

# Experience of Tomakomai CCS Project

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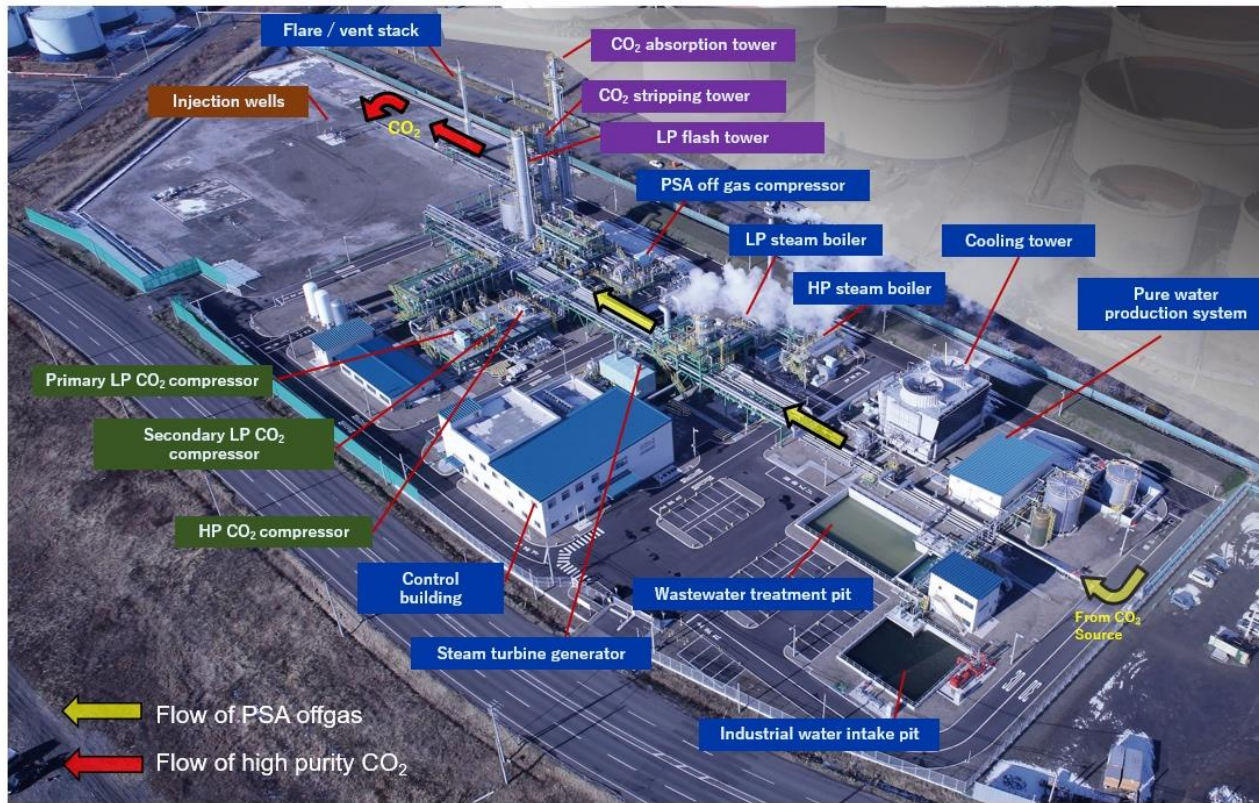
Deep Dive Workshop, Asia Clean Energy Forum 2020

# Tomakomai CCS Demonstration Project

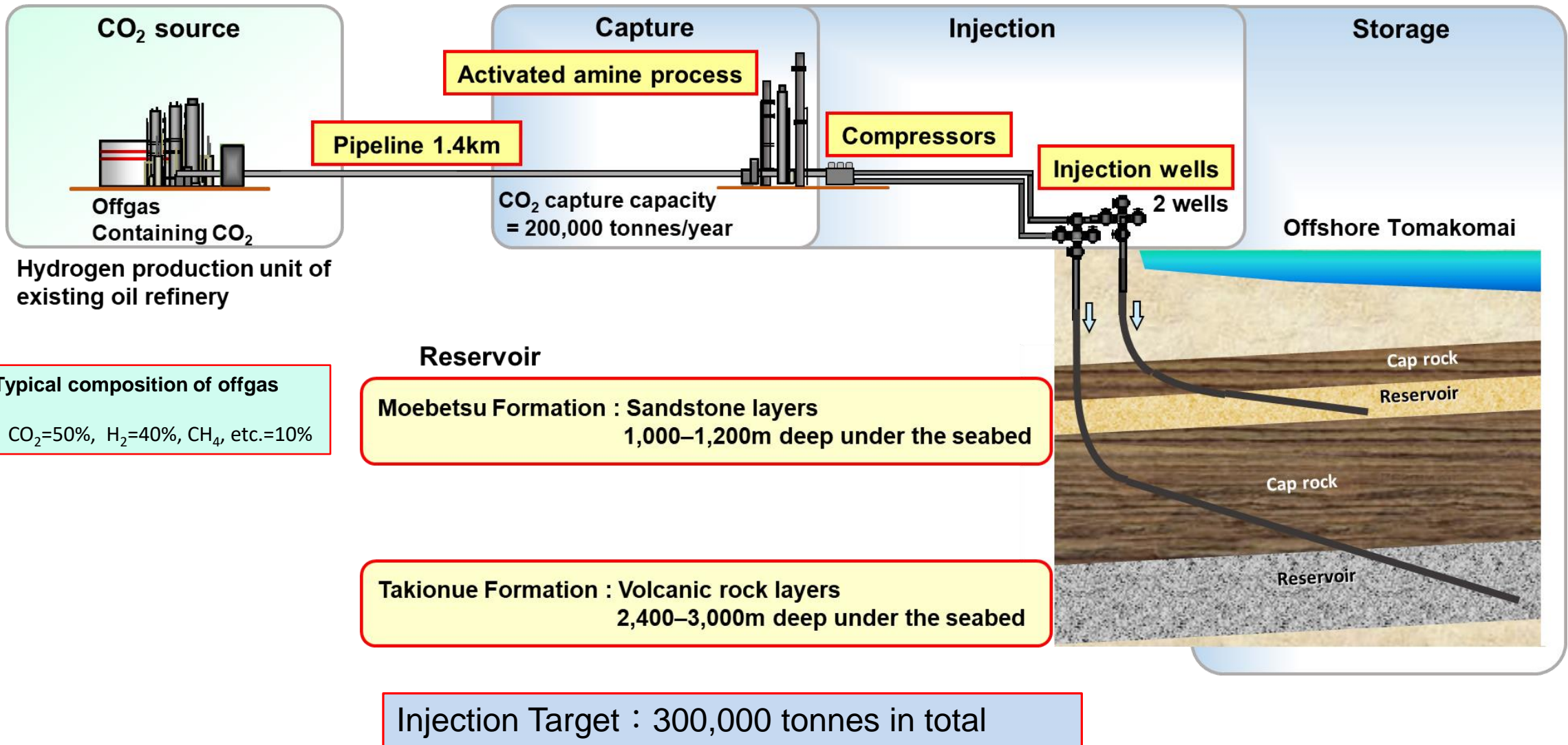
## First Large-scale CCS Demonstration Project in Japan

