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Canada

Buried-valley Aquifers: Delineation and Characterization from Reflection Seismic and Core Data at Caledon East, Ontario

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Buried valley aquifers are an important source of water supply in Ontario. They are significant to water resource managers as interest grows in source water protection, security of supply, and in constraining estimates of watershed-scale water balances. Prospecting methods for this aquifer type have seldom used modern exploration techniques to discover, target, and assess reservoir potential and flow-system properties. The town of Caledon East, located on the southern flank of the Oak Ridges Moraine, east of the Niagara Escarpment (Figure 1) is facing a water supply problem. Buried-valley aquifers are one possible source of additional water, but are currently poorly understood in the area. This abstract provides a preliminary analysis of recent geophysical and sedimentological data collected in the area and places it in a regional stratigraphic context.

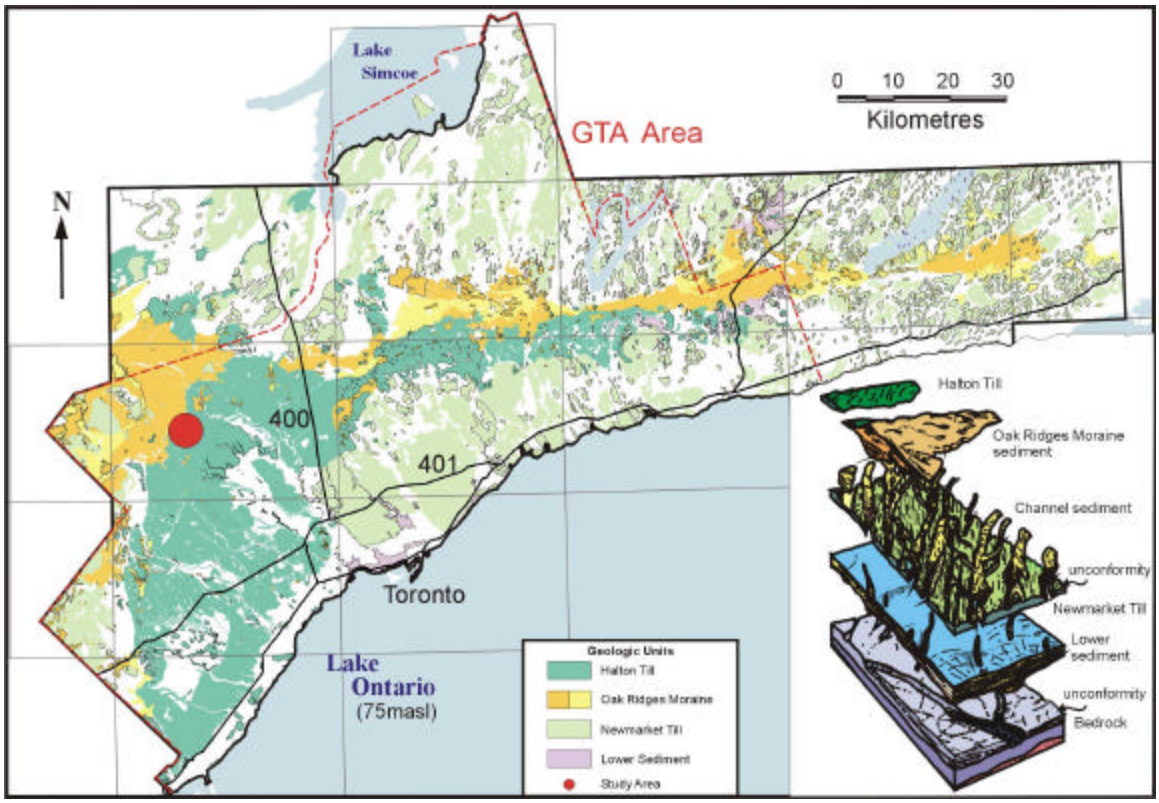

Figure 1. a) Location and generalized geology map of the Greater Toronto Area. b) Conceptual rendition of the stratigraphic architecture and the principal stratigraphic units of the GTA (see Sharpe et al., 1996).

