Research and Development on Aquifer Storage of Carbon Dioxide in Japan

February 20, 2006

Takashi Ohsumi

RITE
（Research Institute of Innovative Technology for the Earth）

Research Institute of Innovative Technology for the Earth

Background

JAPAN

Potential Estimate for World:

Tanaka(1991): CO_2 utilization potential in EOR

Koide(1992): Aquifer storage potential

Potential Estimate for Japan:

examined in 1993, and
published by Tanaka et al. (1995)

RITE's NAGAOKA project started at NAGAOKA in 2000; actual injection from 2003 until 2005

WORLD

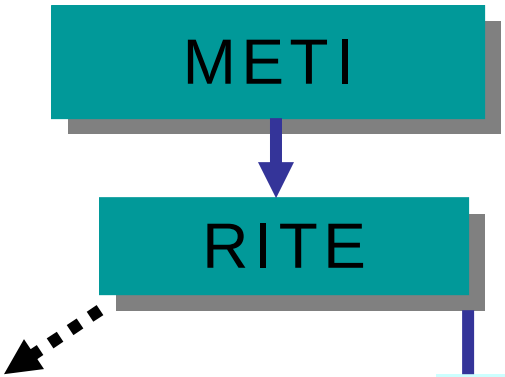
E. Lindberg (late 80's): CO_2EOR regarded as storage

B. Hitchon (early 90's): proposed a concept of Aquifer Disposal Storage

STATOIL (1996) launched Sleipner Project

R&D on the underground sequestration of CO_2 started in 2000, operated by

Research Institute of Innovative Technology for the Earth



25 MUSD until 2005

SEC
(Safety & Environmental Center For Petroleum Development)
- field injection test

in-house study

CO_2 Seq. Res. G
- laboratory experiment

System Res. G.
- LCA, risk analysis, public acceptance,..

