upon predictive site evaluation.

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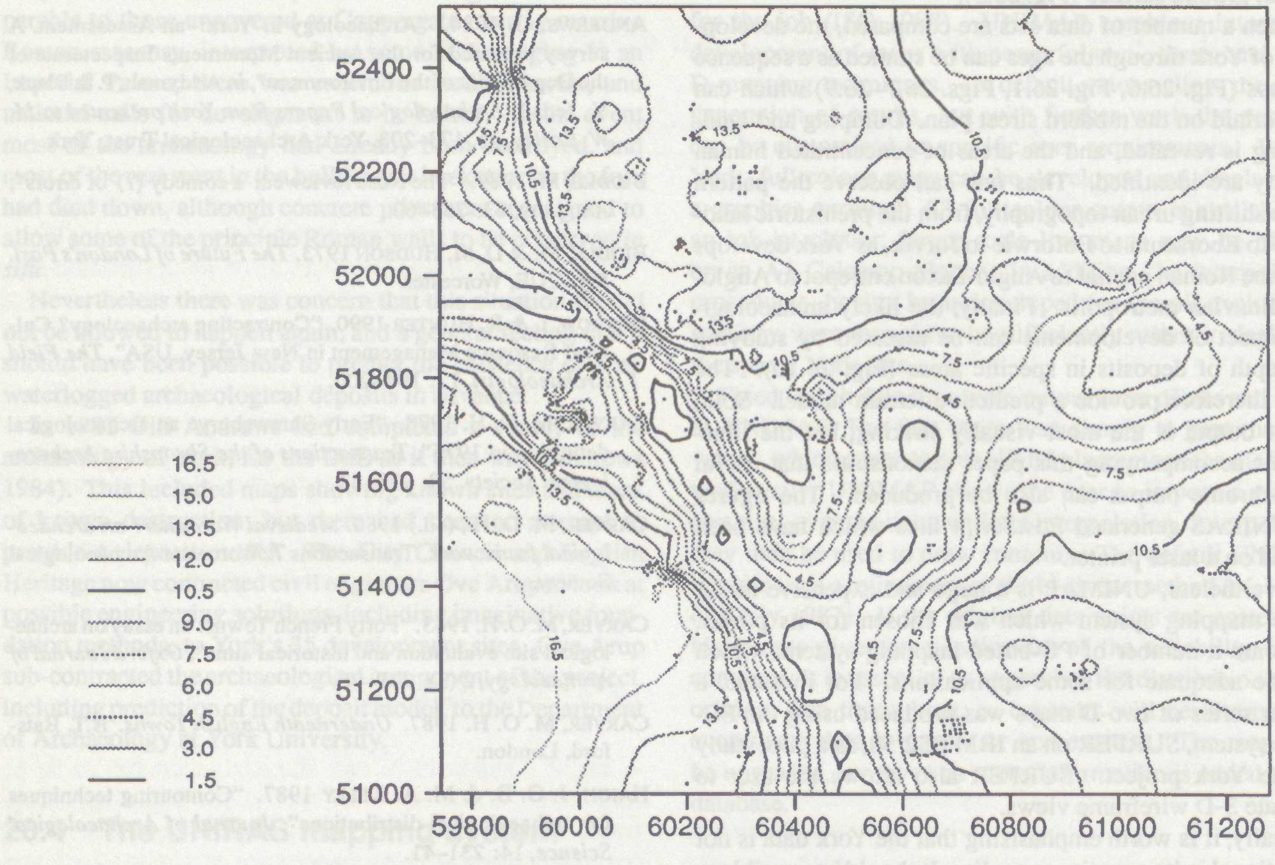

