Development of a city-wide physical property model of the greater Glasgow area using a voxel-based representation of lithology

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The BGS PropBase project has sought to develop a physical property model of a major UK city and to identify potential aquifer sequences in shallow heterogeneous lithostratigraphic units. As a precursor to this, new methodologies have been applied to develop a city-scale lithology model of shallow, unconsolidated sediments in Glasgow, Scotland.

The model has been created by developing a stochastic voxel representation of clastic geology, based on upscaling of observed borehole lithology, independent of lithostratigraphy. Assessments of uncertainty are made using multiple realisations of lithology and using these to compute the probability of one of a limited set of lithologies existing in any voxel. Although similar to work previously undertaken in the Netherlands by TNO, this model uses a borehole dataset which has not been cleaned and refined, nor has it been substantially reinterpreted to improve resolution.

Results have been compared with existing lithostratigraphic models of the Greater Glasgow area created using the BGS GSI3D framework modelling methodology. In a dense borehole field, this demonstrated that voxel modelling may readily respect a larger proportion of the boreholes within the modelling area.

Comparison of the voxel models with lithostratigraphic surfaces from the previous GSI3D models has resulted in a quality assurance process that allows assessment of the quality of the framework model in terms of representing subsurface lithologies.

Subsequently, physical property data were upscaled into the voxel model on a per-lithology basis. These parameterised grids may be integrated into BGS ZOOM groundwater models; this project is thereby at the confluence of four different modelling approaches:

(i) geological framework modelling,
(ii) voxel modelling,
(iii) property modelling, and
(iv) input grids for groundwater modelling.

The techniques applied in the course of the project have the potential to be regularly used in developing future BGS model outputs and to be incorporated as standard tools of the BGS modelling workflow.