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Near Surface Geophysical Investigation for Geotechnical Geohazard Assessment Using Seismic Refraction and Resistivity Survey

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Summary

Uncertainties in geology can cause challenges in geotechnical engineering projects, especially when it comes to applications involving the transport of needed natural resources. Near surface geophysics has been successfully applied in many geotechnical engineering and hazard assessment applications to support borehole and other geologic findings. In this study, seismic refraction tomography (SRT), electrical resistivity tomography (ERT), with supporting claims from multichannel analysis of surface waves (MASW) and borehole logs, were used in a geotechnical engineering application to complete a geohazard assessment at a site located adjacent to a river in the mountains of northern British Columbia. Site geology consisted of cobbles and boulders in an area where a previous debris flow occurred, indicating that hazards associated with the adjacent slopes also need to be considered. The river is regularly imaged using satellite imagery to monitor the river's migration, which may affect linear infrastructure along the river's margins. At the site of interest, transmission towers and natural gas pipelines run parallel to a river, seen in Figure 1, where the riverbanks are susceptible to erosion due to the high velocity of the river. The client tasked BGC Engineering (BGC) with answering questions such as; will future bank migration impact the existing infrastructure and to determine ground conditions along a newly proposed alignment, upslope of the existing right of way. With the use of the conducted surveys and provided borehole data, a hazard assessment was successfully completed to aid site planners mitigate the multiple hazards in the area.

