Applied 3D geological modelling in the Mersey Basin, NW England

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Introduction

The River Mersey, NW England provided the focus for large scale industrial development principally during the 18th and 19th centuries. Rapid industrialisation associated with urban expansion and population growth has left a legacy of derelict and contaminated land and polluted groundwater.

The cities of Manchester, Salford and Liverpool on the banks of the Mersey are now the focus for major regeneration. Projects such as the Mersey Waterfront Development and the creation of the UK's first Media City in Salford will require up-to-date geoenvironmental information. The use and application of information about the properties of the sub-surface is critical to ensure that development takes place sustainably.

In NW England, the British Geological Survey (BGS) has developed 3D geological models of superficial deposits and bedrock units concentrated along a zone between Manchester in the east and Liverpool in the west, including Warrington in between (Lower Mersey Development Zone). This major urban development zone overlies the regionally important Sherwood Sandstone aquifer, which falls under Government legislation to control abstraction and pollution. 3D geological models have been developed to aid environmental decision-making to ensure that sustainable regeneration can be achieved.

Importantly, the 3D geological models also include artificial deposits. These deposits and excavations result from the activities of man and affect the physical properties of the shallow subsurface. Artificial deposits are often associated with highly variable ground conditions that may affect subsequent development. 3D geological modelling provides a powerful tool to enable the development of conceptual models to predict the variability of the shallow sub-surface and its properties prior to development. Potentially difficult ground conditions can therefore be anticipated and their presence incorporated into site investigation and development design.

This paper presents selected results of applied urban 3D geological modelling using Warrington, in the central part of the study area as a case study.

3D Geological Modelling of Superficial Deposits

3D geological models have been developed for superficial deposits and bedrock. This paper focuses on the development of models of natural and artificial superficial deposits overlying Permo-Triassic bedrock.

Seven main natural superficial deposits have been modelled using GSI3D™. Geological modelling of superficial deposits in the project area was carried out using GSI3D™ modelling software (Kessler et al., 2008). The software and its workflow allow the user to create 3D geological models by combining interpreted digital borehole data, Digital Terrain Models (DTMs) and digital geological maps to construct an intersecting grid of cross-sections. From the series of intersecting cross-sections, the surface and sub-surface distribution of each geological deposit is then defined and the geological model is calculated to derive the 3D distribution, geometry and elevation of each geological unit.

Over 850 borehole records within the National Geoscience Data centre at the BGS were interpreted geologically.

The results of 3D modelling in the Lower Mersey Development Zone have revealed a complex pattern of glacigenic, and post glacial sediments summarised in Table 1. An example of the completed 3D geological model for the Warrington area is shown in Figure 1.

3D Modelling of Artificial Deposits

Artificial deposits comprise deposits or excavations that result from man's modification of the landscape.

The Modelling artificial deposits in GSI3D™ uses a range of historic datasets including…

- Data are captured in GIS format, classified as Made, Worked, Landscaped, Infilled or Disturbed Ground (Powell et al., 1999; Ford et al.,

2006) and attributed with the source and age of data

- The data is then modelled in GSI3D™ using borehole information to define the base of Made and Worked Ground and subtracting them from the DTM, with the 2D artificial ground polygons delineating the areas.

	Geological Unit	Thickness (m)	Lithology	Environment (inferred)
Holocene	Artificial Deposits	0-5	Mixed	Anthropogenic (Artificial Deposits)
	Alluvium	0-3	Sand or peaty sand	Fluvial
	Peat	3-5	Peat	Organic
	Shirdley Hill Sand Formation	0-2	Sand	Aeolian
	Buried Peat	0-2	Peat	Organic
Pleistocene (Devensian)	Intra-till lenses	<1->10	Sand and gravel	Sub-glacial and supra-glacial drainage associated with glacial ice
	Till	<7	Gravelly clay with thin interbedded sands and silts	Sub-, supra- and intra-glacial
	Basal glaciofluvial deposits	<9	Sand and gravel	Sub-glacial drainage

Table 1. Summary of Superficial Deposits in Warrington.

