ASSESSING LANDSLIDE HAZARDS USING ELECTRICAL AND ELECTROMAGNETIC METHODS; A CONTRIBUTION TO THE OTTAWA VALLEY LANDSLIDE PROJECT

H.T. Calvert, Geological Survey of Canada, Ottawa, Canada

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. Previous work by GSC has shown that the electrical conductivity of Leda clay and silt of the Ottawa Valley is primarily controlled by pore-water salinity. Lower salinity pore-water occurs in areas where an overlying sand layer allows increased recharge and leaching of salt from the silt and clay. The leached sediments are less cohesive resulting in "sensitive soil" with poor slope stability. It was proposed that large scale electromagnetic surveys be undertaken to map the distribution of sensitive clays in the area as an aid to landslide hazard identification.

An extensive (1000 km^2) electromagnetic survey was carried in the Bourget area using a Geonics EM34-3 ground conductivity meter. This geophysical instrument measures the electrical conductivity of the sub-surface to depths up to 60 m. In addition, ground penetrating radar (GPR) and multi-electrode electrical resistivity surveys along three transect provided detailed images of the subsurface. One transect investigated a slope adjacent to the 1993 Lemieux Landslide. The other transects are located 4 km to the east on slopes free of landslides. Two-dimensional modelling, constrained by data obtained from borehole conductivity logs, was used to determine the electrical resistivity section for each transect. These sections were then used to construct a geological model for each slope.

The electromagnetic survey was effective in rapidly identifying areas where sensitive sediments may be present. Areas in which landslides have occurred were found to be located in zones exhibiting higher electrical resistivity (lower electrical conductivity). However, zones with shallow bedrock or thick overlying sand may have similar electrical resistivities, illustrating the need to study anomalous zones in detail using electrical resistivity, and GPR, seismic methods, or borehole information.

Two-dimensional modeling of the resistivity survey for the slope adjacent to the Lemieux Landslide indicated that only 2 to 3 m of sand overlie sensitive marine sediments. This was confirmed by a GPR survey. As a result, there is about 15 m of relief on the surface of the marine sediments, which may indicate a potential for slope movement. For the slopes located 4 km to the east, electrical resistivity and GPR surveys indicate that the thickness of the sand is 15 to 20 m. The resulting low topographic relief for the surface of the underlying sensitive marine sediments probably explains why slope instability has not been observed in this area.

Electrical and electromagnetic surveys have proven to be useful in mapping sensitive sediments and assessing landslide hazards.