Project Period: FY2012-2020 (9 years)

Location: Tomakomai City Hokkaido

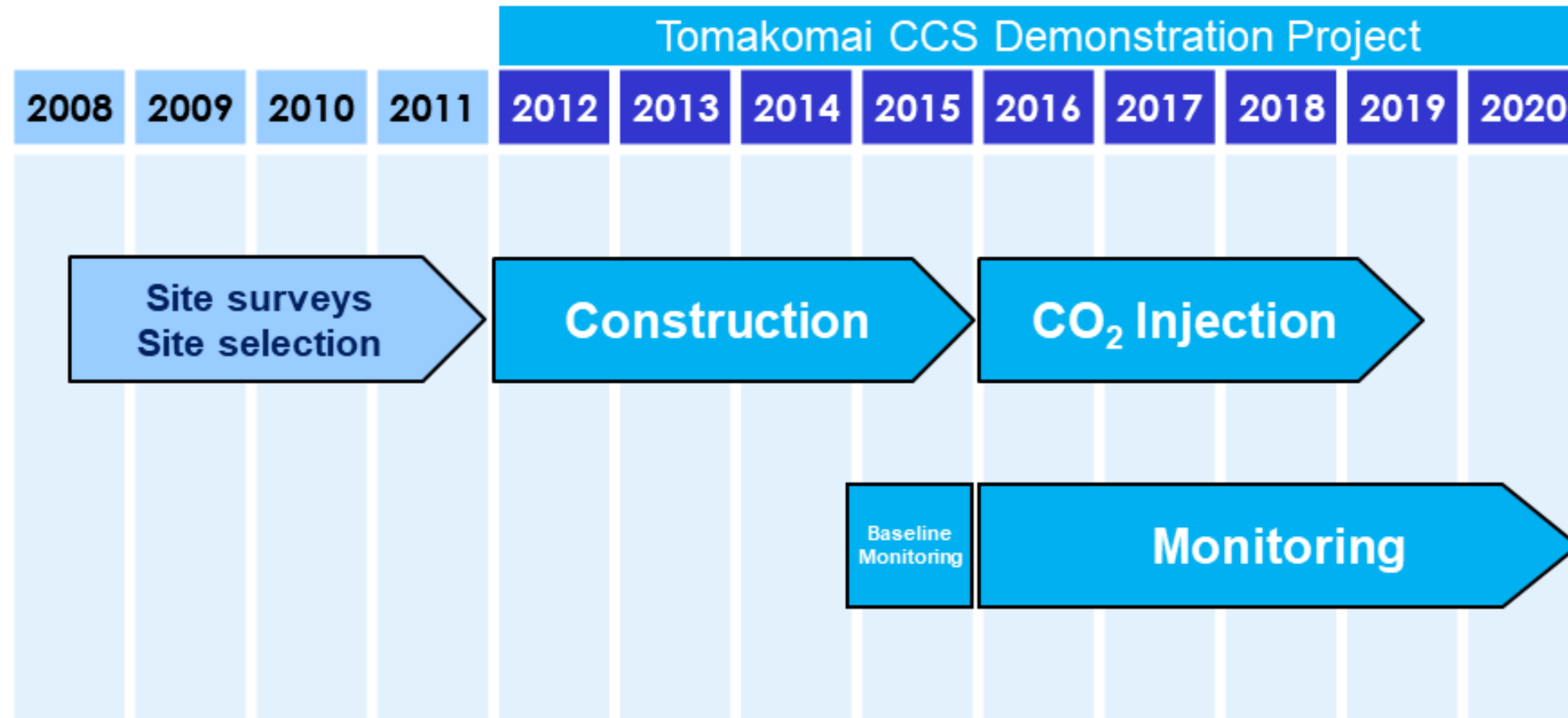


# Flow Scheme of Project



➤ First full-chain CCS system in Japan from capture to storage has been conducted successfully

