# Evidence for Rock Mechanical Layers Influencing Channel Morphology in a Buried Bedrock Valley

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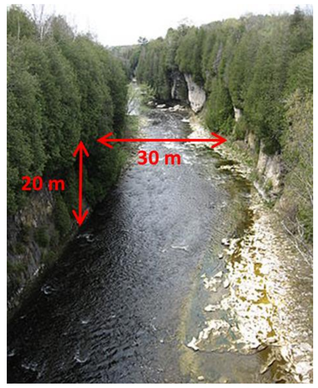
## Introduction

Buried bedrock valleys are relatively common features occurring in glaciated terrains across Canada, the northern United States, and northern Europe where they formed as a result of preglacial, glacial, and glaciofluvial erosion.

Buried bedrock valleys can influence groundwater flow systems, playing a role in recharge of bedrock aquifers and may act as preferential pathways that enhance a deeper aquifer's susceptibility to contamination.

A detailed assessment of the relationship between bedrock lithological properties and bedrock valley incision will contribute to a better understanding of the role buried bedrock valleys play in groundwater flow systems.



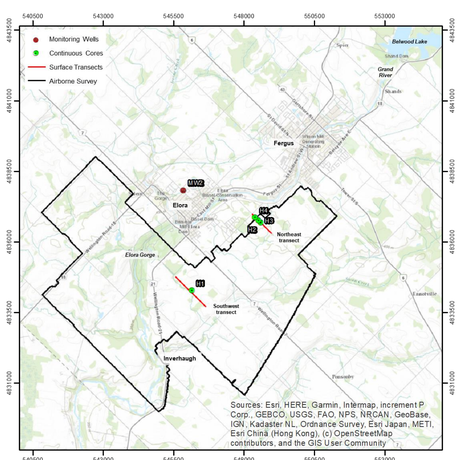

Example of the Elora Gorge, a modern bedrock river that has not yet been buried by sediments

https://en.wikipedia.org/wiki/Elora_Gorge

## Study area

The channel morphology of a buried bedrock valley in Elora, Ontario, Canada was characterized using:

- Airborne frequency-domain electromagnetic (FDEM) and residual magnetic survey (RESOLVE$^{TM}$ system)
- Two co-located, high-resolution surface geophysical transects oriented orthogonal to the buried bedrock valley
  - ➢ Gravity
  - ➢ Seismic refraction
  - ➢ Electrical resistivity tomography (ERT)

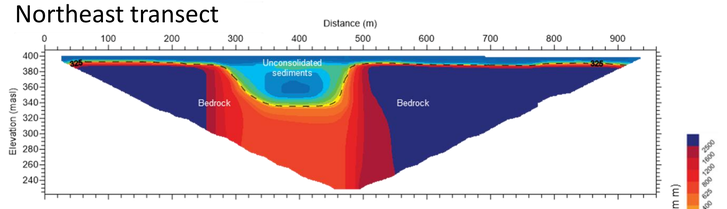





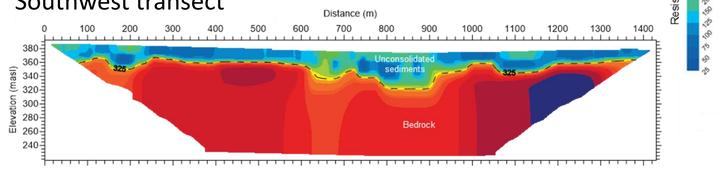
An airborne frequency-domain and residual magnetic survey was completed over the study area using the RESOLVE$^{TM}$ "bird" is 9 m long.

## Contrasting valley profiles revealed

Northeast transect

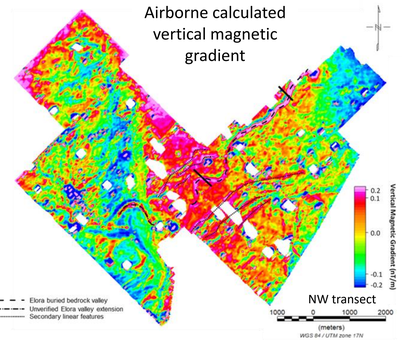



Southwest transect

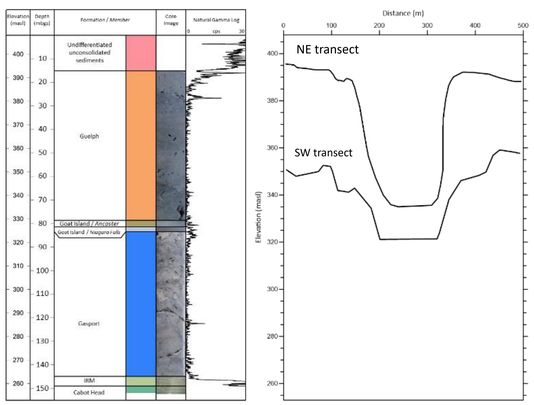



Geophysical transects at the site revealed a linear U-shaped valley in the NE deeply incising bedrock, becoming progressively shallower downslope towards the SW.

Why the difference in valley morphology?




## What is controlling morphology difference?

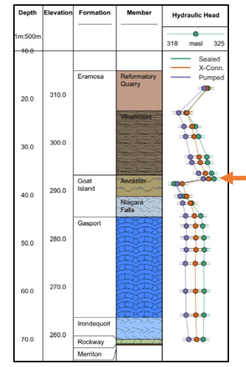



A comparison of valley profiles with a nearby borehole (~3.5 km NW of study area) shows several bedrock units at elevations that may align to the valley thalweg. One of these, the Ancaster member of the Goat Island formation, is documented in the area as having high mechanical strength and, therefore, may have controlled valley incision.

## Properties of the Ancaster mb

Evidence of high mechanical strength and potential aquitard properties:

- Forms caprock of much of Niagara Escarpment including lip of Niagara Falls
- Is the riverbed along modern-day bedrock rivers in the area
- Finely crystalline, siliceous dolostone with abundant chert nodules
- Hard and resistant to scratching in rock core
- Local area head profiles show hydraulic head loss across the unit
  - Indicates a competent aquitard

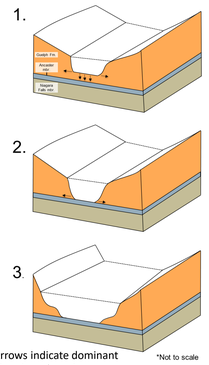



Munn, J.D., Kennel, J.R., Maldaner, C.H., Coleman, T.I., and Parker, B.L. 2020. Measuring fracture flow changes in a bedrock aquifer due to open hole and pumped conditions using Active Distributed Temperature Sensing. Water Resources Research, 56(10).

## Hypothesis for bedrock control on valley incision

The erosion resistive mechanical properties imposed by the chert-rich Ancaster mbr during incision may have influenced valley morphology, with the river channel widening to maintain the cross-sectional area for flow.

1. Vertical erosion dominates in mechanically weak Guelph Formation
2. Vertical erosion is halted by mechanically resistive Ancaster member, forcing lateral erosion
3. Valley continues to expand laterally




Arrows indicate dominant direction of erosion

*Not to scale

## Future Work

Enhanced understanding of bedrock valley morphology and associated spatial variability of bedrock hydraulic properties proximal to buried bedrock valleys could have important implications for future groundwater resource assessments in this region.

Continuous bedrock coring below the Quaternary sediment interface at these two transect positions is in progress with results helping to evaluate these hypotheses.

## Selected references

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## Acknowledgments

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