Nagaoka site

onsite surface facilities

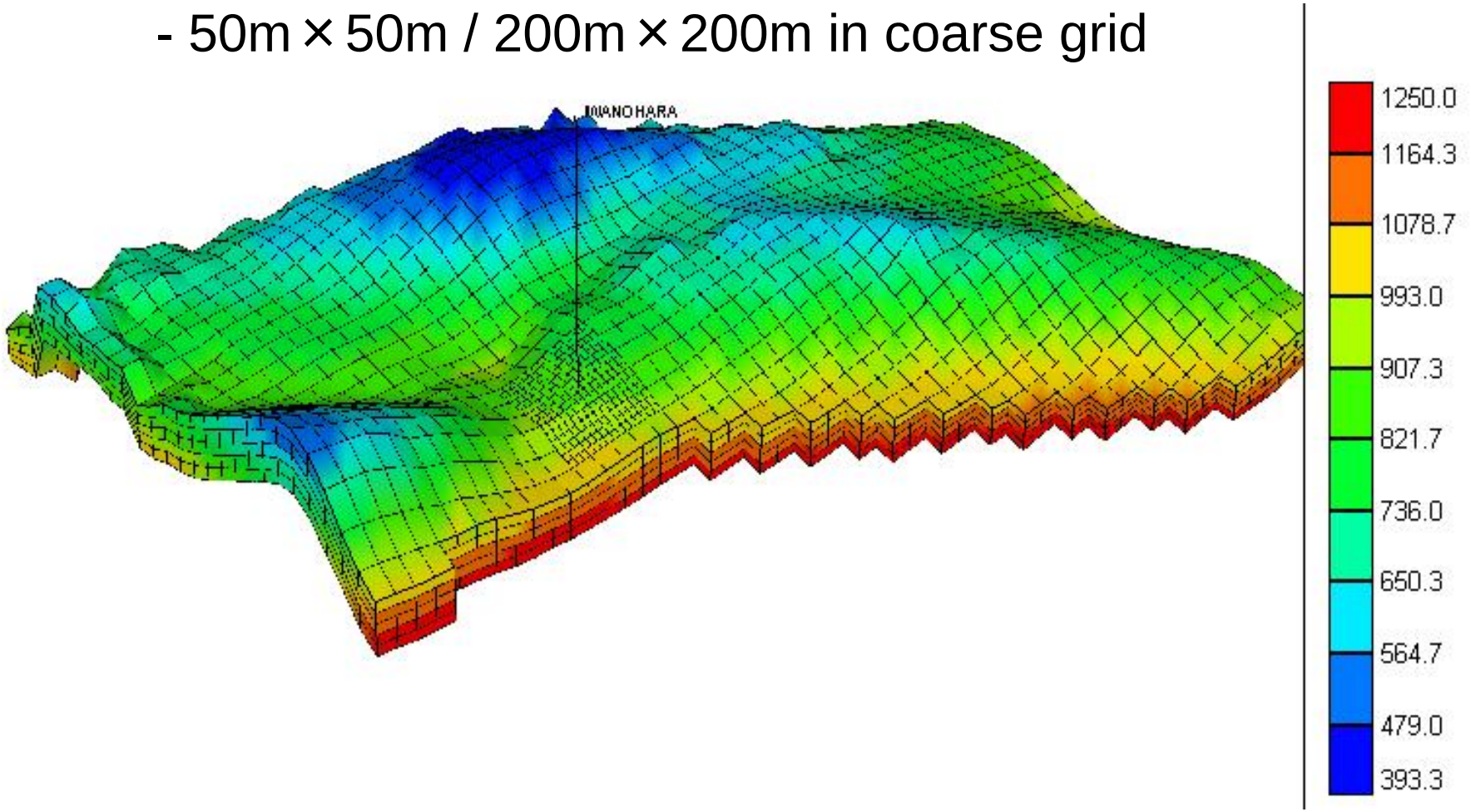
Nagaoka site

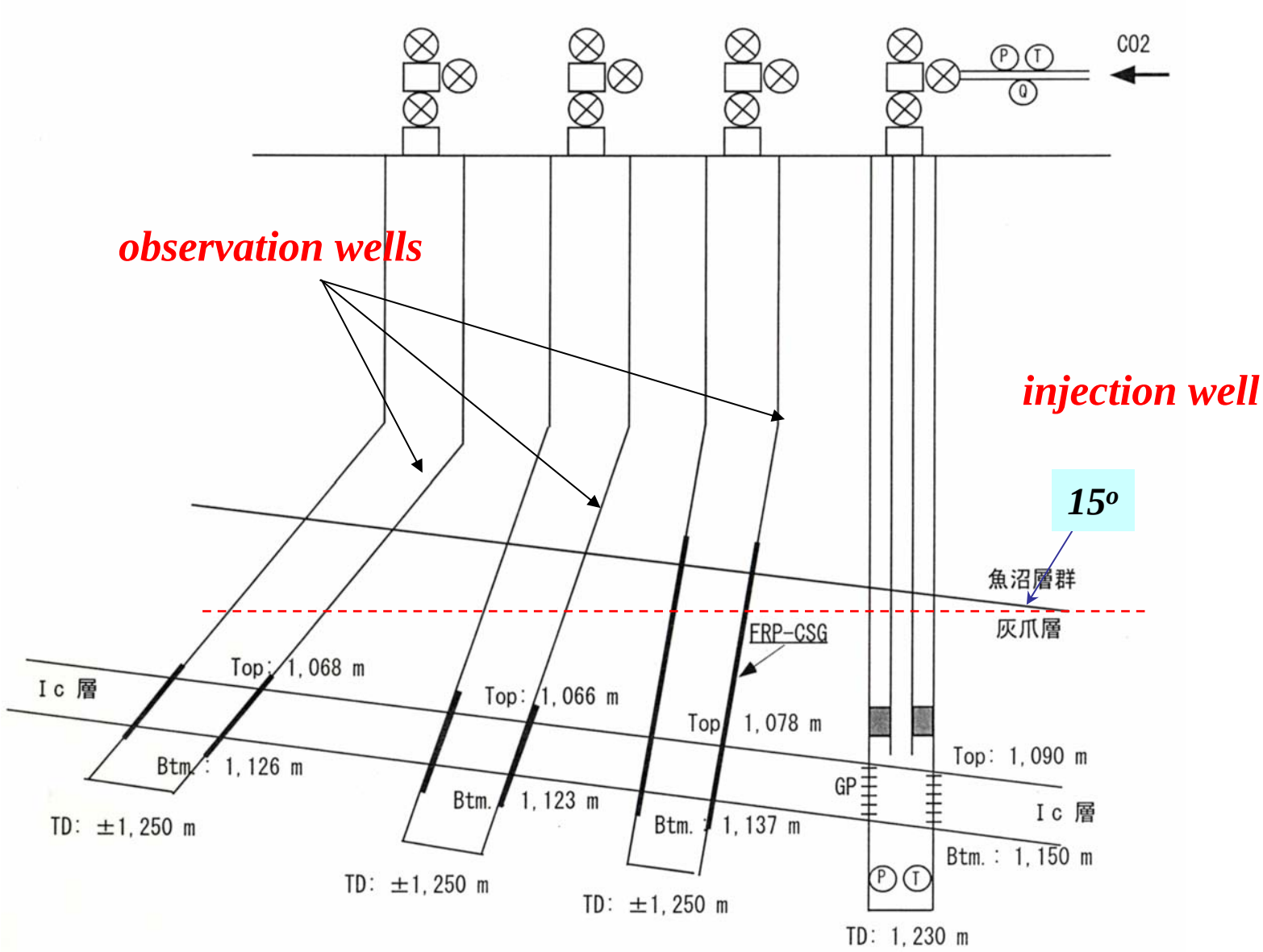
storage tank (90 m^3) and lorry

target aquifer

horizontal grid size:

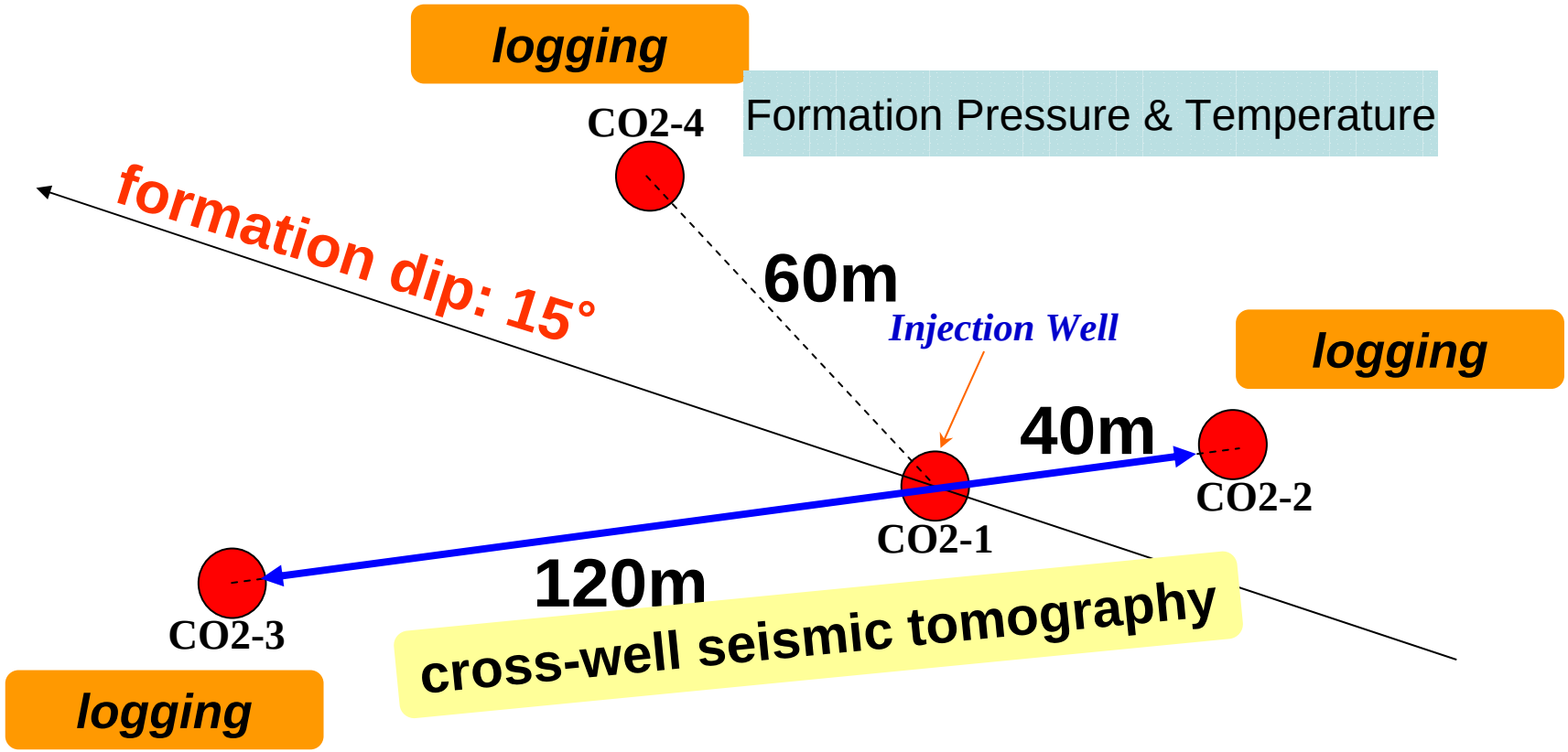
- 25m × 25m in fine grid
- 50m × 50m / 200m × 200m in coarse grid




