

Hydrological environment in the Sendai Plain

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The latest study of groundwater flow system has been applied not only groundwater quality but also environmental isotope as tracer, such as H, D(2H), T(3H), 16O, and 18O. There are many reports that subsurface temperature distribution is distorted by thermal transport due to groundwater flow, and some studies using this thermal distortion to analyze groundwater flow. Each tracer applied hydrological survey has specific information about groundwater flow, therefore, there is a limit to understand regional groundwater flow system using single tracer. It is necessary to establish multi tracer method using combinatorial tracer and gain information of recharge area, flow path and residence time with a high degree of accuracy to make clear the regional groundwater flow system. The purpose of this study is to understand groundwater flow system multiple using hydraulic potential, distribution of subsurface temperature, groundwater chemical composition and stable isotope.

Sendai Plain, Northeast Japan, extends about 40 km north-south along the Pacific coast of Honshu with a width of 10 km bounded by a mountain region (elevation 1,000 to 1,500 m) in the west. On the east side of the mountain region is an area with steep hills (elevation 50 to 300 m) followed by low land area forming the plain. Many tributaries of Nanakita, Natori, and Abukma Rivers emerge from the peripheral mountain regions, and flow toward the sea. Sendai Plain is an alluvial coastal plain, and basement of the Quaternary system, which is main aquifer, is shallow compared with other plains such as the Kanto Plain around Tokyo Metropolitan area or the Nobi Plain around Nagoya City. Thickness of the Quaternary system in the Kanto Plain, for example, is more than 2,000 m, while maximum thickness of Quaternary system in the Sendai Plain is only 80 m. A large amount of groundwater was used for industry causing land subsidence in inland area and salinisation in bay area. When control of withdrawal began, heads recovered and subsidence was gradually reduced.

There are more than 20 observation sites in the area and those are used for monitoring groundwater levels and land subsidence. We measured temperature-depth profiles of 16 observation wells using digital thermister at 2 m intervals with a precision of 0.01 degree centigrade. Groundwater, spring water and river water were collected at 63 for common chemical compositions and stable isotopes (delta D and delta 18O).

Many temperature-depth profiles in the Sendai Plain have departure from steady state. Since groundwater chemical compositions and variations of stable isotope indicate that groundwater flow system in the Quaternary system is different from that in the Tertiary system, change of thermal gradient at the boundary between the Quaternary and Tertiary systems is likely to have caused by difference of groundwater movement. Subsurface temperature is constant at 14 degree centigrade in the Quaternary system and thermal gradient is very low. Analyzed chemical compositions and isotope variations suggest that groundwater flow system in the Quaternary system is local and downward flux due to recharge is dominant. Therefore, it seems that downward heat transport from surface constricts upward terrestrial heat flow. In the Tertiary system, on the other hand, groundwater flow system is regional and upward terrestrial heat flow is dominant factor in subsurface thermal regime.