International Workshop on Offshore Geological CO_2 Storage,
19-21 April 2016, Austin, USA

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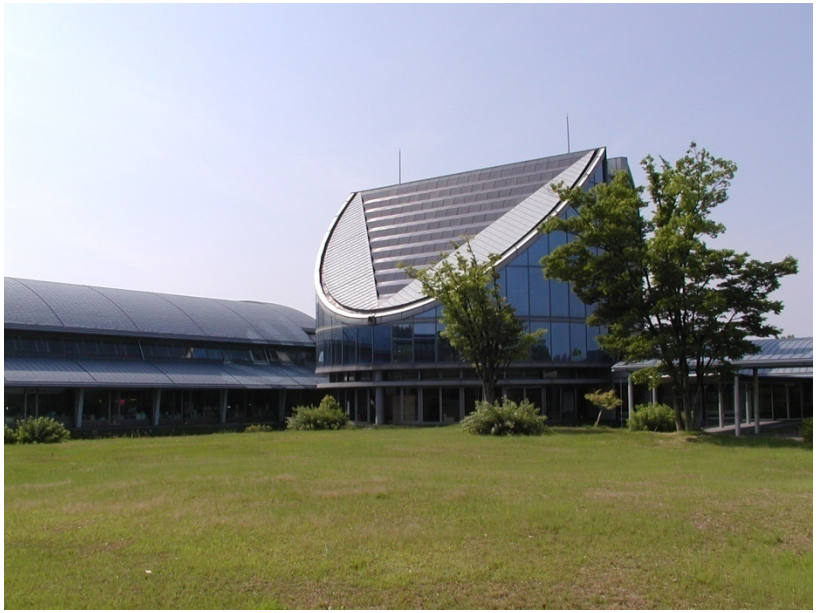
How to reach an offshore injection phase, Japan case study

19 April 2016



Ryozo Tanaka

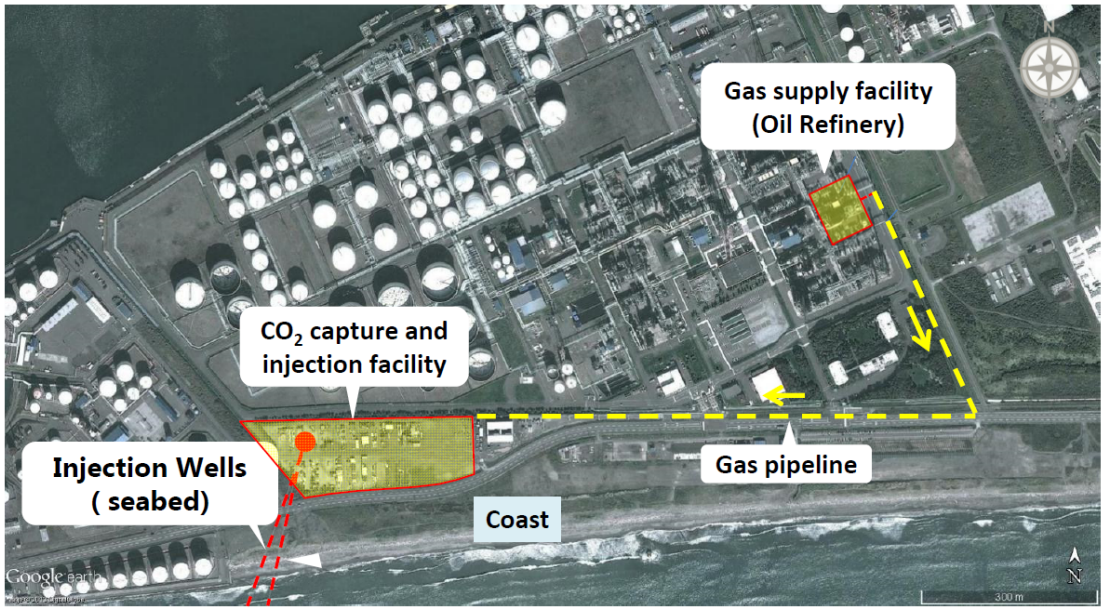
Senior Researcher

CO_2 Storage Research Group

Research Institute of Innovative Technology for the Earth (RITE)

Japan's full-chain CCS demonstration project with an offshore CO_2 storage site became operational in Tomakomai on 6 April 2016.

CO_2 is captured at a hydrogen production unit and will be injected at a rate of more than 100,000 t/yr for three years.



(METI, 2016)

(METI, 2015)

CO_2 Storage Projects and Vision of CCS

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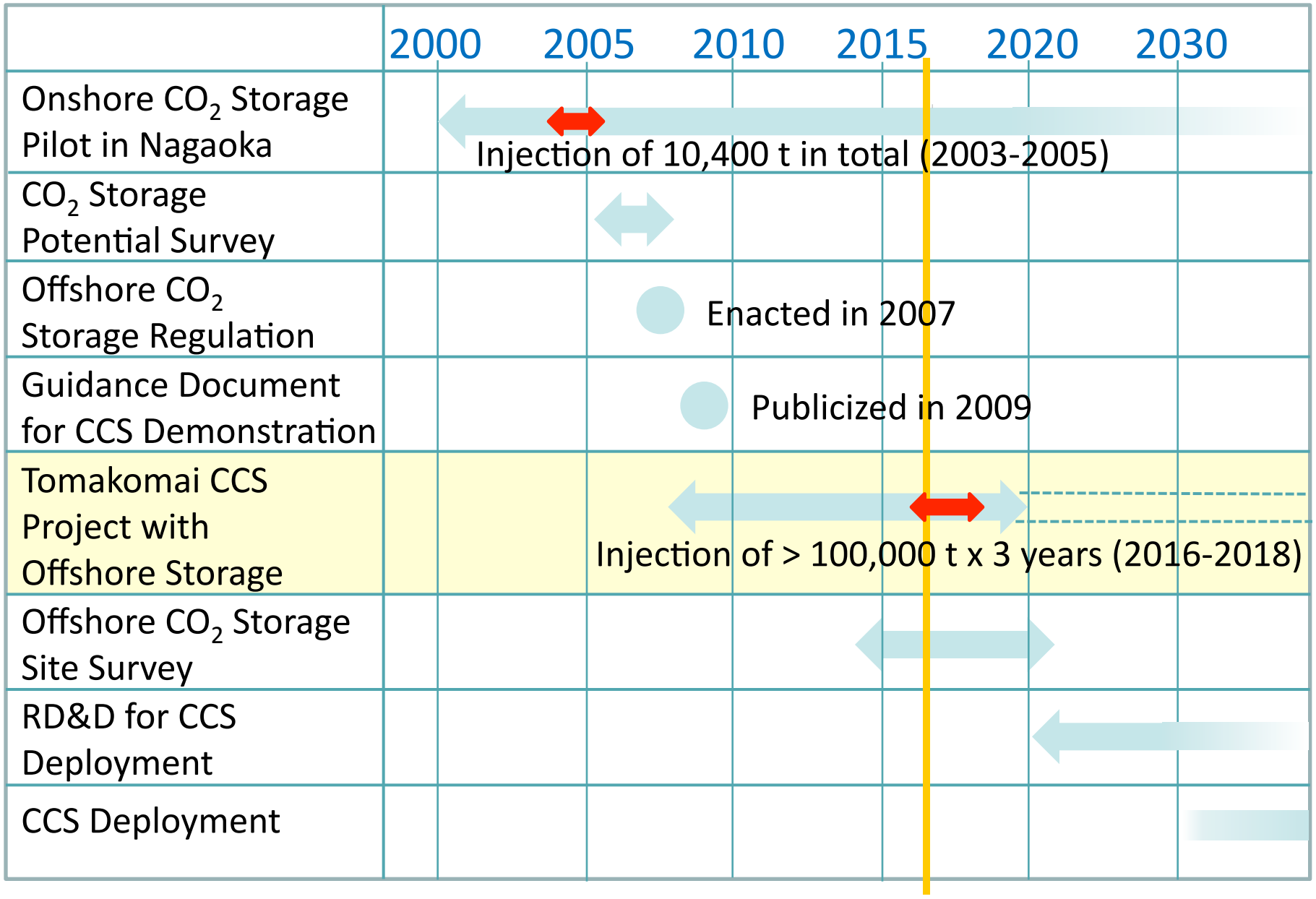