Sparse archival borehole data outline an ~E-W trending bedrock valley, that appears to connect eastward with the larger Laurentian valley (Figure 2). To investigate the extent, depth, and architecture of

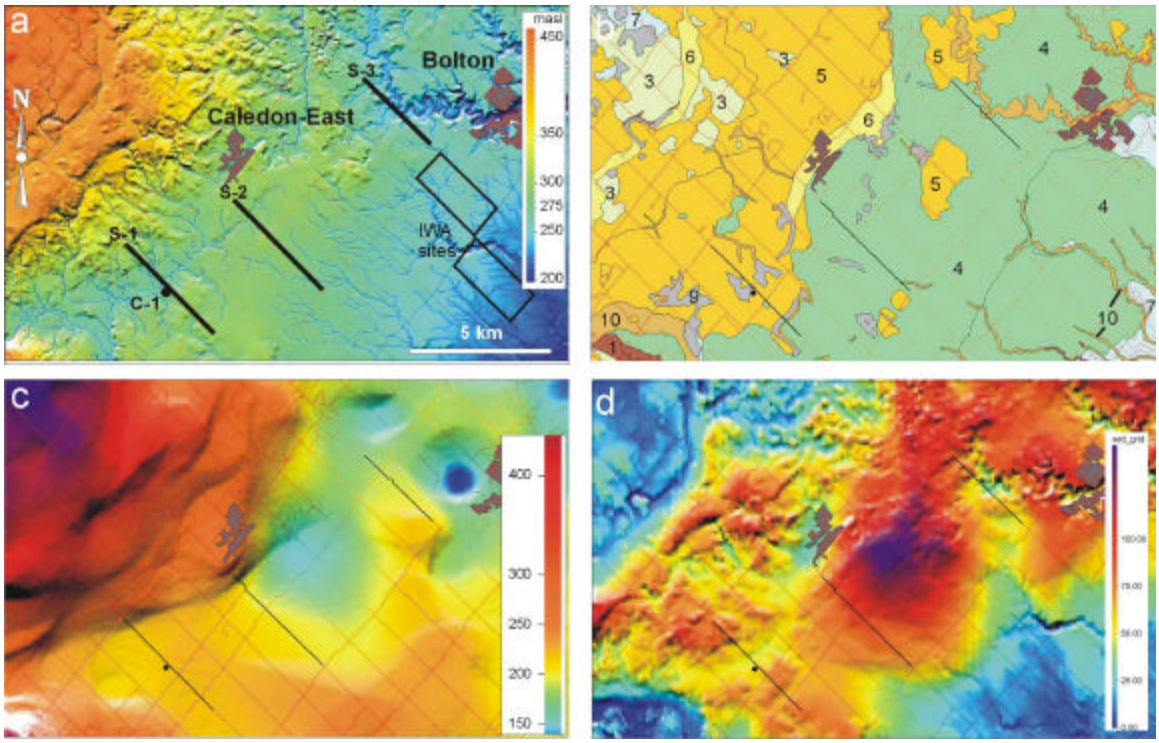

Figure 2. Geological context of study site. a) Digital elevation model (DEM) of the area with seismic sections (e.g. S-1) and borehole sites (C-1, IWA sites) indicated. b) Surficial geology map. Numbers refer to geological units: 1 - bedrock, 3 - sandy till, 4 - silty Halton Till, 5 – Oak Ridges Moraine sand, 6 – glacifluvial sand, 7 – glacilacustrine silt, 9 – organic, 10 – alluvium. c) Bedrock surface DEM modified from Russell and Stacey (2001). Scale is in metres above sea level. Borehole C-1 revealed bedrock 100 m deeper than indicated by the bedrock DEM. d) Sediment thickness map. Note thick region of sediment between seismic lines S-1 and S-2 coincides with a region of outcropping ORM sediment over a bedrock low. Scale is in metres.

the suspected bedrock valley, and its sedimentary fill, high-resolution geophysical and geological data were collected. This work included ~10 line kms of reflection seismic data, along 3 profiles spaced at intervals of 4-6 km, downhole geophysics, and detailed sediment logging data from an ~ 180m-deep, continuously cored borehole (Figure 2a). Several cored boreholes from a nearby landfill investigation of the Interim Waste Authority (IWA sites, Figure 2a) provide additional detailed geological context.