observation wells
injection well
15o
CO2
P
T
Q
魚沼層群
灰爪層
FRP-CSG
Ic 層
Top: 1,068 m
Btm.: 1,126 m
TD: ±1,250 m
Top: 1,066 m
Btm. 1,123 m
TD: ±1,250 m
Top 1,078 m
Btm.: 1,137 m
TD: ±1,250 m
GP
Top: 1,090 m
Ic 層
Btm.: 1,150 m
TD: 1,230 m

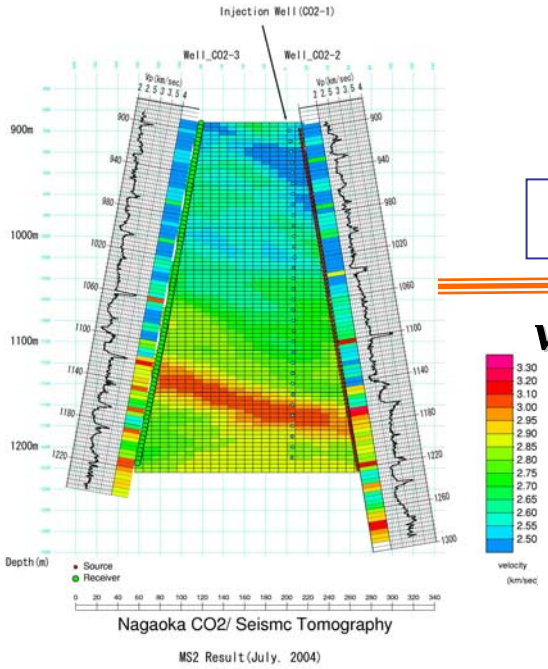

No.4 1095m - 1100m
1
2
3
4
5
6
7
8
9
1m

geophysical monitoring of CO_2 sequestration



result of the MS-2 (2nd monitoring survey)

