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Geophysics As a Tool for Pipeline Design in Challenging Terrain

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SUMMARY

Pipeline regulators are increasingly demanding more information from pipeline operators about ground conditions along proposed new pipeline routes. Pipelines are frequently routed through challenging and sensitive terrain. The two examples presented herein include watercourse crossings in mountainous terrain and alignments underlain by discontinuous permafrost. These areas require geotechnical investigations for pipeline design requirements; however, non-intrusive geophysics is a powerful and cost-effective tool that can be used to refine extensive drilling programs.
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Pipelines routed across large watercourses are commonly installed using horizontal directional drill (HDD) methods. HDD’s are favourable to operators as they limit environmental impacts, and the deep burial depths provide protection to the pipe. Understanding the geology of a watercourse is critical to planning the HDD path. Electrical resistivity tomography (ERT) and seismic refraction are useful tools for characterizing the sub-surface materials. However, conducting continuous ERT profiles of watercourse crossings in mountainous terrain is inherently difficult as the rivers can be boulder-bedded, difficult to access, and too swift to wade. As such, several innovative methods were developed for safely deploying and operating ERT cables for continuous profiles under these conditions.

Pipeline designers also need to determine if a proposed pipeline route is underlain by permafrost. Occurrences of permafrost within the discontinuous zone are difficult to identify using aerial imagery alone, and drilling in remote locations is expensive and provides limited information. Terrain conductivity mapping can be used over the proposed pipeline route to delineate zones of high apparent resistivity, providing a quick, real-time method of targeting areas of suspected permafrost for subsequent 2-D resistivity imaging surveys. Multichannel resistivity systems allow for rapid data collection for determining the thickness and lateral extent of the underlying permafrost. These identified permafrost occurrences can then be targeted for geotechnical drilling investigations.