Numerical simulation for the long-term evolution of freshwater-seawater interface

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For the evaluation of the long-term safety of the geological disposal of radioactive waste, a critical factor is the long-term stability of deep geological environments for time periods over several hundred thousand years.

A preliminary transient simulation has been carried out using an advection-dispersion model in order to assess the effects of climatic and sea-level changes on the long-term evolution of groundwater flow systems and the distribution of salinity concentration. Larger scale 3D geological models from inland to coastal area in Japan have been developed on the basis of geomophological data, the nation-wide geological maps covering both terrestrial and marine areas of Japan. Regional scale 2D hydrogeological models incorporating the spatial distribution of hydraulic properties, such as hydraulic conductivity, focusing on the coastal area also have been developed. These hydrogeological models have been discretised into numerical flow models comprising of seventeen hydrogeological units derived from the 3D geological structural models. The transient simulations taking into account sea-level changes and uplift have been carried out by using the GETFLOWS numerical code. The simulation period extends from the present to about 300,000 years into the future and considers three global climatic cycles.

The results of the simulations show that the groundwater chemistry periodically changes corresponding to the sea-level changes. However this period is not constant and varies depending on the gradient of seabed. Much shorter periods are seen in the coastal areas where sea with shoals exists compared to the ones with a steep seabed. The results also show that the trasition speed and shape of the seawater-freshwater interface depends on the spatial distribution of the hydrogeological structures and hydraulic properties, which determine the groundwater velocity. Of great importance to note here is to cary out 3D and long-term simulations taking acount of climatic cycles when the geological environments have greater hydrogeological heterogeneity.