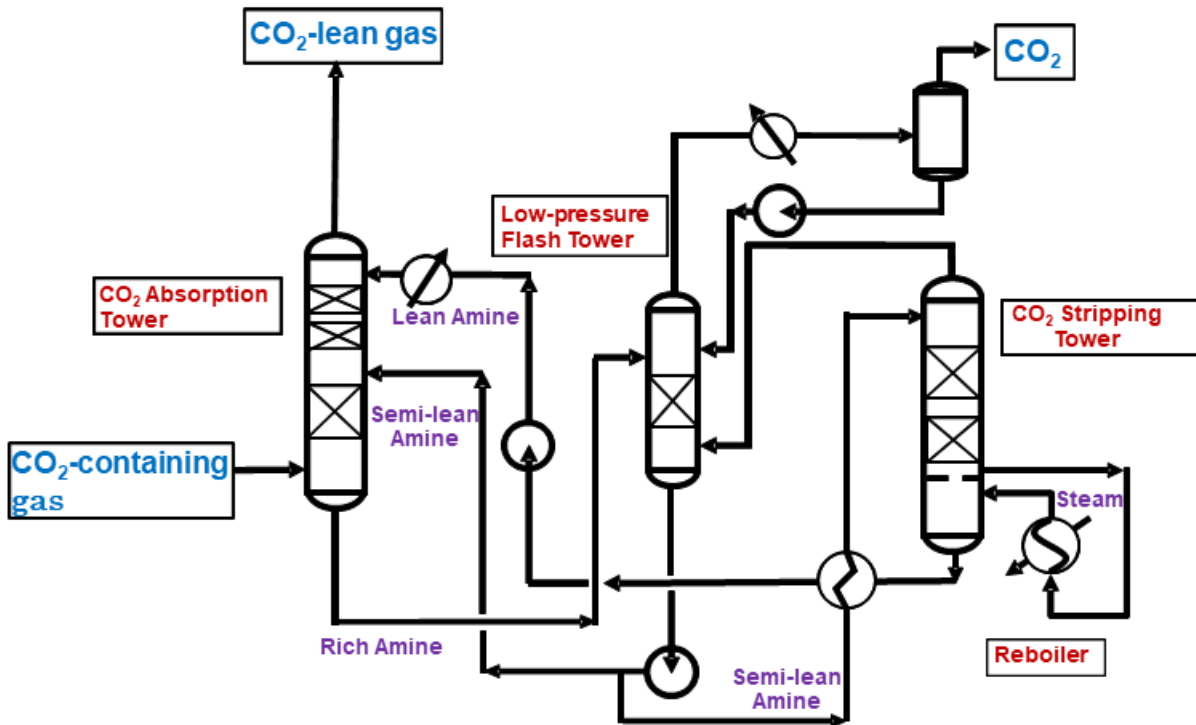
# Schedule of Project



Year are in Japanese Fiscal Years (April of calendar year to March of following year)

- Target of 300,000 tonnes of CO<sub>2</sub> injection achieved on November 22, 2019
- Monitoring operations are being continued

# CO<sub>2</sub> Capture Process – Two Stage Absorption System



Loading Factor: 98% (100%=25.3 t-CO<sub>2</sub>/h)

<b>CO<sub>2</sub> recovery rate %</b>	<b>99.97</b>
<b>Reboiler duty (GJ/t-CO<sub>2</sub>)</b>	<b>0.88</b>
<b>Heat energy <sup>1)</sup>(GJ/t-CO<sub>2</sub>)</b>	<b>0.98</b>
<b>Electric energy (GJ/t-CO<sub>2</sub>)</b>	<b>0.18</b>
<b>CO<sub>2</sub> capture energy <sup>2)</sup> (GJ/t-CO<sub>2</sub>)</b>	<b>1.16</b>

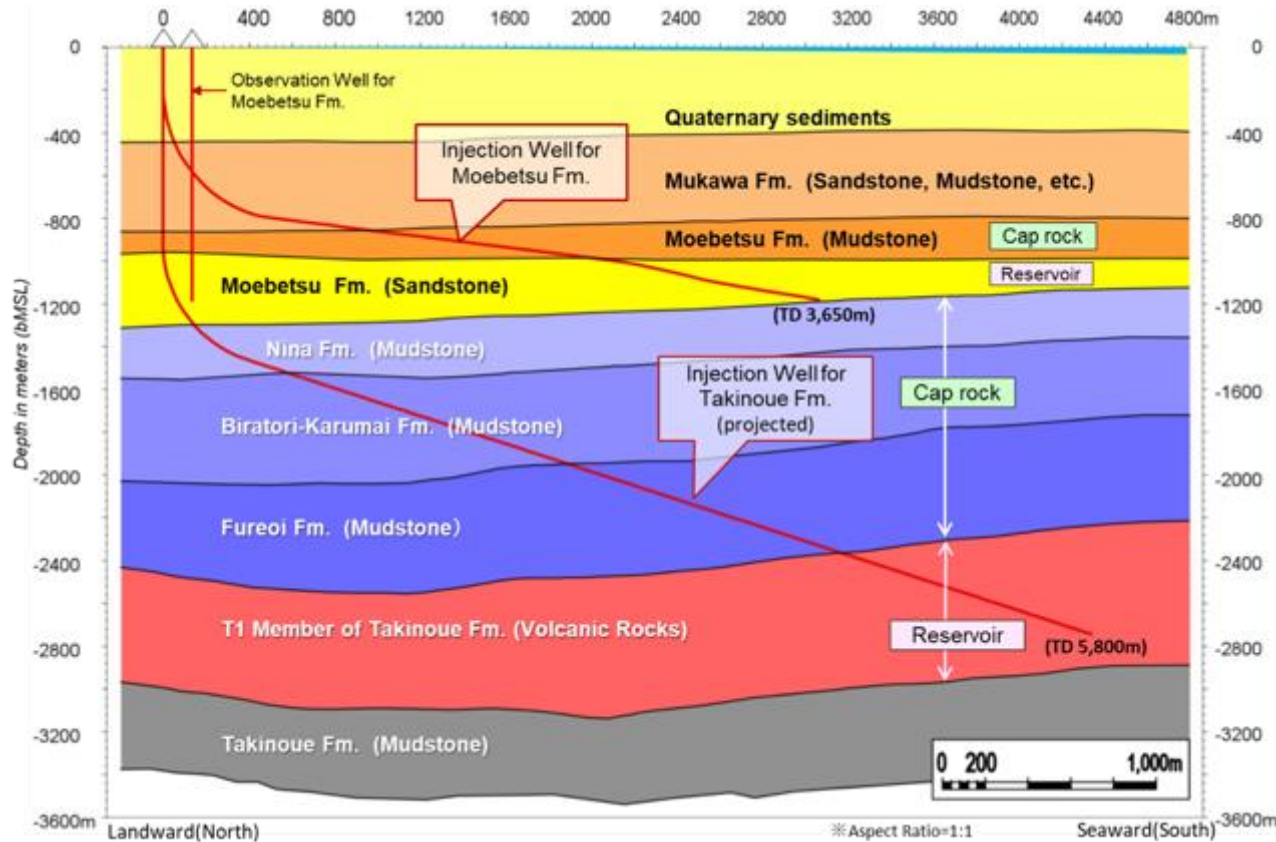
Note 1) : Reboiler duty/steam boiler efficiency

