Depth to Bedrock: Three-dimensional Bedrock and Overburden Thickness Methodology for Mineral Aggregates and Groundwater Geology Mapping in Ontario

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The Ontario Geological Survey (OGS) has developed a methodology for determining an area's bedrock elevation and overburden thickness, that provides a valuable tool for carrying out groundwater geology mapping projects. OGS is also responsible for producing Aggregate Resources Inventory Papers (ARIPs), which are used in municipal planning to help assure future supplies of crushed stone, sand and gravel. A key component of each ARIP is a bedrock resource map that shows the distribution of suitable bedrock and thin-drift areas (generally < 8m overburden). Starting in 2004, the 3-dimensional bedrock and overburden thickness methodology will be used in creating the ARIP bedrock resource maps.

Data used in determining the bedrock surface and overburden thickness include: a provincially standard digital elevation model (DEM), provincial water well records, geotechnical boreholes, and surficial and bedrock geology maps. Supplementary data include: topographic maps, aerial photographs, and Landsat imagery. Data sets are assessed and appropriately filtered. For example, boreholes with reported surface elevations differing by more than 10 m. from the DEM are excluded from interpolations, because their locations may be inaccurate.

Borehole layer information is translated to "bedrock" or "overburden" using an OGS translation table and database query. The depth to bedrock for each borehole is calculated. Borehole bedrock elevations are calculated as DEM elevation minus depth to bedrock. Outcrops are assigned DEM elevation as bedrock elevation, and vertices of thin-drift areas are assigned DEM elevation minus 1 m.

Kriging is used to interpolate an initial bedrock elevation surface from all the bedrock elevation points. Wells not reaching bedrock (overburden wells), but going deeper than the initial kriged surface, are assigned a bedrock elevation of DEM elevation minus well depth. These elevations are added to the interpolation set, which is kriged again to honour the deep overburden wells. This bedrock surface is carefully inspected in plan and perspective views for evidence of problems in the dataset. Once the data problems are resolved, the bedrock elevation surface may be kriged again. Figure 1 illustrates the bedrock elevation computations.

An overburden thickness surface is calculated as DEM minus bedrock elevation surface. The mineral aggregates geologist uses the overburden thickness information, bedrock geology, and land use information to draw preliminary bedrock aggregate potential areas, which are checked during fieldwork. New information from fieldwork is used to finalise the Selected Bedrock Areas for ARIP mapping. Figures 2 and 3 illustrate the overburden thickness and aggregate potential derivations.

This approach is also used by OGS in 3-dimensional groundwater mapping projects and Groundwater Resource Information Papers (GRIPs). This methodology enables the production of bedrock topography maps, overburden thickness maps and 3-dimensional models of fundamental stratigraphic units. Stratigraphic "picks" are used to refine the continuity of key units.

The following software is used by OGS in this work:

- Microsoft ® Access ® database software.
- ESRI ® ArcGIS ® and Spatial Analyst ® geographic information system software.

