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# Using Geophysical Well Logging and Borehole Temperature Monitoring to Understand Seawater Intrusion in a Heterogeneous Basalt Aquifer in Jeju Volcanic Island, Korea

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As part of an effort to characterize coastal aquifers, geophysical well logging and borehole temperature monitoring were applied systematically to the eastern coast of Jeju Island, Korea. With the temporal variation of groundwater level, electrical conductivity, and temperature measured by automatic equipment at seawater intrusion monitoring wells, a relationship between tide fluctuations and the measured parameters was constructed. It was found that the correlation tended to weaken with increasing distance from the coastline. Geophysical well logging, especially electrical conductivity and temperature logs, determined spatial variations in the distributions of fresh water and salt water. The standard for defining the fresh water and salt water was followed by the relationship between the groundwater electrical conductivity and total dissolved solids from the hydrochemical analysis of groundwater samples. The vertical profiles of electrical conductivity represented patterns typical of a freshwater-saltwater interface depending on the degree of seawater intrusion and aquifer properties. A sudden decrease of electrical conductivity was observed at the bottom depth of borehole, which is thought to be part of the saltwater zone. Borehole temperature monitoring using thermal line sensor enabled us to characterize the variability of coastal aquifers at a high temporal and spatial resolution, and furthermore, heterogeneous aquifer systems and the behavior of fresh water and salt water could be estimated. The absolute values of temperature at the tide cycle clearly demonstrated the influences of tidal fluctuations on vertically heterogeneous coastal aquifers. It was verified that the fresh water and salt water moved alternately in opposite directions of tidal fluctuations through main aquifers. Based on interpretation of the geophysical well logging and borehole temperature monitoring data, a conceptual model of seawater intrusion was proposed as an alternative model to replace the traditional conceptual model in the eastern part of Jeju Island. Coastal aquifers flow through two or more independent channels with weak vertical connections. Freshwater-saltwater interfaces and main aquifers primarily formed the geological boundaries, implying that the coastal aquifers flow through the boundary between each volcanic formation. Consequently, geophysical well logging and borehole temperature monitoring could enhance knowledge of the subsurface structure of basalt and interactions of fresh water and salt water in coastal areas. This approach is expected to increase our understanding of and ability to manage groundwater systems of a volcanic island.