Note 2) : Heat energy + Electric energy

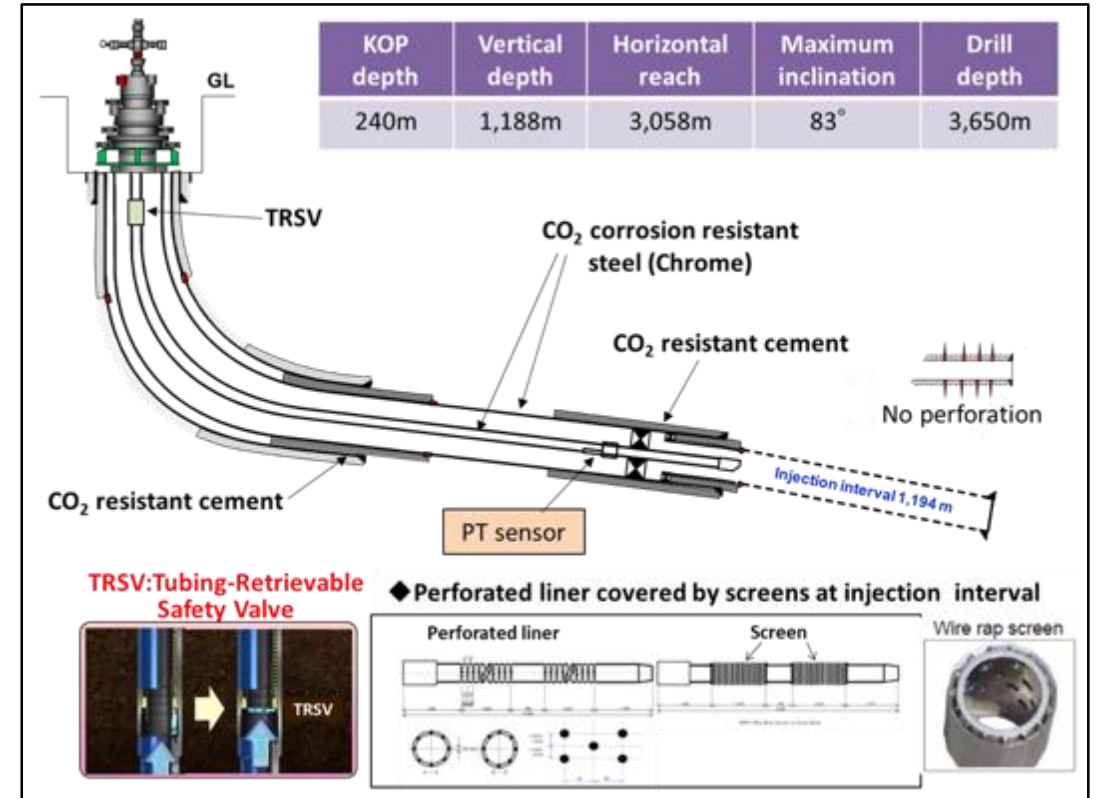
- In LPFT (Low-pressure Flash Tower), CO<sub>2</sub> is stripped by depressurization; thermal energy of steam of CO<sub>2</sub> Stripping Tower is also utilized to strip CO<sub>2</sub>
- Greater part of semi-lean amine from LPFT is returned to CO<sub>2</sub> Absorption Tower for CO<sub>2</sub> absorption; as only the remaining smaller portion is sent to CO<sub>2</sub> Stripping Tower, reboiler heat required can be reduced