Results confirm the presence of and delineate the suspected bedrock valley that is ~100 m deep, ~2-4 km wide that appears to trend and widen to the northeast (Figure 2c). Seismic reflector patterns tied to borehole data show 4 main elements (Figures 3 and 4).

1. A basal, semi-continuous, high-amplitude reflector seismic facies that is interpreted as shale and limey bedrock of the Georgian Bay Formation.
2. Overlying bedrock is a continuous, relatively coherent high-amplitude facies ~10 m thick that is interpreted to be diamicton.
3. A <100 m thick seismic facies of high-amplitude, less continuous, truncated and inclined reflectors that is interpreted to be stacked sand and gravel sets with cut-and-fill and cross-

bedding structures. This seismic facies is inferred to represent high-energy deposition from a subglacial fluvial system.

4. An 80-100 m thick, low-amplitude, weakly planar seismic facies that is interpreted to be sand and silt. Borehole data indicate increasing mud content upward in this seismic facies (Figure 4).

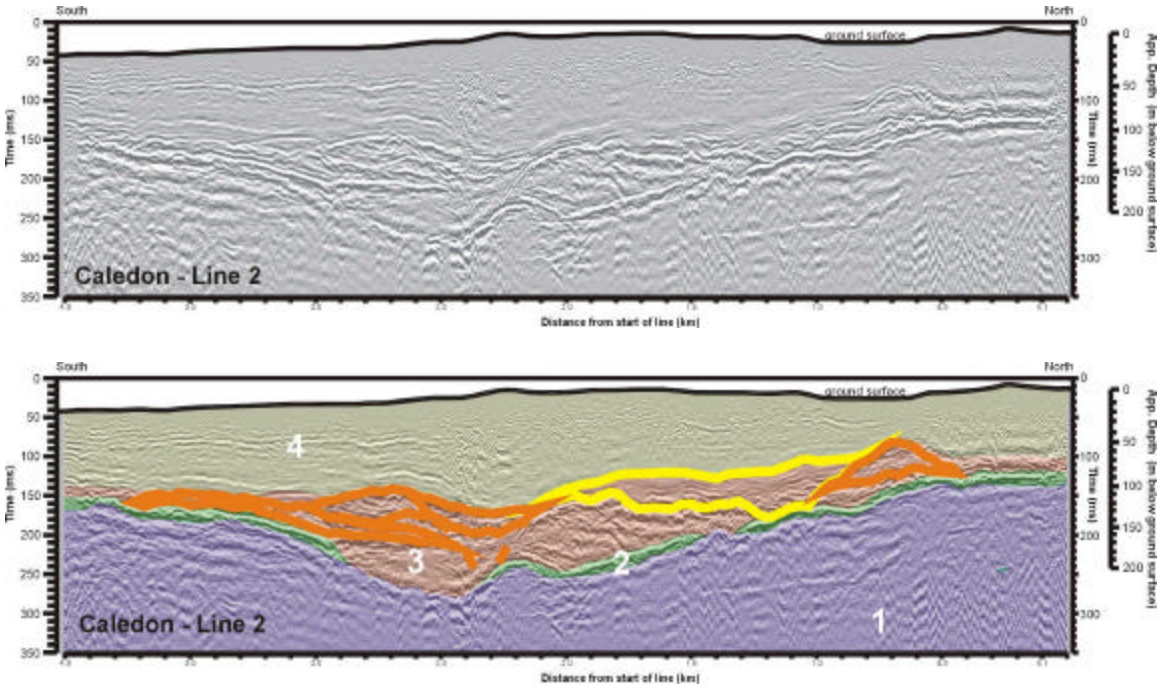

Figure 3. Reflection seismic profile presented as an amplitude plot (a) an interpreted line drawing (b). Number in b are; 1 – bedrock, 2 – diamicton or coarse gravel on bedrock, 3- gravel, 4 – fining upward unit of sand and silt.

The succession is interpreted to correlate with the regional Oak Ridges Moraine and Halton Till stratigraphic units (Barnett et al. 1998). Similar structures and coarse sediment have been interpreted from seismic facies and confirmed with continuous core in the region (Pugin et al. 1999; Russell et al. 2003; Sharpe et al. 2003). Coarse sediment of unit 3 provides up to ~100 m thick and
~ 2 km-wide target for hydraulic testing. This buried gravel deposit, located along the axis of the valley, is a potentially new and previously unrecognized aquifer.