Figure 26.1: Roman York, with position of data points plotted

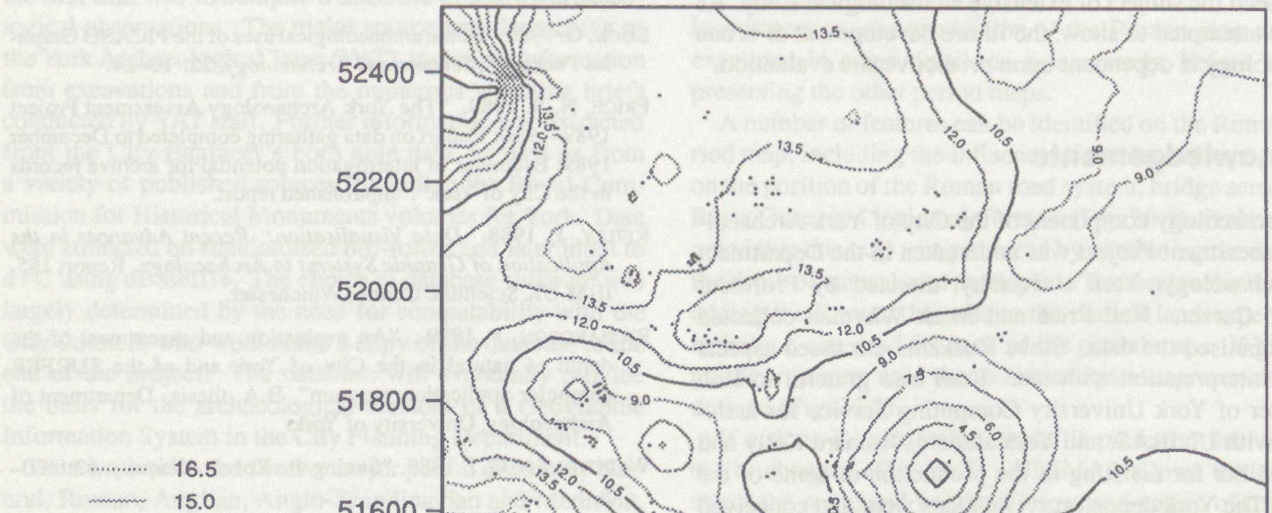

Figure 26.2: Roman York: using Roman data only

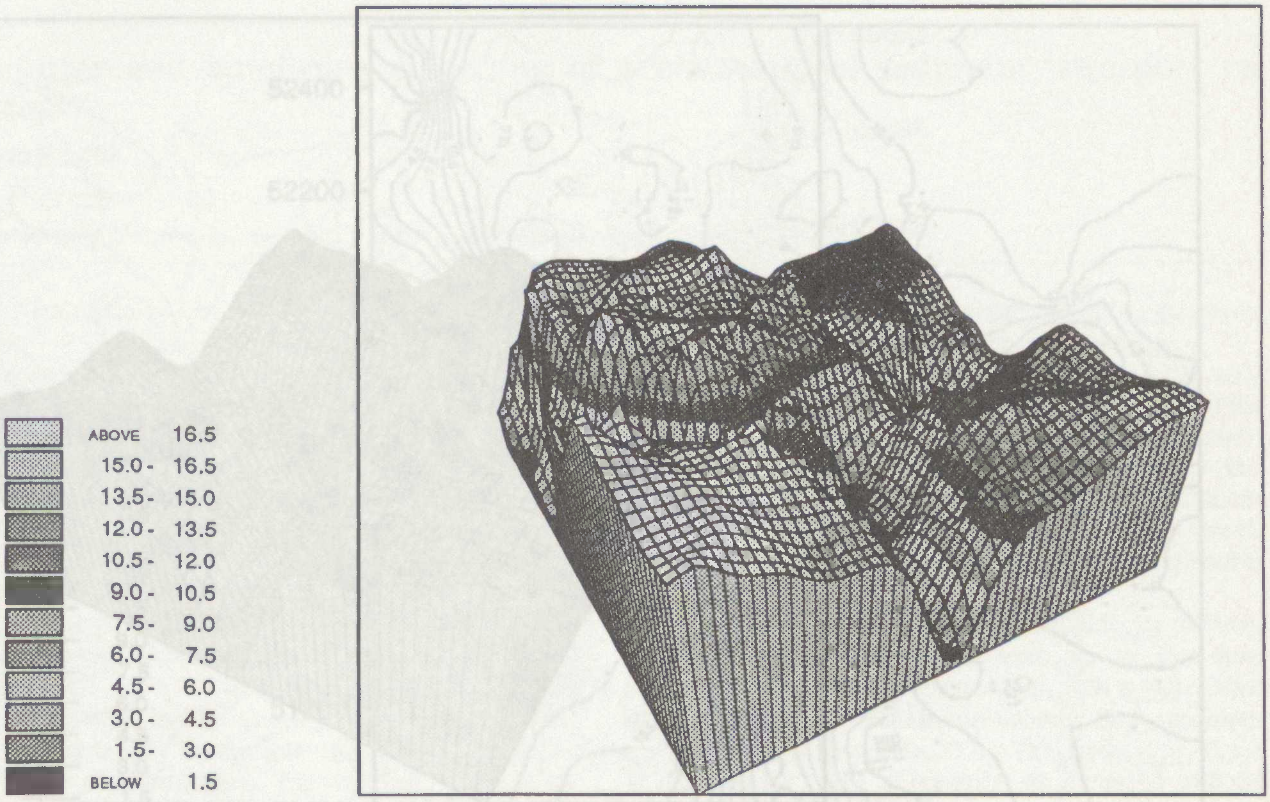

