

# Borehole Geophysical Services

Cardno's borehole geophysical services provide a wealth of data for analysis of the subsurface conditions that impact your operations



Cardno's Geological Logging Systems (GLS) offer the latest technology and methodology to produce advanced three-dimensional data using borehole geophysics to provide you with the information needed to make sound technical and cost-effective decisions for your business. Our clients include leaders in the oil and gas industry, mining professionals, environmental and geotechnical firms, as well as municipalities.

With 40 years of experience, Cardno is an industry leader, providing fully digital, state-of-the-art equipment and consulting resources for specialized environmental, geotechnical, hydrogeologic, mining, and coalbed methane applications.

GLS personnel will determine logging suites best suited to each specific application. All of the suites are generated in fully digital form. Logs are monitored on the screen and prints are generated for immediate use. Data is simultaneously transferred to a

disk for storage and can be re-plotted at a later date or transcribed to an ASCII, CSV, or AutoCAD® drawing file (.DWG) format. Cardno operates a large fleet of fully-equipped geophysical logging units.

Geophysical logs provide continuous, in-situ data.

- > Oil & Gas - Within the oil and gas industry, GLS measures borehole deviations and provides downhole video to 5,000 feet. Gyros measure the orientation of wells to avoid crossover with other wells or locate intersections with mine workings or targets. GLS reporting also provides lithologic identification of materials found in boreholes for strategic decision making.
- > Mining - In the mining industry, borehole geophysical services provides valuable data across the full mining lifecycle, from exploration to mine closure. GLS generates information that can enhance profitability,

improve safety, and reduce environmental impact.

- > Groundwater - GLS is an effective method for determining ground-water quantity and quality. Integration of borehole-geophysical logging with water-quality sampling provides a complete picture, whether the objective is to develop a water-supply well or remediate a contaminated aquifer.
- > Hydrogeology - Various logs provide detail of the character and thickness of different hydrogeologic units penetrated by wells and test holes. This information is essential for proper placement of casing and screens in water-supply wells and for characterizing and remediating ground-water contamination.



### **Cardno's GLS capabilities:**

- > Acoustic Televiwer
- > Borehole Deviation (Gyroscopic and magnetically oriented available)
- > Borehole Video Cameras
- > Caliper
- > EM Flowmeter
- > Fluid Conductivity
- > Fluid Temperature
- > Gamma-Gamma Density (High Resolution or Compensated)
- > Induction
- > Natural Gamma Ray
- > Neutron
- > Full Waveform Sonic, CBL - Cement Bond
- > Fluid Sampler
- > Various Resistivity Logs

### **Case Study: Groundwater Contaminants**

The site had multiple ground water contaminants including dissolved metals, LNAPL and DNAPL phase liquids in a complex fractured bedrock aquifer setting. Goals of the project were to identify both shallow and deep ground water flow pathways which are dependent on fracture orientations and ground water gradients. The borehole geophysics consisted of a comprehensive suite of logs, including acoustic televiwer, electromagnetic flowmeter, temperature, delta temperature, fluid conductivity, formation resistivity, downhole video, and caliper. This suite of logs provided the information needed to identify ground water flow path directions and vertical gradients, allowing the

modeling of migration pathways of the various phases of dissolved contaminants. This information was critical in order to plan groundwater remediation at the site.

### **Case Study: Mining Site - Shaft and Slope Development**

A geotechnical and hydrogeologic investigation was performed for development of a combination vertical shaft and slope entry into a large underground mine. Goals of the project were to identify rock mass characteristics as well as specific fracture locations, joint set orientations, water in-flow zones, and hydrologic parameters of the rock mass at the site. Borehole geophysics was performed in a series of holes at the site to quantify these parameters.

### **Cardno Safety – Zero Harm**

Cardno is committed to a rigorous approach to safety in all our operations through our program, Cardno Zero Harm – Every Job. Every Day. This means conducting our business in a way that protects our people, clients and members of the public from harm, and promotes our commitment to environmental responsibility. We are committed to achieving our 'Zero Harm' goal by continually improving our safety systems and vigilance at our workplaces through strong leadership, employee participation and practical action. Our safety standards for density and neutron logging exceed those required by the Nuclear Regulatory Commission.

Cardno began offering borehole geophysical services in the mid '70s as the US mining industry and oil and gas exploration demanded more comprehensive information.

"Cardno has supported AE Drilling successfully for a number of years on a complex Superfund site in North Carolina, which involved extremely difficult scheduling...Cardno has an unblemished record of arriving at our sites on time with fine equipment and professional staff."

Mark Lassiter, President  
AE Drilling Services, LLC

Cardno is a professional infrastructure and environmental services company, with specialist expertise in the development and improvement of physical and social infrastructure for communities around the world. Cardno's team includes leading professionals who plan, design, manage and deliver sustainable projects and community programs. Cardno is an international company listed on the Australian Securities Exchange [ASX:CDD]