# Injection Wells

Schematic Geological Section



Injection well for Moebetsu Formation

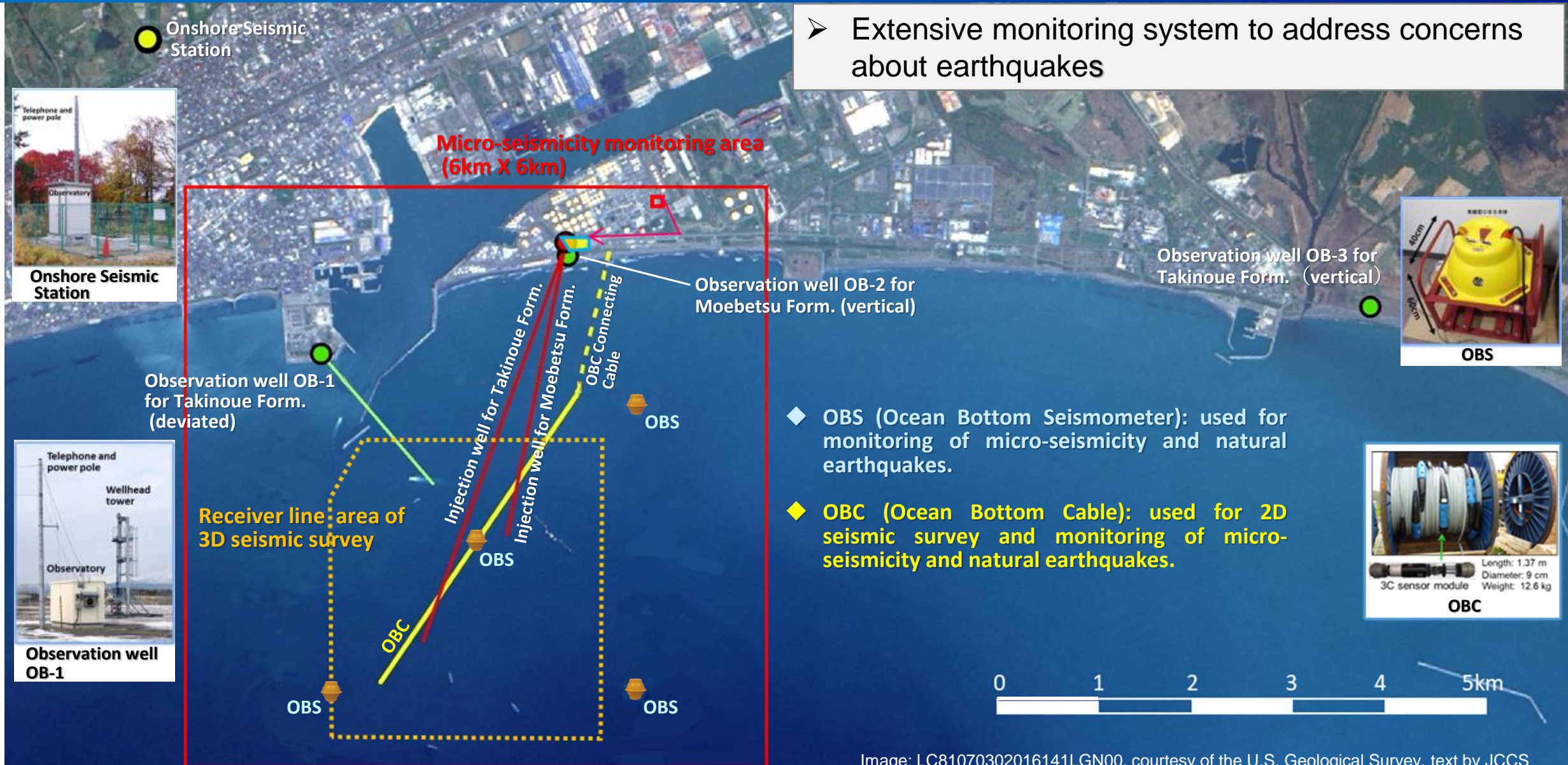


Non-scale

- Deviated CO<sub>2</sub> injection wells drilled from onshore into offshore reservoirs
  - Cost reduction of drilling, operation and maintenance
  - No disturbance on marine environment and harbor operation
- Injection interval length exceeding 1,100m to enhance injection efficiency