Figure 26.3: Roman York

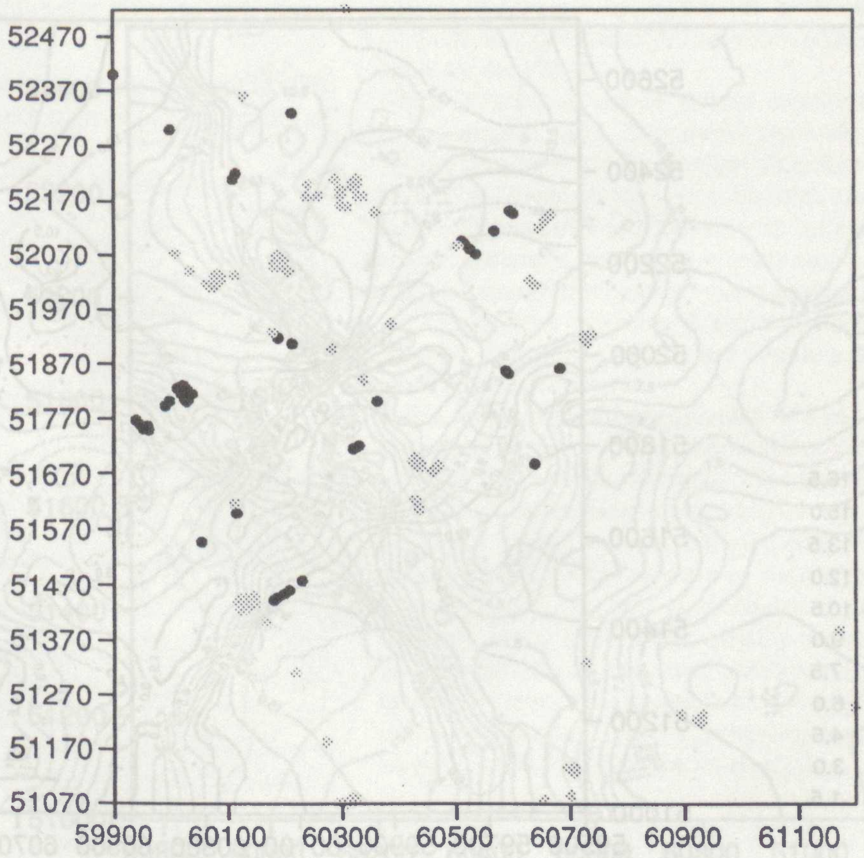

Figure 26.4: Roman York: anaerobic deposits (shown dark); aerobic deposits are shown light