Onshore CO_2 storage pilot in Nagaoka

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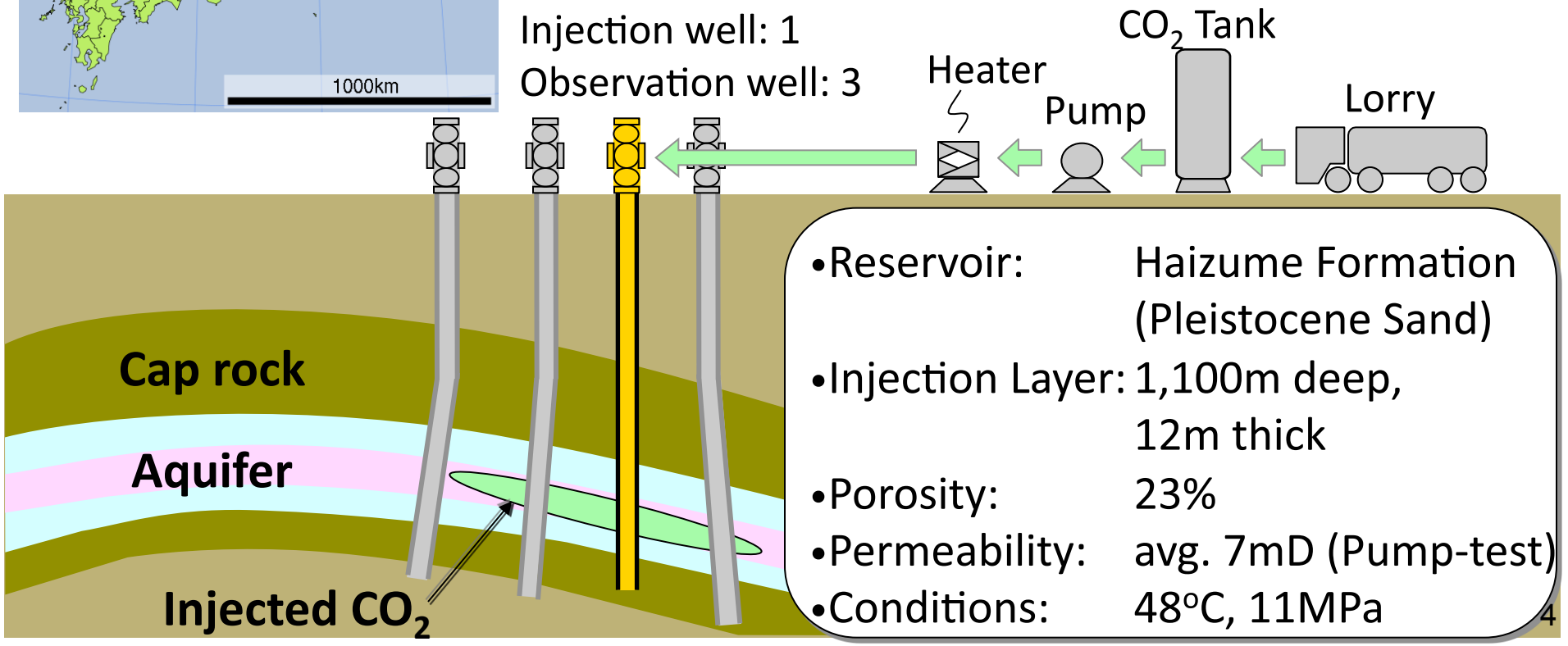
RITE-led project in the INPEX's Minami Nagaoka gas field

- Total volume: 10,400 t-CO_2
- Rate: 20 - 40 t/day
- Period: July 2003 - January 2005



- Reservoir: Haizume Formation (Pleistocene Sand)
- Injection Layer: 1,100m deep, 12m thick
- Porosity: 23%
- Permeability: avg. 7mD (Pump-test)
- Conditions: 48°C, 11MPa

Overview of Nagaoka Storage Site

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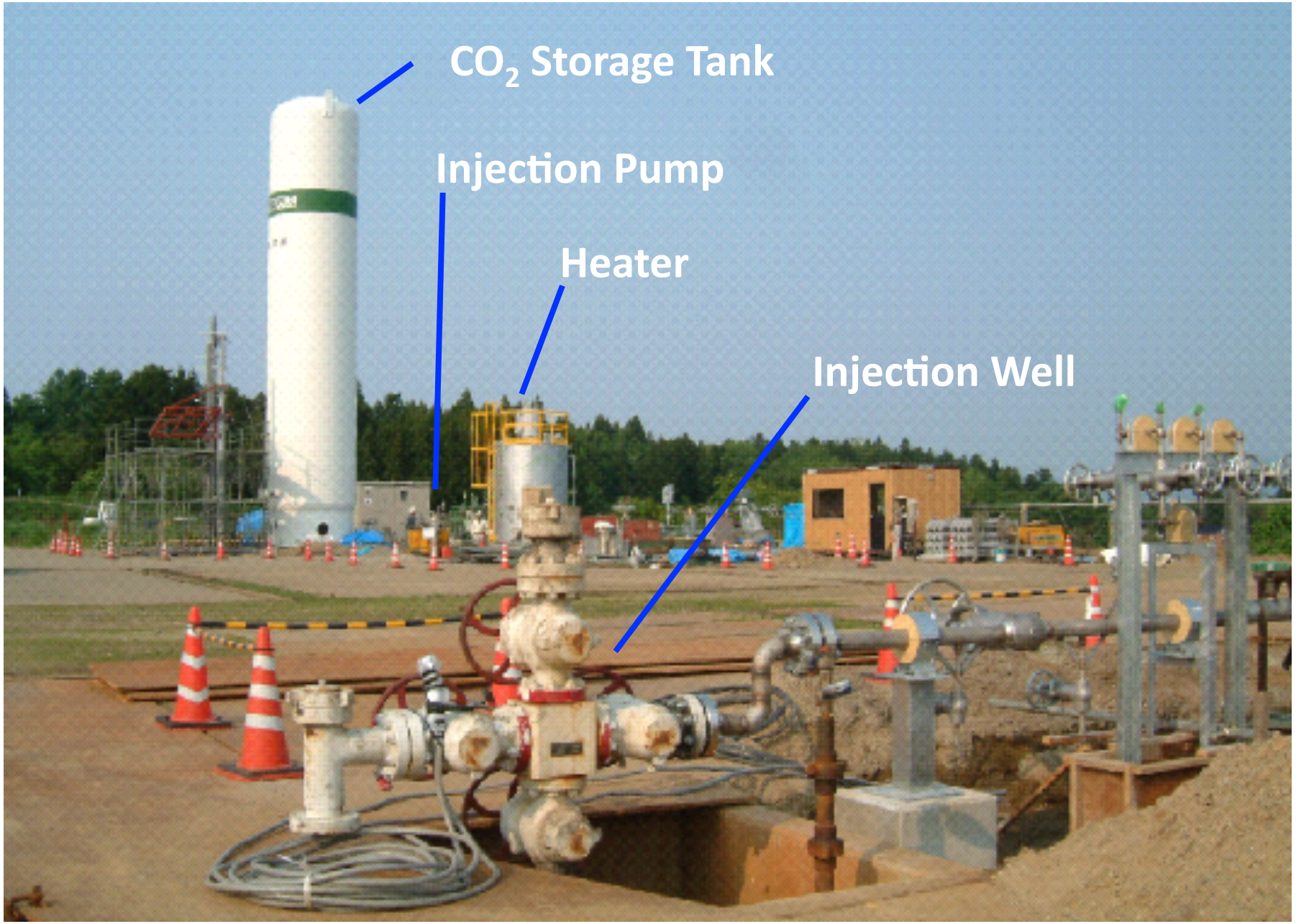