# Layout of Monitoring System

➤ Extensive monitoring system to address concerns about earthquakes

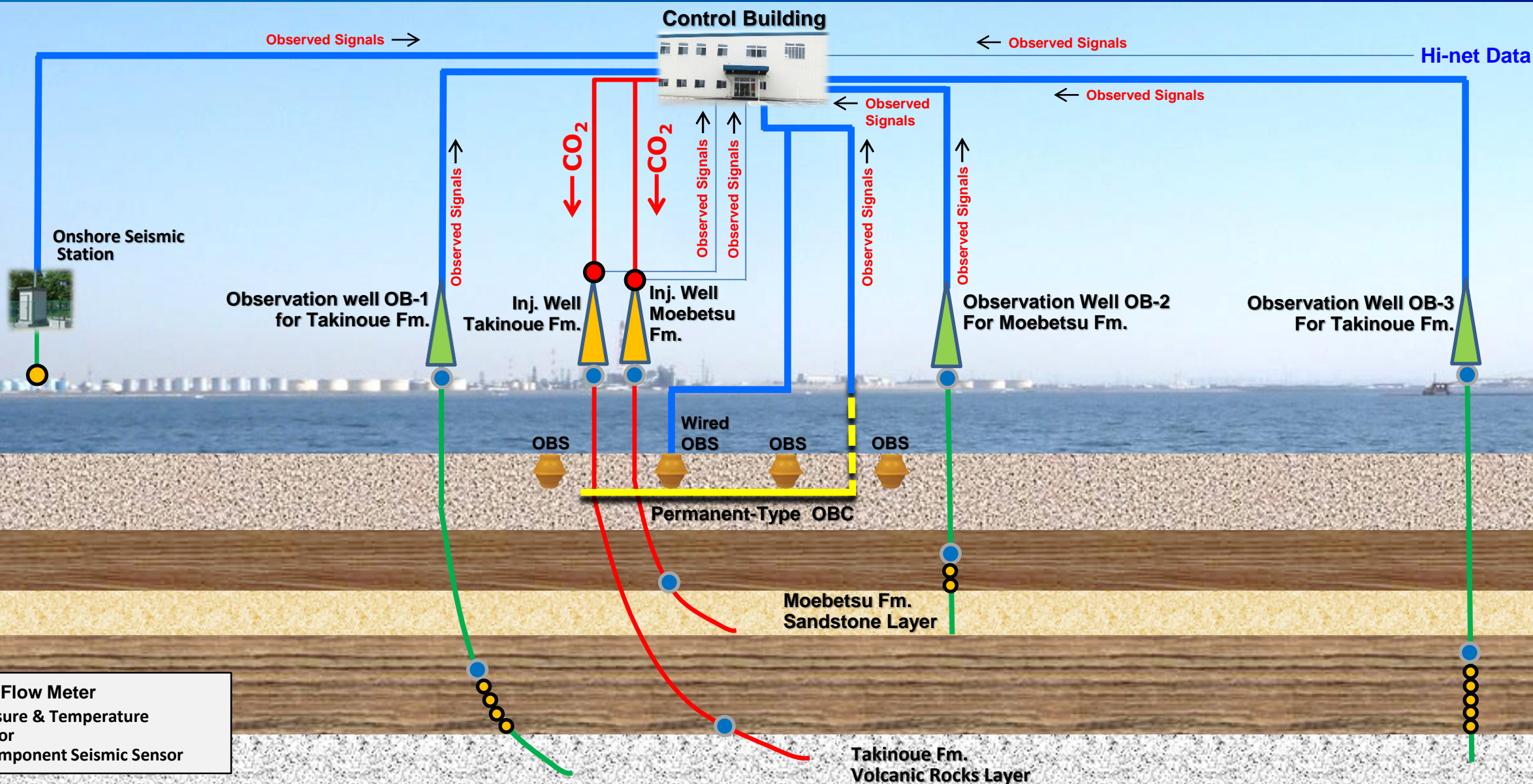


◆ **OBS (Ocean Bottom Seismometer):** used for monitoring of micro-seismicity and natural earthquakes.

◆ **OBC (Ocean Bottom Cable):** used for 2D seismic survey and monitoring of micro-seismicity and natural earthquakes.

Image: LC81070302016141LGN00, courtesy of the U.S. Geological Survey, text by JCCS

# Schematic Diagram of Monitoring System



- : CO<sub>2</sub> Flow Meter
- : Pressure & Temperature Sensor
- : 3-Component Seismic Sensor

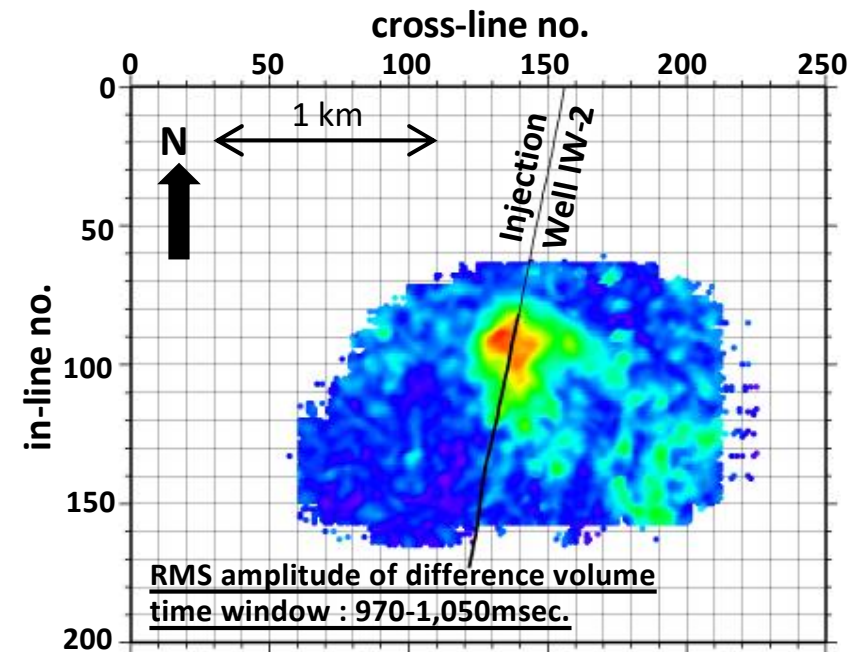
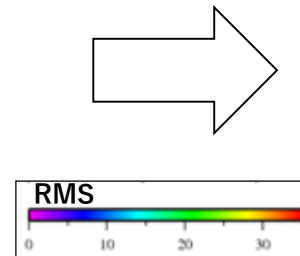
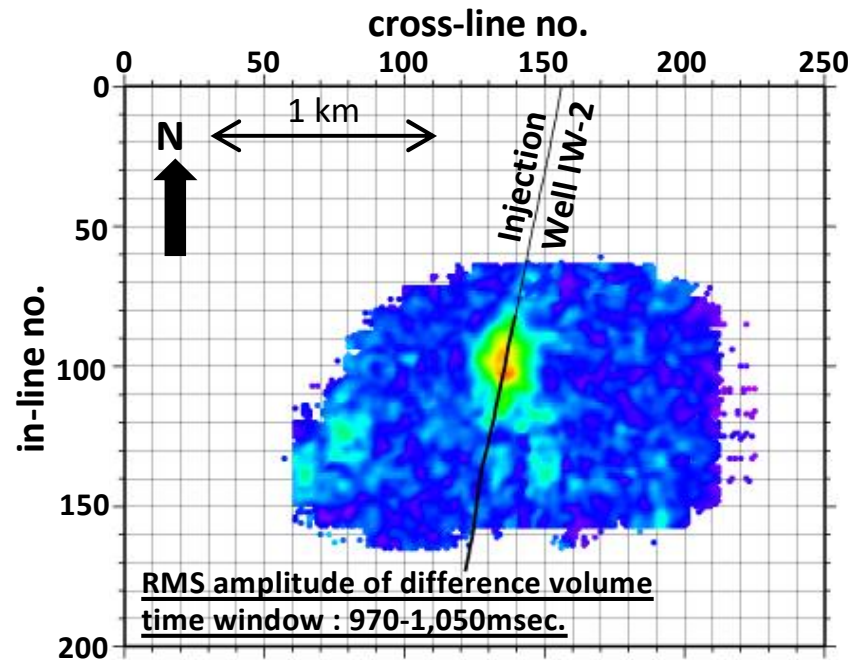


