Tomakomai CCS Demonstration Project

Long Term Prediction of CO_2 flow Behavior by Field Scale Flow Simulation Model

Japan CCS Co., Ltd.

Summary

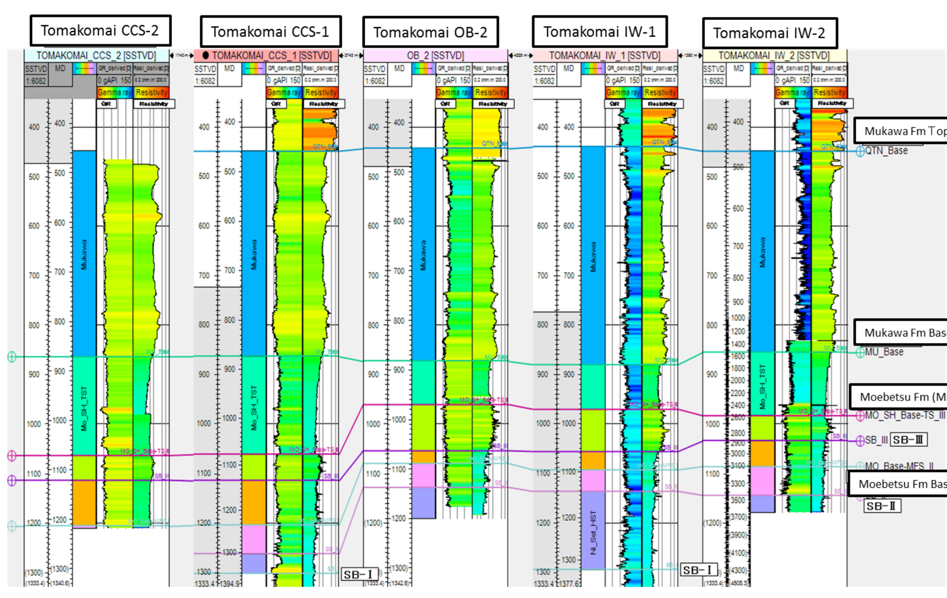
Japan CCS Co., Ltd. (JCCS) has been conducting a long term prediction of CO_2 flow behavior utilizing a field scale flow simulation model since 2009. The flow simulation model was constructed by geological modeling and rock property modeling. In geological modeling, a geological model which simulates the 3D geological structure is constructed from well correlation data based on horizon interpretation and 3D seismic data obtained by previous exploration activities. In rock property modeling, porosity and permeability determined by well logging data and core data of each well are input to the geological model. By using this flow simulation model, it is possible to identify CO_2 flow behavior and geological trapping contribution during CO_2 injection. The simulation results in this poster describes the construction flow of the simulation model, and an example of CO_2 behavior simulation of the deep saline aquifer.

Construction Flow of Simulation Model

【Geological Modeling】

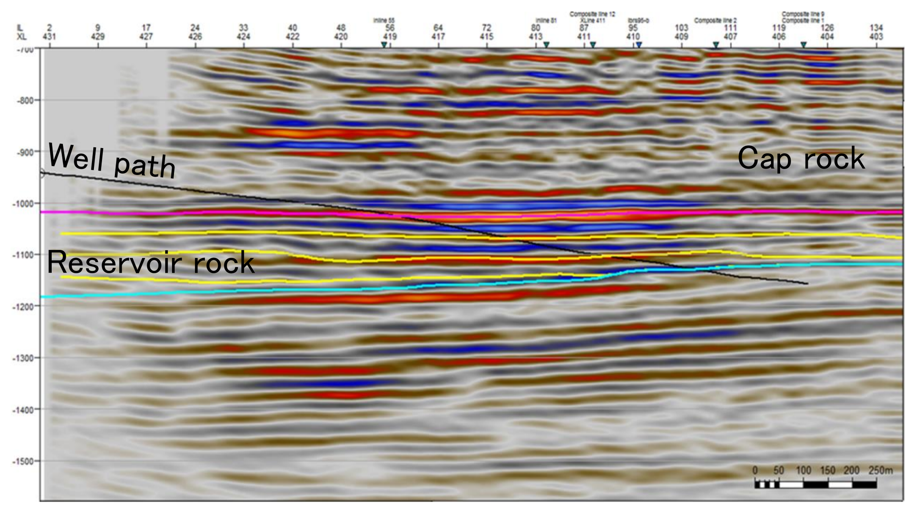
① Well Correlation

Horizons for structural interpretation of the object field delineated by past exploration were correlated at existing wells utilizing various data in order to identify the marker horizons in each well and grasp the rough geological structure of the field.