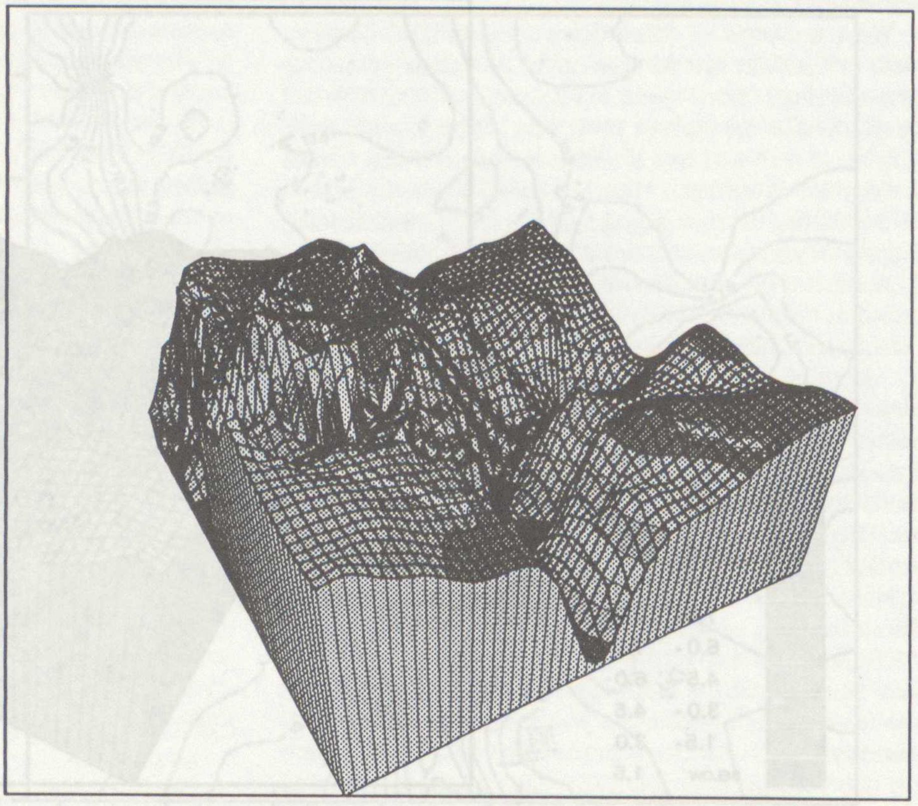

Figure 26.5: Roman York, with Roman roads

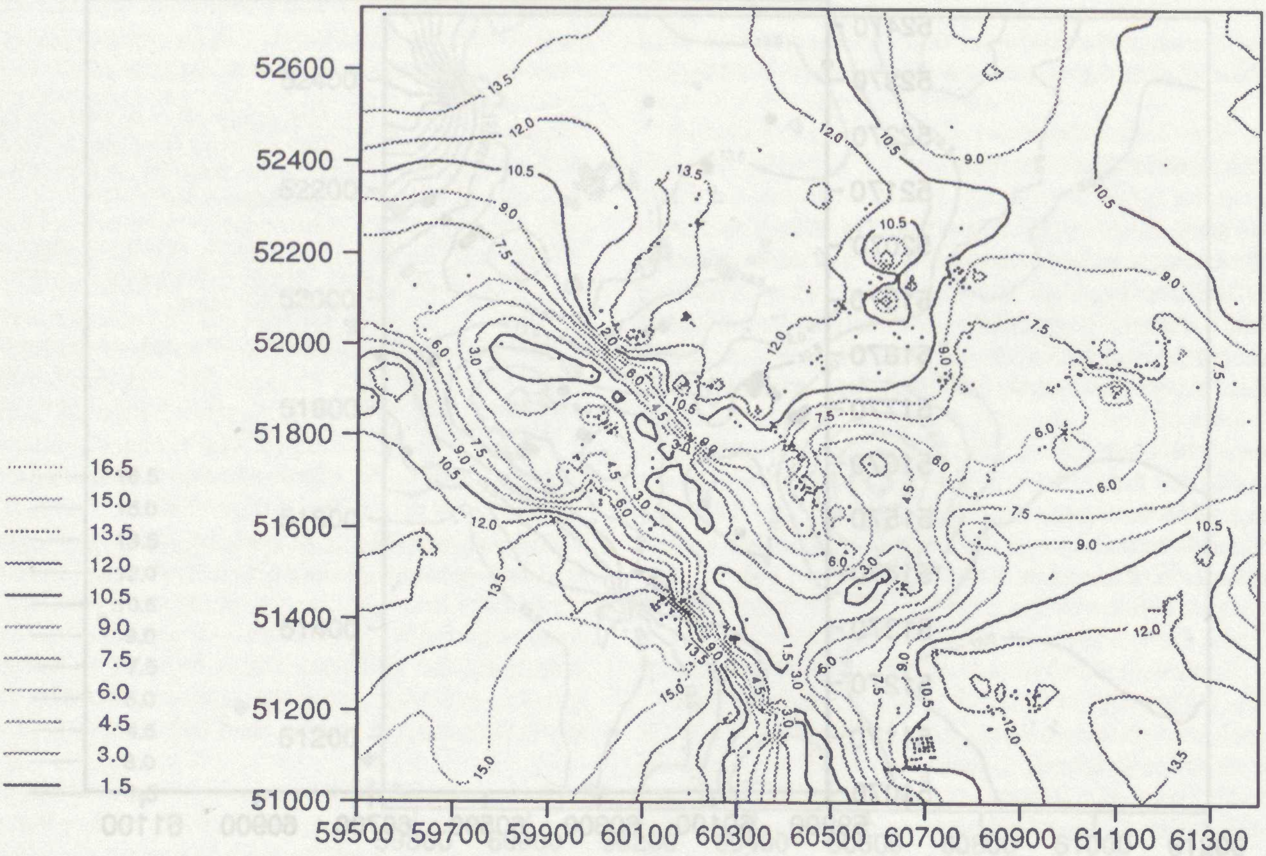

