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A Review of Assessments of Potential CO_2 Storage Capacity in Japan

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Outline

- Historical review of assessments of potential CO_2 storage capacity in Japan
- Overview of the reassessment of potential CO_2 storage capacity in Japan by RITE/ENAA*
  - CO_2 storage concept
  - Key parameters:
    - Storage factor
    - SupercriticalCO_2 saturation
  - Geological assumptions
- Summary
- Future issues

* Engineering Advancement Association of Japan

Historical Review

- Tanaka et al. (1995)
  - Assessment of potential CO_2 storage capacity in Japan
- FY2000-2007 (RITE/ENAA)
  - A part of "CO_2 Geological Storage Project" funded by METI*
  - **Reassessment of potential CO_2 storage capacity in Japan**
  - Assessment of potential CO_2 storage capacity near the large-scale emission sources in Japan
- FY2008-2011 (NEDO**)
  - "Innovative Zero-emission Coal Gasification Power Generation Project: Feasibility Study on A Total System from Power Generation to CO_2 Storage" funded by METI
  - A follow-up project of the RITE/ENAA project
  - Detailed assessment of high potential areas
- Activities of Japan CCS Co., Ltd. (JCCS)
  - Detailed assessments for high potential areas in Japan

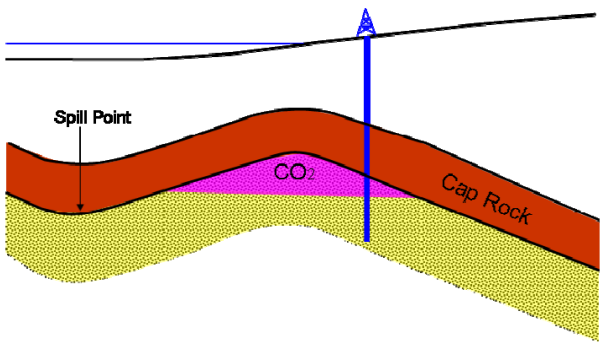
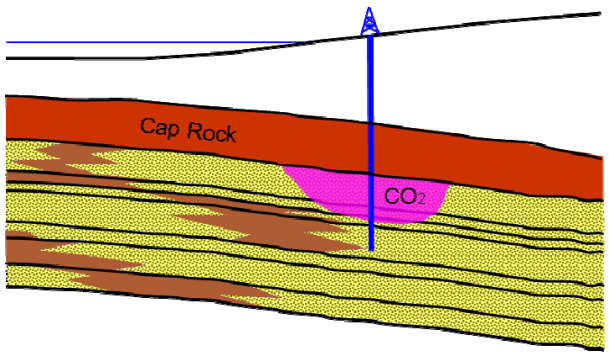
* Ministry of Economy, Trade and Industry of Japan

**New Energy and Industrial Technology Development Organization

Overview of Reassessment

- Proposal of CO_2 storage concept
- Areas assessed
- Making extensive use of the seismic and well data owned by METI for geological interpretations
- Introduction of a concept of “storage factor” in calculations of potential CO_2 storage capacity
- Supercritical CO_2 saturation determination
- Geological assumptions for depth and effective thickness of deep saline aquifers