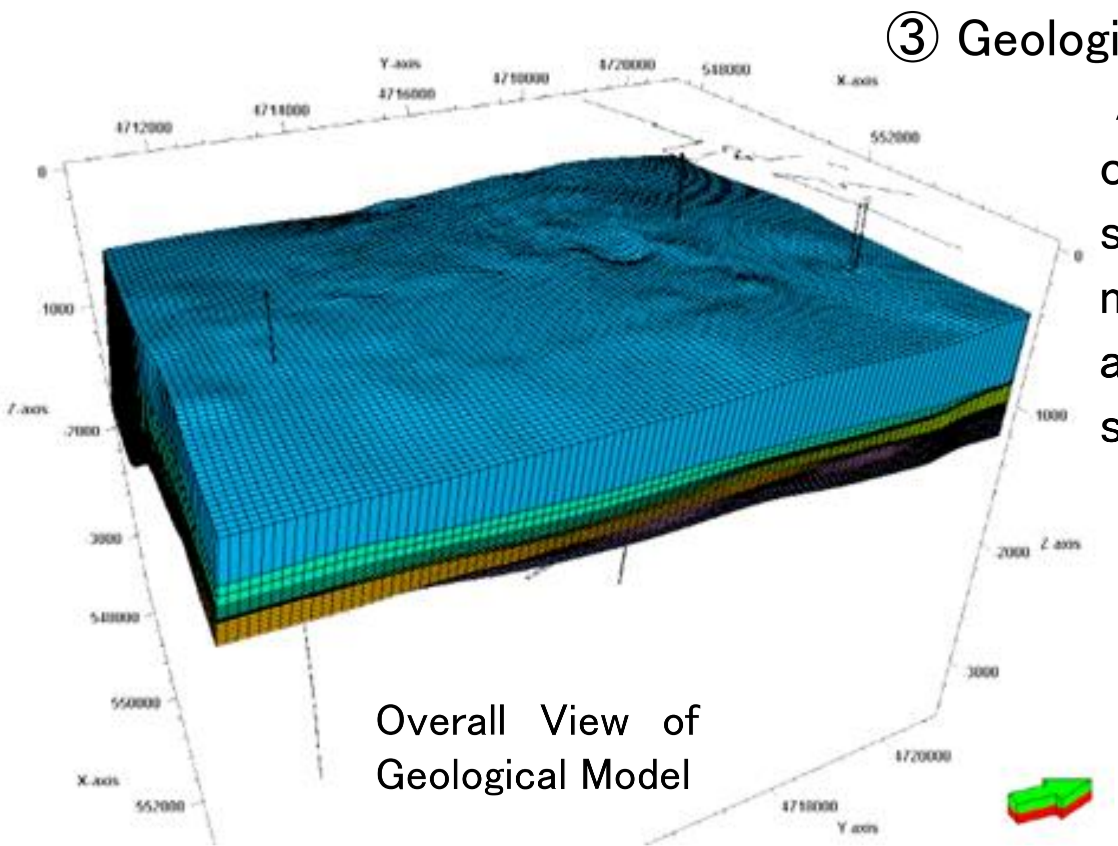
② Interpretation of 3D Seismic Exploration

Geological interpretation using 3D seismic data was conducted based on marker horizons in each well, and the detailed geological structure such as formation thickness and existence of faults was evaluated.



③ Geological Model Construction

A geological model was constructed in the 3D seismic data using modeling software, and a grid system for flow simulation was created.

