Analysis of Borehole-Radar Reflection Logs From Selected HC Boreholes at the Project Shoal Area, Churchill County, Nevada

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ABSTRACT

Single-hole borehole-radar reflection logs were collected and interpreted in support of a study to characterize ground-water flow and transport at the Project Shoal Area (PSA) in Churchill County, Nevada. Radar logging was conducted in six boreholes using 60-MHz omni-directional electric-dipole antennas and a 60-MHz magnetic-dipole directional receiving antenna.

Radar data from five boreholes were interpreted to identify the location, orientation, estimated length, and spatial continuity of planar reflectors present in the logs. The overall quality of the radar data is marginal and ranges from very poor to good. Twenty-seven reflectors were interpreted from the directional radar reflection logs. Although the range of orientation interpreted for the reflectors is large, a significant number of reflectors strike northeast-southwest and east-west to slightly northwest-southeast. Reflectors are moderate to steeply dipping and reflector length ranged from less than 7 m to more than 133 m.

Qualitative scores were assigned to each reflector to provide a sense of the spatial continuity of the reflector and the characteristics of the field data relative to an ideal planar reflector (orientation score). The overall orientation scores are low, which reflects the general data quality, but also indicates that the properties of most reflectors depart from the ideal planar case. The low scores are consistent with reflections from fracture zones that contain numerous, closely spaced, sub-parallel fractures.

Interpretation of borehole-radar direct-wave velocity and amplitude logs identified several characteristics of the logged boreholes: (1) low-velocity zones correlate with decreased direct-wave amplitude, indicating the presence of fracture zones; (2) direct-wave amplitude increases with depth in three of the boreholes, suggesting an increase in electrical resistivity with depth resulting from changes in mineral assemblage or from a decrease in the specific conductance of ground water; and (3) an increase in primary or secondary porosity and an associated change in mineral assemblage, or decrease in ground water specific conductance, was characterized in two of the boreholes below 300 m.

The results of the radar reflection logging indicate that even where data quality is marginal, borehole-radar reflection logging can provide useful information for ground-water characterization studies in fractured rock and insights into the nature and extent of fractures and fracture zones in and near boreholes.