Imaging coastal permafrost conditions and sedimentary structures with GPR

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Extensive multi-frequency (50, 100, 250, and 500 MHz) ground penetrating radar surveys were conducted in the Mackenzie Delta, Canada to map the character of near-shore permafrost conditions and sedimentary structures. The data were collected over sea ice and frozen ground conditions in the winter of 2005 and 2006 using multiple GPR systems. Verification of the interpretation was accomplished through direct measurement of ice thickness and water depth, sub-bottom coring and installation of ground temperature cables. Differential GPS data were used to provide position control on the GPR data and enable effective spatial correlation of the interpreted structures. When the system was towed by a snowmobile, up to 20 line kilometres per day could be acquired with 20 cm trace spacing at 250 MHz and 1 m tracing spacing at 50 MHz.

Parameters measured included ice thickness, water depth, sedimentary structure, and the location of thermal interfaces. The presence of floating versus bottom-fast ice had a dramatic effect on the radar propagation and character of the reflections. Reverberations were one of the largest sources of “noise”, however, they were usually restricted to certain frequencies and could be extracted using the coincident multi-frequency data.

This form of surveying enabled very effective bathymetric mapping in water depths 0-10 m, quantitative measurement of sub-bottom seasonally frozen and permafrost layers and the character of bottom and sedimentary structures (including sub-aqueous channels).