Principal Research Results

Towards Development of Evaluation Method of CO_2 Geological Storage near Large-Scale Emission Sources

Background

To reduce the cost of CCS (CO_2 capture and storage) in Japan, geological storage in the gently inclined aquifer *1 widely distributed over the coastal area which can shorten transportation distances can be considered. However, since there is concern that CO_2 stored in the inclined aquifer moves up in the reservoir over long time, it is required to evaluate the migration behavior of stored CO_2, to carry out monitoring of underground migration, and to evaluate the environmental impact of stored CO_2. Therefore, development of the evaluation method of CO_2 geological storage suitable for the storage mechanism in the inclined aquifer is required for realization of reliable geological storage (Fig. 1).

Objectives

The purpose of this study is to develop the method and technology required for development of a feasible CO_2 geological storage evaluation method according to the storage mechanism in gently inclined aquifer, and to summarize that method and examples.

Principal Results

1. Evaluation method of CO_2 storage capacity

As a storage capacity evaluation method to the gently inclined aquifer which is widely distributed deep underground in coastal areas of Japan, the evaluation flow which consists of "selection of reservoir and seal layer", "quality assessment of reservoir and seal layer", and "calculation of storage capacity" was shown, and the geological survey method required for the evaluation flow was summarized systematically.

2. Evaluation method of CO_2 migration behavior

The numerical-analysis method for migration evaluation of stored CO_2 was developed, and the acquisition methods of foundation data needed for the analysis were summarized. As a result of applying this numerical-analysis method to the in-situ CO_2 injection experiment, it was shown that this method can be adaptable to a field experiment. In addition, as a result of analyzing the underground behavior for 1000 years of stored CO_2 in the gently inclined aquifer as a case study, hardly migration over 1000 years above the aquifer and only about 1km horizontally movement from the injection point were shown (Fig. 2).

3. Evaluation method of chemical impact on rock and groundwater

To evaluate the chemical impact of stored CO_2 on rock and groundwater, we develop the experimental method which estimates amounts of heavy metals and trace elements released from rock into groundwater in the presence of dissolved CO_2, based on the experimental result (Fig. 3).

4. Monitoring technique of CO_2 underground migration

In order to verify the applicability of the electrical method and the self-potential method as technologies which can easily and economically monitor the underground migration behavior and stored range of injected CO_2 from the land surface, the laboratory experiment using rock samples, and the in-situ experiment during $5m^3$ of CO_2 dissolved water injection in to a depth of about 1000m were performed. Consequently, the possibility of the CO_2 underground behavior monitoring by these methods was shown (Fig. 4).

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Future Developments

To further enhance technical reliability of CO_2 geological storage, we will aim at confirmation of on-site adaptability of the evaluation method of CO_2 migration behavior and monitoring technology, and quantitative evaluation of the residual gas trap effect *2.

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Reference

S. Tanaka, et al., 2009, "Evaluation method of CO_2 geological storage near the large-scale emission sources in Japan – Research and development for deep aquifer storage –", CRIEPI Report N07 (in Japanese)

*1 : An aquifer which shows horizontal or gently tilted structure in the same direction and continues almost in parallel (e.g., homocline). Since there is no structural trap by anticline, it is thought that stored CO_2 moves upward by buoyancy in the long term.

*2 : The effect that traps CO_2 of a certain quantity by capillarity pressure and wettability when CO_2 is discharged from pore of rock in the condition where CO_2 phase and groundwater phase exist. It is considered an important trap mechanism in the aquifer which does not show trap structures.

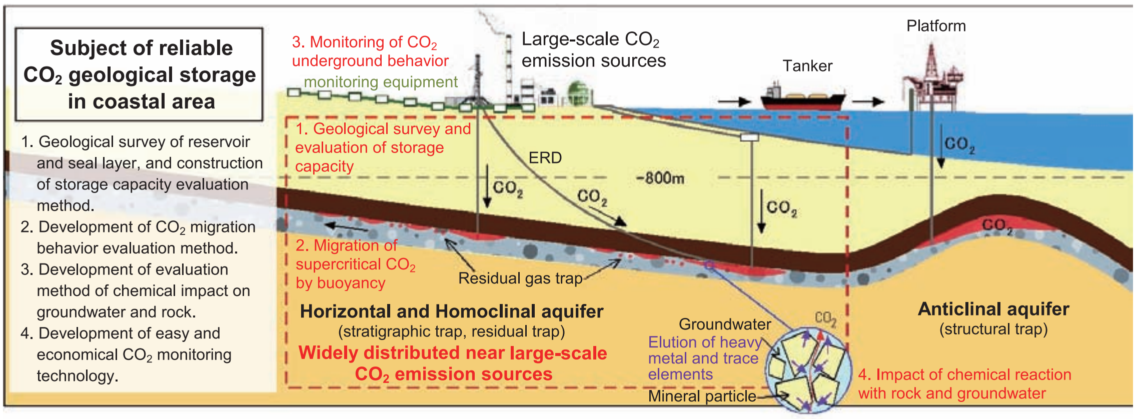

Fig.1 Basic concept and subjects of CO_2 geological storage to the gently inclined aquifer widely distributed 800m below ground near large-scale CO_2 emission sources (modified from figure in RITE homepage).