Figure 26.6: Natural deposits

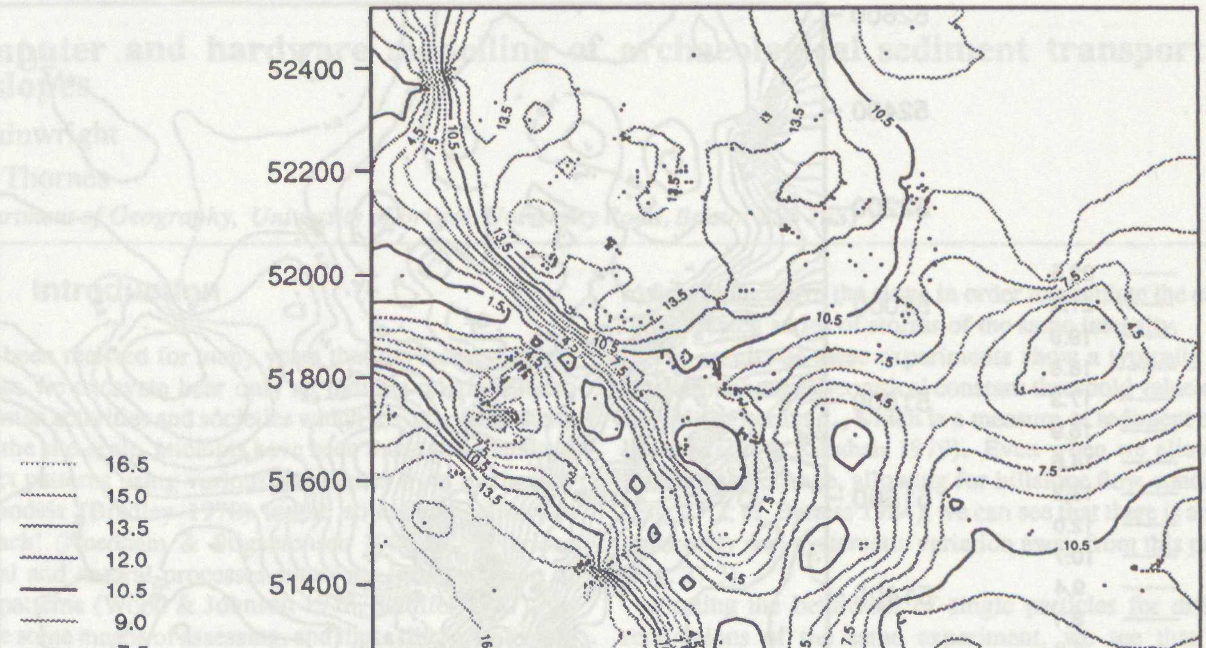

Figure 26.7: Anglian York

