Geosphere Stability Project (5) Estimation of Groundwater Recharge Rate in Consideration of long-term Changes in Surface Hydrological Environment

*Ryuji Takeuchi[1], HIRONORI ONOE[1], Ken-ichi Yasue[1]

1.Japan Atomic Energy Agency

In geological disposal for high-level radioactive waste, a time scale for assessment of long-term stabilities of geological environments is more than several hundreds of thousand years. In the time scale, surface hydrological environment changes by climate changes and by landform changes (e.g. uplift, erosion). Especially, groundwater recharge rate (GRR), which plays upper boundary condition of groundwater flow for deep underground, changes by precipitation, evapotranspiration and runoff-volume. Thus, it is important to estimate GRR in consideration of change of surface hydrological environment. This study shows the estimation method of GRR in consideration of climatic changes and landform changes.

GRR can be estimated by the water-balance method. In the method, estimations of precipitation, evapotranspiration and runoff volume are needed. As a result of observation data based on the previous studies, it has been confirmed that precipitation and evapotranspiration show a positive correlation with temperature. Thus, precipitation and evapotranspiration are calculated by the correlation equation of temperature.

For runoff volume, a method to calculate Runoff-Ratio (RR), which is a ratio of runoff volume against precipitation, is applied. RR is calculated by runoff volume, precipitation and Runoff-Index (RI) decided by landform characteristics.

To confirm the applicability of this method, GRR under the paleo surface hydrogeological condition is estimated in the Toki-River basin. The basin is located on the southern part of Central Japan. The basin is also located on the small undulating mountainous or hilly areas in the relatively low elevation field. The area of the basin is about 340 km^2.

The climate of last 0.3 Ma in the study area has been estimated by Sasaki et al (2006). As a result, the temperature difference in the interglacial period and glacial period is approximately 8-10 degrees Celsius. Based on this result, the temperatures of the interglacial period and the glacial period are calculated.

The precipitation and evapotranspiration are estimated by the correlation equation of estimated temperature. The equation for precipitation is decided by the data measured in the Pacific coast of Japan, North Asian, North Europe and North America. The equation for evapotranspiration is decided by the data obtained at high latitude area including this study area.

For runoff volume, at first, the RI which is common to "the current landform and the paleo landform" is calculated. Next, the correlation equation between RI and RR under the current surface conditions are decided. Finally the runoff volume is calculated by the correlation equation using the paleo surface condition.

In the estimation results, the GRR of 0.45 Ma are estimated to be 118% to 237% and the GRR of 0.14 Ma are estimated to be 81% to 196% against the current GRR (118mm/year). In the result of current landform in the glacial period, the GRR is estimated to be 58% to 72%.

Under the glacial periods in the paleo surface environmental conditions, precipitation and runoff volume are estimated to be smaller than the current them. However the GRR under the paleo conditions is larger than the current GRR. This result shows a possibility that the change of runoff volume caused by the change of landform gives a large influence on the change of GRR.

On the other hand, the runoff volume based on the landform of 1.0 Ma couldn’t be estimated. It might cause that the estimated landform is poor undulations and flat terrains. The future issues

are an improvement of the runoff estimation method and a confirmation of applicability of the method to poor undulation of landform.

This study is carried out under a contract with METI (Ministry of Economy, Trade and Industry) as part of its R&D supporting program for developing geological disposal technology.

Keywords: High-level radioactive waste, Geological disposal, Groundwater recharge rate, Change of climate in long-term, Change of landform in long-term