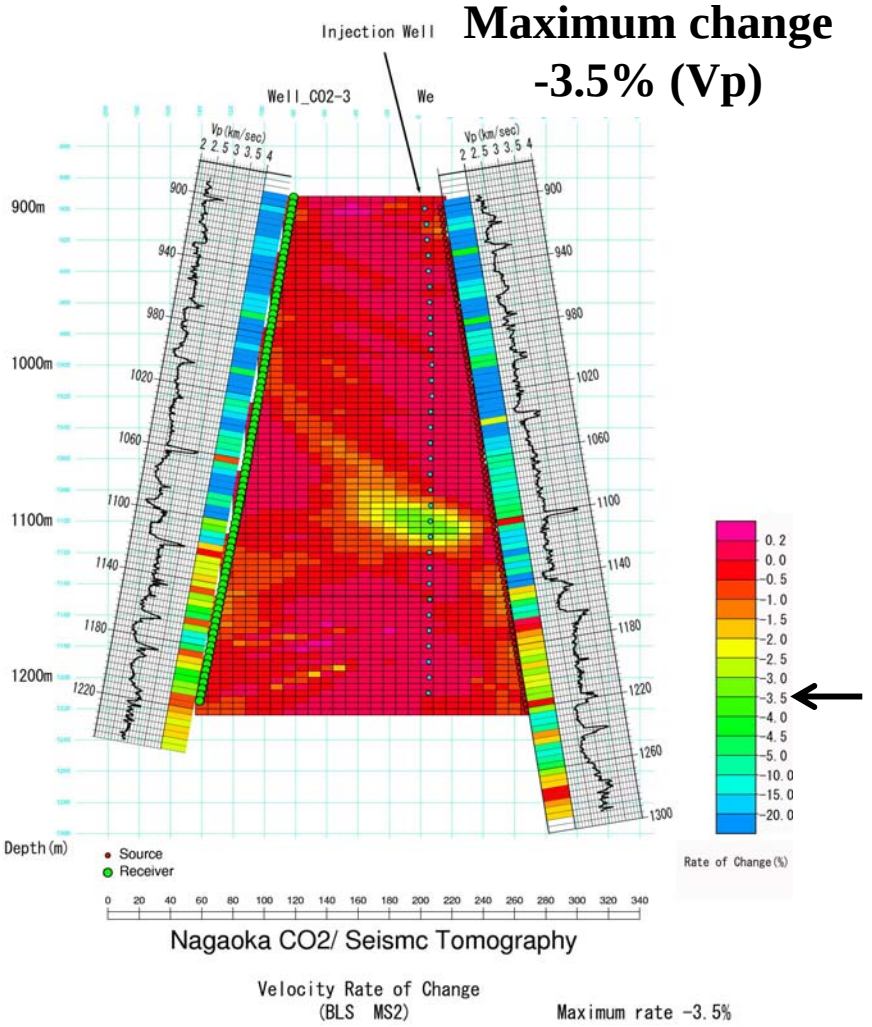
Result of the MS-2



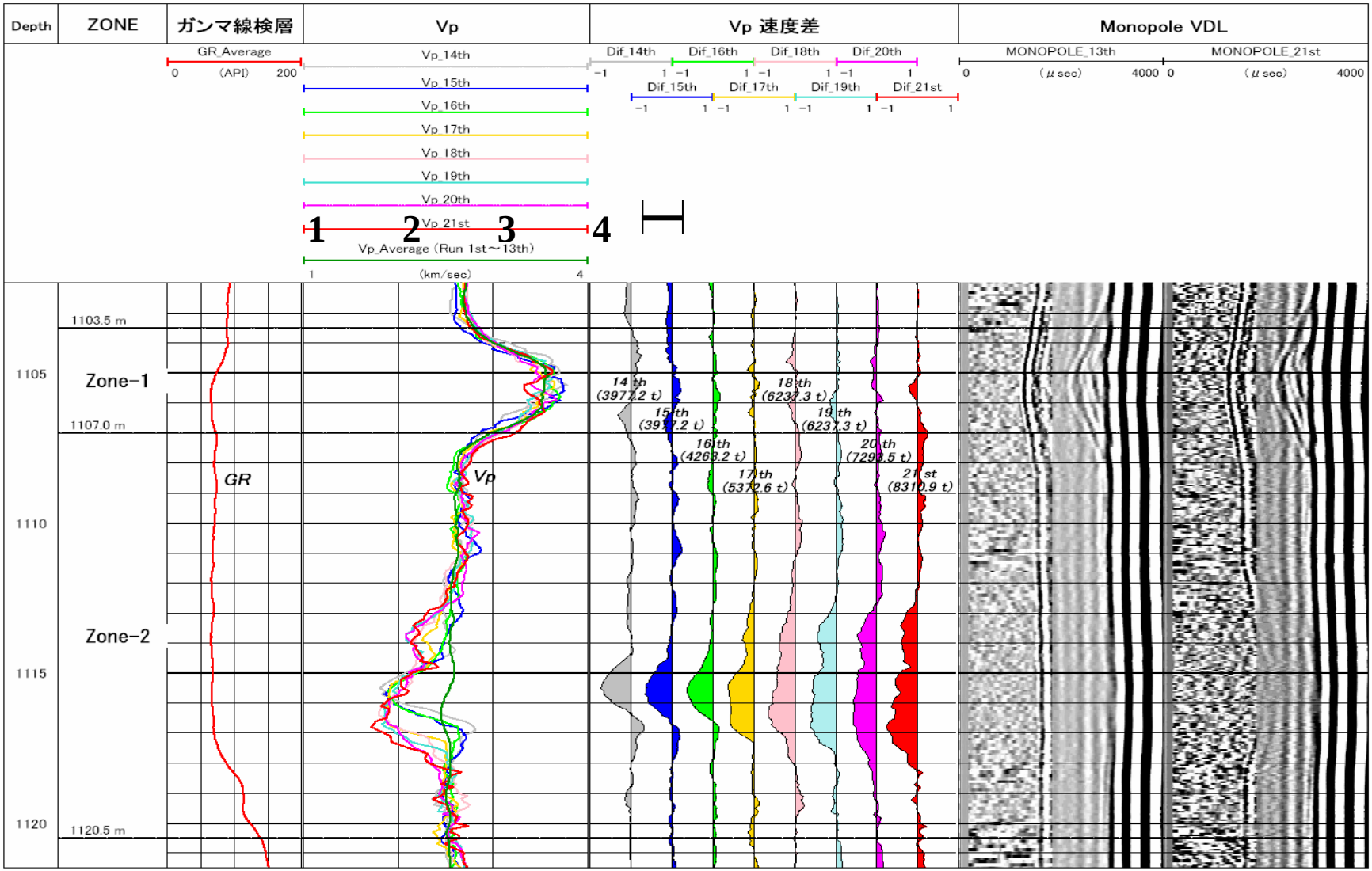
V/Vo (%)

velocity change

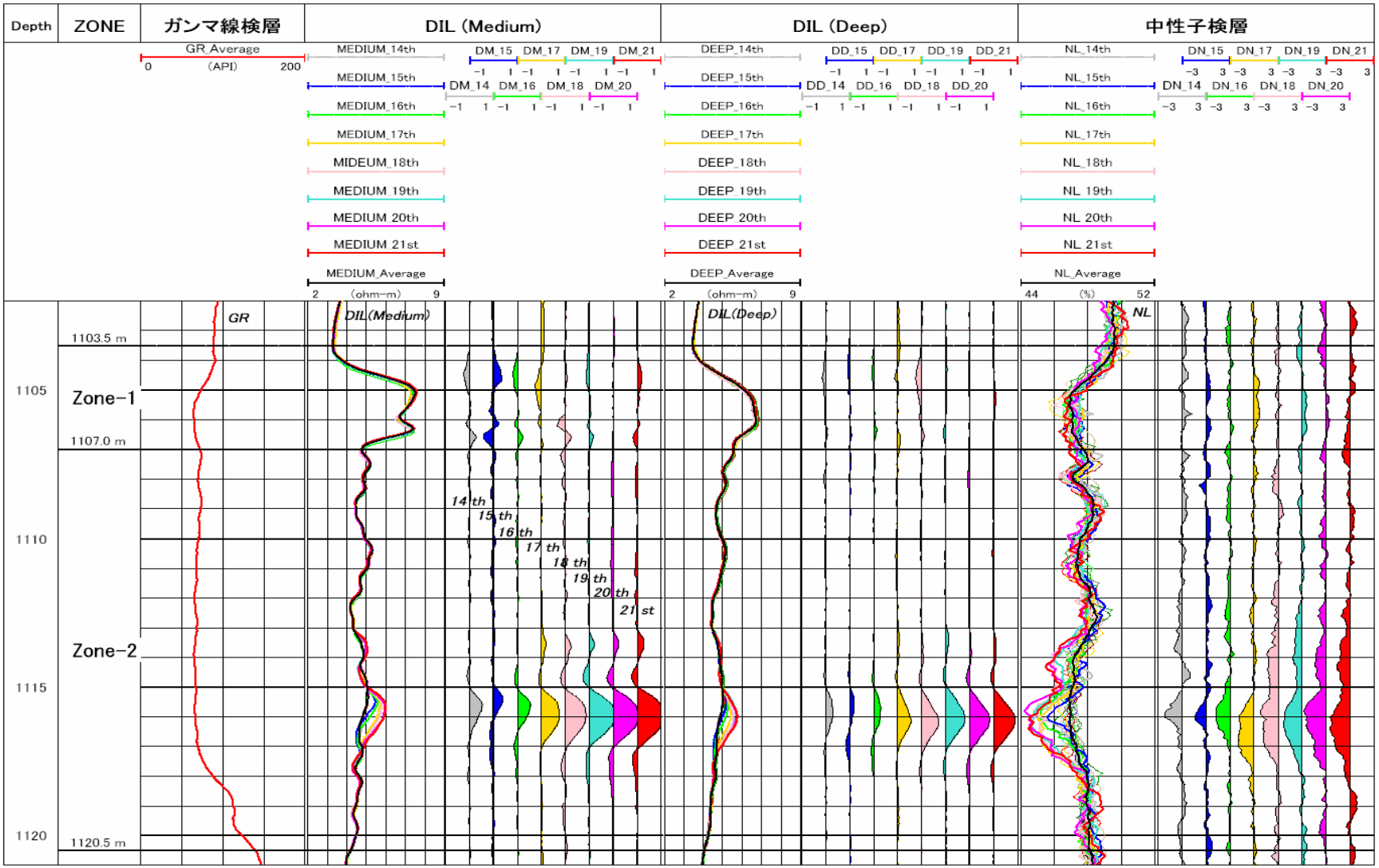
Maximum change
-3.5% (Vp)