CO_2 Monitoring in Nagaoka

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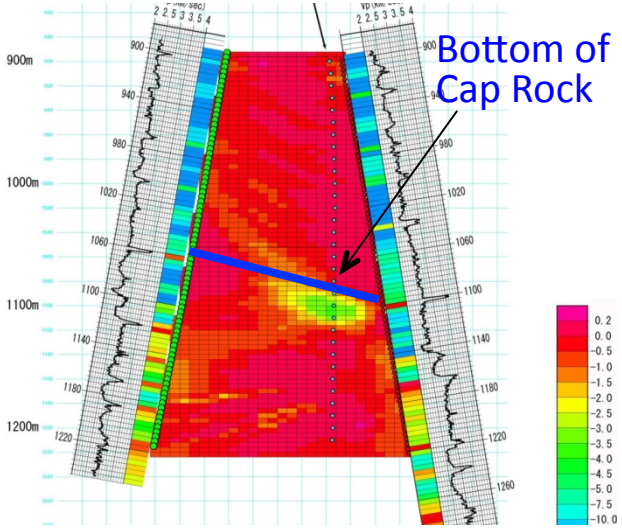
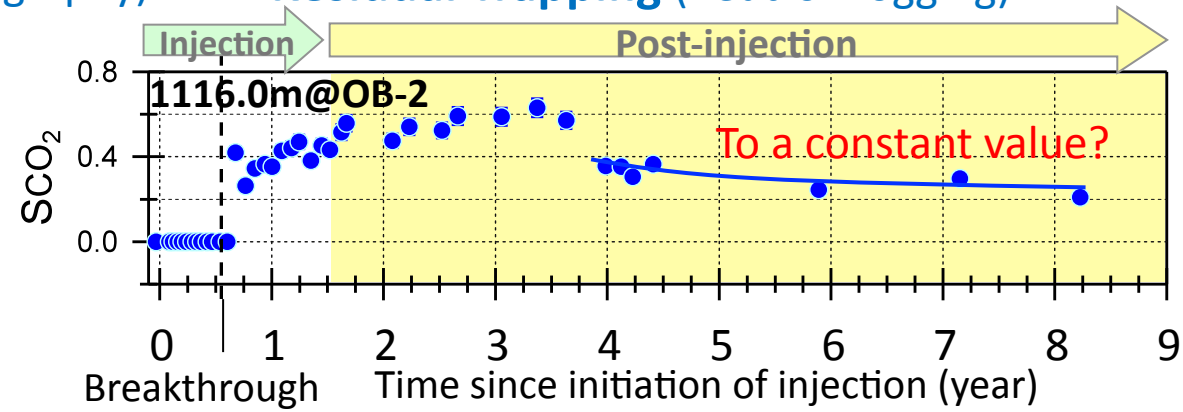
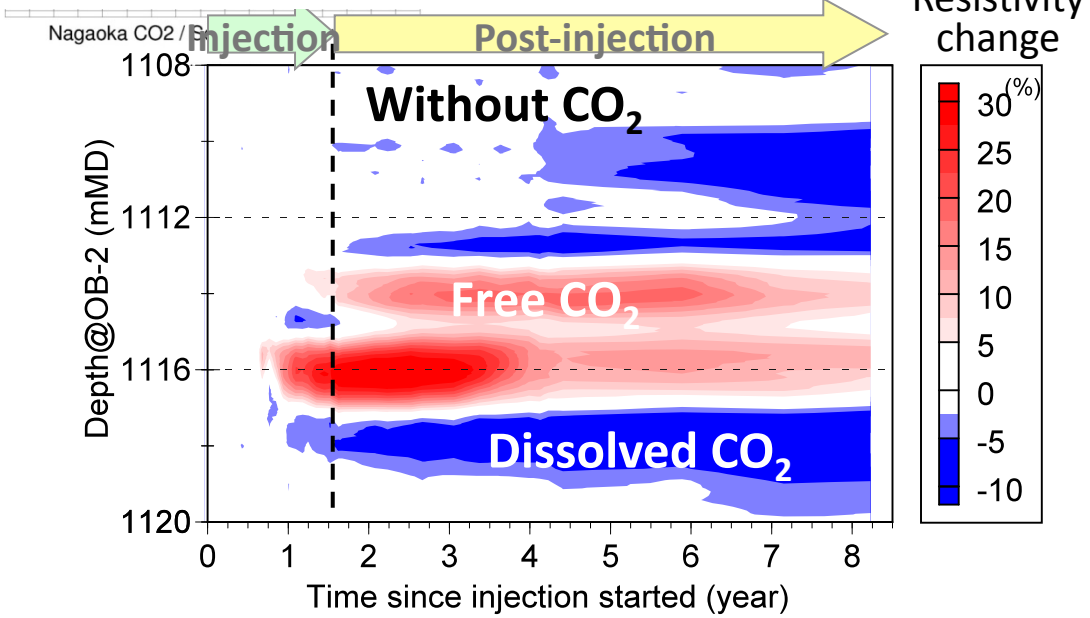
Structural Trapping (seismic tomography)



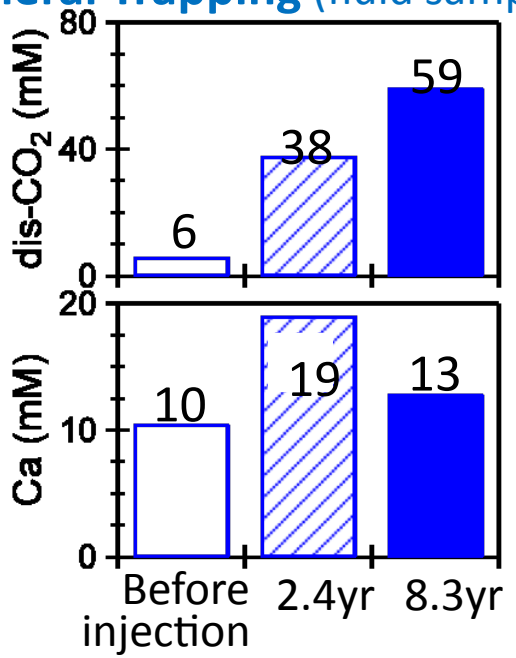
Residual Trapping (neutron logging)



Solubility Trapping (Induction logging)



Mineral Trapping (fluid sampling)



