

Contract No.: B2532537

Technology: Crosshole/Borehole Radar

Contractor: Colorado School of Mines

Summary of technology:

The radar method uses the propagation of electromagnetic energy at radio frequencies (1 to 3,000 MHz) to determine characteristics of the ground. The equipment used consists of one hundred megahertz (100MHz) pulse-type transmitter and receiver antennas. The radar method transmits pulses of radio energy into the subsurface and receives the returning pulses that have been scattered (reflected, refracted or diffracted) from interfaces between materials with different electromagnetic properties. The system measures signal amplitude as a function of travel time. From the collected data, information on the electromagnetic velocity, attenuation, and dispersion of the materials may be determined. The distance to a reflector (e.g. void) can be determined if the rock between the borehole and the void has a known or measurable velocity.

For the crosshole method, the transmitter is positioned in one borehole while the receiver is positioned in another. For the borehole method, the transmitter and receiver are positioned in the same borehole and the system operates in a reflection mode. For these projects, a RAMAC/GPR control system from Mala GeoSciences was used. The data was digitally recorded on a laptop computer.

Stated limitations of technology:

The primary factor causing signal attenuation (and limiting the extent of investigation) is the electrical conductivity of the material through which the radar energy passes. Materials with higher conductivity cause higher rates of attenuation. Weathered rock may have increased conductivity (higher water content, more conductive minerals) and heterogeneity (which increases scattering). Other limitations include imprecise knowledge of the location of the holes and of the radar tools in the holes. Resolution is limited for objects smaller than 1/3 of a wavelength or if there is inadequate tomographic angular coverage.

Field demonstration results:

Field Demonstration Conditions	Goal of Demonstration	Results of Demonstration
Two boreholes located on a hillside and spaced 35 feet apart. A water-retaining bulkhead was constructed in the mine tunnel so that both air-filled and water-filled conditions could be tested.	Locate a 11 x 11-foot mine tunnel between the boreholes at an approximate depth of 206 feet (Since conducted from a borehole, the depth is limited only by hole depth and equipment).	The tunnel was detected with the borehole method, but the results (interpreted depth) were off by 10 feet. The crosshole method detected a void (tunnel) but the data quality was poor and the specific location of the tunnel could not be determined. See report for more details.