A Comparison of Electrical Methods for Detection of Hydraulic Pathways in a Fractured Rock Aquifer, Clare Valley, South Australia

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Abstract

Within fractured rock, the irregular and often unpredictable distribution and geometry of hydraulically conductive fractures produces large spatial variations in bore yield and groundwater quality. As fractures act as conduits for flow of both groundwater and electrical charge, methods that can efficiently detect the distribution of electrical pathways can be used to infer characteristics of significant hydrological parameters. This study compares the capabilities and limitations of electrical data obtained from direct current (DC) and electromagnetic (EM) surface azimuthal measurements, and from DC borehole-to-surface and cross-borehole measurements, for the interpretation of major hydrological structures.

Data obtained from surface methods, while limited by poor depth sensitivity and overburden provides a useful tool for determining variations in directional conductivity at sites free of bedrock exposure and boreholes. Application of borehole-to-surface methods yielded a better resolved interpretation of sub-vertical fracture strike and was useful in identifying lateral variations in bedrock heterogeneity. Improved flexibility and sensitivity to measurements at depth permitted cross-borehole electrical tomography data to be used in accurately reconstructing the spatial distribution of sub-horizontal, laterally extensive, electrically conductive zones. While the technique was restricted to sites with multiple boreholes, the data obtained was used to constrain specific flow paths over a regional scale.