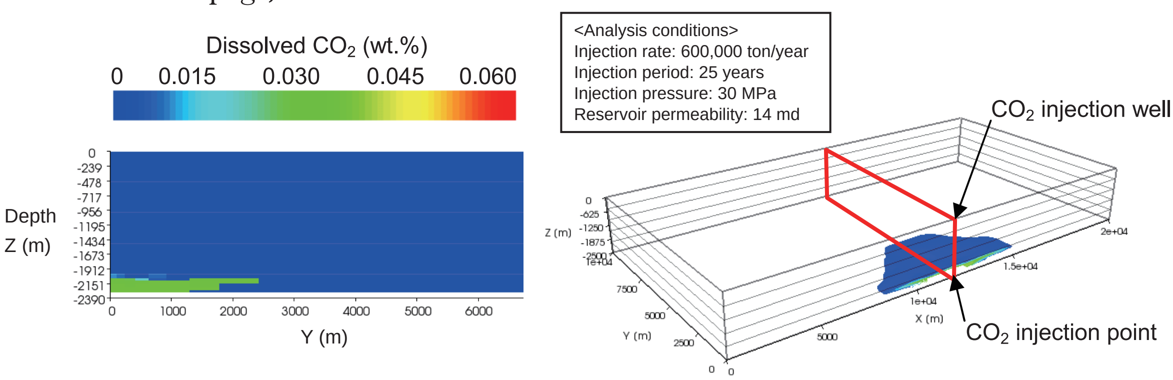

Fig.2 Result of the case numerical-analysis of CO_2 underground behavior in the gently inclined reservoir (1000 years after injection).

CO_2 hardly moves to the bed above a storage layer 1000 years after injection (600,000 ton/year for 25 years), and the horizontal moving distance is about only 1km.

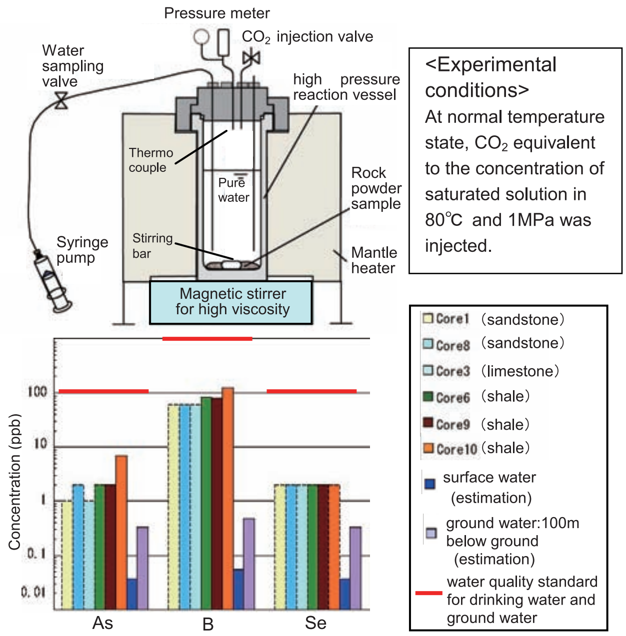

Fig.3 CO_2-water-rock acceleration experimental device and result of the case experiment.

The amounts of heavy metal were below groundwater quality standard value from the result of the experiment for 14 days (Dotted line: lower than determination-limit).

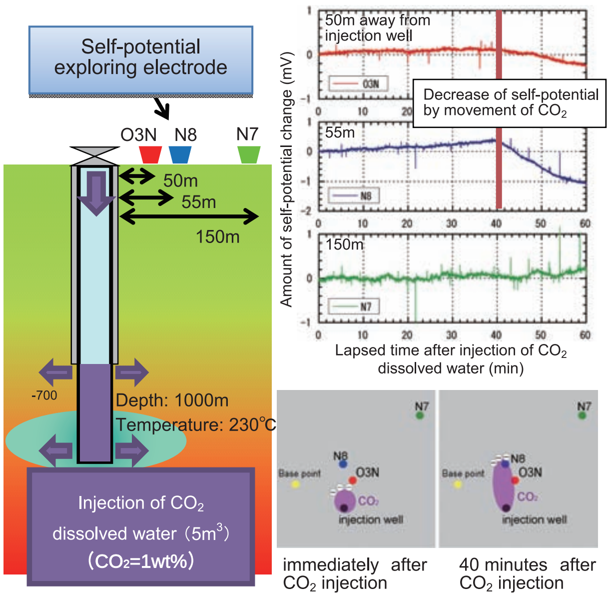

Fig.4 Result of CO_2 underground behavior monitoring experiment.

Slight changes of self-potential were observed near the CO_2 injection well.