British Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

Modelling the quality of sand and gravel resources in 3D

Katy Mee, Kathrine A Linley, Joseph M Mankelow and Richard A Shaw

Introduction

The construction industry is a critical sector of the UK economy and natural aggregates, such as crushed rock, sand and gravel, are the most commonly used construction minerals. Demand for aggregates will continue into the future and this demand will primarily be met by indigenous production. However, minerals can only be worked where they occur and with increasing pressure on land use, it is important that mineral resources are identified and appropriately safeguarded. It is imperative that we understand how these deposits are distributed not just on the surface but also underground (Figure 1).

Whilst 2D mineral resource data is proving invaluable in assisting planners, developers and industry in land-use planning and decision-making, it does come with limitations, such as being unable to depict the internal variation in the quality of the deposit with depth or provide an indication of the ratio of mineral to waste. Such information is essential when assessing the economic viability of extraction and, within BGS, 3D modelling techniques are being used to address these issues.

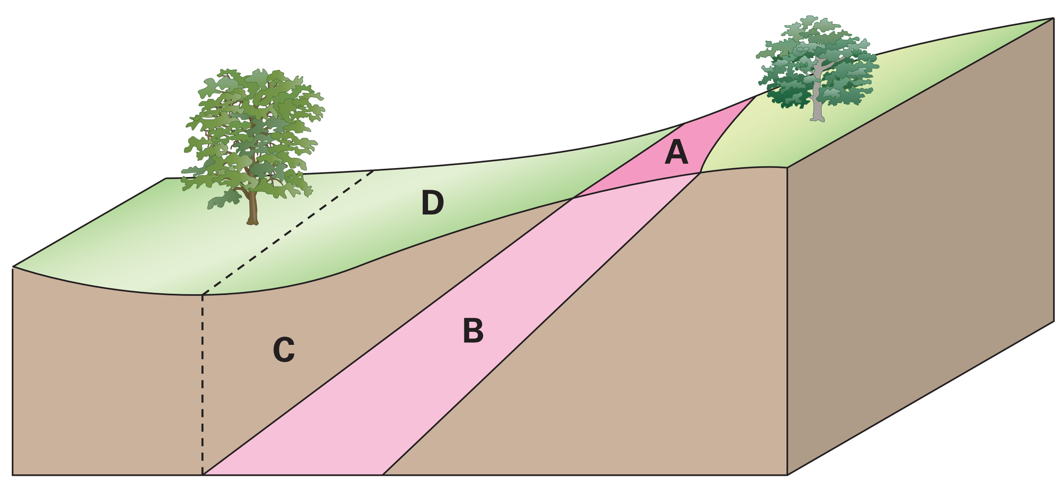

Figure 1 The difference between (A) surface expression (outcrop) and (B) possible subsurface extent of a geological formation. (C) shows where overburden is adjacent to the outcrop area and may conceal the full extent of the formation when viewed in 2D plan, and hence the area of land needing to be safeguarded (D).

Summary and conclusions

Gocad 3D modelling software and modern geostatistical techniques are being utilised to develop models of the internal variability of sand and gravel resources. The development of such models provides valuable enhancement to existing British Geological Survey (BGS) 2D mineral resource datasets.

Information contained within the models will be important to mineral planners who must decide which areas of mineral resource to safeguard and also to the minerals industry, which needs to identify suitable future extraction sites and protect them from sterilisation by other developments.

Industrial Mineral Assessment Unit (IMAU) borehole data

The BGS Industrial Minerals Assessment Unit (IMAU) undertook a major survey of sand and gravel resources between 1971 and 1990, producing 149 maps and reports and 12 500 detailed borehole interpretations. Particle size (grading) analyses were taken for approximately every 1 m interval down each borehole. By utilising this borehole data in modern 3D modelling packages (Gocad) it is possible to undertake an assessment of the quality (particle size distribution) of particular geological formations identified as aggregate mineral resources. A pilot study is underway in the Reading area of the UK (Figure 2) to determine the feasibility of modelling sand and gravel resources using pre-existing data, through the application of modern geostatistical techniques.

