Sandia National Laboratories

Environmental Program

Environmental Measurement-While-Drilling System for Real-Time Screening of Contaminants

Technology Need

Information on environmental conditions and drill bit location and temperature during drilling is required in many environmental restoration operations. An inexpensive data collection system for identifying and tracking contaminant concentrations and monitoring drill bit conditions is needed for many waste site operations.

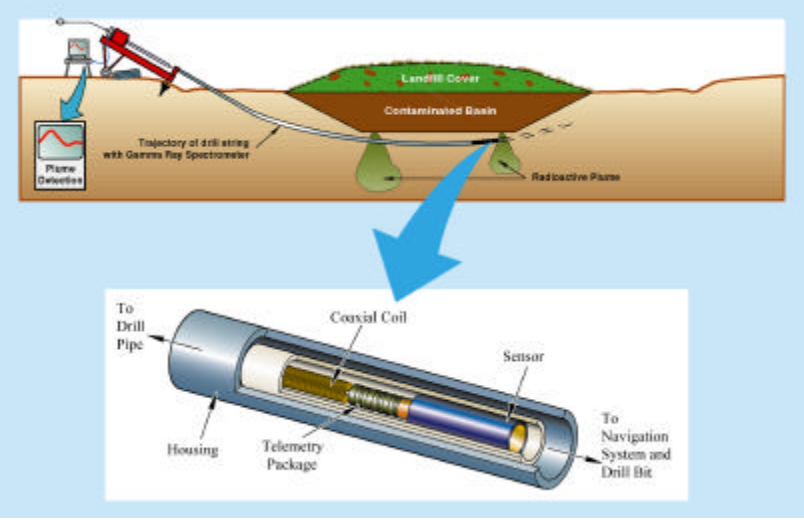
Objective

The Environmental Measurement-While-Drilling (EMWD) System represents an innovative blending of new and existing technology in order to obtain real-time data during drilling. The objective of this project is to distinguish contaminated from non-contaminated areas in real time while drilling at hazardous waste sites.

Project Description

In EMWD, downhole sensors are located behind the drill bit and linked by a high-speed data transmission system to a computer at the surface. As drilling is conducted, data is collected on the nature and extent of contamination, enabling on-the-spot decisions regarding drilling and sampling strategies. The EMWD system has been adapted by the integration of a Gamma Ray Spectrometer (GRS) in place of the original simple gamma radiation detector. The GRS consists of a sodium iodide-thallium activated crystal coupled to a photomultiplier tube (PMT). The GRS output feeds to a multichannel analyzer (MCA). The MCA data, as a 256 channel gamma spectrum (100 KeV-1.6 MeV), is transmitted to the surface via a signal conditioning and transmitter board. The system also monitors the up-hole battery voltage as measured downhole, and the temperatures associated with the detector and instrumentation. The design includes data assurance techniques to increase safety by reducing the probability of giving a safe indication when an unsafe condition exists.

The system provides real-time data on an eight differential/single analog multiplexer and any number of digital channels. Sampling speed from the analog channels can reach 100kHz. The telemetry system is firmware programmable to easily support many different data formats and additional data channels. The data transmission format (Digital FM Bi-phase, 4800 baud) provides excellent noise rejection for jumping the wireless connection between the rotating drill pipe and the stationary receiver. A Sandia-designed receiver removes the FM carrier, generates the data clock, and buffers data to be used by an IBM or compatible personal computer. A 28V rechargeable battery pack can supply



downhole instrumentation power for more than 18 hours of drilling. The battery pack remains topside for easy maintenance and / or recharging.

The system is compatible with directional drilling techniques that use minimal drilling fluids and generate little-to-no secondary waste. The current system includes a continuous read-out-non-walk-over guidance and location system for use with the EMWD system. The orientation sensor package was integrated with the EMWD-GRS system without significant modification. In addition, sensors are needed for the detection of heavy metals, volatile organic compounds, and natural gas. Technology developers are currently working with the EPA to obtain certification.

Preliminary field tests were successfully completed at the radioactive calibration facility in Grants, New Mexico, at Sandia, and at the Charles Machine Works, Inc. (CMW) directional boring test site. The EMWD Gamma Ray Spectrometer (EMWDGRS) system was field demonstrated at Westinghouse Savannah River Site F-Area Retention Basin in April 1996. The "Hot Site" demonstration continuously monitored for gamma activity in real time while drilling two boreholes. Contaminant levels of Cs-137 recorded by EMWD-GRS during drilling agree with contaminant levels previously determined through quantitative laboratory analysis of soil samples. In addition, previously unidentified gamma radiation "hot spots" were identified. The extremely successful demonstration resulted in no radiation contaminated equipment or waste. The EMWD-GRS with orientation sensor package was tested in a cold site demonstration. No problems were encountered recording the orientation sensor data along with the gamma spectrometer data. Preliminary results from this test are encouraging.

The EMWD system has many applications, including site characterization for contaminant detection and delineation. This will guide sampling activities and borehole emplacement options (i.e., a drill operator can back out of contaminated soils and redirect a drilling operation around the contamination). Other potential users of EMWD include utility emplacement and petroleum industries.

Advantages

There are time, cost, and safety advantages to using the field screening approach of the EMWD system: (1) data on the nature of contamination will be available in minutes, as opposed to weeks or months from an off-site laboratory; (2) field screening while drilling can reduce the number of costly drilling operations; (3) substantial cost savings will result by minimizing the number of samples required for off-site confirmatory analyses; (4) worker safety will be enhanced as a result of minimizing waste generation and by quickly alerting field personnel to potentially hazardous conditions; and (5) contamination can be mapped with no site disturbance.

Costs

This project has developed a prototype system that costs less than $20,000, not including research and development cost. Operations and maintenance costs are likely to be low, while reoccurring costs will be limited to replacement of an inexpensive spool of coaxial wire for each drilling operation.

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