Geophysical Research Abstracts
Vol. 15, EGU2013-5156-2, 2013
EGU General Assembly 2013

Modelling shallow urban geology using reservoir modelling techniques: voxel-based lithology and physical properties of the greater Glasgow area

Andrew Kingdon (1), John D.O. Williams (1), J. Paul Williamson (1), R. Murray Lark (1), Marcus R. Dobbs (1), Timothy Kearsey (2), Andrew Finlayson (2), and S. Diarmad G. Campbell (2)

(1) British Geological Survey, Keyworth, Nottingham, United Kingdom (aki@bgs.ac.uk, +44 115 936 3415), (2) British Geological Survey, Murchison House, West Mains Road, Edinburgh, EH9 3LA, United Kingdom

Conventional 3D geological models of lithostratigraphy undertaken by BGS have facilitated a significant step forward in understanding of the 3D sedimentological and structural controls in the subsurface of the UK.

However, when lithostratigraphic units are mapped or modelled in 3D, intra-unit variability is often not recognized and may be substantial, particularly in sedimentologically heterogeneous successions. Because of this BGS has been testing voxel grid-based approaches in urban areas with high borehole density. A city-scale lithology model of shallow, unconsolidated sediments in Glasgow, Scotland has been developed as a test of the applicability of these techniques to aid geological understanding and possible future applications. This is of particular significance in this location due to the complex fluvial and glacial history of the superficial geology which alternates between inter-fingering sedimentary packages and short-scale variability of subsurface materials.

The model has been created by developing a stochastic model of clastic geology on a voxel support, based on upscaling of observed borehole lithology, independent of lithostratigraphy. Multiple realisations of lithology were generated, each honouring the borehole observations. Lithology information has therefore been used to both develop a model of the distribution of lithology throughout the grid, but also to develop an understanding of the associated uncertainty by providing estimates of the probability with which a particular lithology occurs at a given node. This lithological model compares well with 'traditional' deterministic lithostratigraphic 3D models created in the same area, and with field-based geological maps.

This lithological voxel model has been used as a matrix through which physical property data can be attributed within the grid by stochastic modelling and simulation of the variability of properties within the lithological units. Several different property datasets have been populated across the grid, including geotechnical parameters, such as density, derived directly from site investigations, and properties derived from particle size distribution such as hydraulic conductivity. This can be augmented in deeper parts of the succession with borehole geophysical log derived property data.

This model may be applied to understanding of both the strength of the subsurface materials to aid development, and also hydrogeological properties to inform 4D process models, thus extending BGS's capabilities to deliver scientific understanding of geological problems. For example, with ongoing large-scale redevelopment of post-industrial sites across the Greater Glasgow area, these techniques have the potential to provide a clearer understanding of both the risks and opportunities of these sites. This project will act as an exemplar of the applicability of voxelated representations of lithology and physical property data to subsurface planning as a precursor to the wider rollout of the techniques to many UK cities.