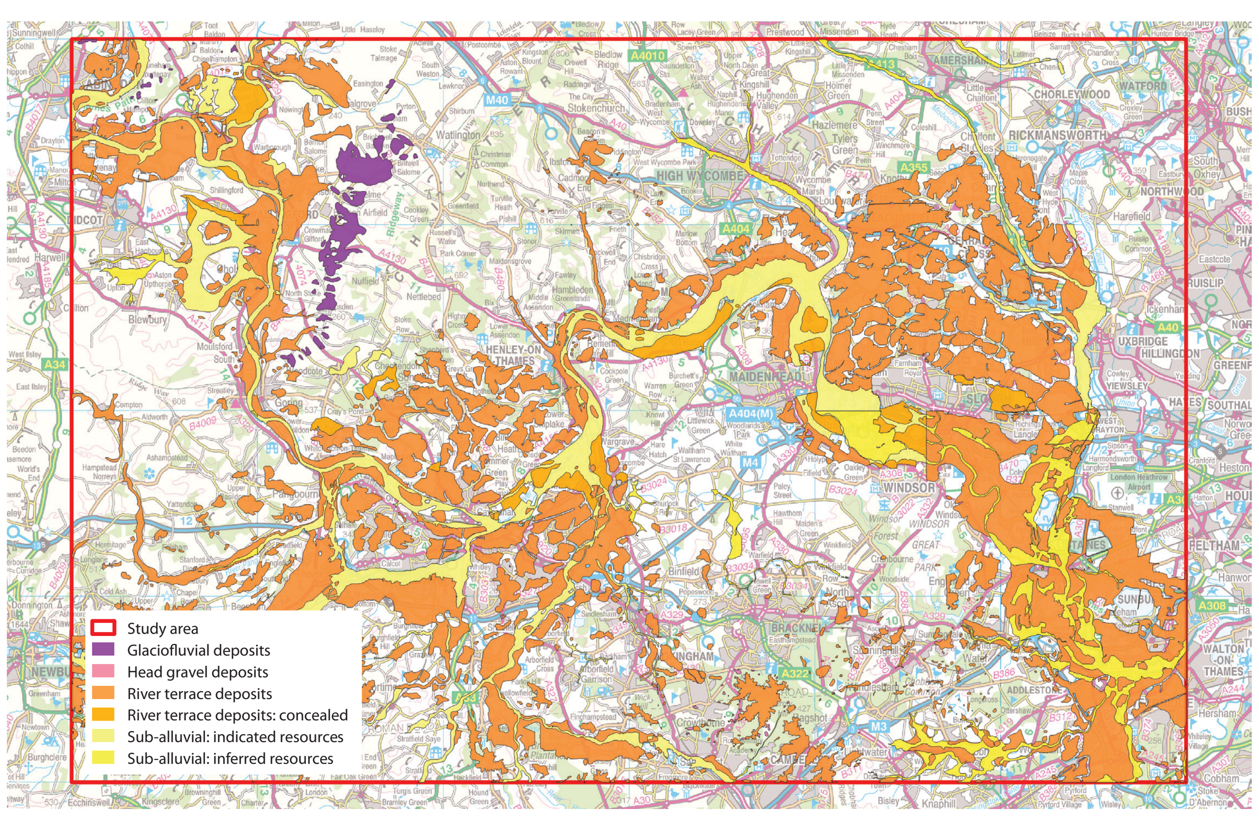

Figure 2 Study area around Reading showing distribution of aggregate resources in 2D. British Geological Survey © NERC. Based on OS topography © Crown Copyright. All rights reserved. BGS 100017897/2011.

Data was extracted from the IMAU database and underwent a data 'cleaning' process, including initial assessment of the data in a GIS (Figure 3) and pre-processing in Excel to transform the data into a suitable format for Gocad. Whilst assessment in the GIS allows for visualisation of the sand and gravel resource in 2D, it does not give any idea of how the resource is distributed vertically.