Dis-CO_2 and Ca at 1118m

Geological Modelling of Nagaoka Site

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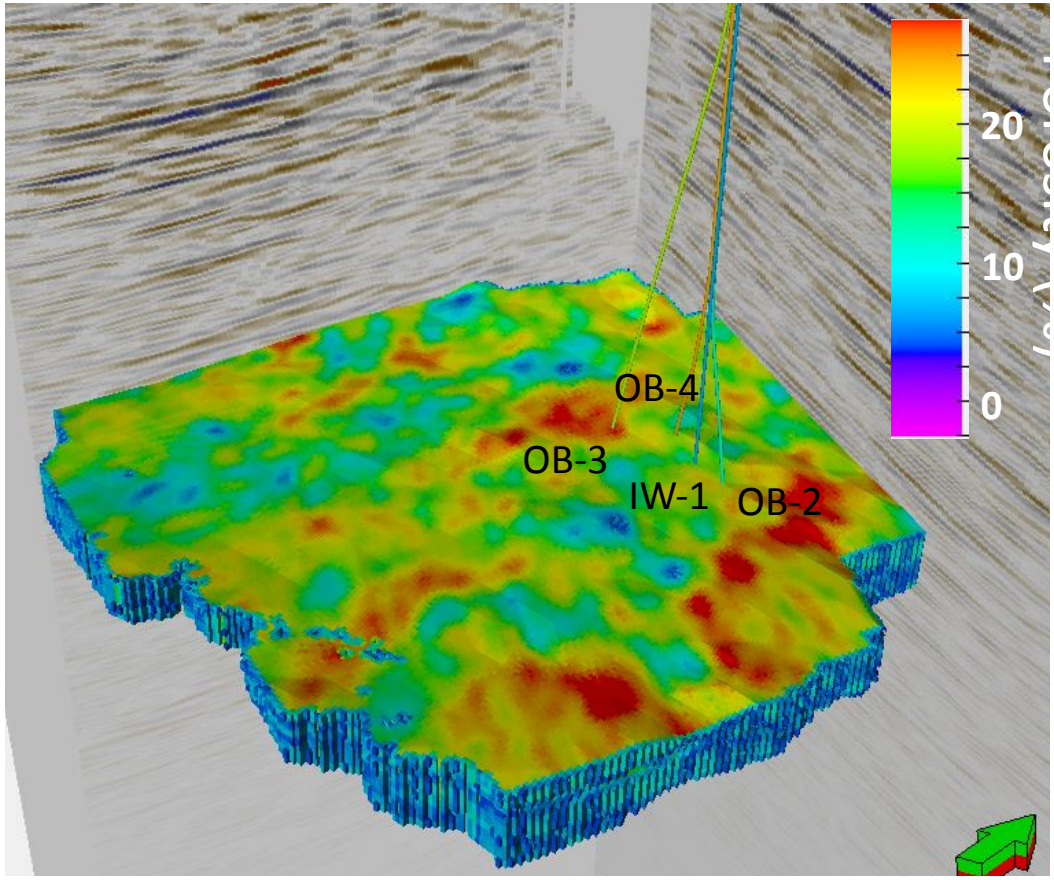
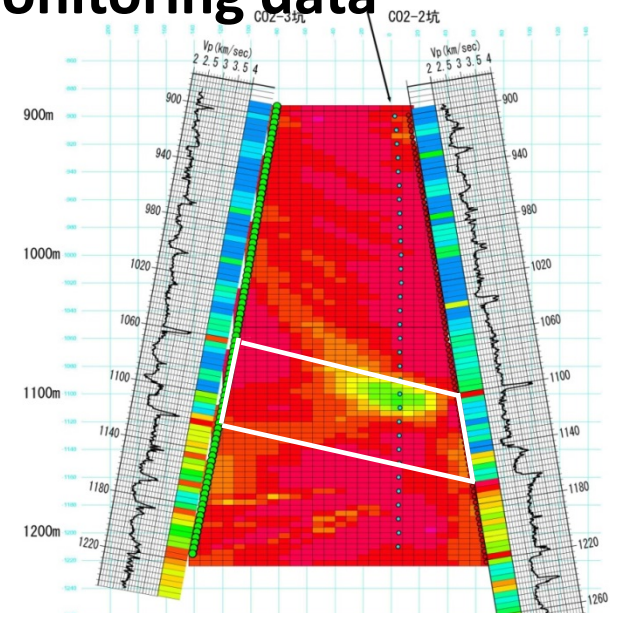
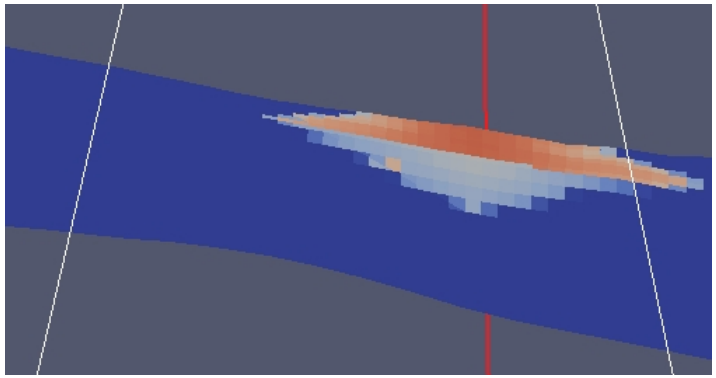
Geological Modelling (*e.g.* Porosity distribution)



Monitoring data



Simulation result



CO_2 Storage Potential Survey

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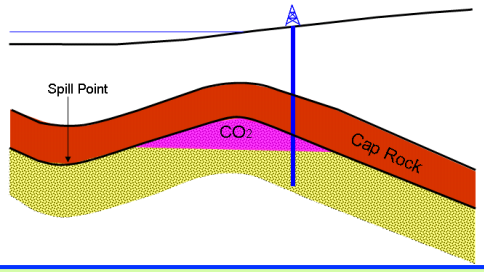
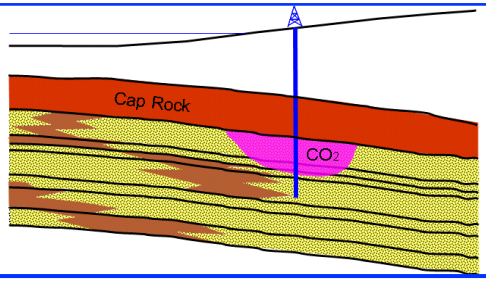
RITE-led Survey, based on available well and seismic data (2005-2007)

Geological Data	Category A **(Closed structure aquifers)**	Category B* **(Open structure aquifers)**
Existing oil/gas field: Well and seismic survey data abundant	A1: 3.5 Gt-CO_2	B1: 27.5 Gt-CO_2 (dissolved-in-water type natural gas fields)
Exploratory well and seismic survey: Well and seismic survey data available	A2: 5.2 Gt-CO_2	
Basic seismic survey: Seismic survey data available, but no well data	A3: 21.4 Gt-CO_2	B2: 88.5 Gt-CO_2 (16 offshore areas)
Type of Reservoir Structure		
Sub-total	30.1 Gt-CO_2	116.0 Gt-CO_2
Total	146.1 Gt-CO_2	

Based only on public domain data of oil & gas exploration. Inland basins, such as Seto inland sea, Osaka Bay are excluded. *Deeper than 800m and shallower than 4,000m, located in waters shallower than 200m.

