Geological knowledge + spatial information systems = three-dimensional (3D) models + safer water

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GIS and the development of standardized spatial datasets have proven invaluable for the Ontario Geological Survey's contributions to ensure safe water resources in Ontario, Canada. Recent provincial legislation mandates the development of watershed based Source Water Protection plans which include watershed characterization, regional groundwater flow models, the establishment of aquifer recharge and well protection zones, and identification of threats to water safety.

Fully attributed GIS-based seamless foundation maps, including surficial geology, Paleozoic bedrock geology, bedrock topography, physiography, and drift thickness maps, have been generated for southern Ontario. Clients use the maps in conjunction with land use, population and livestock density, water quality, and contaminant source map layers to calculate risk and vulnerability. As a second example, groundwater chemistry in major rock and overburden aquifers in southern Ontario is being mapped on a 10 km grid as part of the ambient groundwater project. Baseline groundwater quality information highlighting areas of naturally occurring hazards are being delineated by establishing 'normal' levels of over 80 parameters, many of which have a poorly understood range and distribution.

This presentation will focus on the application of spatial data systems including 3D modelling of thick glacially-derived sediments for groundwater applications. Protocols have been established for a full workflow that allows for seamless progression from one project area to the next. Large and generally poor quality legacy data sets (water well, geotechnical and oil and gas records) are assembled and standardized into primary material types. These data are augmented by new geophysical and high quality geological information. Foundation GIS map layers are prepared by attributing a grid of points with recoded geological information. Location and geological formation tables are input into Datamine Studio® for 3D modelling. Manually digitized points identifying the top of each model unit are used to interpolate wireframe surfaces. The points are weighted according to data quality so that the wireframes honour good quality data and smooth out poor quality data. Finally, a block model is created by filling the space between

each wireframe with a regular grid of subcells. This information is exported to a text file for input to other software packages for hydrogeological modelling or visualization. Dot maps address questions of uncertainty in the modelled surfaces by clearly illustrating the reliability and spatial distribution of the source data. A cross-section viewer and a .kmz file that portrays fence diagrams, transparent overlays of structural contours, isopachs and aquifer recharge/susceptibility maps as well as borehole location and lithologic information in a web-based (Google™ Earth) environment allows for enhanced user interaction with the spatial data.

The presentation will explore the challenges and benefits of applying modern digital technologies to a very real issue - protecting a scarce natural resource and providing safe drinking water for society.

Keywords: 3D modelling, GIS, groundwater