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Temporal Variation of Saltwater/Freshwater Interface in the Coastal Aquifer, Mangsang, Korea

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ABSTRACT

Groundwater hydrologists have been primarily concerned with identifying and maintaining potable groundwater reserves. At the shoreline the main attention was the identification of the saltwater/freshwater interface in the coastal aquifer. The classic Ghyben-Herzberg relationship based on gravitational balance had been widely used in many practical applications even though it represents an unrealistic, hydrostatic situation. To describe a truly dynamic equilibrium, the concept of an outflow gap has been introduced and calculated by Potential theory and the Glover solution. But actually saltwater and freshwater take the form of transition zone rather than sharp interface, and the saline groundwater is also not stationary. Recent numerical models can treat saline groundwater as hydrodynamic continuum, but there is a serious lack of data to calibrate and verify models. Particularly the investigations about the variations by the change of natural conditions such as tide, rainfall, land wind had been rarely performed. Therefore the purposes of this research are to observe and interpret the actual presence of saltwater/freshwater interface and investigate its temporal variation by the change of natural conditions in the coastal aquifer.

The study site is located at the beach of Mangsang in the western side of East Sea. The aquifer is composed of beach sand and fractured rocks. The sand layer has the depth of about 15 m, and hydraulic conductivities range from 1×10^{-1} cm/sec to 5×10^{-3} cm/sec. The fractured rock has the hydraulic conductivity about 10^{-5} cm/sec to 10^{-6} cm/sec. The monitoring wells have the screen intervals individually of 2~15 m and 15~30 m deep from land surface. The main investigation had been performed at the well installed in shallow sandy layer.

The electrical conductivity (EC), temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP) had been directly measured in wells. Figure 1 shows some results of EC and temperature measurements. EC profiles of May and

December indicate that the saltwater/ freshwater interface exists about 8 m below land surface. EC profile of September shows that upper parts had been influenced by seawater flooding during summer storm and lower part had been influenced by large amount of fresh groundwater discharge. The temperature profiles roughly indicate the features of fresh water discharge zone.

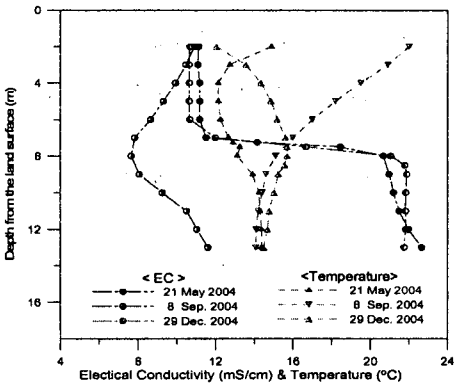

Fig 1. Vertical profile of EC and temperature

Continuous data of EC, water level, tide level, precipitation, temperature, air pressure have been acquired at study site. Figure 2 shows part of results. In the no-rain period, tide level is the major factor of the changes in monitoring data. But rain events have intensively influenced on the water level and EC values. EC values at 7.5 m depth became lower by rain event, but those at 11 m depth were contrast. It could mean that transition zone (interface) became thinner. While strong storm converted this situation, EC values at 11 m depth dramatically became lower. It means the vertical descent of saltwater /freshwater interface.

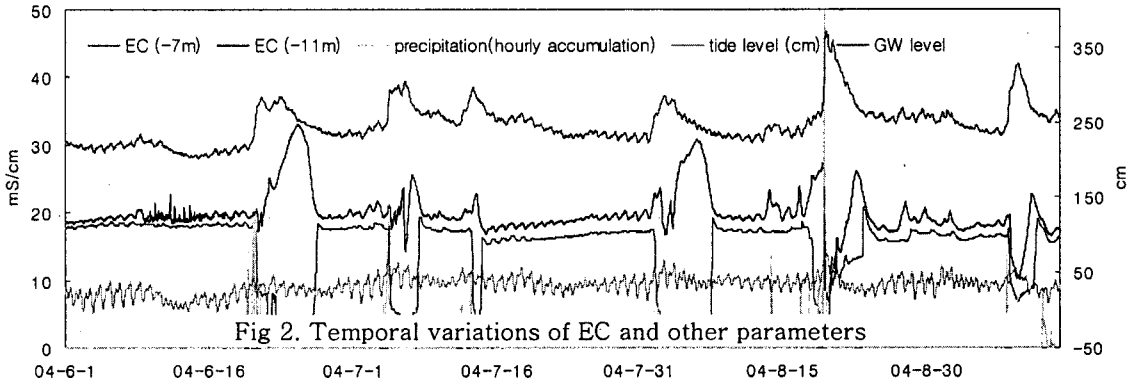

Fig 2. Temporal variations of EC and other parameters

For the comparative interpretation between collected data, correlation analysis and spectrum analysis had been performed. With the results of cross-correlation during the no-rain period, the tide level was positively correlated with the water level and negatively correlated with the EC. Cross-correlation results using whole data shows that rainfall influence on the water level with about 20 h lag time. Rainfall, the water level and tide level show negative correlation with EC at 7.5m depth, but poor correlation with EC at 11m depth.

Key words: saltwater/freshwater interface, coastal aquifer, electrical conductivity

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