Project Research — Development of a Supply/Demand Infrastructure for Next-generation Electric Power

Basic CO_2 Storage Technology Development Considering Geological Structure in Japan

Background and Objective

For preventing global warming, many countries consider the introduction of CCS, which recovers CO_2 from CO_2 emission plants and storage it underground. However, the implementation of CCS has not been made in most countries yet, because there are many unsolved problems regarding economy, CO_2 storage technology development, carbon tax, and the obligations of CCS itself.

In this project, we collected and analyzed information regarding the latest CCS activities in Japan and the world, studied the phenomenon, and developed basic technologies for CO_2 underground storage, considering geological conditions near the coast where many large CO_2 emission sources are located.

Main results

1 Basic CO_2 Underground Storage Technologies Considering Geological Structures in Japan

Geological structures in coastal areas where large CO_2 emission sources are characterized by a gently declining slope from inland out towards the sea. We proposed flows for investigating a CO_2 storage candidate site and for evaluating faults (Fig. 1). We improved the numerical performance simulation method by introducing a two-phase flow evaluation method.

We applied these flows and performance evaluation technology to the CO_2 storage candidate site of ZeroGen (responsible organization of an Australian CCS project) in order to construct a geological and hydrological model and to predict CO_2 migration performance by injecting 1 million tons of CO_2 into a well (Fig. 2). The field tests showed that the CO_2 injection pressure was higher than the estimated pressure; therefore, the CO_2 injection cost is estimated to be very high, and the ZeroGen project was thus cancelled. We learned that reliable site evaluation is necessary to observe accurate particle size distribution and the heterogeneity of permeability distribution in the reservoir layers (N11003) (conducted in collaboration with ZeroGen).

2 Development of CO_2 Monitoring Methods in the sea

As CO_2 storage sites may be located under the sea in Japan, we proposed an sea-based CO_2 monitoring system, integrated with: an acoustic tomography method, sea robots (AUVs) without cables and so on, as a leakage detection system for during and after CO_2 injection (Fig. 3) (some parts of the research funded by RITE). We also developed a numerical simulation method that can predict CO_2 diffusion in the sea in case of CO_2 leakage occurring during transportation and injection and after injection.

3 Study of CCS Research Trends and CO_2 Transportation and Injection

According to a study of CCS policy and trends regarding technology development, we pointed out that public acceptance is most important. Some examples showed that large-scale CCS projects were cancelled due to the objections of local residents (V11006) (conducted by request from the Federation of Electric Power Companies). We also showed that CO_2 transportation and injection into under the sea floor by ships with CO_2 injection pumps and flexible pipes is more advantageous than pipe lines in some cases (conducted in collaboration with the University of Tokyo).

Other reports: (N16)

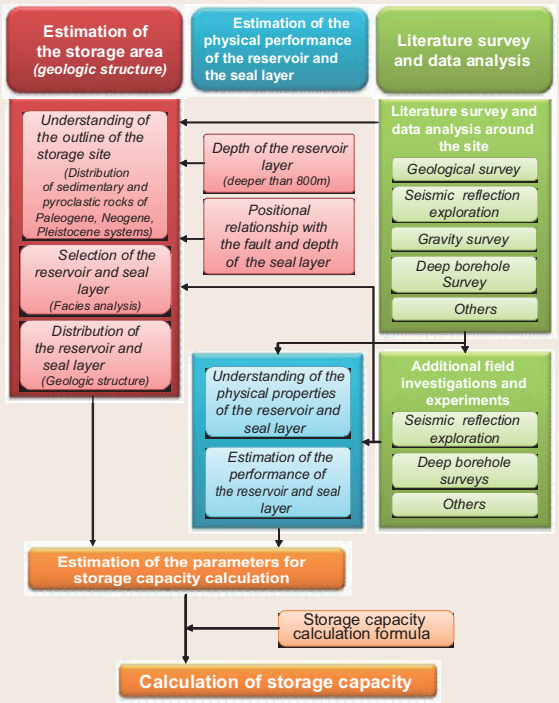

Fig. 1: CO_2 storage candidate site evaluation flow

It is necessary to integrate the evaluation of accurate geological information and characteristics for the reliable estimation of the seal layer and reservoir.

