Sensors & Software

GPR FOR KIMBERLITES

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Overview

Kimberlites are the primary host rock for diamonds. Most kimberlites are small vertical pipe-like rock features, The exploration challenges in diamond exploration are many but there are two critical steps. The first is locating a kimblerite feature while the second is evaluating its diamond potential.

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Problem

The exploration phase normally entails searching many square kilometers of geologically favourable areas for kimberlite zones that may be only a few hundred meters across. Tools include airborne and ground geophysical surveys and ground soil sampling for trace minerals. GPR, being a very high resolution method, is not usually used in the exploration phase.

Once located, the diamond bearing potential has to be evaluated. Since the grade of diamondiferous rocks is very low, typically 1 carat (200mg) carets per tonne, large samples (many tonnes of rock) must be extracted and processed to obtain representative assays.

In this assessment stage, bulk sampling requires detailed mapping of the near-surface geologic structure. The goal is enable extraction of sufficient and representative bulk samples with minimum engineering development. In many situations, the target geology may be deeply weathered or be under a lake, limiting access.

GPR Contribution to Solution

In favourable settings, GPR can image geologic structure to 10's of meters depth. An illustration of the power of GPR is shown with data acquired during the assessment phase of kimberlite discoveries in the NWT Canada.

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An example cross section of GPR data is show here; data were acquired with a 50 MHz pulseEKKO 100 GPR system operated in common offset reflection profiling mode. In general, 25 to 100 MHz center frequency GPR is most effect to address the scale of heterogeneity commonly present in the overburden.

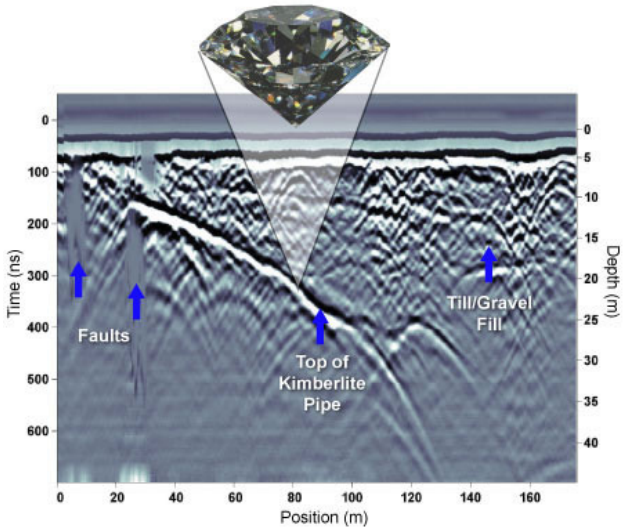
This example demonstrates many GPR responses. The top of kimberlite is clearly visible dipping from a depth of 14 to 44 m across the section. Two high attenuation zones suggest faults at the edge of the pipe.

Results & benefits

This case study demonstrates a common use of GPR. Many pre-engineering projects require a more detailed understanding of geologic structure than drilling can provide. Some key conclusions from this work are:

- GPR can deliver very high resolution images of geologic structure
- For remotes areas, GPRs are compact field portable instruments
- Operation is simple and intuitive and immediate feed back is available on-site in real time.
- Users can be effective with only a few hours of training
- While not illustrated here, rapid area coverage combined with GPS spatial positioning enable 3D visualization for site assessment - see an example of 3D visualization of fanset & foreset bedding from a prograding delta

GPR responses vary greatly depending on the target being sought and the host material. GPR response variability can be challenging to new GPR users. When learning about GPR, the best practice is to review several similar case studies to develop an understanding of variability. Check for other insightful information on the resources tab to learn more. Use Contact Us or Ask-the-Expert to reach our Application Specialists who can help you tap into Sensors & Software's vast array of technical information.



Annotated GPR cross section showing overburden structure and depth to the fresh kimberlite rock. The weathered kimberlite rock has been eroded by ice actions and a thick layer of glacial drift deposited over the pipe structure.

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