CO2-2　Vp (Sonic)

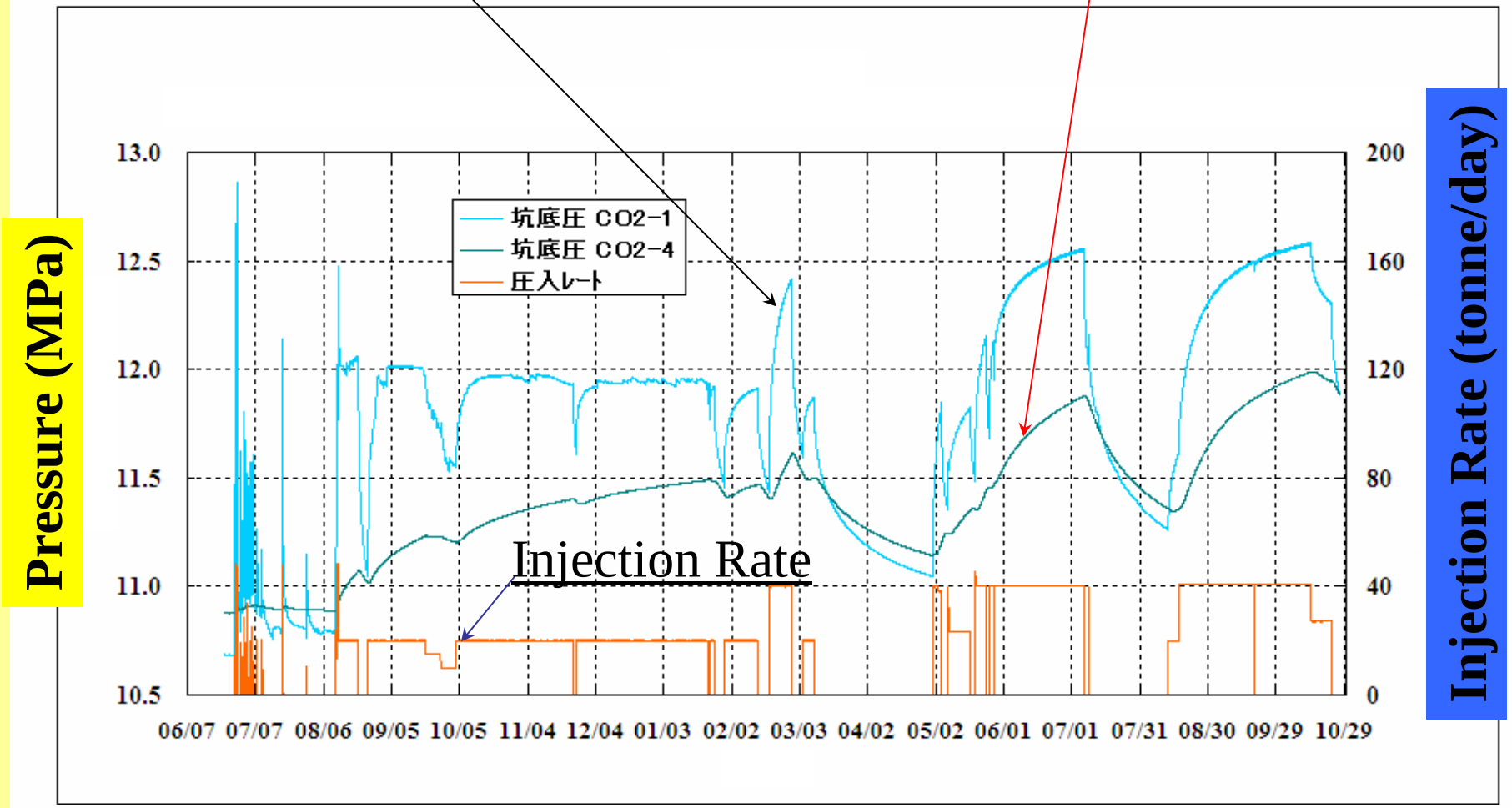


CO2-2 (Induction & Neutron)



The CO_2 Injection Pressure

The Reservoir Formation Pressure at the observation well CO2-4



Estimation of CO_2 Aquifer Storage Potential in JAPAN

Introduction

The technical feasibility of CO_2 storage in aquifer has been proven and demonstrated by the successful experiences in numerous EOR projects and the commercial practice in Sleipner.

Previously, Tanaka et al. (1995) had estimated the aquifer storage capacities as 91.5 B tonnes in Japan.

Encouraged by these facts, Japan had started a 5-year national R&D program of “Underground Storage of Carbon Dioxide (NAGAOKA project is a main part of this program)” to consider the effectiveness of geological storage in Japan.

Since 2005, this project comes into an extra 3-year follow-up phase for selecting a few preferable storage sites as candidates for large-scale demonstration tests in the next phase and for commercial implementations in the near future. As a part of these efforts, the re-estimation of CO_2 aquifer storage capacities was also performed.