CO_2 Storage Potential Distribution

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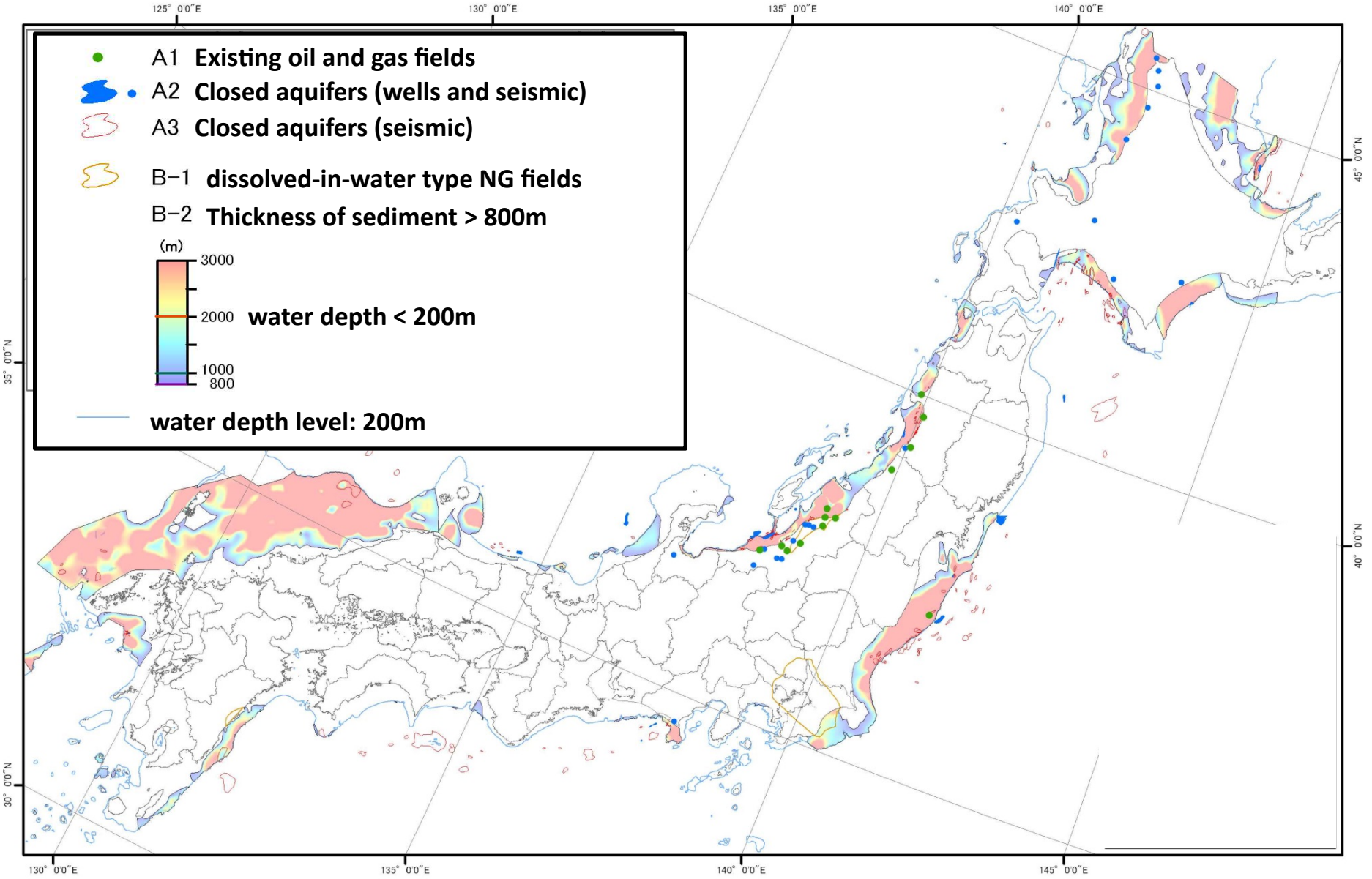

Tomakomai CCS Demonstration Project

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METI commissioned the CCS demonstration planning and the implementation of the demonstration to Japan CCS Company.

2008	Storage site screening: 115 sites ➡ 7 sites
2009 – 2012	CCS F/S, including fault assessment: 7 sites ➡ 3 sites Geological survey and project planning: 3 sites ➡ Tomakomai
2012 – 2015	Tomakomai project construction phase 2012 Q2 – 2015 Q3: Engineering, procurement and construction 2014 Q4 – 2015 Q4: Baseline monitoring 2015 Q3 – 2016 Q1: Test operation
2016 – 2018	Tomakomai project operation phase Injection started on 6 April 2016
2019 – 2020	Post-injection monitoring

