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Modeling of Bio-Chemical Reducing Process of Salt Groundwater in a Coastal Aquifer

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ABSTRACT

The prediction of major cation chemical evolution during groundwater flow in coastal aquifers is an important consideration in the assessment of changes in water quality during contaminant migration. The chemical evolution of groundwater depends on the physical, chemical and bio-chemical processes and the effects of these processes must be represented in a quantitative manner in order to make accurate prediction of contaminant migration. In coastal aquifers where the relationship between seawater and freshwater is complex, cation exchange reactions and biochemical reducing processes must be incorporated to the mass transport models to predict changes in groundwater chemistry during the flow as these major processes contribute significantly to the final composition of groundwater.

Bio-chemical reducing processes in coastal aquifers have been recognized as an important factor in the mechanisms of chemical species in salt groundwater. Salt groundwater infiltrating into the deep subsurface environment will generally become more reduced due to consumption of oxygen through reactions with organic matter, iron and sulfides contained in soils. When reduced salt groundwater meets the fresh oxidized groundwater at the mixing region of the aquifer, iron and manganese precipitate. The precipitated iron and manganese are harmful to osmosis and create problems to desalination plants. Therefore, it is important to study the geochemical characteristics of salt groundwater in a reduced condition with consideration of oxidation and reduction reactions and biochemical reactions.

Bacteria play a major role in the chemical and biological redox reactions therefore there is a possibility that microbial activity influences the geochemical condition of subsurface environment. The implications are particularly important in connection with performance assessments for repositories of high-level radioactive wastes. There is a growing recognition of the role that biotic factors could play in these repositories, either directly though microbially induced corrosion or indirectly by altering the chemical environment or contributing to the transport of radionuclides. Groundwater becomes strongly reducing deep underground. Reducing conditions contribute to low solubility of radionuclide materials thus limiting the amounts that can be transported by groundwater. It is therefore necessary to study the biochemical reducing conditions in the subsurface to fully understand the chemical and ecological effects of these repositories in the ocean floor.

In this study a solute transport model that considers the biochemical reaction and cation exchange reactions was developed in order to simulate the important chemical and biological reaction processes in a salt groundwater aquifer. A soil column experiment was conducted in order to validate the solute transport model. The results of the experiment were compared with the results of the simulation model.

Key words: cation exchange reactions, biochemical reactions, iron and manganese precipitation

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