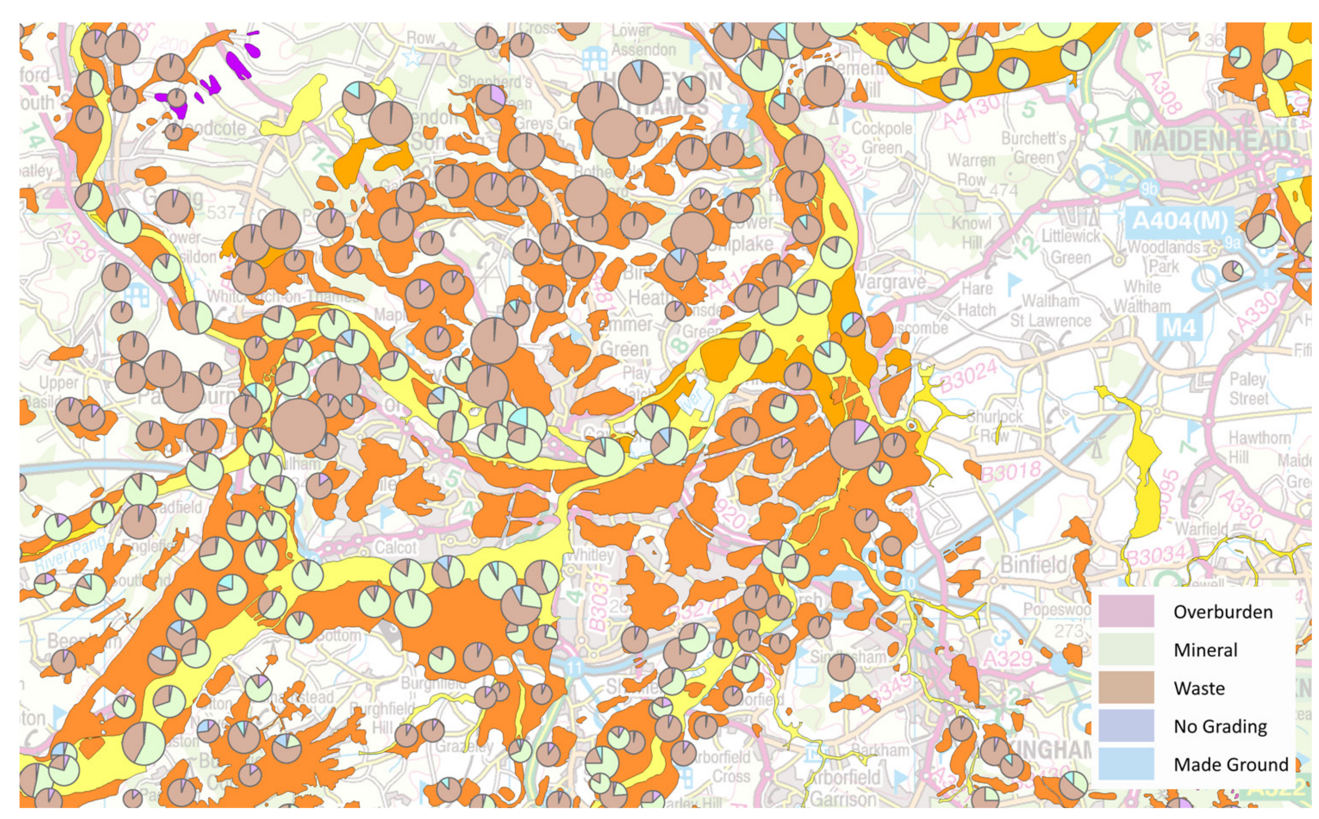

Figure 3 Pie charts show the relative proportions of mineral, waste and overburden in each IMAU borehole but do not reveal their vertical distribution. Circle size is proportional to borehole depth (i.e. bigger equals deeper). British Geological Survey © NERC. Based on OS topography © Crown Copyright. All rights reserved. BGS 100017897/2011.

3D modelling

Particle size analyses for each borehole interval in the Reading pilot study area were imported into Gocad as a series of points (Figure 4). This allows the modeller to view the vertical distribution and thickness of waste, overburden and mineral layers within each borehole. Geostatistical methods will be used to interpolate between sampled and unsampled locations to produce a voxet model (Figure 5) showing how the distribution and quality of the resource varies in 3D and will aid planners in making more informed decisions about which areas to safeguard.

