Non-invasive investigation of permafrost along a planned route of pipeline, road or airstrip in cold regions involves the use of effective methods for detecting, characterizing, mapping and monitoring permafrost conditions on various spatial and temporal scales. Among the available near-surface geophysical methods, the electrical resistivity imaging is probably the most suitable method since the resistivity contrast between unfrozen and frozen ground can be one or two orders of magnitude.

Induced polarization (IP) profiling was carried out to study the spatial distribution of ground ice in two permafrost mounds near Umiujaq in Nunavik, Canada. A dipole-dipole array was used to perform the IP profiling. Pseudo-sections of electrical resistivity and chargeability giving a misrepresented cross-section of the sub-surface were first draw. The inversion of IP profiling was also performed using DCIP2D developed by UBC-GIF for estimating the spatial distribution of electrical properties in the ground to create realistic models of sub-surface resistivity and chargeability cross-section. The inverse models show clearly the presence of ice-rich core in the permafrost mounds. The ice-rich cores are underlined by high resistivity values while the unfrozen zones show low resistivity values. The localisation of the permafrost table is highlighted by a strong contrast of resistivity while the permafrost base is marked by a transitional change in resistivity. In the hollow between the permafrost mounds, the models show low resistivity values characteristic of unfrozen zone. A synthetic resistivity sounding built from the most acceptable inverse model correlates well with electrical resistivity logging carried out in the permafrost mound during cone penetration tests. The inversion of IP profiling is fundamental for defining realistic models of sub-surface resistivity and chargeability.

Electrical resistivity imaging is a appropriate near-surface geophysical method for permafrost investigation such as detecting the absence/presence of permafrost, assessing the cryostratigraphy, mapping the lateral changes in permafrost conditions, estimating the ice/unfrozen water content, determining the permafrost base for shallow permafrost occurrences and monitoring seasonal variations in permafrost conditions from electrical resistivity imaging carried out at regular interval. Electrical resistivity imaging can be used for the delineation of ice-rich zone in frozen ground along major transect such as the route of pipeline, road and airstrip in cold regions.

## NS41B CC: 220 C-E Thursday 0830h

### Near-Surface Geophysics Posters: Evaluation and Management of Water Resources *(joint with H, GC, PP, ED)*

*Presiding:* **R Knight,** Stanford University

#### NS41B-01 0830h POSTER

#### Poster Component of Near-Surface Geophysics: Evaluation and Management of Water Resources II.

Near-Surface Geophysics (noe-mail@xxx.xxx)

Near-Surface Geophysics, Posters From the Oral Session NS41A

A list of the abstracts and authors that will be presenting posters in this session can be found in session NS41A. The authors are each giving a 5-minute overview of their poster in the session Near-Surface Geophysics: Evaluation and Management of Water Resources II. The presentations start at 0830h in Room 516B on Thursday.

## NS43A CC: 516 B Thursday 1330h

### Near-Surface Geophysics: Evaluation of Transportation, Building and Energy Infrastructure, and Related Resources I

*Presiding:* **L Pellerin,** Green Engineering, Inc.**; M Chouteau,** Ecole Polytechnique

#### NS43A-01 1330h

#### How Much Gravel? Use of Ground Penetrating Radar for Aggregate Resource Evaluation

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Ground penetrating radar (GPR) was tested in two gravel quarries in eastern Newfoundland, Canada, to determine its usefulness for aggregate resource evaluation.

In Mercer's Pit, near Tors Cove, GPR profiles show irregular, discontinuous reflections that extend to depths of more than 30 m. Boulders are common at depth (identified on the profiles by numerous individual diffractions). The area is interpreted as a much thicker gravel deposit than had been estimated by previous methods, however, the presence of boulders could indicate a lower quality resource. Analysis of a peat bog near the pit shows a prominent contact on the GPR profiles. It is interpreted as the hummocky surface of the gravel deposit (continuous, high amplitude reflections), which underlies a much weaker reflective zone of peat.

At Snow's Pit, near Bay Roberts, a series of overlapping diffractions at depth are interpreted as representing the bedrock surface, which varies from 5 to 15 m below the surface. Aggregate deposits overlie the bedrock (irregular, discontinuous reflections) and contain very few boulders. This deposit also was found to be larger than previously thought, and is low in boulder content throughout.

