

## Geosphere Stability Project (1) Development of Geological-Evolutionary Model in the Tono 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, climate change, and 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 change and climatic perturbations, 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 Tono area, Central Japan.

#### Overview of R&D progress

This study has been carried out in the Toki River basin, approx. 20km square. Four stages, 3Ma (million years ago), 1Ma, 0.45Ma and 0.14Ma were selected for geological modeling based on geological history of the last millions of years in and around the study area. 3D steady-state groundwater flow simulations and sensitivity analysis focused on topographic change, recharge rate perturbation and conductivity of faults were carried out using these paleo-geological models. Recharge rates of glacial and interglacial periods in each stages due to climatic perturbation were estimated using the water balance method based on paleo-surface hydrological conditions. 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 and then estimation of spatial distribution of long-term stability of groundwater flow conditions and extraction of important factor for assessment of long-term evolution of groundwater flow conditions in the study area have been carried out. In addition, the result 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 mountain area for reconstruction of paleo-topography, geological modeling and assessment of long-term evolution of groundwater flow conditions from several hundreds of thousands of years in the past to the present are 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 is the most important factor for assessment of long-term evolution of groundwater flow conditions in 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 mountain 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: Long-term stability of the geological environments, Geological-Evolutionary Model, High-level radioactive waste, Geological disposal, Tono area, Mountain area