Overview of Tomakomai CCS Project

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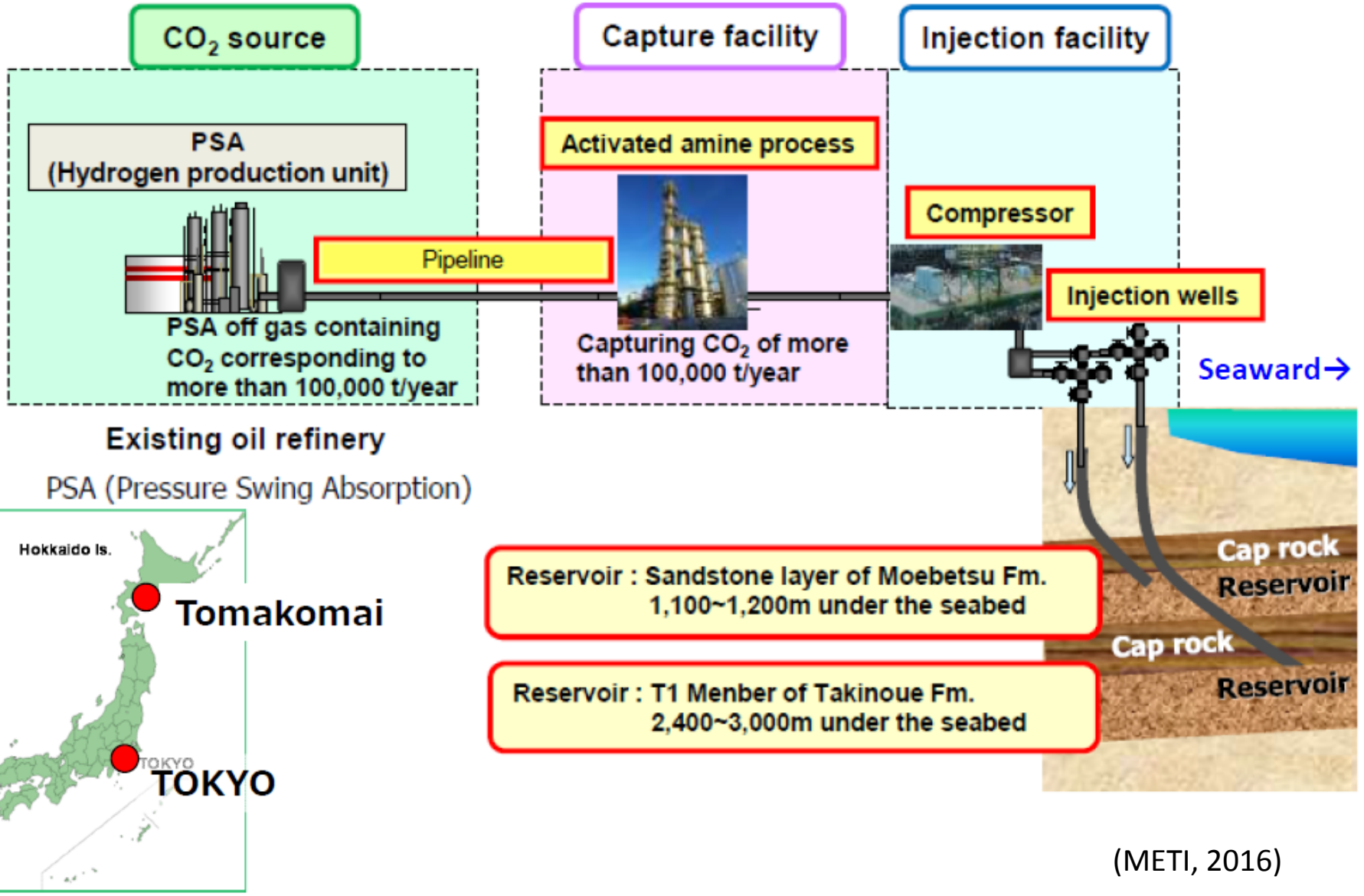
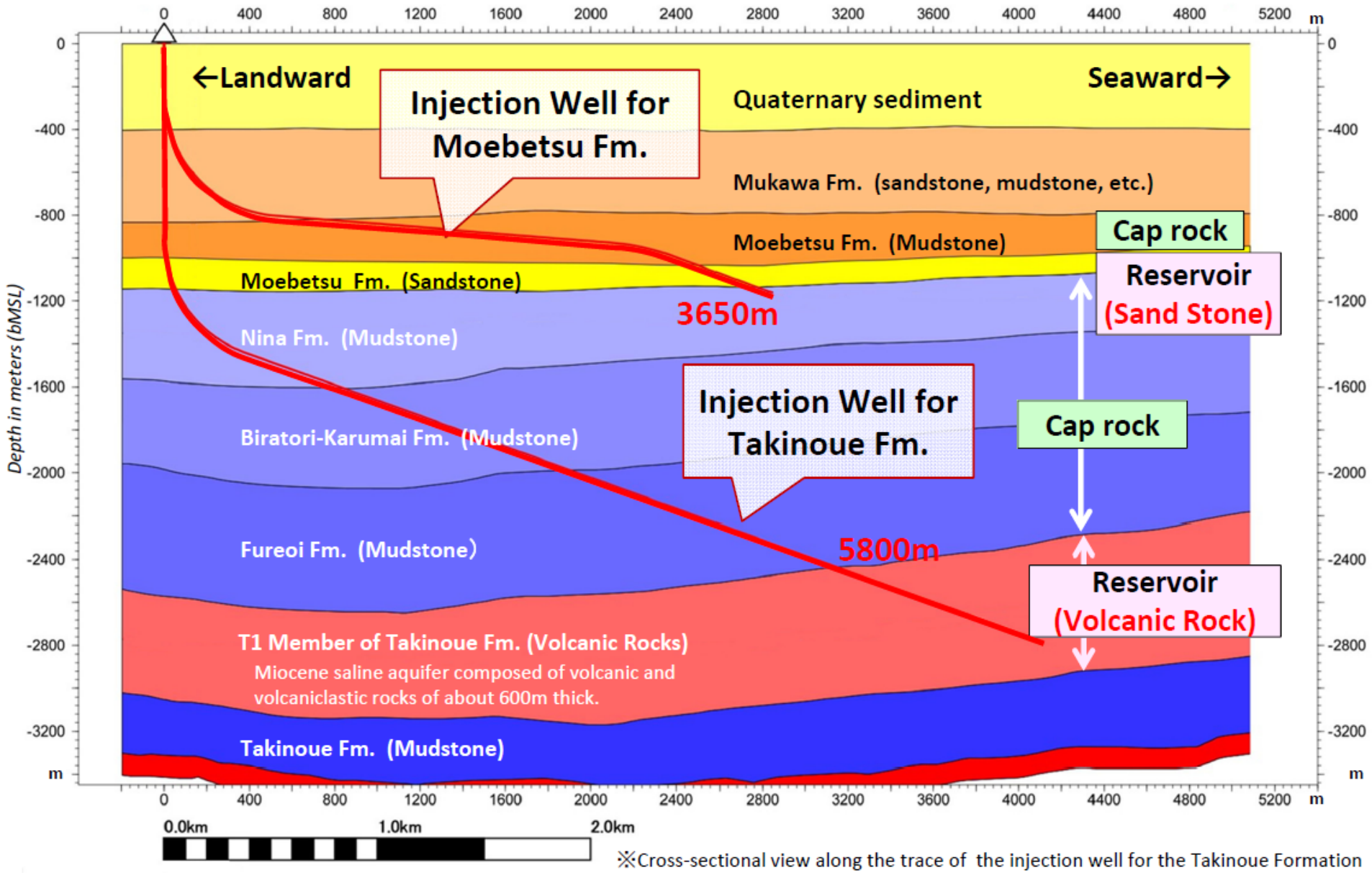


(METI, 2016)

Offshore CO_2 Reservoirs in Tomakomai



※Cross-sectional view along the trace of the injection well for the Takinoue Formation

(METI, 2016)

CO_2 Monitoring Plan in Tomakomai

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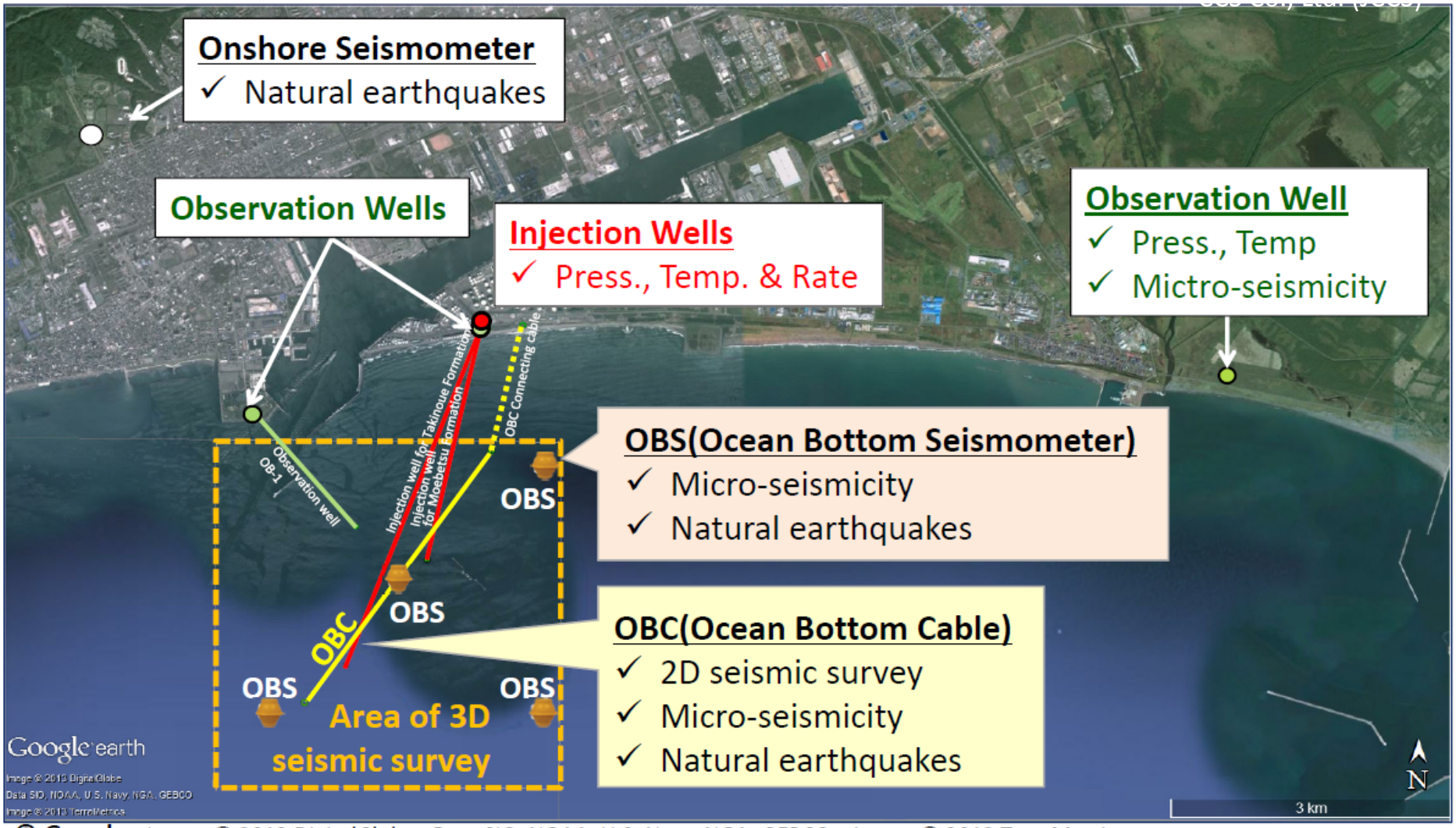