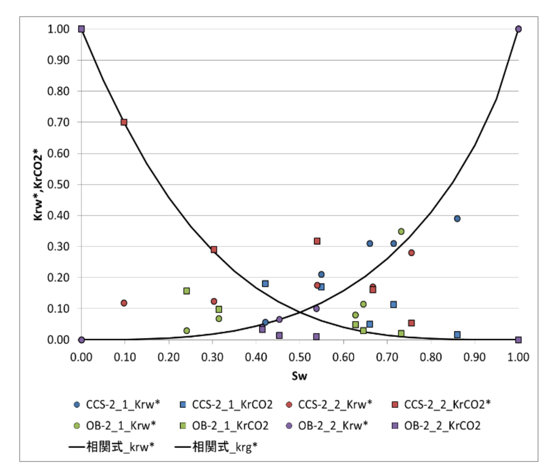


Overall View of Geological Model

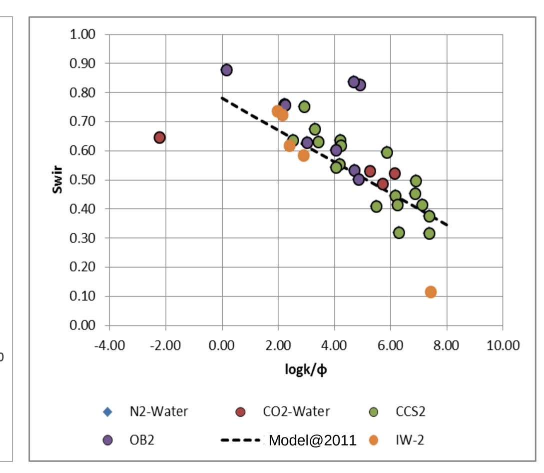
【Rock Property Modeling】

①Core and Well Logging Data

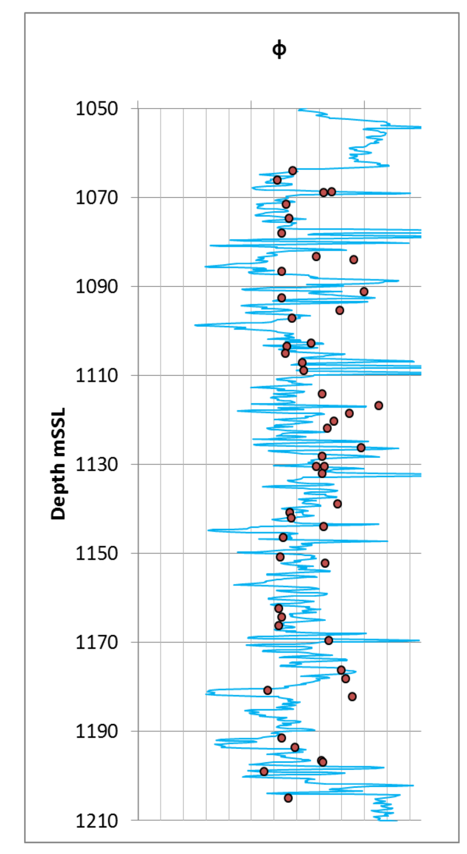
The porosity, permeability, capillary pressure, CO_2 –water relative permeability of the reservoir and the threshold pressure of the cap rock were measured by core analysis. Continuous data of rock properties at each well was acquired by well logging. The logging data was calibrated using the core data to improve the accuracy.