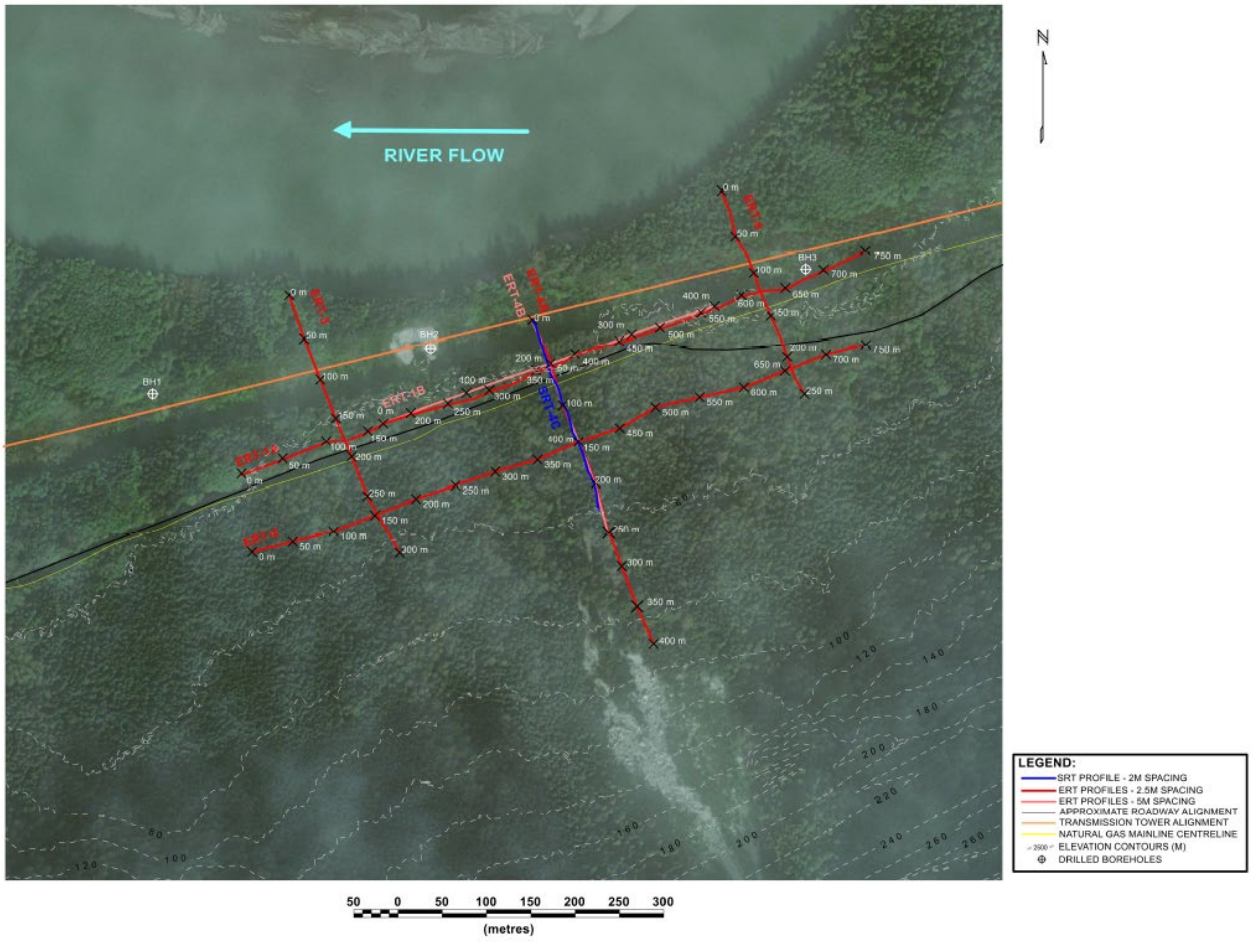

Figure 1: Map of collected survey lines, local infrastructure and drilled boreholes.

Method

Seven ERT lines and one SRT line were collected in the field, by three BGC personnel. The ERT survey measured the differences in electrical resistivity of the subsurface to distinguish the geological characteristics of the subsurface and riverbanks to help assess hazards and determine mitigation measures. Data were acquired with an ABEM Terameter LS System, by using an expanded gradient acquisition sequence, and a minimum electrode spacing of 2.5m. ERT data was then processed using RES2DINV tomographic inversion software to create a smooth subsurface pseudo section. Line locations were collected using a handheld Trimble GeoXH GPS unit and ground elevations were sampled from a bare earth elevation model based on client provided lidar acquired in 2018, to later be used in data processing.

The SRT survey was a secondary survey which primarily served to delineate bedrock for possible utility relocation. One 240 m profile was collected perpendicular to the riverbanks with a shot and geophone spacing of 8m and 2m, respectively. Geometrics Geode seismographs and 4.5 Hz

geophones were used for acquisition with a sledgehammer and plate used as a seismic source. Line locations and elevations were also sampled as previously described.

Shot gathers acquired were processed using the Rayfract tomographic inversion software to calculate a compressional wave (P-wave) model from first breaks picks. Additionally, a shear-wave (S-wave) velocity model was created by using multichannel analysis of surface waves (MASW). With this method being useful in supporting the evaluation of material properties, material boundaries and ground variations (Anbazhagan, P. and.Sitharam, T. G., 2006), interpreted results may aid in hazard recognition and site characterization.

Results and Conclusions

In survey lines parallel to the river, elevated resistivity values were predominantly observed south-west of the site, suggesting unsaturated coarse-grained material. Perpendicular lines collected west of the site showed higher resistivities near the river margins, while the eastern ones observed lower resistivities suggesting saturated coarse-grained material, which were validated by previously drilled boreholes. Seismic results successfully identified bedrock, predominantly in the north-west section perpendicular to the river, approximately 40 m below ground surface. Rough texture and small-scale lobed features, observed in lidar imagery along the upper slope, supported the ERT interpretations of colluvial or coarser grained material while smoother textures in the shallower slopes supported the evidence of relatively finer grained or fluvial material.

Site characteristics largely changed adjacent to the river due to previous construction and fill, however layer properties were still interpreted with ERT, SRT, MASW and provided borehole results. The survey was designed to not only deduce the geohazard effects correlated with bank erosion, but also take into consideration the high probability of reoccurring rockslides, debris flows, and other hazards associated with the slopes south of the site. This site investigation will aid site planners in construction to mitigate the hazards of the constantly migrating river and various geological hazards in the area.

References

Anbazhagan, P. and.Sitharam, T. G. (2006). Evaluation of dynamic properties and ground profiles using MASW: correlation between V_s and N_{60}. *13th Symposium on Earthquake Engineering*, Paper No. 008. Retrieved from https://www.koreascience.or.kr/article/CFKO200607841284282.pdf.