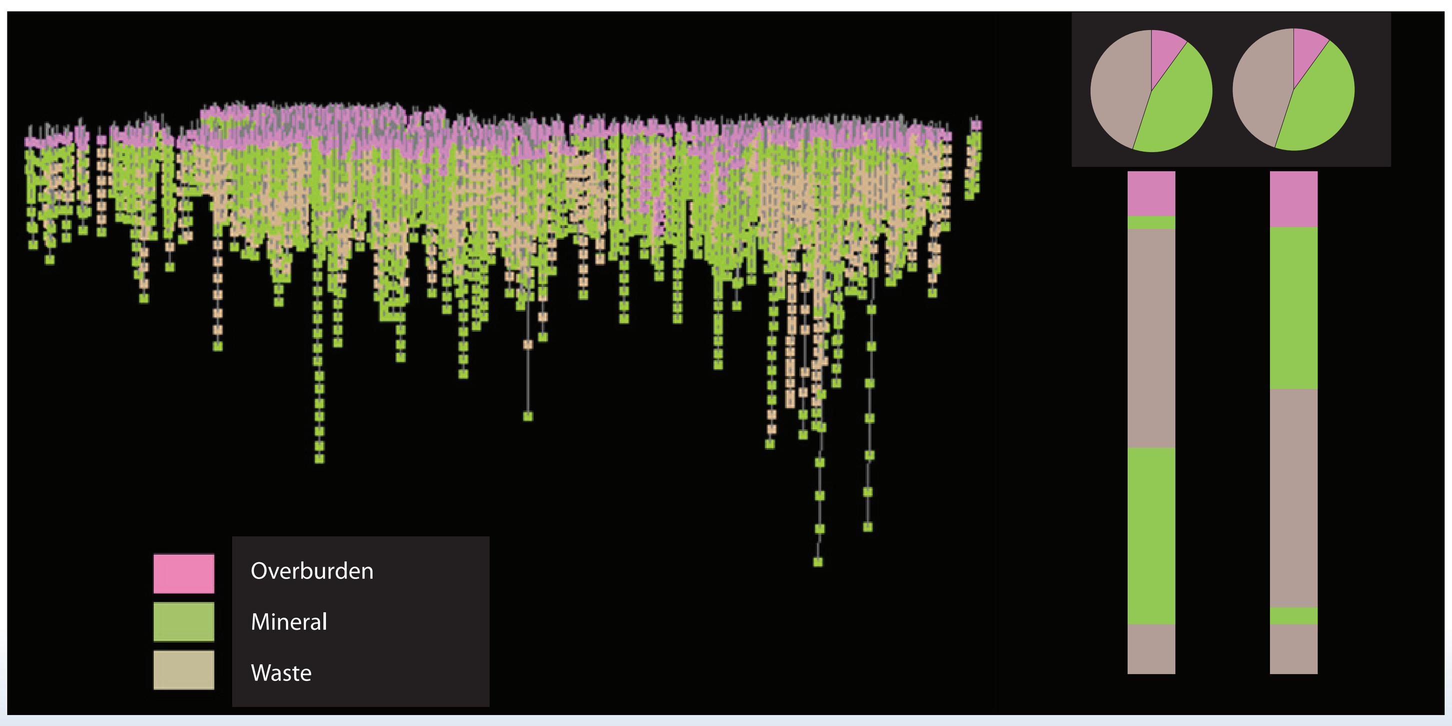

Figure 4 Vertical distribution of overburden, mineral and waste layers within IMAU boreholes in the Reading area as viewed in Gocad's 3D viewer (left). The pie charts (right) show how two boreholes with the same proportions of waste, mineral and overburden may have very different implications for extraction of the resource.

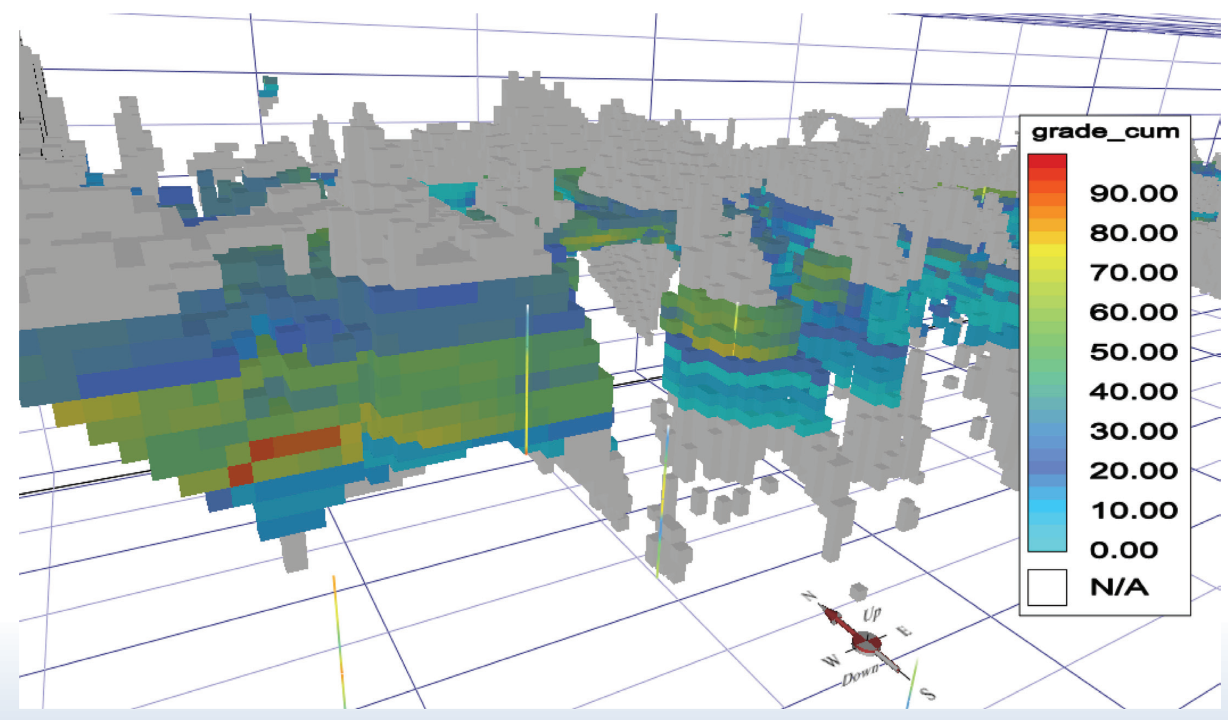

Figure 5 An example of a voxet model showing the cumulative percentage (grade_cum) retained on the 1 mm sieve of a sand and gravel deposit near Ipswich. Similar interpolation will be carried out for the Reading study area using Gocad.

Contact information

Katy Mee www.mineralsuk.com email: minerals@bgs.ac.uk