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Evaluation of permeable fractures in rock aquifers

Hang Bok Lee

Underground Space Department, Korea Institute of Geosciences and Mineral Resources, Daejeon 305-350, Republic of Korea (leehb@kigam.re.kr)

In this study, the practical usefulness and fundamental applicability of a self-potential (SP) method for identifying the permeable fractures were evaluated by a comparison of SP methods with other geophysical logging methods and hydraulic tests. At a 10 m-shallow borehole in the study site, the candidates of permeable fractures crossing the borehole were first determined by conventional geophysical methods such as an acoustic borehole televiwer, temperature, electrical conductivity and gamma-gamma loggings, which was compared to the analysis by the SP method. Constant pressure injection and recovery tests were conducted for verification of the hydraulic properties of the fractures identified by various logging methods. The acoustic borehole televiwer and gamma-gamma loggings detected the open space or weathering zone within the borehole, but they cannot prove the possibility of a groundwater flow through the detected fractures. The temperature and electrical conductivity loggings had limitations to detect the fractured zones where groundwater in the borehole flows out to the surrounding rock aquifers. Comparison of results from different methods showed that there is a best correlation between the distribution of hydraulic conductivity and the variation of the SP signals, and the SP logging can estimate accurately the hydraulic activity as well as the location of permeable fractures. Based on the results, the SP method is recommended for determining the hydraulically-active fractures rather than other conventional geophysical loggings. This self-potential method can be effectively applied in the initial stage of a site investigation which selects the optimal location and evaluates the hydrogeological property of fractures in target sites for the underground structure including the geothermal reservoir and radioactive waste disposal.