GPR was found to be an effective tool for delineating the extent and volume of aggregate resources in these examples. It provides a detailed view of the subsurface and large amounts of information are gathered quickly and easily. GPR can be used to revise volume calculations of quarries already in operation and to estimate the volume of potential new deposits. It is also useful for planning pit development and analysing prospective areas that quarry operators do not yet own or have rights to, with virtually no environmental impact on the land surveyed.

#### NS43A-02 1335h

#### Electrical Resistivity Imaging for Investigating Slope Stability, Fort St. John, British Columbia

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The Peace River District of northeastern British Columbia is characterized by steep river valleys that have been incised up to 300 m deep in poorly consolidated Cretaceous and Quaternary sediments. Since the area is a major producer of oil and gas, numerous pipelines and roads transect these valleys. Slope stability has been a major problem at several locations and will continue to pose a problem for future development in the area. Understanding the mechanisms of slope stability will allow better assessment of the risks to infrastructure. The Geological Survey of Canada is conducting studies to determine the role that groundwater infiltration and flow have in controlling slope movements. Near-surface geophysical surveys provide a quick non-invasive method of investigating ground conditions. Since moisture content of the underlying strata plays an important role in slope stability, electrical methods are particularly suitable. For this study, two-dimensional electrical resistivity imaging was conducted along three pipeline route slopes in the Fort St. John area during July 2002. An automated electrical resistivity imaging system was used to acquire continuous Wenner array images up to 1300 m in length. The system used 48 electrodes spaced 5 m apart, to obtain a high-resolution image of the subsurface with an exploration depth of approximately 40 m. Two-dimensional inversion software was used to obtain topography-corrected electrical resistivity models for each slope. Borehole information was incorporated in the interpretation of the results. Electrical resistivity imaging proved to be a fast and effective method for investigating the extremely steep slopes encountered in the Fort St. John area. The results indicate that the method is very useful in identifying seepage zones and extending hydrostratigraphy from borehole observations. These studies will assist modeling of groundwater flow by confirming areas of predicted groundwater discharge and by delineating areas where moisture content changes are taking place.

#### NS43A-03 1340h

#### Assessment of Continuous Resistivity Profiling for the Characterization of Paved Roads

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We have assessed the continuous resistivity profiling method using towed arrays as a diagnostic NDT method for the evaluation of pavements. Whether the pavement consists of a sequence of asphalt, concrete slab and subgrade layer (rigid pavement) or a layer of asphalt overlying a subgrade and grade base layers (flexible pavement) defects within those different layers can cause pavement deterioration that must be identified. We first examine the response of the method to the various problems using numerical modeling. It is shown that with an optimally designed system the method allows the determination of the thickness and the location of cracks in the asphalt cover. It is also sensitive to the presence of cracks, internal defects and chloride ions (de-icing salt) within the concrete slab below. For reinforced concrete it is possible to estimate the concrete resistivity related directly to its composition (quality) and the thickness of the top coating over the level of rebars. A low resistivity of concrete will usually be diagnostic of advanced stage of rebar corrosion and delamination could occur. However it is shown that the rebars cause current channeling and the depth of investigation is limited then to the depth of the first row of rebars. Finally heterogeneities within the foundation reflecting subsidence, bad drainage, frost-defrost cycles or cavities can be mapped. The optimal design is based on a system with 10 to 20 receiver dipoles and one transmitter dipole (first or last of the array) with a dipole length typically of 10 cm that can be used in equatorial or in-line mode. Static resistivity measurements have been carried out at the laboratory scale over concrete slabs built to verify results obtained from the numerical modeling. Observed data fit very well the modeled data and validate the overall conclusions. Tests have been performed in December 2003 in some selected streets (6 visited, 3 re-visited) of Montreal using a CORIM system (Iris Instruments, France), a capacitively-coupled resistivity towed equatorial array that continuously record data collected with six receiver dipoles and one transmitter dipole. Typical acquisition sampling and velocity were 0,20-0,50 m and 1 to 2 km/h respectively. Although the system is not optimally designed for the applications described above it provides useful diagnostic information about the state of deterioration of pavement. Data have been imaged using 2D resistivity inversion. In general it shows a high resistivity for the shallow depth related to the asphalt layer and a decreasing resistivity with depth related to the concrete slab first and the granular foundation below. Lateral variations appear to be correlated with degradation of the concrete slab.

#### NS43A-04 1345h

#### Near Surface Characterization Of Concrete Structures Using Rayleigh Waves

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