CO_2 –Water Relative Permeability



Correlation between Residual Water Saturation and Permeability/Porosity



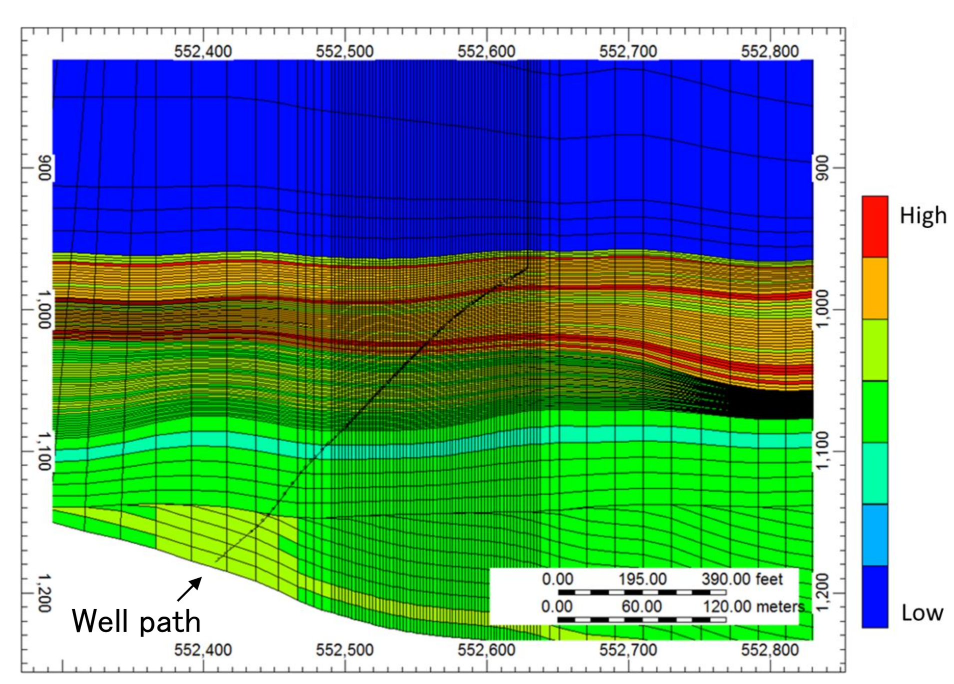
Well Logging data of Porosity (Calibrated by Core Data)

② Well Testing Data

Well testing (fall off test) by brine injection was carried out during drilling to estimate the reservoir property (permeability) by pressure transient analysis. The result was also applied to calibrate the well logging data.

③ Flow Simulation Model

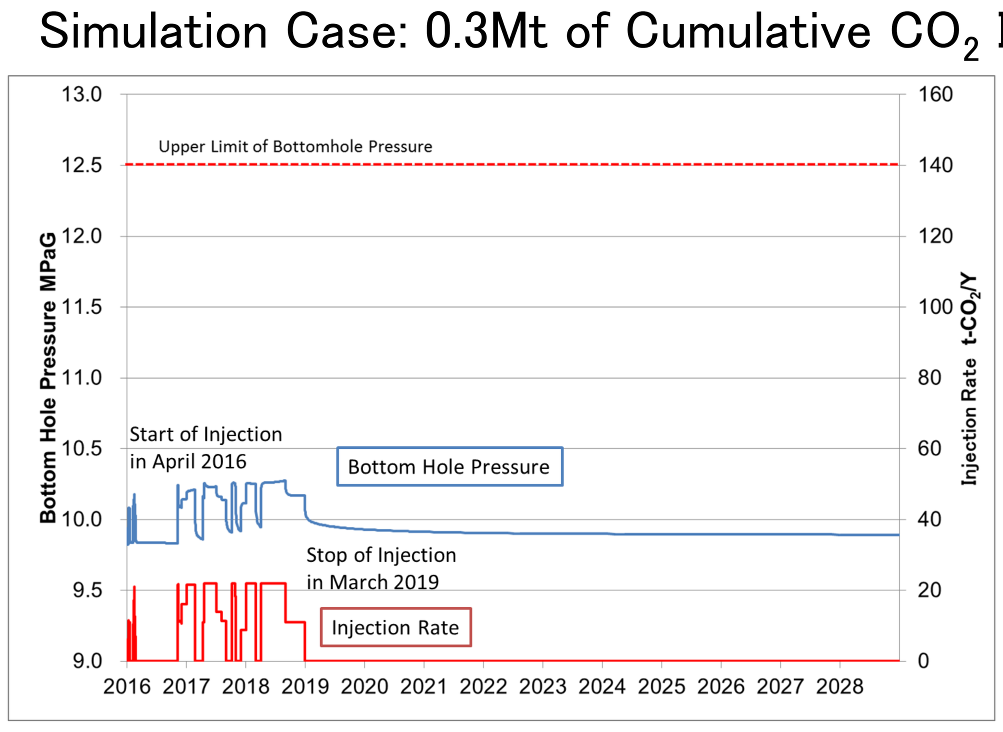
The porosity and permeability in the injection well were upscaled to grid size and input to each layer of the reservoir model, to express heterogeneity in the vertical (depth) direction.



