# GEOPHYSICAL FIELD STUDIES, WESTERN NEWFOUNDLAND


## G. KILFOIL[1], A. BLAGDON[2], A. LEITCH[2], M. IRVINE[1] AND G. ROBERTS[1]

[1]Geological Survey of Newfoundland and Labrador, [2]Memorial University of Newfoundland


In August, 2017, initial DC resistivity (DCR) and ground penetrating radar (GPR) surveys were conducted near the communities of Daniel's Harbour and Parson's Pond. The objective was to test geophysical techniques for their use for investigating the shallow subsurface, to provide a better understanding of the extent and nature of unconsolidated surficial sediments, responsible, in part, for slope instability in coastal regions. Geophysical responses recorded in different environments were compared and contrasted, to determine:

1) whether responses due to the local geology at various sites would have sufficient contrast to assist in the definition of subsurface stratigraphy;
2) the effects of surface disturbances (former houses, roads, driveways, lawns) on the recorded results;
3) the extent to which salt water (an electrolyte) may influence the DCR and GPR recordings, at sites proximal to the shoreline.

At Daniel's Harbour, geophysical profiles were carried out on level ground at safe distances from coastal cliffs, parallel to the shoreline, 1) at the recent landslide site north of the town (Fig. 1), and 2) at a site on the south edge of town, where evidence of historical landslides/erosion exists locally. Because these sites were located near previous or existing man-made structures, and are adjacent to the salt water, a third (reference) site was established in the centre of a farm field, located about 1 km inland from the other sites. The glacial stratigraphy is considered to be similar at all of the Daniel's Harbour sites (Fig. 2). The DCR and GPR surveys from the Daniel's Harbour field sites yielded good quality, and remarkably similar, results (Fig. 3). Proximity to salt water appears to have minimal detrimental effects on the DCR or GPR surveys.

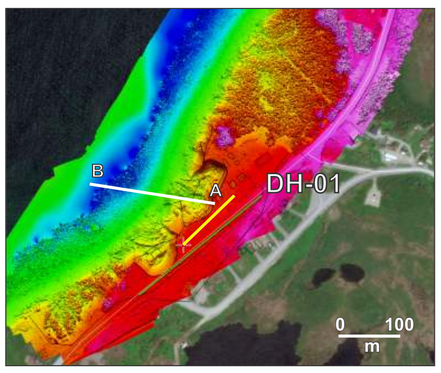


Figure 1: Daniel's Harbour DSM (Irvine, 2018), on Bing imagery, with survey locations

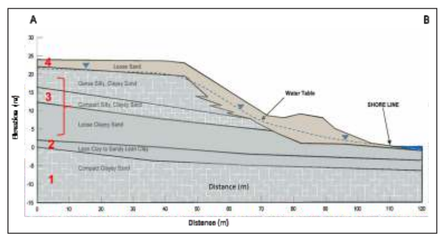


Figure 2: Glacial stratigraphy at the Daniel's Harbour landslide site, as interpreted from shallow drilling. See Figure 1 for location

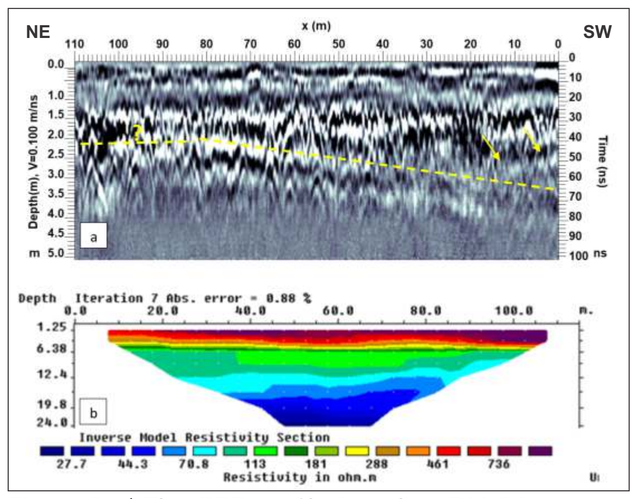


Figure 3: a) The GPR profile from line DH-01.
b) Corresponding DCR inverted section


Figure 4: Parsons Pond field site with survey lines, Bing imagery

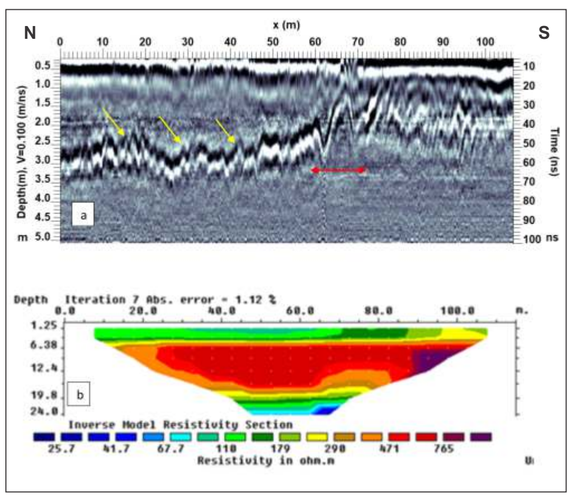


Figure 5: a) The GPR profile from line PP-01
b) Corresponding DCR inverted resistivity section

As a contrasting Quaternary geological environment, a survey site was selected near Parson's Pond (Fig. 4). Similar to Daniel's Harbour, coastal cliffs are at ~15 m elevation, but here, erosion has been predictable and steady, with annual rates approaching 1 m per year. Good quality DCR and GPR results obtained from the Parson's Pond site provide depth profiles in marked contrast to those from Daniel's Harbour, reflecting the contrasting subsurface stratigraphy at the two locations (Figures 3 & 5, from Kilfoil, et al. 2018). The most resistive layer at Daniel's Harbour is the uppermost ~5 m of loose sand and gravel, whereas the depth section at Parson's Pond shows the most resistive parts in mid-section, from 5 to 18 m depth, which corresponds to the near shore marine sediments, well exposed along the coastline (Fig. 7).