# Seismic Survey Results - 2nd & 3rd Monitor Surveys -

- Distribution of CO<sub>2</sub> in Moebetsu Formation confirmed by seismic surveys since FY2017. Injected CO<sub>2</sub> is limited to upper portion of reservoir in correspondence with predictions made in advance, and not believed to have behaved abnormally.

2<sup>nd</sup> monitor survey (61,239 - 69,070 tonnes; JFY2017 )

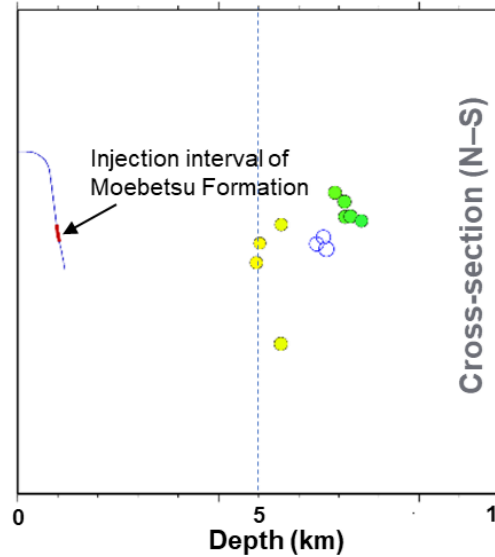
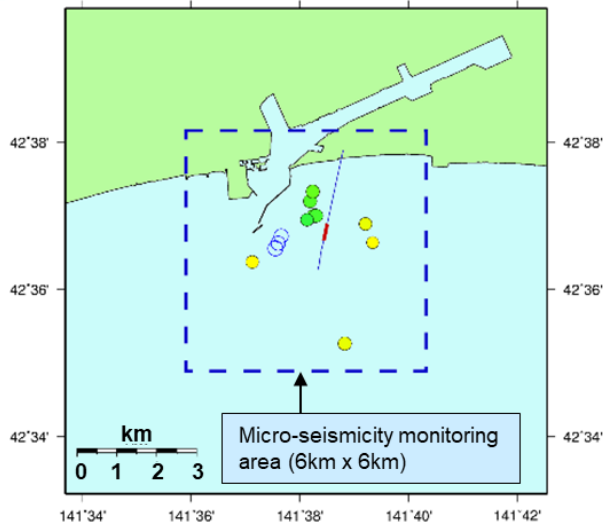
3<sup>rd</sup> monitor survey (207,209 tonnes; JFY2018 )



※ S/N ratio and accuracy of difference calculation is low due to the limited area of the data utilized for calculation.

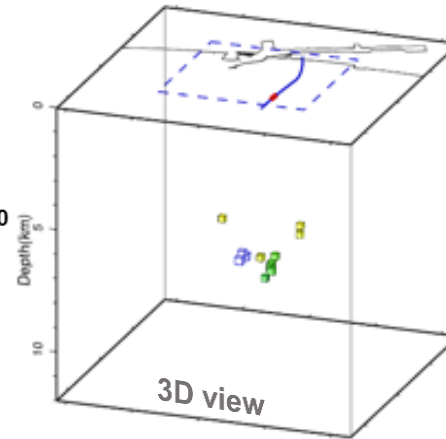
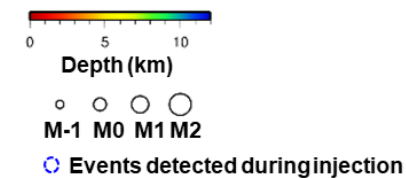
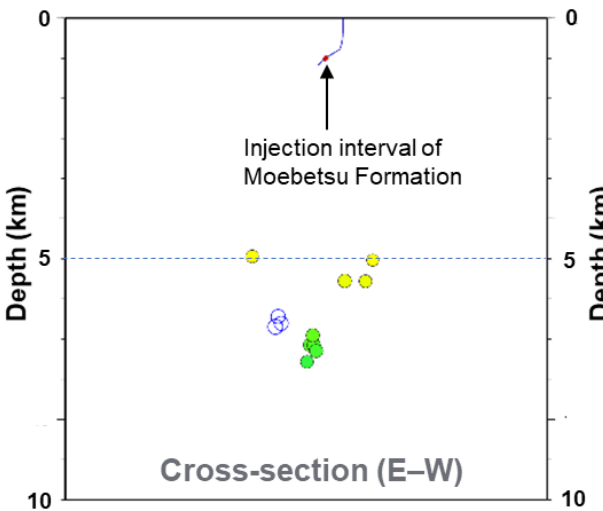
# Results of Micro-seismicity Monitoring