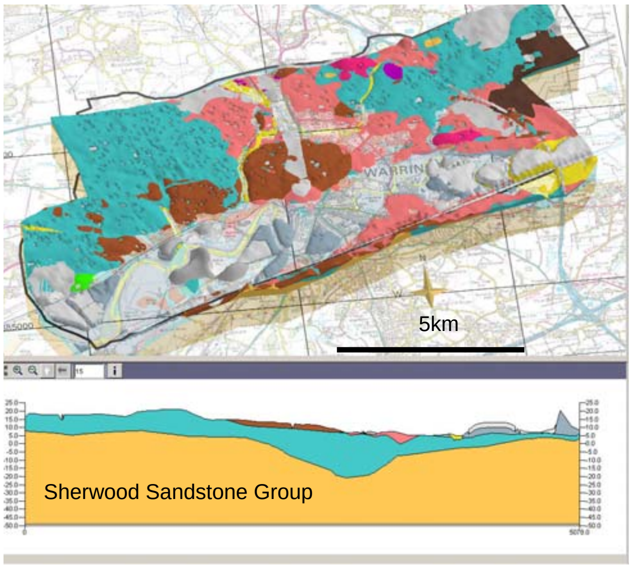

Figure 1 – 3D geological model and synthetic cross-section, Warrington, UK. Blue – Till, Pink – Glaciofluvial Sand and Gravel, Dark Grey – Intertidal Deposits, Brown – Shirdley Hill Sand, Light Grey – Artificial Deposits. © Crown Copyright. All rights reserved. 100017897/2009.

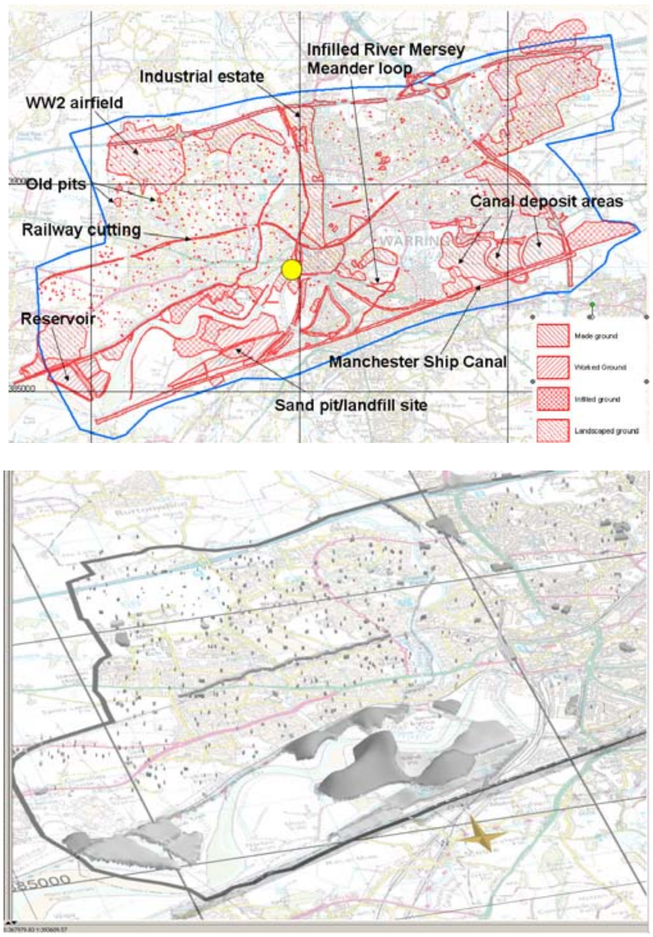

Figure 2 - Artificial Deposits modelling in 2D and 3D. © Crown Copyright. All rights reserved. 100017897/2009.

Conclusions

3D geological modelling using GSI3D™ provides a powerful tool to unravel the 3D geological and anthropogenic evolution of major UK urban areas.

It allows the 3D characterisation of the shallow sub-surface, including deposits and excavations relating to the activity of humans.

By applying 3D geological models of the shallow urban sub-surface, ground conditions and their properties can be used to support planning and sustainable development.

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