Geosphere Stability Project
(2) Development of Geological-Evolutionary Model in the Horonobe area

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Introduction

Geosphere stability project is being carried out by Japan Atomic Energy Agency (JAEA) in order to establish techniques for investigation, analysis and assessment of the long-term stability of geological environments, taking into account long-term geological phenomena such as volcanism, faulting, uplift, denudation, subsidence, climate change, sea-level change.

In this study, FEP (Features, Events and Processes) analysis and scenario development for geological-evolutionary modeling of mountain area and plain area have been carried out. Paleo-hydrogeological models were constructed in consideration for long-term geological environment such as topographic and climatic change, and spatial distribution of long-term stability of groundwater flow conditions were numerically assessed.

This paper summarizes the current status of R&D activities with development of geological-evolutionary model in the Horonobe area, northern Hokkaido Japan.

Overview of R&D progress

This study has been carried out in the area of approx. 90 km (east-west) and 30 km (north-south) including outer shelf, plain and hill taking into account sea-level changes and the development of land area. Two stages, approx. 1Ma and 0.33Ma were selected for paleo-geological modeling based on geological history of several millions of years in and around the study area. 3D steady-state groundwater flow simulations and sensitivity analysis using these models were carried out focused on topographic change, climate change (recharge rate and sea-level change), conductivity of faults and strata, and the formation of discontinuous permafrost.

In this study, long-term evolution of groundwater flow conditions caused by long-term geological phenomena was assessed using statistical analysis based on the result of sensitivity analysis. From the results of statistical analysis, the spatial distribution of long-term stability of groundwater flow conditions was estimated and then important factors for assessment of long-term evolution of groundwater flow conditions in the study area were extracted. In addition, the results of groundwater flow simulation were analyzed from the viewpoint of geochemical environment within the groundwater. Results of this study are summarized as follows;

- Practical approach of plain area for the restoration of paleo-topography and geological structure, modeling of geological evolution and assessment of long-term evolution of groundwater flow conditions during past one million years were shown.
- Statistical analysis using groundwater travel time is effective in order to estimate spatial distribution of long-term stability of groundwater flow conditions quantitatively.
- Topographic change and climate change are the most important factors for assessment of long-term evolution of groundwater flow conditions in plain area.
- Long-term evolution of groundwater flow conditions in plain area is slow compared with that in mountain area, while a plain area is sensitive to changes of geological phenomena compared with a mountain area.
- Long-term stability area of groundwater flow conditions could be estimated qualitatively by comparison between the result of groundwater flow simulation and groundwater chemistry, pH and

redox potential within the groundwater.

Future studies

In future work, technical know-how and uncertainties of geological-evolutionary modeling will be analyzed. In addition, methodology of investigation, modeling and assessment in the plain area for understanding of long-term evolution of geological environments will be systematized.

This study was carried out under a contract with Agency of Natural Resources and Energy (ANRE), part of Ministry of Economy, Trade and Industry (METI) of Japan, as part of its R&D supporting program for developing technology of geological disposal of high-level radioactive waste.

Keywords: Geosphere stability, Geological-evolutionary model, High-level radioactive waste, Geological disposal, Horonobe area, Plain area