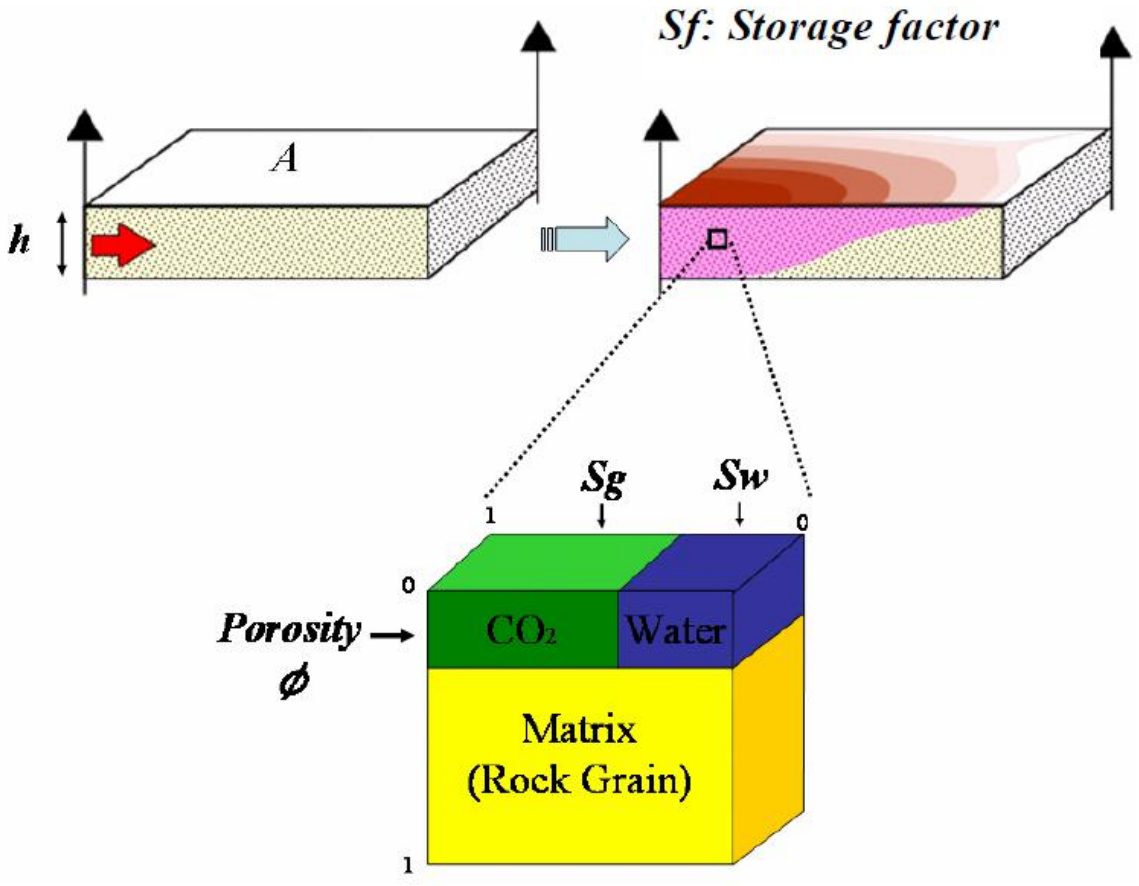
CO_2 Storage Concept

	Category A	Category B
Type of Trap	Structural Traps	Gently Dipping Homoclinal Structures and/or Heterogeneous Aquifers without Trapping Structures
Oil and Gas Fields	A1	B1
Drilled Structures	A2	
Undrilled Structures	A3	B2
Trap Mechanism	<u>Structural Trapping</u> Primary: Supercritical state Secondary: Dissolved in formation water	<u>Stratigraphic/Residual Trapping</u> Primary: Dissolved in formation water Secondary: Supercritical state (Stratigraphic and Residual)
Storage Concept		
Capacity	Actual storage	Huge potential in the near future

(modified from Takahashi et al., 2008)

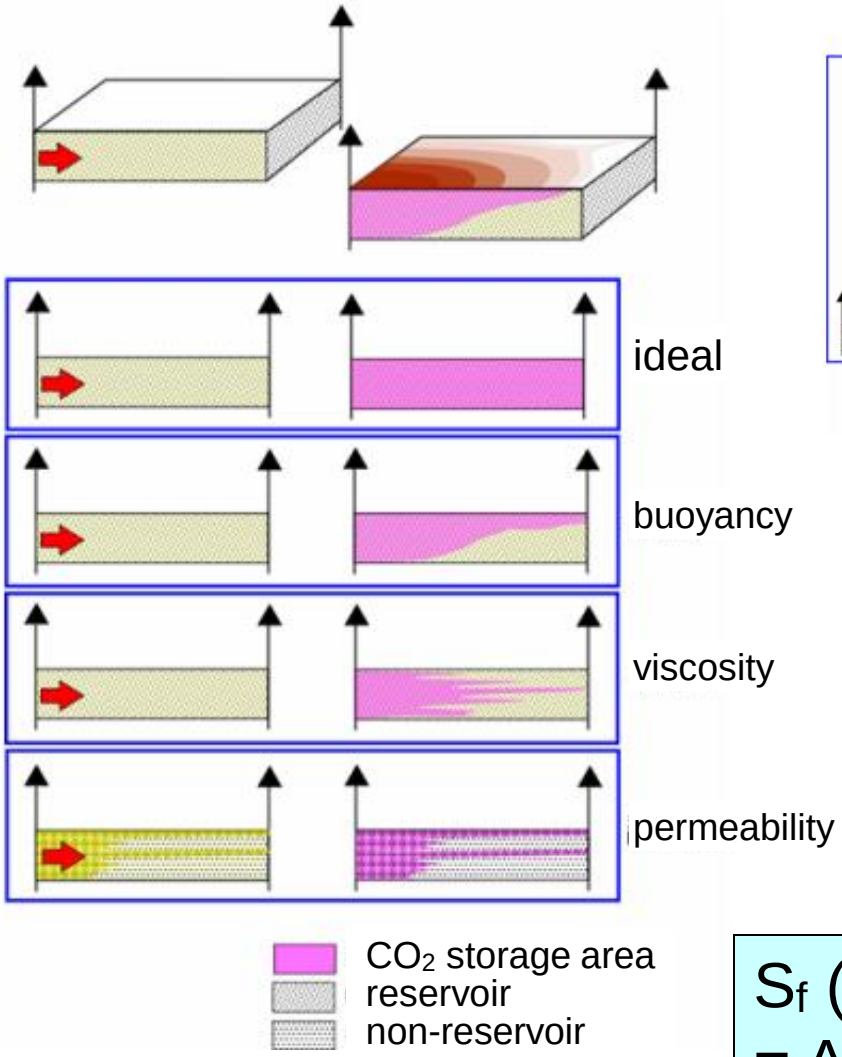
Calculations of Potential CO_2 Storage Capacity

