## Vita

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Universities Attended:

York University (2017)
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**Presentations/Conference Presentations:**

Danchenko, D., Butler, K. E., de Gante Carillo, E., Boulay, D., Yun, T., MacQuarrie, K. T. B., Campbell, I. and McLean, D. B. (2023), Towards quantitative, spatially resolved estimates of dam seepage by time-lapse electrical resistivity imaging (ERI), *Near Surface Geoscience Conference & Exhibition 2023*, Extended abstract, European Association of Geoscientists and Engineers, Edinburgh, UK, pp. 1–5.

Danchenko, D. and Butler, K. E. (2022), Time-lapse resistivity imaging for embankment seepage monitoring, *GELMON 2022: 6th International Workshop on Geoelectric Monitoring*, Geological Survey of Austria, Vienna, Austria.

Danchenko, D. and Butler, K. E. (2022), Time-Lapse Electrical Resistivity Imaging (ERI) for Embankment Seepage Monitoring, *2022 GAC-MAC-IAH-CNC-CSPG Joint Meeting*, Geological Association of Canada, Halifax, Canada.

Butler, K. E, MacQuarrie, K. T. B., Danchenko, D. and de Gante Carillo, E. (2023), Seepage Monitoring Research at Mactaquac Generating Station (Diversion Sluiceway SEP interface region), *Mactaquac Review Board Meeting 45*, NB Power, Fredericton, Canada.

Butler, K. E. and Danchenko, D. (2022), Seepage Monitoring Research at Mactaquac Generating Station (Diversion Sluiceway SEP interface region), *Mactaquac Review Board Meeting 44*, NB Power, Fredericton, Canada.

# Electrical Resistivity Imaging for Embankment Seepage Monitoring

UNIVERSITY OF NEW BRUNSWICK

THESIS DEFENCE AND EXAMINATION

in Partial Fulfillment

of the Requirement for the Degree of
Master of Science

by

**Dmitriy Danchenko**

in the Department of Earth Science

U.N.B., Fredericton, N.B.

**Tuesday, April 23rd, 2024**
**2:30 p.m.**

Forestry/Geology Bldg FG104

Examining Committee

| | |
|---|---|
| Dr. Karl Butler | Supervisor |
| Dr. David Lentz | Internal Examiner |
| Dr. Kerry MacQuarrie | External Examiner |
| Dr. Joseph C. White | Chair of Oral Examination |

# Abstract

Measurements of electrical resistivity variations over time are of special interest for non-invasive investigation of concentrated seepage through embankment dams and levees where the resistivity of the retained water changes seasonally with variations in ion content and/or temperature. To this end, an experimental resistivity monitoring system is in development at the Mactaquac Hydroelectric Generating Station in New Brunswick, Canada, situated along the Saint John/Wolastoq River. With 123 electrodes distributed over a 70 m x 25 m area adjacent to a concrete sluiceway structure, the system runs autonomously each night, collecting over 7000 apparent resistivity measurements (predominantly pole-dipole). These data are averaged over one-week periods and inverted to yield weekly snapshots of the 3D resistivity distribution. In seeking to quantify seepage rates through a target area of these models, a streamlined workflow is needed for assembling a collection of high-quality resistivity data with adequate resolution in the region of interest. The system's sensitivity to resistivity variations in the dam's clay-till core is improved by incorporating 23 electrodes buried along the dam crest. Refined topographic models and an automated data workflow ensure continuous, high quality time-lapse resistivity results. These developments have proven effective, as illustrated by data collected since April 2022. Annually the resistivity of water in the dam's reservoir varied by nearly a factor of four, providing a strong signal suitable for use as a tracer to highlight regions of the core that appear to have experienced preferential water flow. Order-of-magnitude estimates for seepage flux (and its spatial variation) are calculated by analyzing the time lag between resistivity changes measured in the reservoir and correlated changes imaged in the dam core Resistivity monitoring corroborates the inference of shallow seepage obtained from a borehole DTS system in the concrete structure abutting the embankment and offers the advantages of being non-invasive and spatially resolving lateral variability in apparent anomalous seepage extending into the core of the embankment. The results suggest that the ERI approach is feasible for continuous seepage monitoring at water retaining structures, even in an electrically noisy power station environment.