The use of a Ground Penetrating Radar (GPR) to characterize peat stratigraphy and estimate the carbon pool in a boreal peatland

Peatlands are ecosystems where the production of organic matter exceeds its decomposition, resulting in an accumulation of peat (Francez, 2000 Payette et Rochefort, 2001). This is partially the result of a water table close to the surface that reduces the decomposition of organic matter. Peatlands contain therefore large quantities of organic matter that has accumulated during thousands of years (about 8000 years in the Eastmain region). Over the last thousands of years, peat accumulation rates have varied due to changes in climate and the availability of nutrients. Evidence of those variations can be observed in peat coring as layers representing stratigraphic units. Each of these stratigraphic units has distinctive physical and chemical characteristics (e.g. organic carbon (C) contents) that vary through the peat core. Peatlands covers 20% of the terrestrial area now flooded by the reservoir EM-1. Therefore, it is important to obtain a precise idea of the quantities of organic carbon present in these former peatlands to improve the understanding of net greenhouse gas fluxes in the region of the EM-1 project.

Peatland C contents can be estimated by multiplying peat surface (A), mean peat thickness (E), mean organic matter content (P), mean peat density (D) and relative organic matter C content of peat (C), forming A x E x P x D x C = carbon content (Sheng et al. 2004). In this project, peat surface (A) can be obtained using aerial image interpretation or remote sensing while mean peat thickness (E) can be measured by manual probing on site. Mean organic matter content (P) and peat densities (D) are obtained loss on ignition (Dean, 1974) analysis on peat cores in the laboratory (Figure 1). Finally, mean relative organic C contents of peat are estimated at 50%, implying that 1 g organic matter contains 0,5 g organic C (Roulet et al., 2007).

Figure 1: *Peat core from one of the EM-1 region peatlands. This section shows different organic layers close to the sediment surface.*

This method of organic C contents estimation in peatlands has been studied extensively (e.g. Gorham, 1991, Kettles et Tarnocai, 1999 Sheng et al., 2004). However, the results do not reflect reality due to a poor image of the peatland surface topography and mineral basin. This is primarily the result of a discontinuous method (as manual probing) of measuring peat thickness. In the EM-1 project, peat thickness has been measured using a Ground Penetrating Radar (GPR; Figure 2). This device emits electromagnetic waves and detects their reflections and which allow obtaining a continuous measurement of a unit with specific characteristics, as the thickness of a peat layer in this project. An example of a measured GPR profile is shown in Figure 3. The profile clearly shows the peat basin as well as two rock outcrops at the surface, also visible on the aerial image. The interpretation of GPR data are validated using results from traditional sampling methods (manual probing, electrical conductivity analyses, trench survey).

All the data obtained by GPR analysis will be incorporated in a Geographical Information System (GIS) where interpolation techniques will be applied. The principal stratigraphic units that are related to varying C contents can be modelled to be used for precise estimates of organic C accumulated in the boreal peatlands of the EM-1 region.

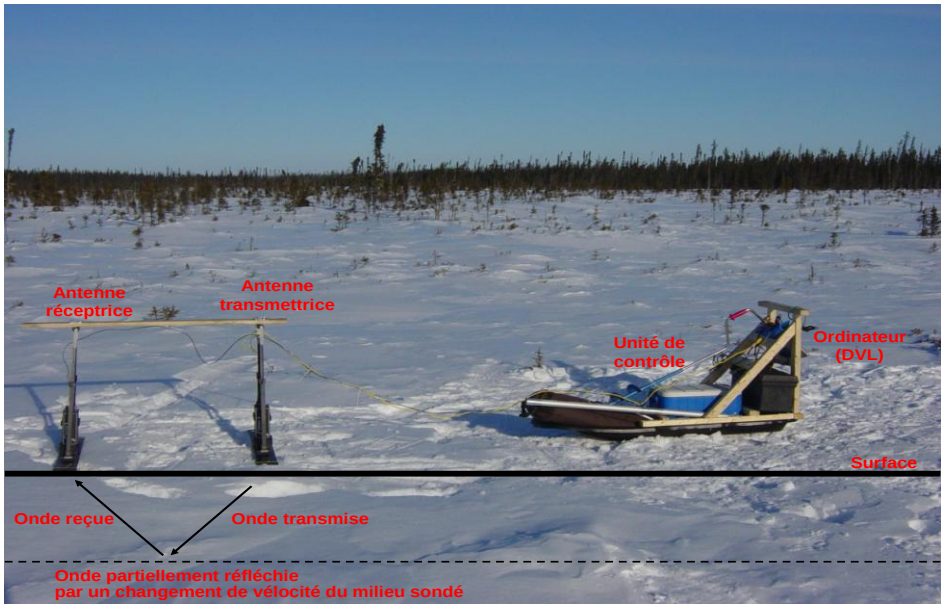

Figure 2: *GPR (Pulse EKKO 100 from Sensors & Software) and all components.*

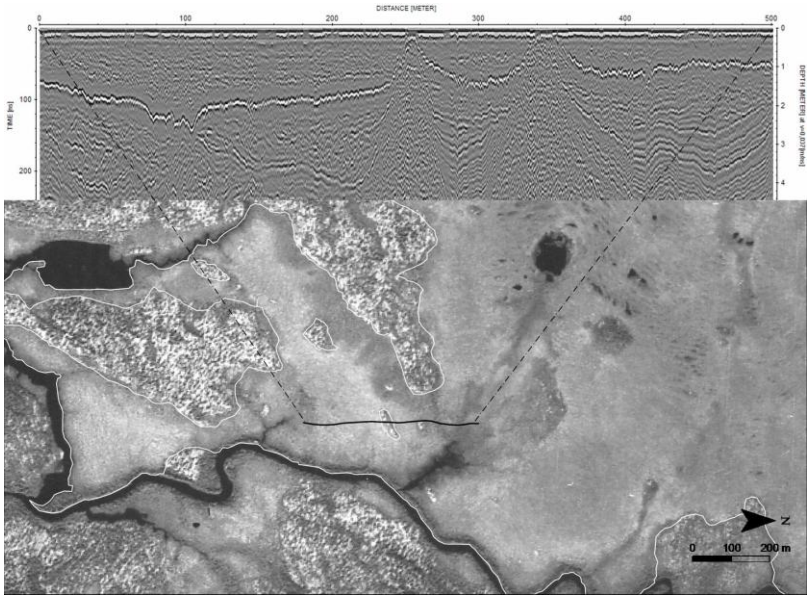

Figure 3: *A GPR profile and the corresponding transect shown on an aerial image (black line on aerial picture).*

Références

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