Permeability Distribution(Well Section)

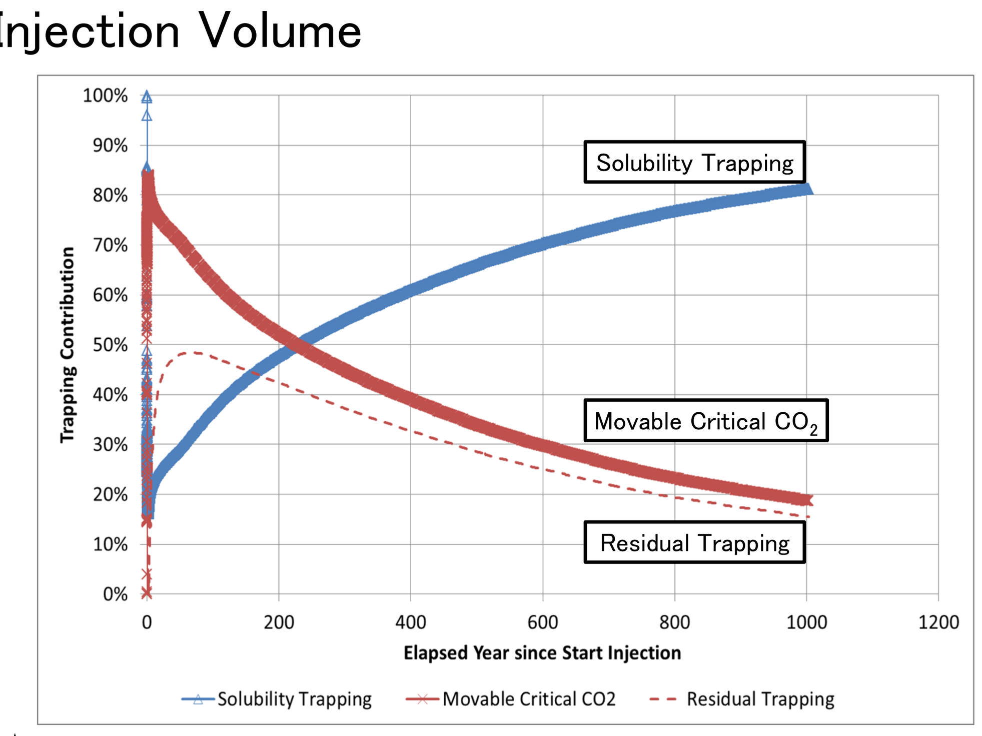
Example of Long Term Prediction of CO_2 Behavior by Flow Simulation

Simulation Case: 0.3Mt of Cumulative CO_2 Injection Volume



★Bottom hole Pressure in Injection and after Shut in

The bottom hole pressure did not exceed the upper limit (90% of Leak off pressure) based on the Extended Leak off Test during drilling and almost returned to initial pressure after 10 years of shut in.