Potential CO_2 storage capacity =
$S_f \times A \times h \times \varphi \times S_g/B_gCO_2 \times \rho$

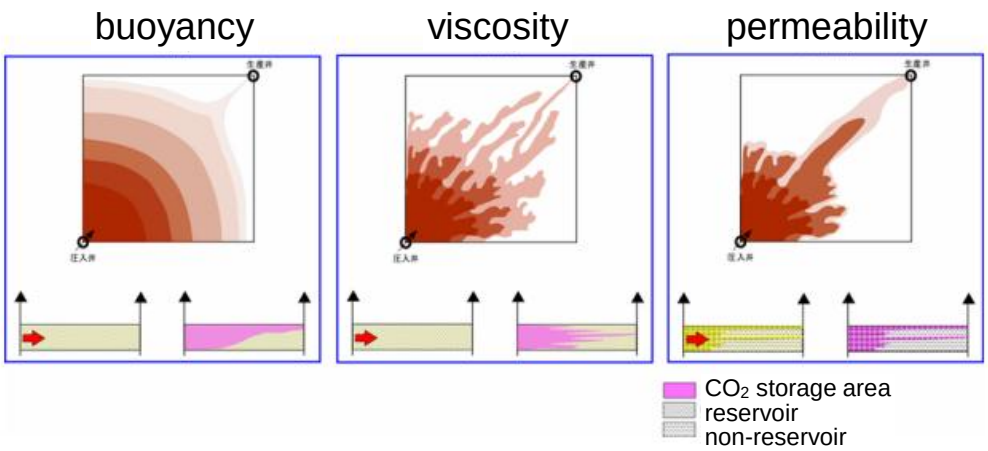


Sf: storage factor
A: area (m^2)
h: net thickness (m)
(= formation thickness x sand/shale ratio)
φ: porosity
S_g: supercritical CO_2 saturation
B_gCO_2: formation volume factor of CO_2
ρ: density of CO_2 at standard conditions (= 1.976 kg/m^3)

“Storage Factor” (S_f) (1)



Vertical Storage Factor



Areal Storage Factor

Definition of Storage Factor:

The ratio of the volume with which the injected supercritical CO_2 has contact to the pore volume of the entire aquifer.

S_f (Volumetric Storage Factor)
= Areal Storage Factor
x Vertical Storage Factor

“Storage Factor” (S_f) (2)

- The idea is based on the concept of Sweep Efficiency in EOR
- Storage factor values given for calculations of potential CO_2 storage capacity:
  - Category A: 50%
  - Category B: 25%
- Assumptions in determination of storage factor values:
  - Areal storage factor: nearly 100%
  - Vertical storage factor:
    50% for homogeneous aquifers
    25% for aquifers with vertical heterogeneity

Supercritical CO_2 Saturation (S_g)

- Retention of two phases of fluids (CO_2 and brine) in deep saline aquifers
- Assumptions of S_g values of 20, 50 and 80% for calculations of potential CO_2 storage capacity
- Interpretation of supercritical CO_2 saturation based on the results of the monitoring by well logging during the injection at the Nagaoka pilot test site: 40-50%