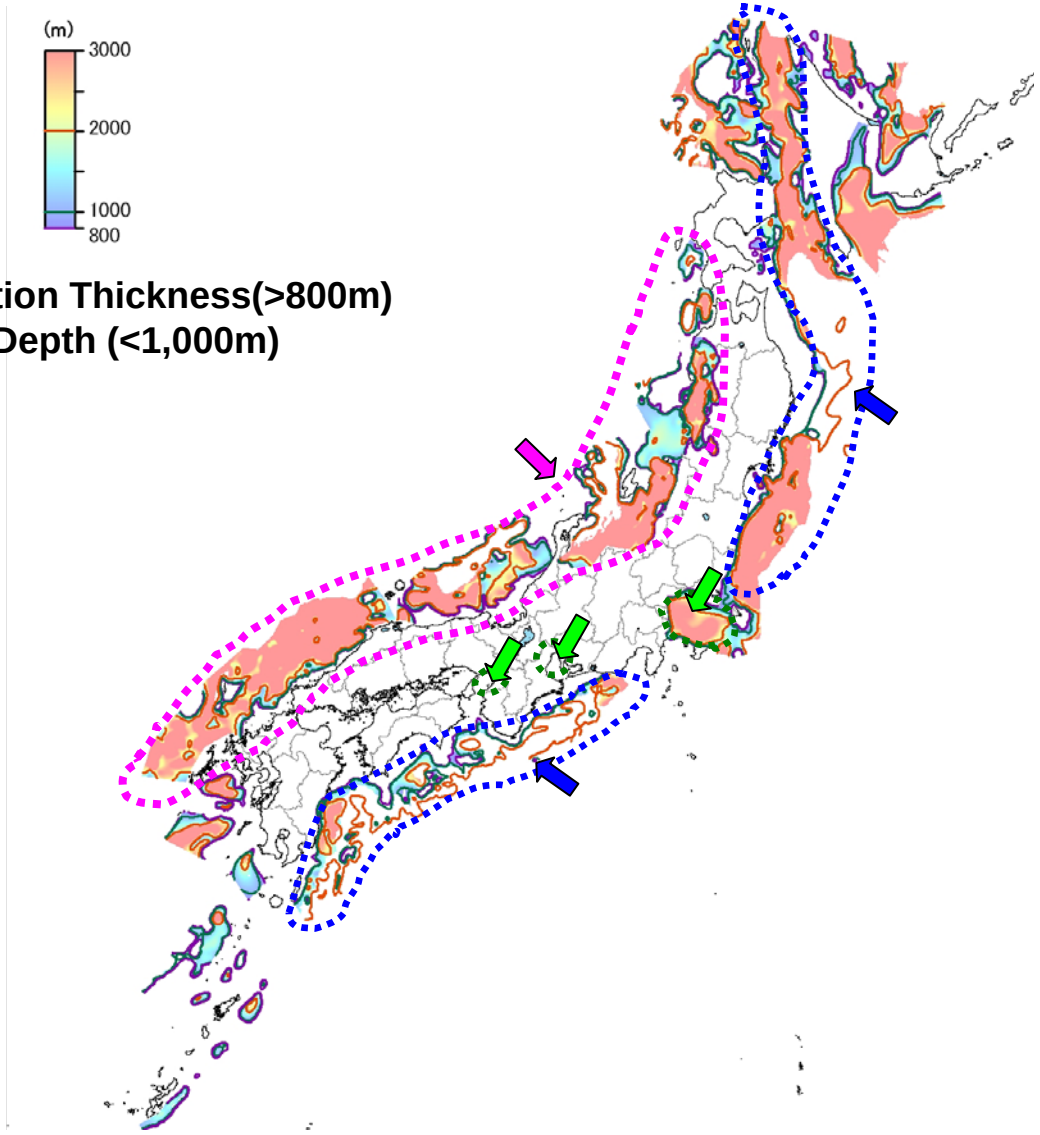
Storage Sites :Locations of Sedimentary Basins in Japan

Japan has a large area of sedimentary basins distributed surrounding the archipelago.

Oil, gas and condensate reservoirs are relevant locations to consider for CO_2 storage because their proven geologic seal that trapped hydrocarbons over a geologic timescale and the acquired various kinds of geologic information.

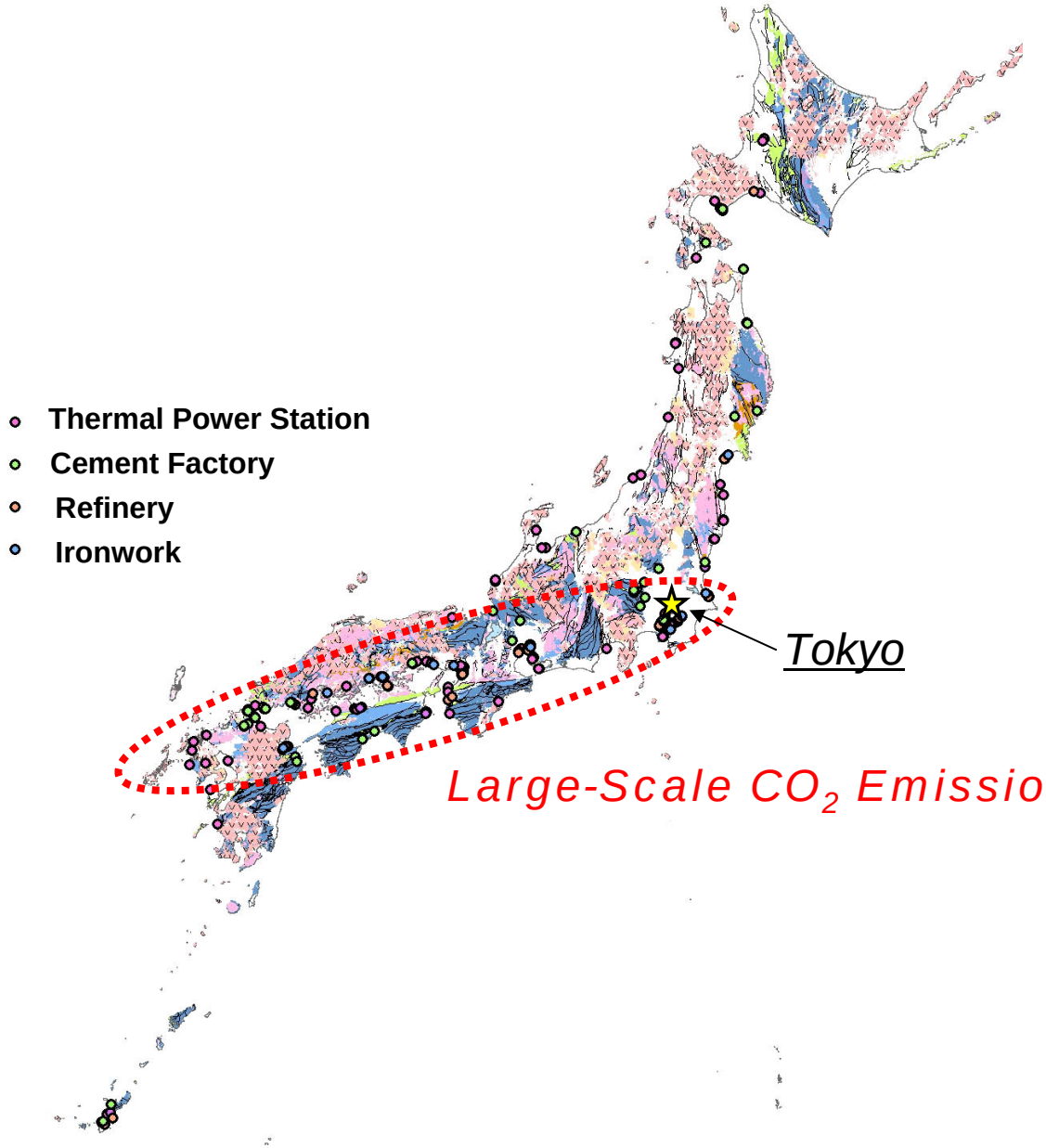
Deep saline formations, which are more common in Japan's geological settings are the first alternatives. They are believed to constitute a large potential storage capacity. However, they usually are much less characterized than reservoirs examined so far by oil & gas industries.