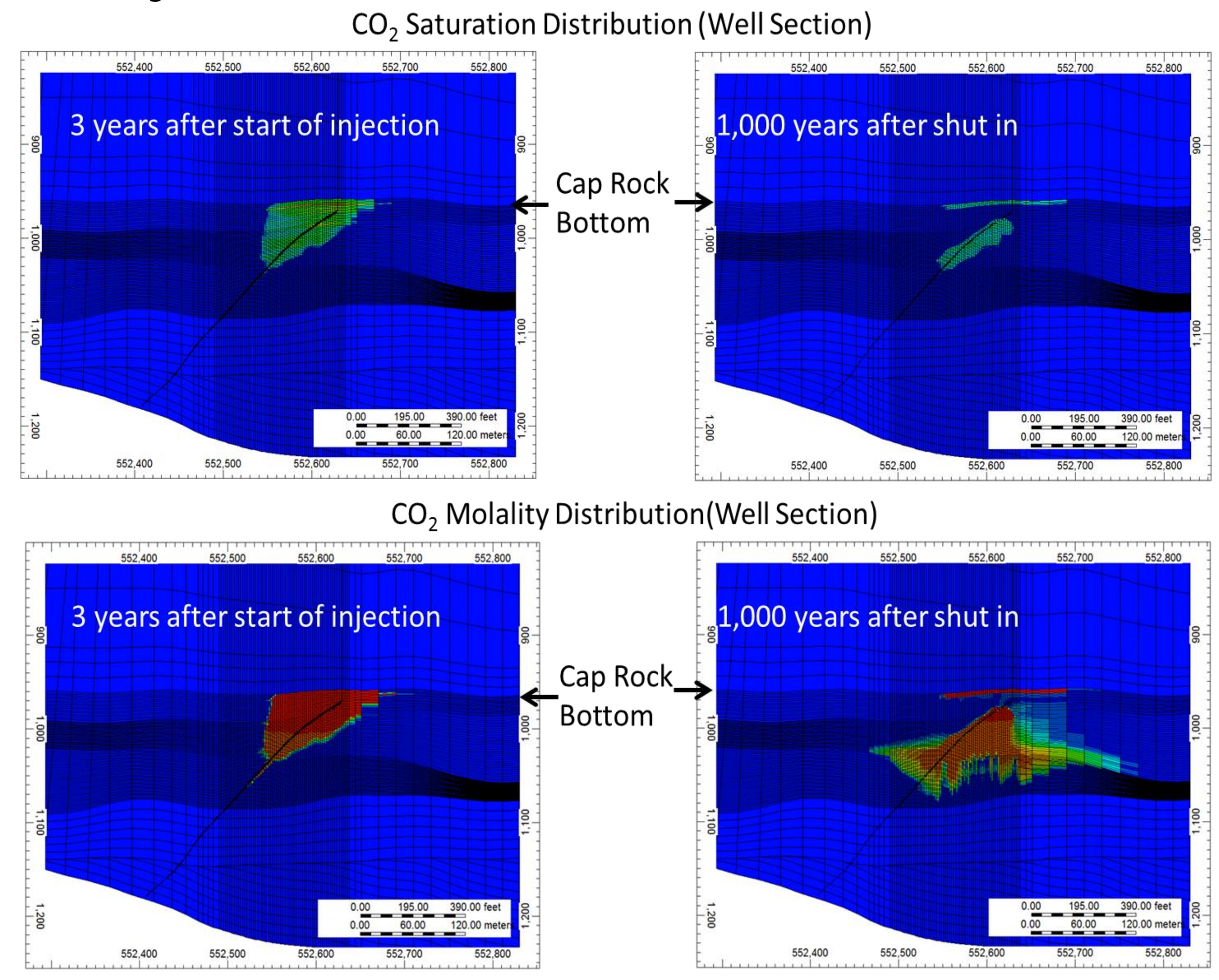
★Trapping Mechanism

The CO_2 was found to remain in the reservoir by solution in saline water (Solubility Trapping) and becoming immovable in rock (Residual Trapping). It is judged that stable and permanent storage is possible because the contribution of movable critical CO_2 will reach almost 0% after 1000 years.

Remark: Mineral Trapping was not considered in this case.

CO_2 Saturation Distribution (Well Section)

CO_2 Molality Distribution(Well Section)



★ CO_2 Saturation and Molality distributions

The CO_2 reached the cap rock and was stored at the upper part of the reservoir. Dissolved CO_2 in water moved slowly downward due to gravity effect.

Conclusion and Future Tasks

Long term prediction of CO_2 flow behavior was conducted by a flow simulation model which was constructed from geological and rock property data of an actual saline aquifer field. The flow simulation model will be updated by bottom hole pressure data during injection and CO_2 distribution in the reservoir estimated by time-lapse reservoir monitoring in order to improve prediction accuracy.

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