Events detected in micro-seismicity monitoring area

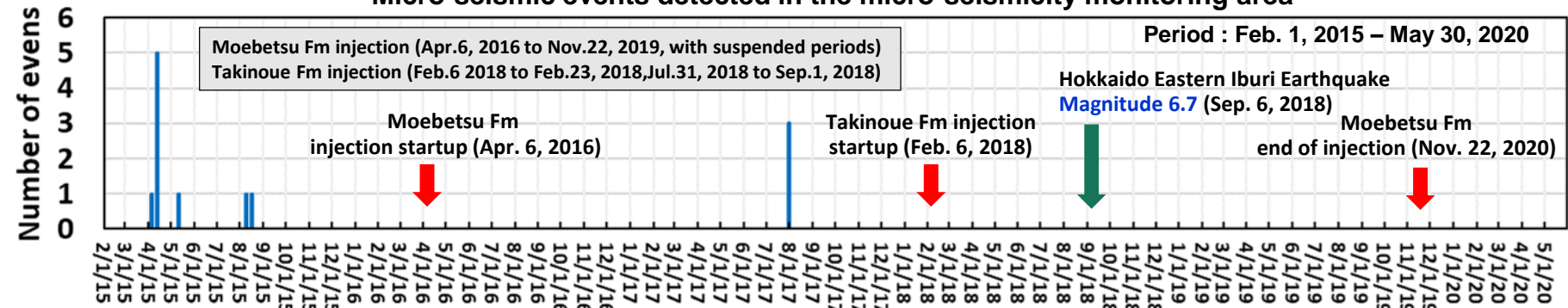


• No micro-seismicity or natural earthquakes attributable to CO<sub>2</sub> injection were detected in vicinity of injection area between startup of injection and December 2019, including before and after 2018 Hokkaido Eastern Iburi Earthquake.

※ Detectability: Mw > - 0.5



Micro-seismic events detected in the micro-seismicity monitoring area



# Public Outreach Activities

## Voice of Tomakomai Citizens

### 1) Information Disclosure

- Thorough disclosure should be made

### 2) Safety/CO<sub>2</sub> leakage

- Want more detailed information on risk of CO<sub>2</sub> leakage

Monitoring & Disclosure Plan

### 3) Dissemination to Young Generation

- Should consider efforts to involve young generation

## Outreach Activities

- ① Panel Exhibitions
- ② Forum for Tomakomai Citizens
- ③ Site Tours
- ④ Information Disclosure System

- ⑤ Mini seminars for students
- ⑥ Kids' lab classes/site tours

## Outreach Activities (JFY2019)

Site Visitors: 2168 people (401 from overseas)

Mini seminars: 27 times

Panel Exhibitions: 8 times

Kids' lab classes: 3 times

Booth in Environmental exhibitions: 11 times

CCS Forum: 600 people

Project being conducted with understanding and support of local community



# Cost Estimation of Practical Model

- Based on Tomakomai demonstration data, conducted cost estimation of 200-thousand tonnes/yr practical model, and 1-million-tonnes/yr practical model under similar conditions and certain assumptions.

(JPY/t-CO<sub>2</sub>)

CCS Cost	200-thousand-ton practical model	1-million-ton practical model
1) Capture / Injection		
CAPEX	852	590
OPEX	4,720	4,079
Total	5,572	4,669
2) Injection wells / Storage		
CAPEX	922	369
OPEX	4,635	1,148
Total	5,557	1,517
3) Grand Total		
Captured	11,129 (=103 USD/t-CO <sub>2</sub> )	6,186 (=57 USD/t-CO <sub>2</sub> )
Avoided	13,328 (=123 USD/t-CO <sub>2</sub> )	7,261 (=67 USD/t-CO <sub>2</sub> )
4) CO <sub>2</sub> emission factor (t-CO <sub>2</sub> emitted from capture/injection facilities) ÷ (t-CO <sub>2</sub> captured/injected)		
t-CO <sub>2</sub> /t-CO <sub>2</sub>	0.165	0.148 (1USD=108JPY)

- CO<sub>2</sub> source gas is separated from PSA upstream; treated off-gas is returned to PSA upstream.
- CO<sub>2</sub> transportation cost not included; facility housing, operator labor costs assumed to be provided by refinery and not included.
- Fuel gas unit cost: JPY1,205/GJ (equivalent to JPY48.2/Nm<sup>3</sup>), electricity unit cost: JPY10.84/kWh (excluding consumption tax).
- Captured cost: CCS cost/injected CO<sub>2</sub> amount; Avoided cost: CCS cost/(injected CO<sub>2</sub> amount — CO<sub>2</sub> generated by CCS)

# Summary

- Operation of full chain CCS system from capture to storage has been conducted successfully and **target of 300,000 tonnes of CO<sub>2</sub> injection has been achieved.**
- Safety and reliability of CCS system has been demonstrated.
- METI, NEDO and JCCS compiled the results and issues of the Tomakomai CCS Demonstration Project and released a Summary Report.

**Notes:**

*METI: Ministry of Economy, Trade and Industry*    *NEDO: New Energy and Industrial Technology Development Organization*

## Experience and Lessons Learned

- **Understanding and support of local community is vital for implementing CCS.**
- CO<sub>2</sub> capture process comprising a two-stage absorption system has achieved **significantly lower capture energy than conventional system.**
- **Deviated injection wells from onshore site into offshore reservoirs saved drilling cost** and avoided disturbance of local livelihood.
- **Concerns about earthquakes and induced seismicity have been addressed.**
  - Natural earthquakes have not caused any damage to reservoirs.
  - No seismicity (Mw > -0.5) has been detected in/around the depth range of the reservoirs before and during injection.



*Thank you for  
your attention.*

<http://www.japanccs.com/>

Japan CCS Co., Ltd. would like to express thanks to Ministry of Economy, Trade and Industry (METI), New Energy and Industrial Technology Development Organization (NEDO) for kind permission to disclose information.