Storage Sites :Locations of Sedimentary Basins in Japan

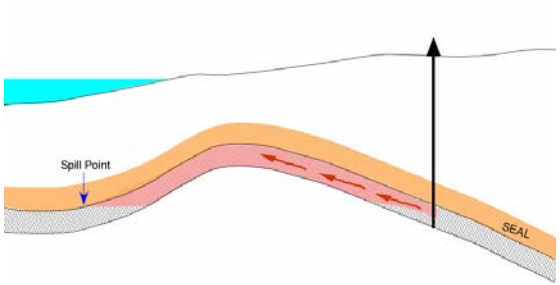
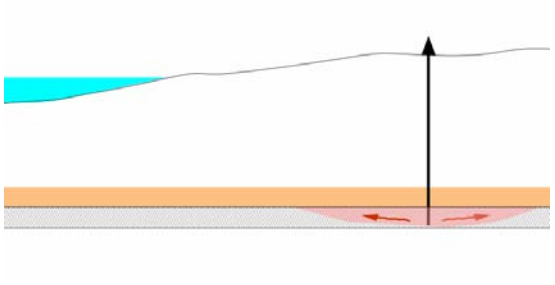


-Formation Thickness(>800m)
-Water Depth (<1,000m)

Storage Sites :Locations of CO_2 Emission Source in Japan



Geological Storage Concept

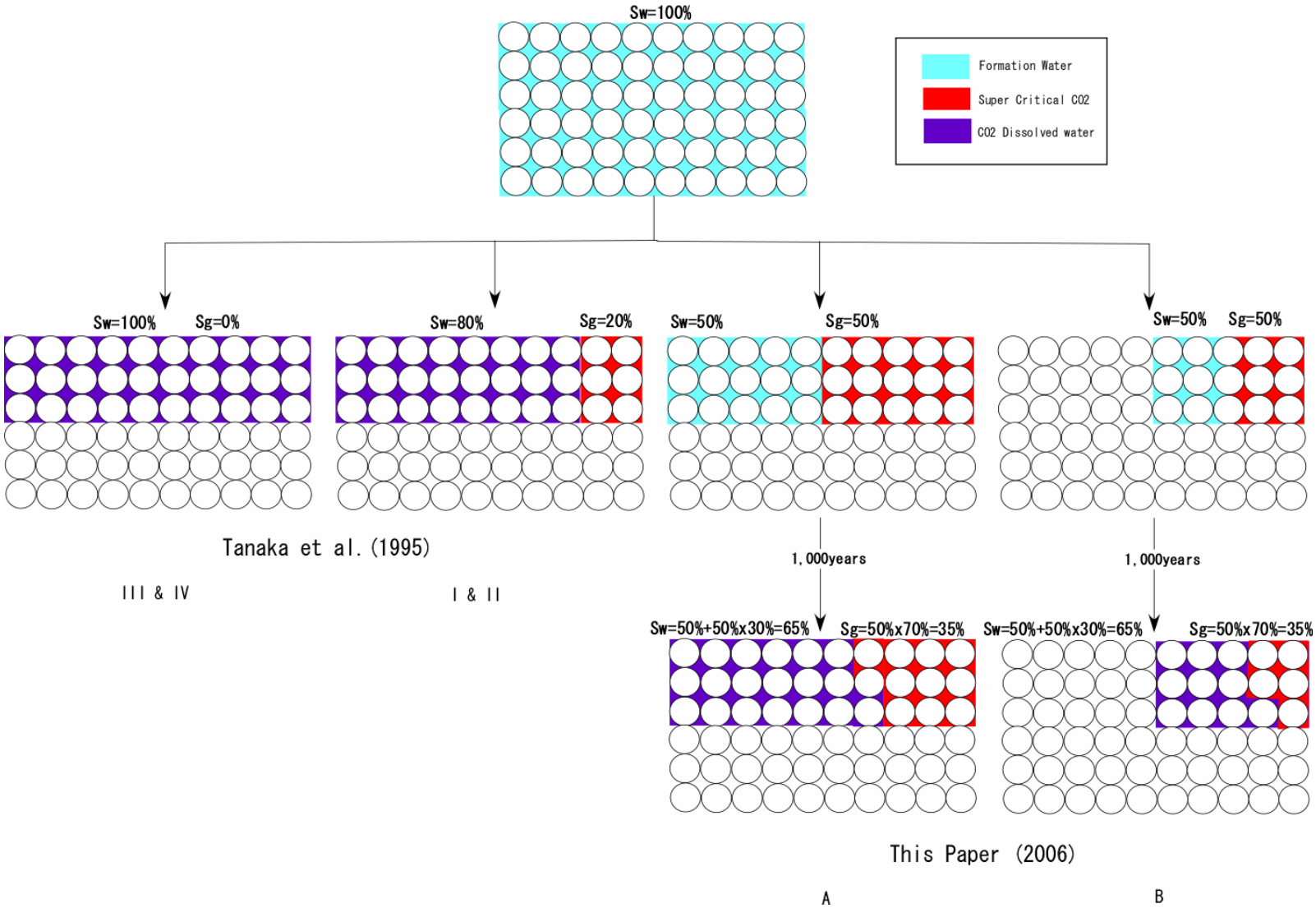
	Structural Traps: A	Monoclinal Structures: B
Oil&Gas Fields	A1	B1
Drilled Structures	A2	B2
Undrilled Structures	A3	
Trap Mechanism	Physical Trapping Primary : Super Critical CO_2 Secondary: Dissolution CO_2	Physical/Residual Trapping Primary : Super Critical CO_2 (Residual) Secondary: Dissolution CO_2
Storage Concept		
Capacity	Actual storage	Huge potential in the near future.