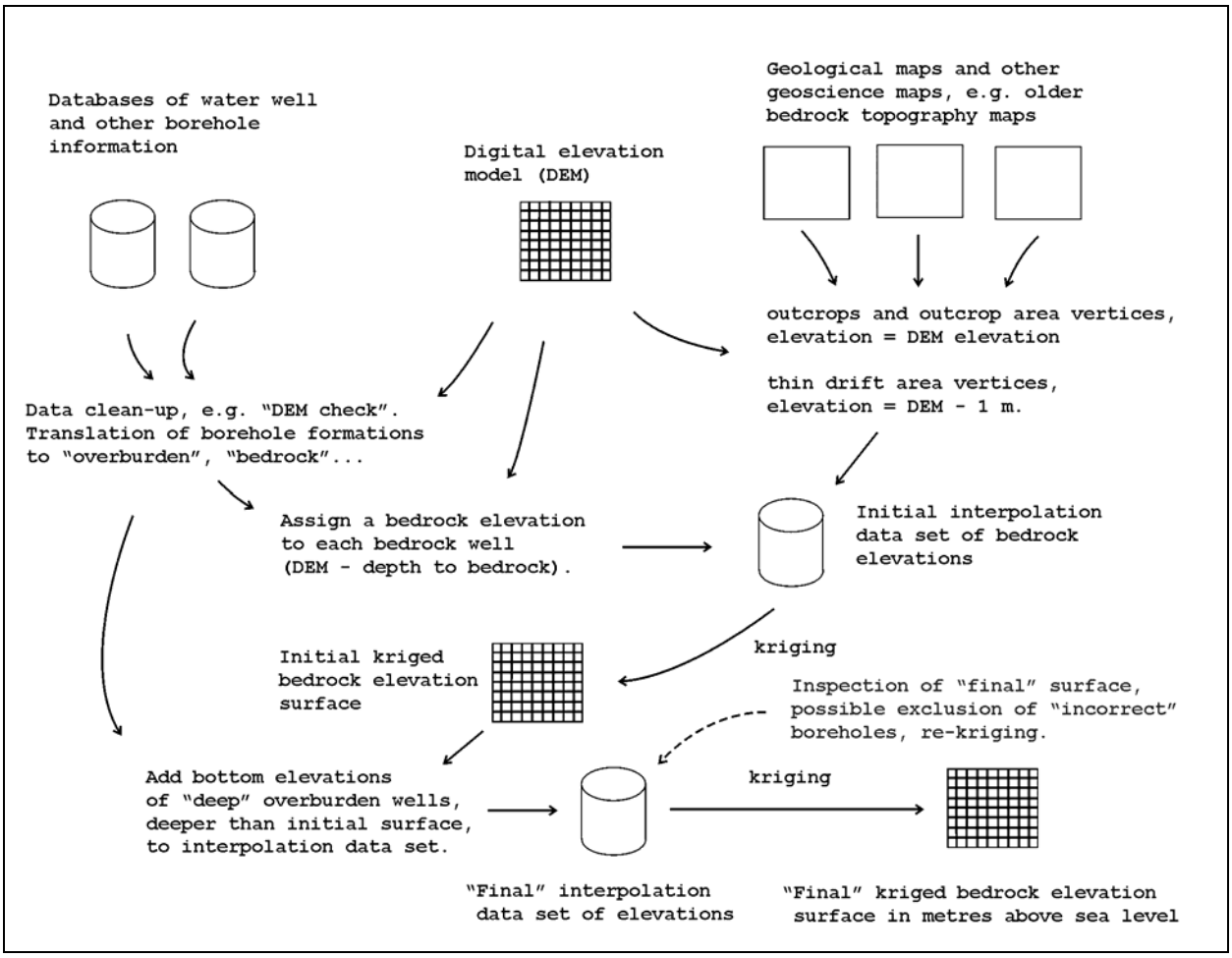

Figure 1. Computing the bedrock elevation surface.

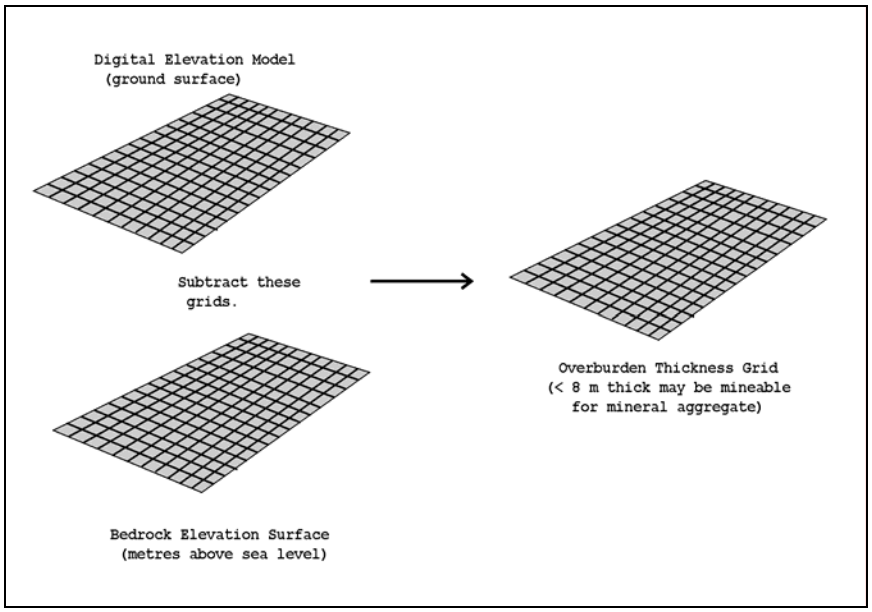

Figure 2. Calculating the overburden thickness.

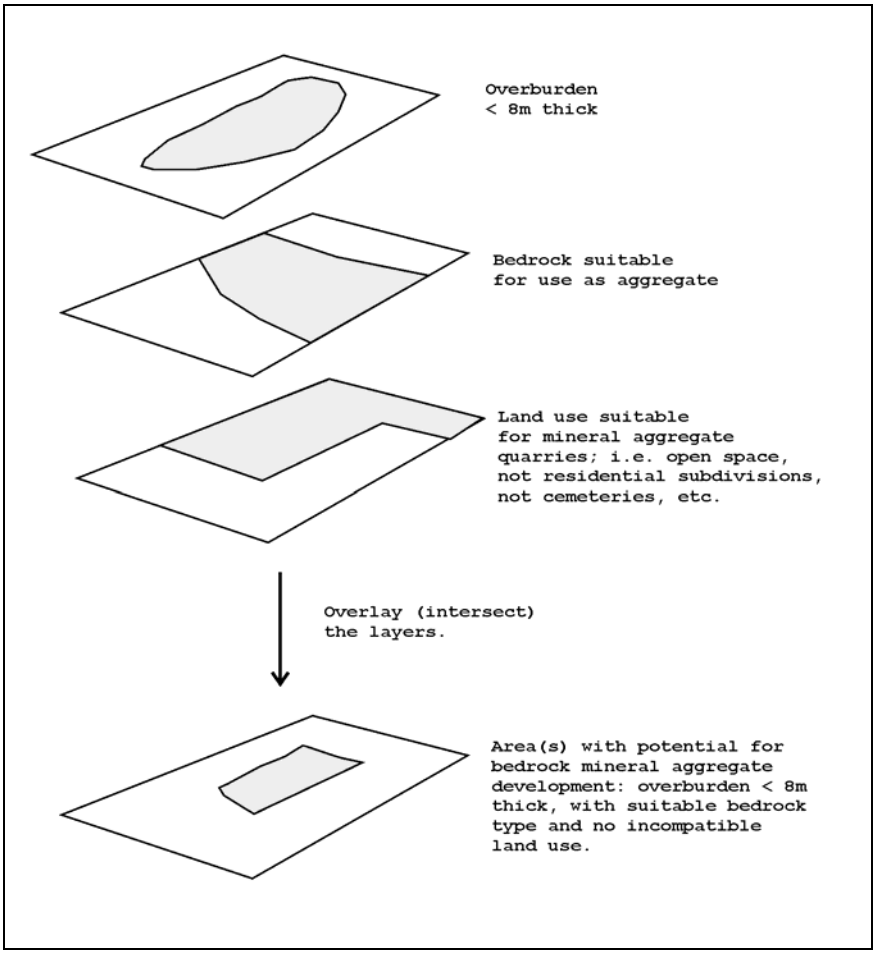

Figure 3. Determining bedrock mineral aggregate potential.