In July 2018, the region was revisited to follow-up on previous work. At the landslide and farm field sites near Daniel's Harbour, the 2017 surveys were augmented by additional coincident DCR and GPR surveys. New survey sites were established at the landslide site located south of Sally's Cove (Fig. 8) and near the S.S. Ethie shipwreck site, a tourist stop located just west of the highway, about 5 km north from Sally's Cove (Fig. 9). At all field sites, gradient magnetic data were also recorded along the DCR/GPR survey lines, as well as in the vicinity, where access permitted.

The initial DCR surveys from 2017 used an electrode spacing of 5 m for a total array length of 115 m. Apparent resistivity modelling was limited to an effective depth of about 25 m, whereas the Quaternary sediments at the landslide site are known (from shallow drilling) to exceed this depth (Fig. 2). In 2018, coincident DCR surveys were carried out using electrode spacings of 2m, 5m and 7m. The 2m surveys were designed to provide depth profiles of the shallow section (to about 10 m depth), more comparable with the GPR data. The aim of the 7m data was to better resolve the resistivity profile at depth. Processing and modelling of the 2018 field data is ongoing.

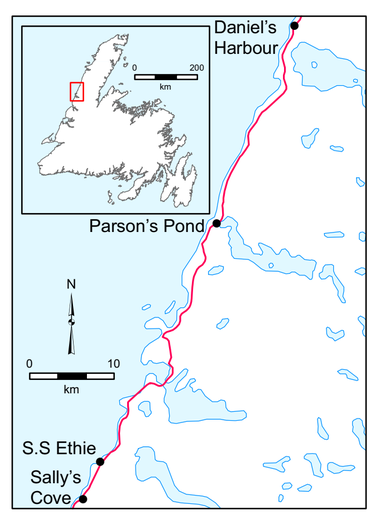


Figure 6: Field site locations

Figure 7: Drone image of coastal cliffs at Parson's Pond, looking east

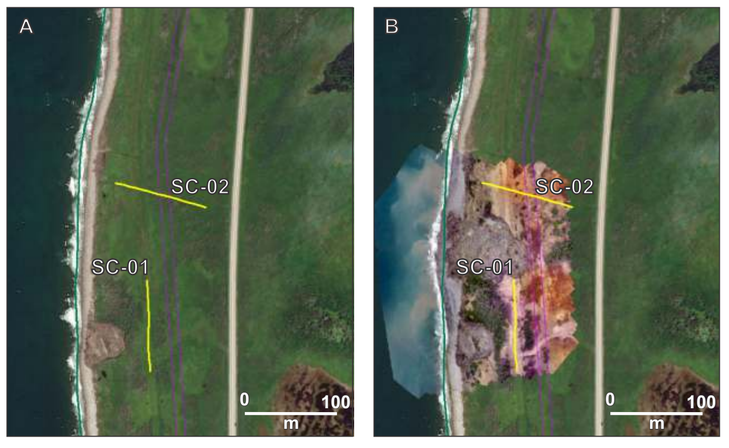


Figure 8: Sally's Cove landslide field site with survey lines. A) Bing imagery, B) Bing imagery with DSM (Irvine, 2018)

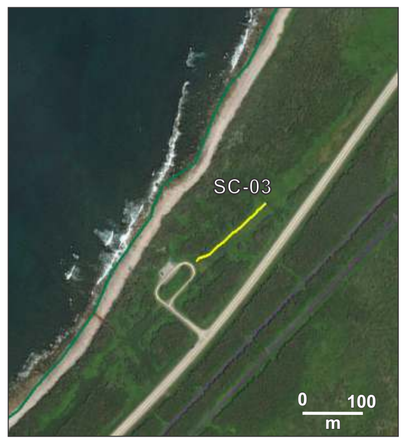


Figure 9: S.S. Ethie shipwreck field site with survey line, Bing imagery


Irvine, M.
2018: Newfoundland and Labrador Geological Survey Division. Coastal Monitoring Database. Newfoundland and Labrador GeoScience Atlas OnLine. Last update: October 2018. http://geoatlas.gov.nl.ca/ (Daniel's Harbour and Parsons Pond drone imagery, 2016)

Kilfoil, G.J., Blagdon, A., Leitch, A., Campbell, H., Irvine, M., Batterson, M., Roberts, G. and Baker, B.
2018: The application and testing of two geophysical methods (direct-current resistivity and ground-penetration radar) as part of the coastal monitoring program to assess terrain stability, in Current Research (2018), Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 18-1, pages 31-57.