Storage Capacity: Calculation of CO2 Storage Capacity

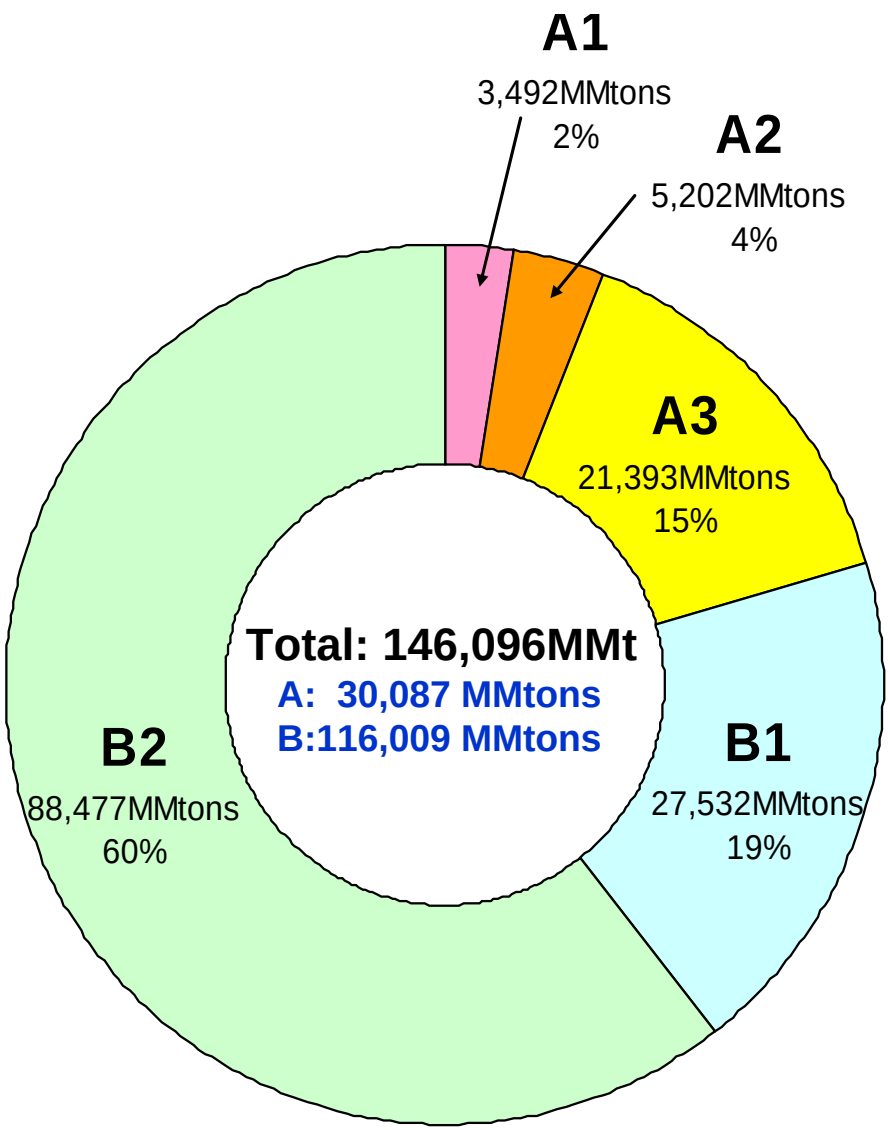
$$C = Ef \times A \times h \times \phi \times Sg / Bg \times \rho$$

C	: Storage Capacity
Ef	: Sweep Efficiency (50% for A, 25% for B)
A	: Area
h	: Average Effective Thickness
ϕ	: Average Porosity
Sg	: CO_2 Saturation (50%)
Bg	: CO_2 Volume Factor
ρ	: Density of CO_2 under 0℃ and 1atm

Storage Capacity: Calculation Concept of CO_2 Storage Capacity



Storage Capacity: Estimated CO2 Storage Capacity



Results: CO_2 Storage Capacities

Tanaka et al (1995)			This Paper (2006)			
Categories	**Definitions**	**Capacity**	**Categories**		**Definitions**	**Capacity**
I	**Oil &Gas Reservoir**	**2.0**	**A**	**A1**	**Oil &Gas Reservoir**	**3.5**
II	**Drilled Anticlinal Structures**	**1.5**		**A2**	**Drilled Structural Traps**	**5.2**
				A3	**Undrilled Structural Traps**	**21.4**
III	**Monoclinal Structures (onshore gas dissolved fields)**	**16.0**	**B**	**B1**	**Monoclinal Structures (onshore gas dissolved fields)**	**27.5**
IV	**Monoclinal structures Offshore(WD <200m)**	**72.0**		**B2**	**Monoclinal Structures Offshore (WD <200m)**	**88.5**
Total		**91.5**	**Total**			**146.1**

(in billion tonnes) (in billion tonnes)