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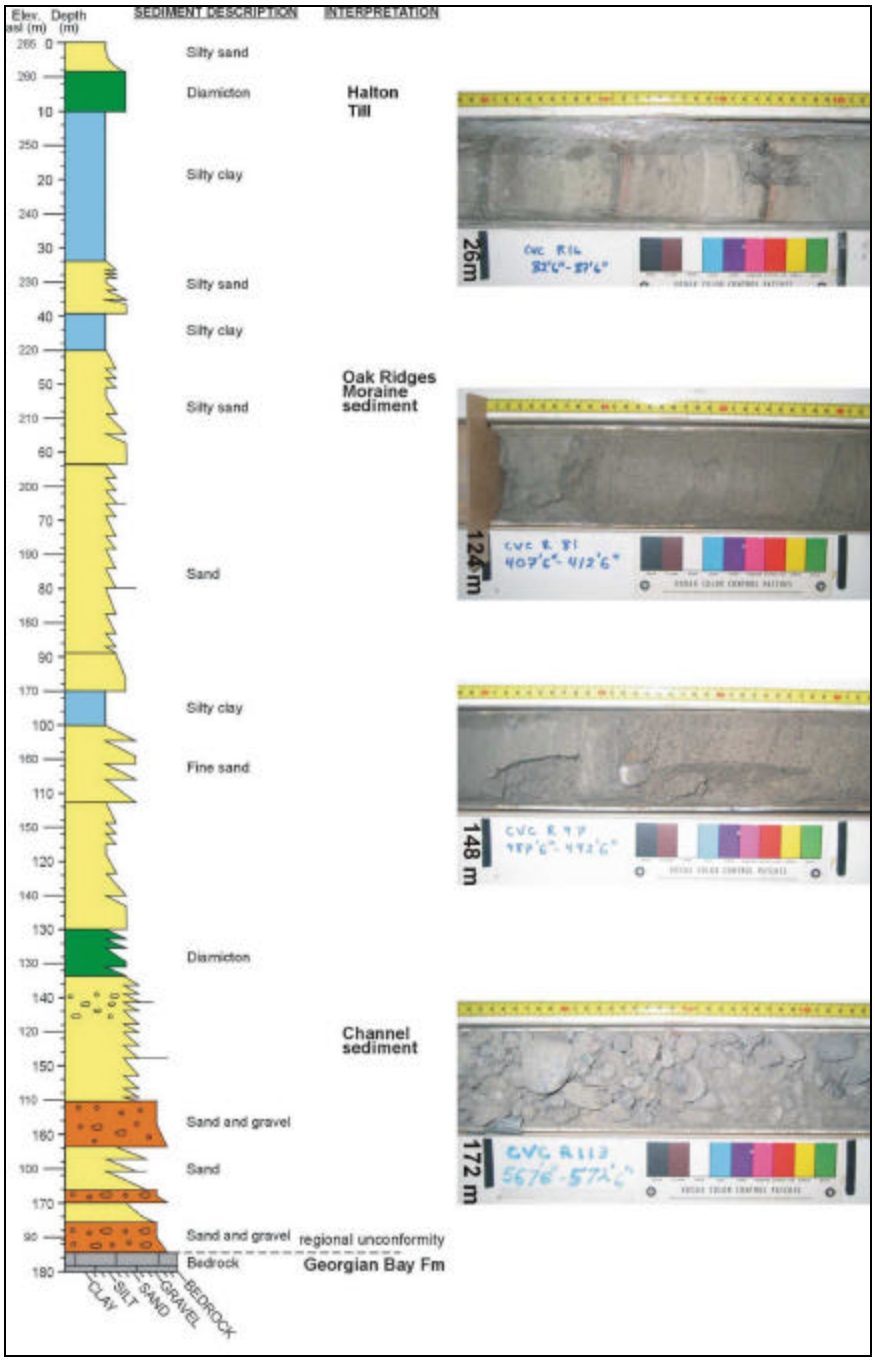

Figure 4. General log of borehole C-1 sediment core and selected photos of sediment facies. Note coarse sediment of the channel fill overlain by a succession of fining upward sand and silt cycles.