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(METI, 2016)

Marine Environment Monitoring in Tomakomai

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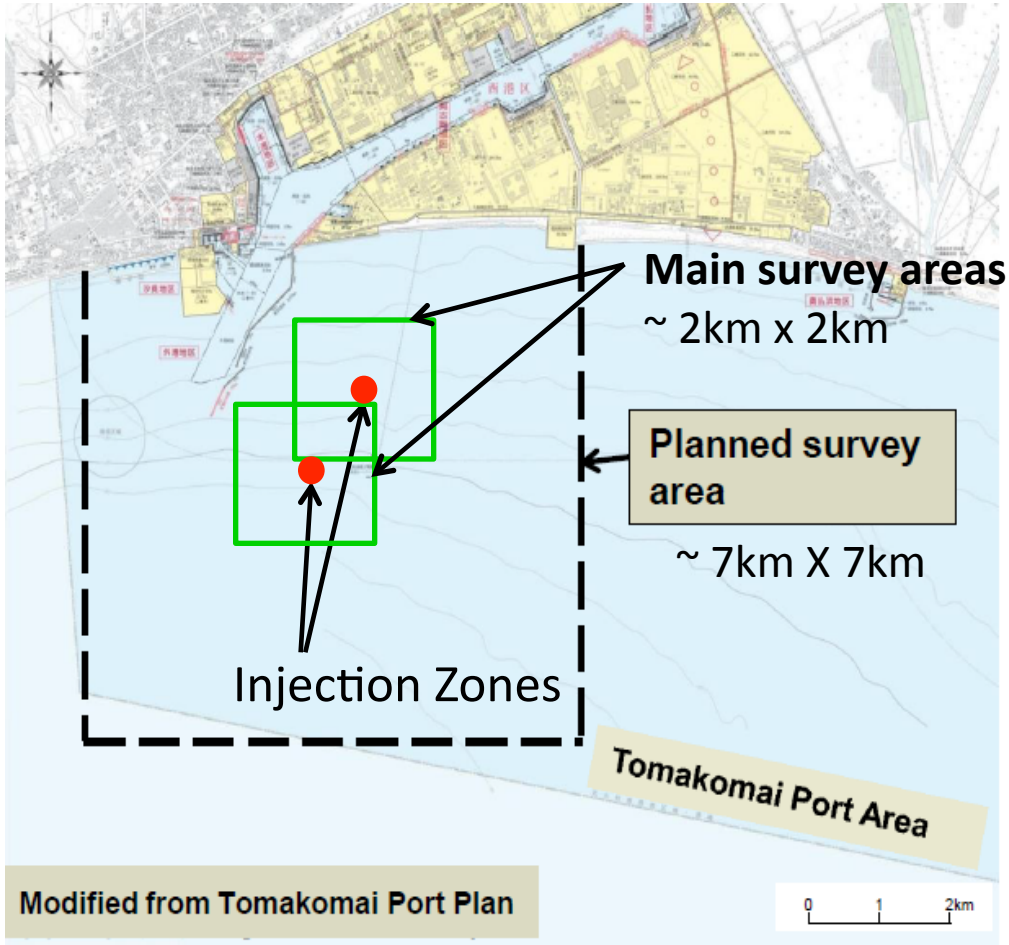
Survey Areas:



Major Planned Surveys:

- Survey of seabed surface by Side-Scan Sonar and Sub-bottom Profiler
- Sampling of seawater by Water Sampler for concentration of CO_2 and plankton observation etc.
- Sediment survey by Bottom Sampler
- Benthos observation by Bottom Sampler, divers, ROV and Dredge

Offshore CO_2 Storage Regulation

Research Institute of Innovative Technology for the Earth

Amendment of the Marine Pollution Prevention Act was enacted by the Ministry of the Environment (MOE) in 2007.

Key Provisions for Offshore CO_2 disposal (storage):

CO_2 storage operators:

(1) must obtain a CO_2 disposal permit from Minister of the Environment,

(2) must conduct marine environment impact assessment before submission of permit application, and

(3) must monitor the status of pollution at the storage site.

Major documents required for permit application

- Project plan
- Monitoring plan
- Site selection report
- Environmental impact assessment Report
- Document to present financial capability
- Document to present technical capability

Guidance Document for CCS Demonstration

"For safe operation of a CCS demonstration project" publicized by the Ministry of Economy, Trade and Industry (METI) in 2009.

1)Safety consideration for placing CCS-related facilities(Mining Safety Act)

2)Transportation Standard (High pressure regulation)

3)Concentration standard of CO2 to be injected (Marine Pollution Act)

4)Safety consideration for the drilling, completion and P&A (plugging and abandonment) for CO2 injection and storage wells (Mining Safety Act)

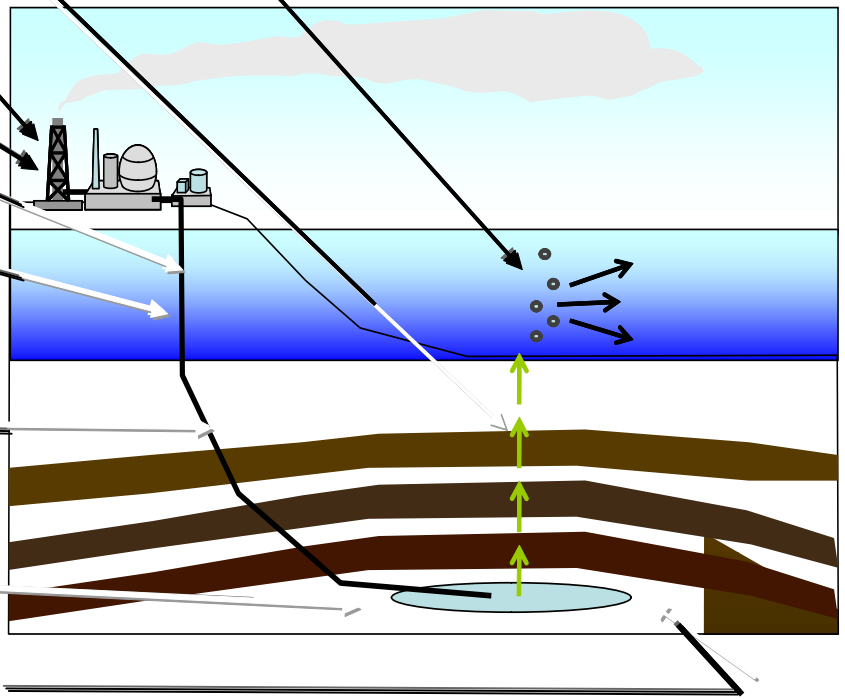
5)Safety considerations for CO2 injection and operation (Planning of injection and operation)

6)Things to be assessed for CO2 storage from geological aspects (Geological structure model)

7)Monitoring (Simulation, History matching)

8)Measures to be taken when abnormalities occur (Standard of detecting, Guideline for coping)

9)Environmental Impact Assessment (EIA) (Scenario of CO2 seepage, Risk change)



Offshore CO_2 Storage Site Survey

Survey to identify 3 or more proven offshore storage sites with > 100 million t-CO_2 storage capacity through seismic and drilling surveys.

