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Subsurface vertical temperature profile and estimated deep groundwater flow in the coastal zone at Horonobe area

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Groundwater flow in coastal regions is greatly affected by changes in the shapes of saltwater/freshwater interfaces. Saltwater/freshwater interfaces can be broadly classified into two types (Marui and Yasuhara, 1999). The interface is frequently located in the offshore region owing to the influence of the hydraulic potential. Fresh groundwater discharges along this interface have been identified locally and globally as submarine groundwater discharges (eg., Church, 1996). In addition, fresh groundwater is expected to be present under the seabed; this store of fresh groundwater is attributed to the evolution of the groundwater flow system with long-term sea-level changes (e.g., Groen et al., 2000). Formation process in these cases is considered to be as follows. During the glacial state, e.g., Last Glacial Maximum, the seabed surface was exposed, and fresh groundwater flow systems were widely developed. Subsequently, with the rapid rise in sea level, low-permeability mud was deposited, and resulted in the suppression of seawater intrusion; thus, fresh groundwater was retained under the seabed.

In the study area located in the coastal zone at Horonobe, northern Hokkaido, deep drilling and geophysical exploration surveys have been carried out. The results revealed the continuous distribution of fresh groundwater from land to the offshore region (Marui et al., 2011). Distribution of this fresh groundwater extends up to 5 km offshore to a maximum depth of 200?300m. However, site data on groundwater flow were unavailable, and the formation processes of the groundwater environment were unclear. Hence, we investigated the subsurface temperature at the borehole DD-1 (depth: 1,004 m). Further, the deep groundwater flow scenario was evaluated on the basis of the subsurface vertical temperature profile.

Deep groundwater flow was divided into an upper active and a lower slow sections by a boundary at a depth of 275 m. The groundwater flow rate in the lower section was very low, to the extent that it could not be determined on the subsurface temperature. Pore-water chemistry varies greatly at the boundary at a depth of 500 m; fresh groundwater with different residence times are estimated to exist above the depth of 500 m (Machida et al., 2011). It is possible that the fresh groundwater below the depth of 275 m had accumulated in the past and stagnated because the groundwater flow estimated on the subsurface temperature reflects the present groundwater flow situation. Therefore, it is suggested that the groundwater environment at the study site strongly reflects not only the present groundwater flow situation but also the hydrogeological history concurrent with the long-term sea level changes. In addition, since sea-level change is a global geographical phenomenon, regions with similar hydrogeological features commonly have possibilities of similar groundwater environments.

Reference

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