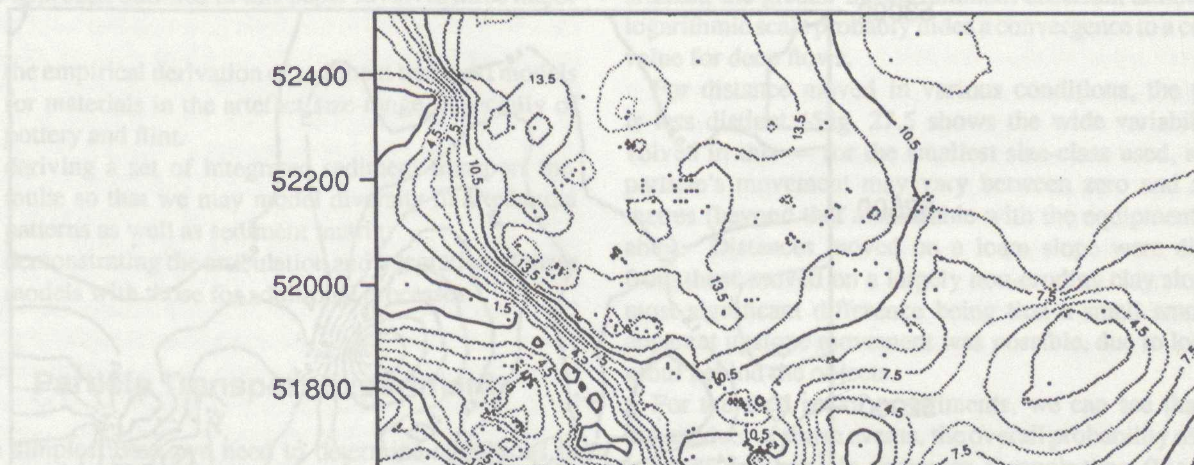

Figure 26.8: Anglo-Scandinavian York

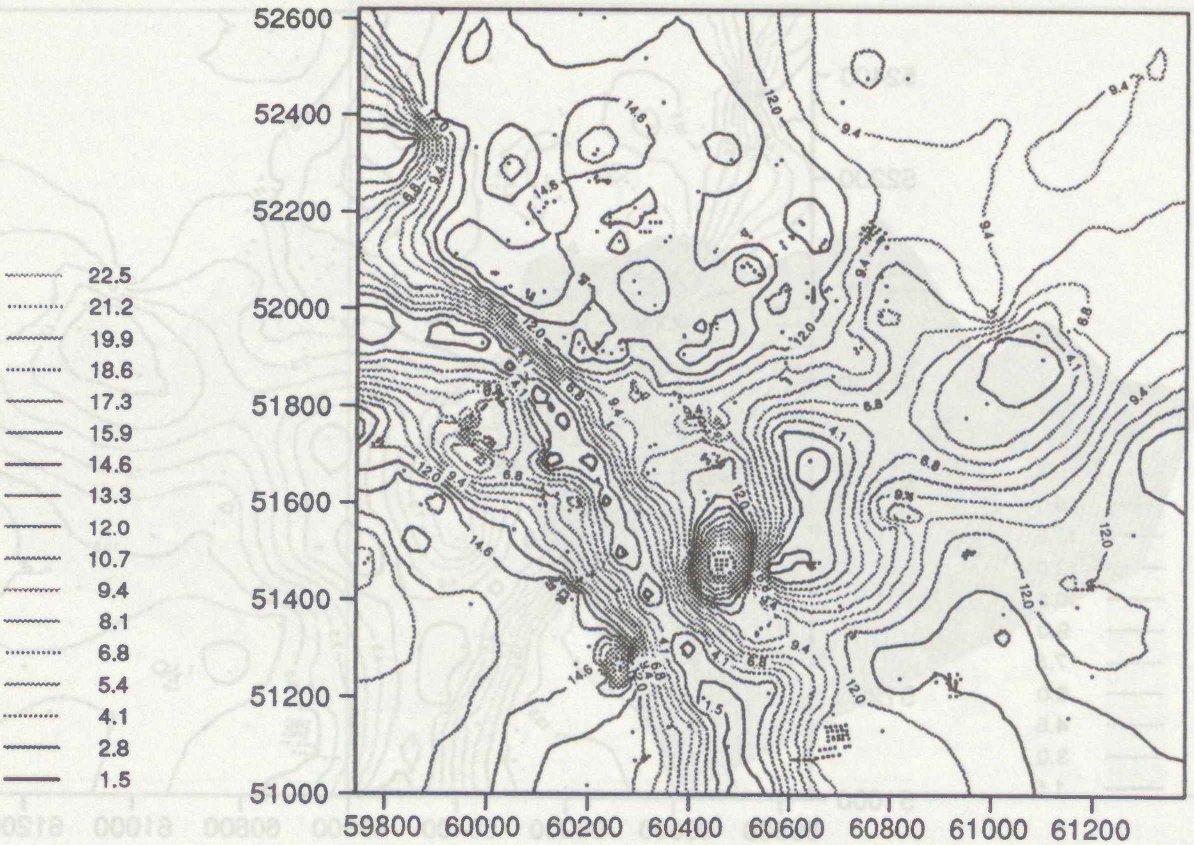

