Use of Airborne Electromagnetic Geophysical Survey to Map Discontinuous Permafrost in Goldstream Valley

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An airborne electromagnetic (AEM) survey was used in Goldstream Valley to map the electrical resistivity of the ground by sending a magnetic field down from a transmitter flying 30m above the ground into the subsurface. This magnetic field creates an electrical current in the ground which generates a secondary magnetic field that can be detected with a receiver in the same instrument in the air. The recorded electromagnetic data are a function of the resistivity structure in the ground. The RESOLVE system used in the survey records data for six frequencies, resulting in a near-surface resolution of 1-3 meters and a depth of investigation up to 110 meters, depending on resistivity of the ground. The high frequencies of the system allow for the near-surface resolution while the low frequencies provide a greater depth of investigation. Recording six frequencies enables the use of inversion methods to find a solution for a discretized resistivity model providing resistivity as a function of depth below ground surface.

Using the RESOLVE system in a populated area results in challenges related to noise, accessibility, and public opinion. Noise sources on the system were mainly related to power lines, which are not always producing the same level of noise and also not to all frequencies used by the system. We were not permitted to fly directly over homes, cars, animals, or people due to safety concerns, which leaves gaps in our dataset. We had a campaign to inform the public about the methods used, their benefits to understanding the environment, and their impacts on the environment.

To interpret our data we used various codes and parameters within those codes to find the most stable solution for the inversion of the data. This method provided resistivity models that were interpreted for frozen and thawed ground conditions constrained by alternate data sources such as well logs, borehole data, ground-based geophysics, and temperature measurements. The resulting permafrost map will be used to interpret groundwater movement into the valley and the behavior of methane release from thermokarst lakes in the valley.

As the project progresses we will use numerical models to simulate permafrost in the valley starting with the last ice age and simulate it through to the next century. The permafrost map will be a useful guide for the modeling efforts, but the modeling efforts will ultimately also contribute to fine tuning the permafrost map. We are also focusing on the groundwater and carbon movement in the discontinuous permafrost environment. We have observed significant differences in methane release from thermokarst lakes in the valley and we are using the permafrost map to explain these differences.

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