SEISMIC METHODS APPLIED TO PALEO-LANDSLIDE AND DISTURBED GROUND SITES; A CONTRIBUTION TO THE OTTAWA VALLEY LANDSLIDE PROJECT

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The Ottawa Valley Landslide Project is, in part, a pioneering study of the capabilities of several geophysical techniques to provide regional-level reconnaissance surveys of critical geological controls related to landsliding in sensitive marine (Leda) clay near Ottawa. Compressional and shear wave high resolution seismic methods were developed for site investigations in Champlain Sea sediments associated with earthquake-induced landslides and disturbed ground in the Lefaivre-Bourget areas of eastern Ontario near Ottawa. Seismic methods are applicable to the following parameters: thickness of unconsolidated sediment overlying bedrock, thickness of Champlain Sea sediments (Leda clay), internal stratigraphy of the Leda clays, shear modulus (Gmax) and shear strength profile through the cohesive sediments, as well as regional structure within the overburden.

In order to bolster the paucity of water-well and other geological information in these areas, site oriented P and S wave reflection field methods were developed to provide detailed subsurface seismic sections over a short length of traverse (e.g. <200 m). These methods consisted of a stationary array of geophones (usually 24 to 48 at 3 to 5 meter spacings) with source locations within and off the ends of the array, to produce common midpoint stacked sections. Using high frequency geophones and small (high frequency) sources, attempts were made to maintain short wavelength (1-3 m) high-resolution results. In addition, the first arrival refraction information from individual records from the suite was used to obtain seismic velocities with depth. Over 150 P-wave reflection sites and 60 shear wave reflection sites were obtained in this manner throughout the adjoining Lefaivre and Bourget areas. In addition to individual sites, a P-wave reflection profile was obtained across an interpreted buried valley in the Lefaivre area, as an aid in positioning drill-holes.

In the Bourget area, a high-magnitude Holocene earthquake triggered numerous large earthquakes. Seismic surveys gave estimates of depth to bedrock, the nature of the unconformity on the top of Pleistocene glacial till, and internal Leda clay stratigraphy. Sites were strategically placed in the vicinity of the slides in order to guide the location of boreholes and to provide estimates of earthquake amplification and resonance.

In the Lefaivre disturbed terrain (also earthquake-induced), seismic methods were able to show the presence of deformed subsurface structure to considerable depth. Shear wave velocity profiles (Gmax) differed between undisturbed and disturbed terrain. Earthquake seismic resonance periods were computed from shear wave velocity structure to vary over a large range (<0.5 s to 2.7 s). Broadband earthquake ground motion amplification due to the effect of near-surface shear wave velocity gradients is widespread throughout the study area.