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Integrating geophysical well logs, long-term monitoring, and hydrogeochemical data to characterize saltwater intrusion of fractured rock on Yeonggwang-gun, Korea

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A combination of geophysical well logging, long-term monitoring, hydrogeochemical survey was performed to evaluate saltwater intrusion of fractured rock on Yeonggwang-gun, Korea. The central survey area comprises a paddy and dry field mainly. The survey area is about 24 km^2 (i.e., 8$\times$3 km). Twenty-nine boreholes were also drilled to collect hydrogeologic, geochemical, and geophysical logging data within saltwater and brackish water area interpreted with surface geophysical and hydrogeochemical survey. The geologic structure from drilling shows a mud layer from surface to 10-15m, a sand layer to 23-25m, and a bedrock layer comprising granite below 23-25m approximately. Hydrogeochemical parameters such as Cl^-/Na^+, $Cl^-/\sum$anion, $Na^+/(Na^++Cl^-)$, Cl^-/Br^-,Ca^{2+}/Na^+ and isotopes techniques as such δD, δ^{18}O, δ^{13}C, δ^{34}S were used to identify sources of salts in saline groundwater. The results revealed that salinity of saline groundwater is caused by the concentration of dissolved salts by seawater intrusion. Long-term monitoring of groundwater level and electrical conductivity during about 145 day period from May 8 till September 30, 2006 was conducted in six boreholes and two stream. Results from spectrum analysis of borehole data showed that groundwater level and electrical conductivity fluctuations within six boreholes coincided with the principal lunar-tidal component corresponding to M_2 (12.421 hours) of tide. These results indicated that groundwater level and electrical conductivity within six boreholes are affected by tidal movement. However the water level fluctuation of two streams didn't show correlation with ground level

of six boreholes. Amplitudes of M_2 components in six boreholes increased according to depth of drilling. These results indicated that groundwater level and electrical conductivity fluctuation are more strongly affected by tidal movement through fractured rock. Finally, fluid replacement conductivity logging and heat-pulse flowmeter logs have been applied to five and two boreholes, respectively. Fluid replacement conductivity logging has been applied to identify permeable fractures and the inflow zones of saline groundwater. As a result of fluid conductivity logging for five boreholes, it is interpreted that the saltwater intrusion in this area is not by remnant saline groundwater after land reclamation but mainly by intrusion of saline water through fractured rock. In order to evaluate the permeable fractures and transmissivities of each permeable fracture, single borehole heat-pulse flowmeter test was conducted in two boreholes. Five permeable fractures are detected and transmissivities of each permeable fracture are estimated using inversion method. To identify the hydraulic connectivity between cross-boreholes, flowmeter test also was performed during quasi-steady state pumping at each borehole. These results indicate that there are many flow paths with different salinity and depth through fractured rocks connected with seaside. Our multidisciplinary approach with different scale and technology can be considered as a valuable attempt to enhancing the reliability for evaluating saltwater intrusion through fractured rock.