  → 50% for all categories

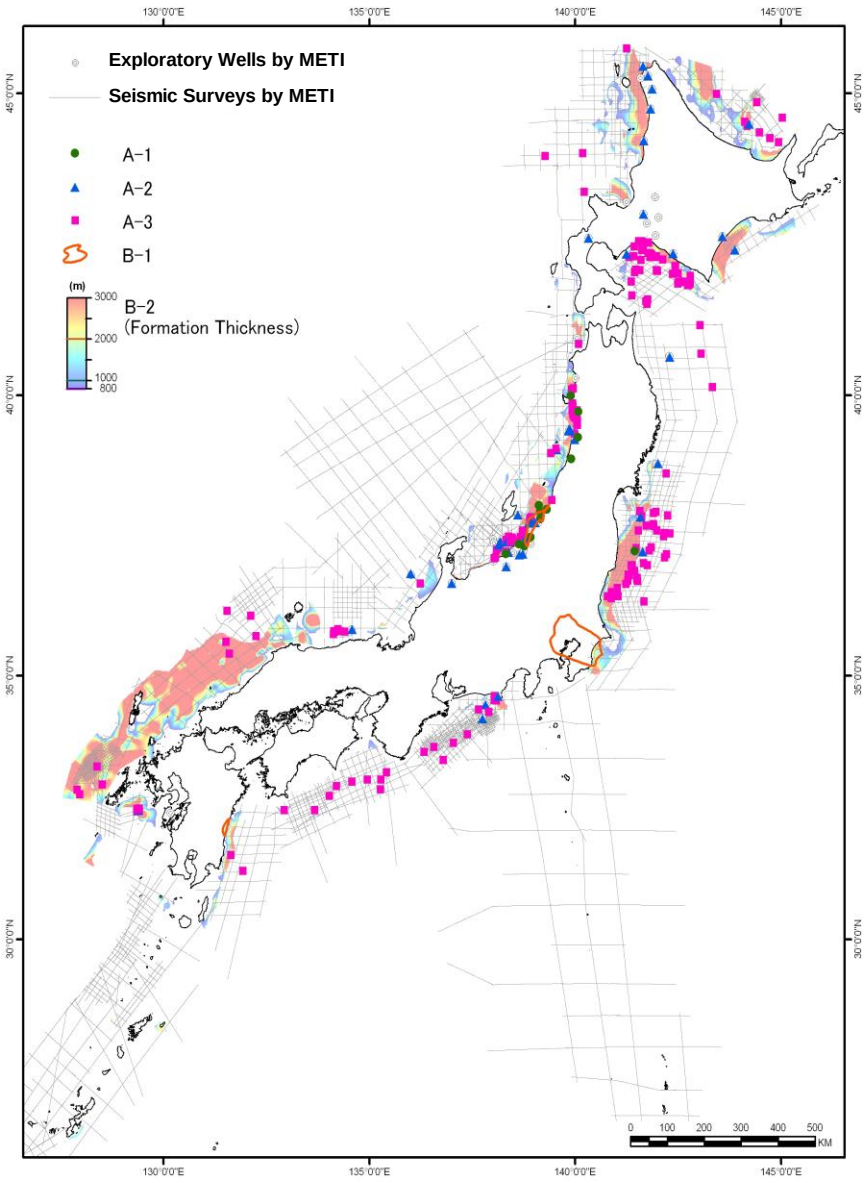
Geological Assumptions: Depth

- Water depths shallower than 200 m
- 800 m below seafloor for offshore areas to keep the stored CO_2 in a supercritical state

Geological Assumptions: Effective Thickness (h)

- Based on the seismic and well data owned by METI
- Tertiary-Quaternary sediments:
  - having a thickness of greater than 800 m
  - in a water depth shallower than 200 m
- Calculations of effective thickness for sub-category B2
  - Calculations of average effective thicknesses based on the well data
  - Final effective thickness values:
    A total of average effective thicknesses x 0.5

Distribution Map of CO_2 Storage Capacity

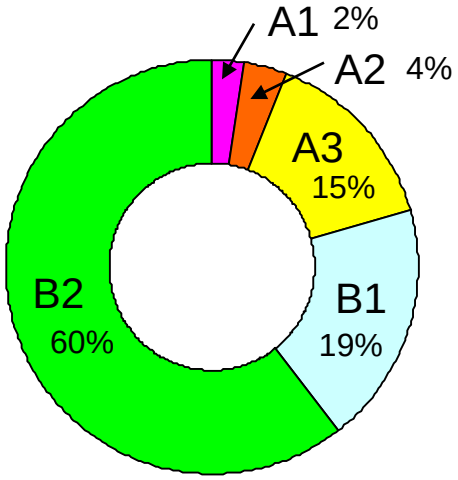


(modified from Takahashi et al., 2008)

Calculated Potential CO_2 Storage Capacity

Categories		Capacity (Mt-CO_2)	Remarks
A	A1	3,492	Including onshore ares
	A2	5,202	Including onshore ares
	A3	21,393	
B	B1	27,532	Including onshore areas
	B2	88,477	
Total		146,096	

Note: Inland basins and inner bays are not included.



Summary

- An overview of the reassessment of potential CO_2 storage capacity in Japan by RITE/ENAA is focused
- Key points in the reassessment of potential CO_2 storage capacity:
  - Proposal of CO_2 storage concept: Two major categories
  - Introduction of a concept of “storage factor”
  - Determination of supercritical CO_2 saturation value based on the results of the monitoring at the Nagaoka pilot test site
  - Geological assumptions for depth and effective thickness of aquifers
- Japan has a huge potential CO_2 storage capacity in deep saline aquifers

Future Issues

- Detailed assessment of potential CO_2 storage capacity in high-potential areas by 3D geological modeling and numerical simulations
- Seismic surveys in shallow water areas
- Basic laboratory research for better understanding of CO_2 behavior in the subsurface

Thank you for your attention !

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