Year	2014	2015	2016	2017	2018	2019	2020 ～

Investigation on Potential CO_2 Storage Site and Capabilities

2D Seismic Survey & Data Analysis …14 sites

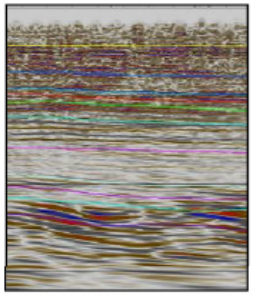
3D Seismic Survey & Data Analysis …6 sites

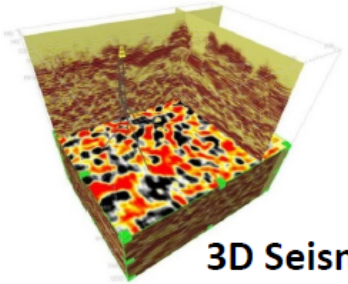
Drilling Exploratory Wells, & Evaluation …5 sites

Drilling wells

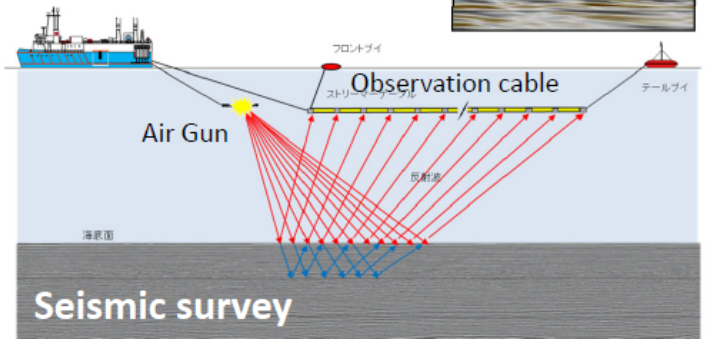
Selection of Storage Sites

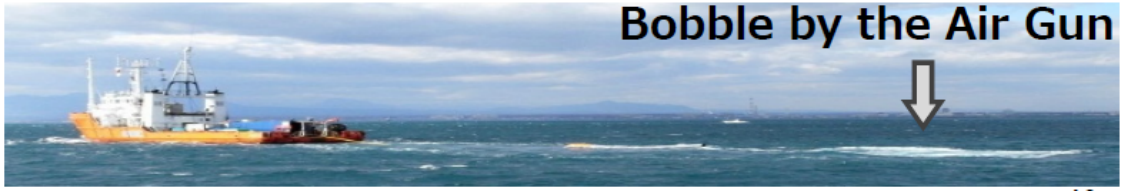
2D Seismic Data





3D Seismic Data





(METI, 2016)

CO_2 Storage Projects and Vision of CCS

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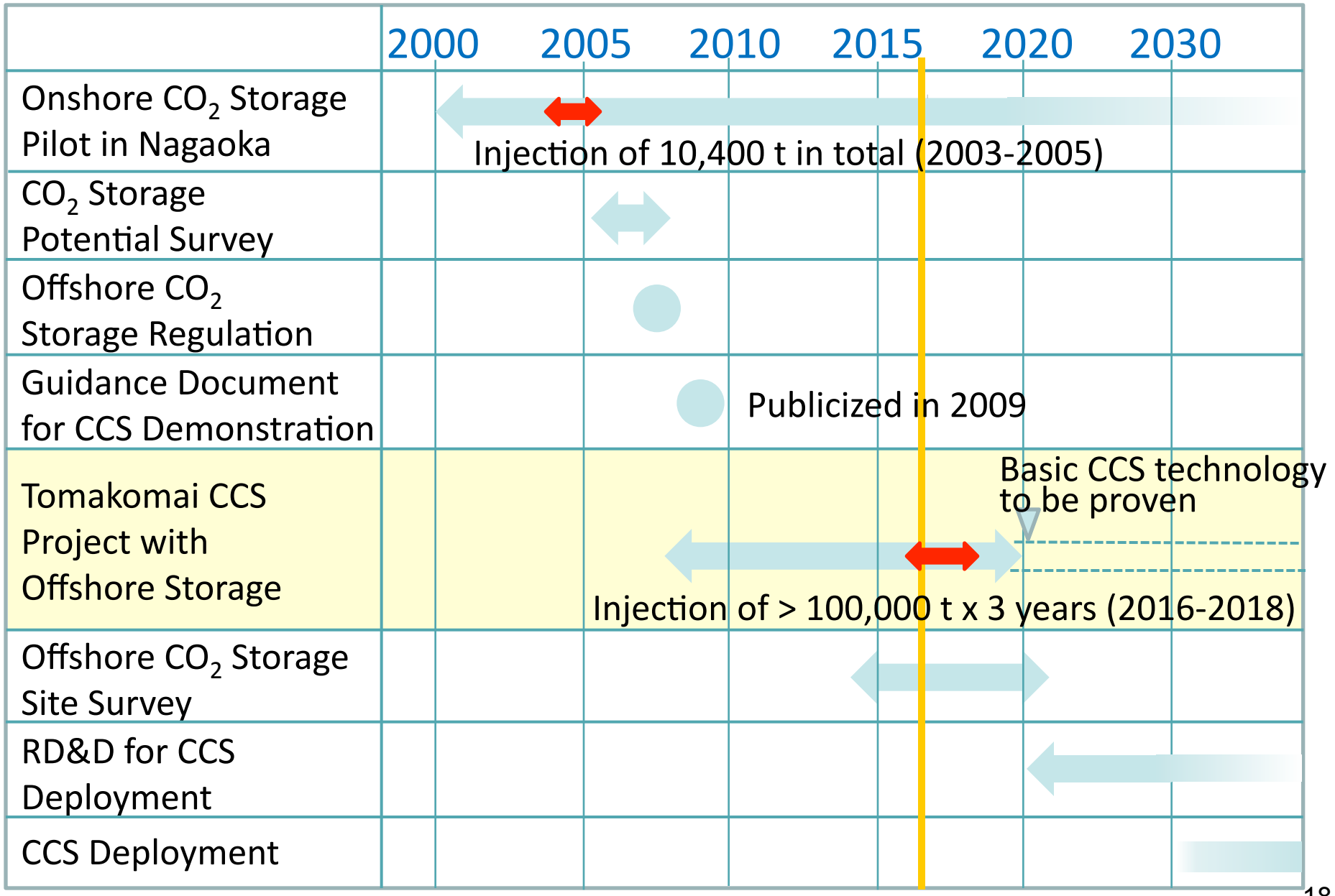

Summary

- Expertise on CO_2 monitoring and modelling has been acquired through the onshore CO_2 storage pilot in Nagaoka.
- The CO_2 storage potential survey concluded that Japan has a CO_2 storage resource of 146 Gt.
- Building on the Nagaoka storage pilot and the CO_2 storage potential survey, the Tomakomai CCS demonstration project with offshore CO_2 storage became operational on 6 April 2016.
- The Tomakomai project is compliance with the offshore CO_2 storage regulation and the guidance document for CCS demonstration projects.
- 3 or more proven CO_2 storage sites will be identified by 2021.
- Following RD&D in the 2020s, large-scale CCS projects may be deployed in Japan in the 2030s.

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