TOWARDS A GREATER UNDERSTANDING OF INDUCED POLARIZATION EFFECTS ON TRANSIENT ELECTROMAGNETIC DATA AND THEIR ASSOCIATED INVERSION MODELS IN PERMAFROST ENVIRONMENTS

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Permafrost degradation is increasingly becoming one of the world's most pressing climate problems in polar and sub-polar regions, having huge impacts on infrastructure and the environment. It is therefore vital to understand subsurface dynamics and structures in these regions. Recently developed and advanced geophysical sensors such as the towed Transient ElectroMagnetic system (tTEM) can be utilized to gain a detailed understanding of subsurface conditions in permafrost regions through rapid mapping and integration with multiple disparate datasets. However, interpretation of electrical and electromagnetic data is complicated in these areas by strong induced polarization (IP) effects often associated with permafrost and underlying geology.

A survey utilizing an adapted tTEM system (SnowTEM) in Ilulissat, Greenland provides a large-scale example of data and associated preliminary inversion models incorporating IP effects. The purpose of the survey was two-fold: to understand 3D distribution of (specifically saline) clays, and to delineate the subsurface geometry within areas planned for development of road systems and a new airstrip. In order to provide information for planning decisions in terms of engineering stability and a greater understanding of how a warming climate and melting permafrost will affect local infrastructure and water supply, the effects of IP and their consequences to interpretation must be better understood.

The SnowTEM survey made a 3D coverage of an area of approximately 640 hectares with a nominal 25m line spacing. In the presence of marine clays, permafrost, and possible schists, the recorded voltage decays show a wide range of IP effects, manifesting as steeply decaying curves, sign-shifts, non-monotonic decays, and completely negative data. Therefore, inversion taking polarization effects into account was critical. We present a catalogue of varying IP effects and their associated inverted models using a hybrid stochastic approach to understand their mapping from the data space to the model space. We show the dependency of IP inversion on the starting model, discuss optimal filtering parameters in the context of IP, and present a pathway toward inversion of a complete dataset.