Figure 26.9: Medieval York

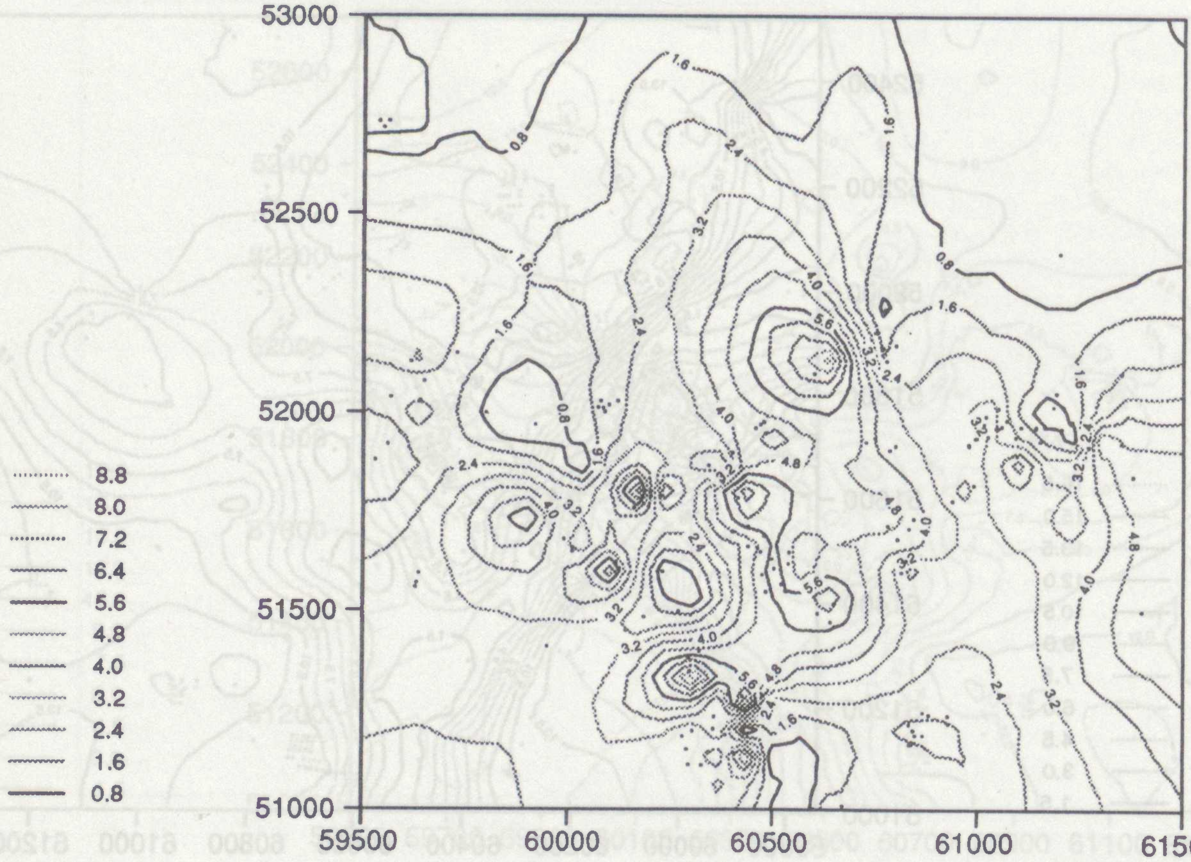

Figure 26.10: Depth of deposit