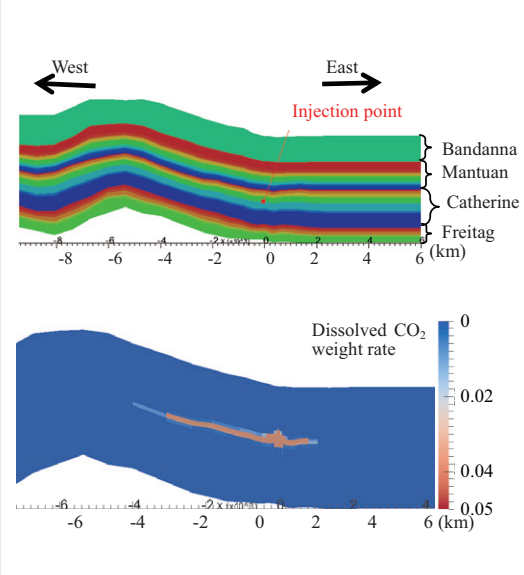

Fig. 2: Application of the performance prediction method to a CO_2 storage candidate site of ZeroGen

We constructed a geological and hydrological model using the evaluation flow with geological information and core samples from ZeroGen. We estimated the CO_2 migration area by injecting 1 million tons of CO_2 for 30 years into a well.

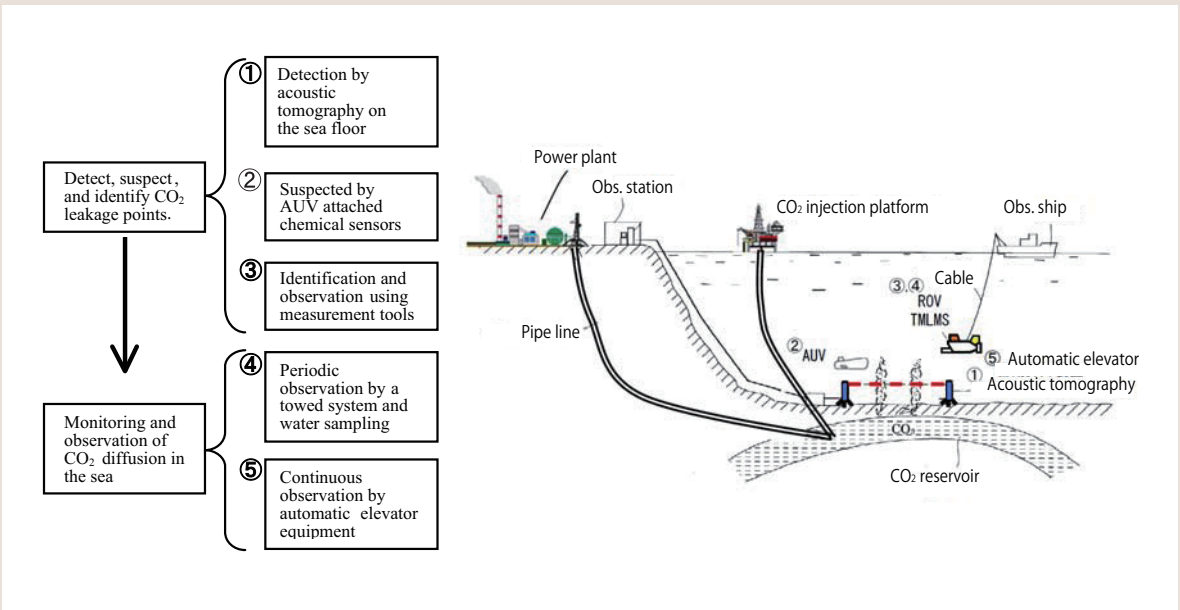

Fig. 3: CO_2 monitoring system in the sea
Left: CO_2 sea monitoring flow; right: CO_2 sea monitoring overview

Monitoring will be conducted through a process aimed at the detection of CO_2 leakage using an acoustic tomography method, including a search of the CO_2 leakage point using AUVs (robots without cables) and the continuous monitoring of CO_2 leakage conditions using a towed observation system.