Electrical resistivity tomography to monitor for seepage at an embankment dam abutment

DANIEL E. BOULAY AND KARL E. BUTLER

Department of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada <dboulay@unb.ca>

Concrete structures at the Mactaquac hydroelectric generating station, located on the Saint John River near Fredericton, New Brunswick, are experiencing an aggregate-alkali reaction, causing them to expand. It has been hypothesized that differential expansion of the concrete abutment to the embankment dam could lead to elevated seepage along that interface. We are developing a 3D resistivity imaging system, installed on the back of the dam, which will be used to monitor for anomalous seasonal and spatial variations in resistivity that may be caused by such seepage. The electrical resistivity of earth materials is sensitive to changes in water saturation, pore fluid temperature, and total dissolved solids, all of which may change seasonally inside the dam in response to changes in headpond temperature and solute load. To start, we will identify zones inside the dam where resistivity variation with the changing seasons is anomalously high, suggestive of changes in temperature, water conductivity and/or moisture content arising from concentrated seepage. Observed seasonal changes in resistivity within different parts of the embankment will be compared to those expected based on prior modelling of seasonal variations in temperature accompanying bulk seepage. The study will also investigate best practices for making automated reliable, repeatable measurements of resistivity year-round despite typical challenges associated with electrode installation, ground freezing and electrical noise at dam sites in northern climates. Repeated measurements of the annual cycle of resistivity within the dam will complement ongoing monitoring of temperature using Distributed Temperature Sensing (DTS), thereby strengthening seepage monitoring at the embankment's interface with the concrete Diversion Sluiceway.

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