Tomakomai CCS Demonstration Project

Japan CCS Co., Ltd.

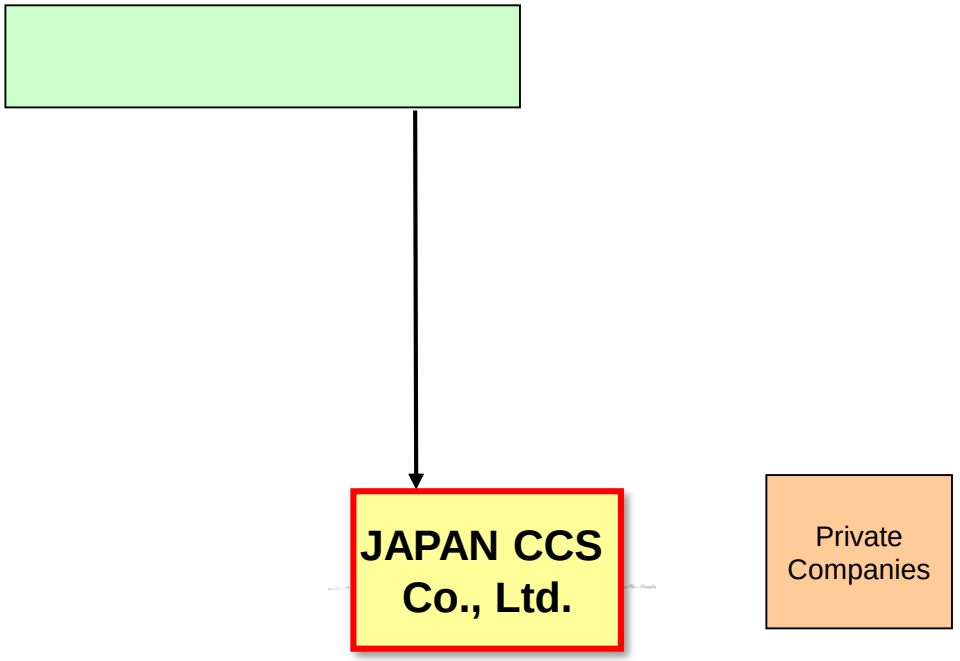
3rd International Workshop on Offshore Geologic CO_2 Storage

May 3, 2018

JCCS Company Profile and CCS Project Framework

Company Profile

Project Framework - Functions of JCCS



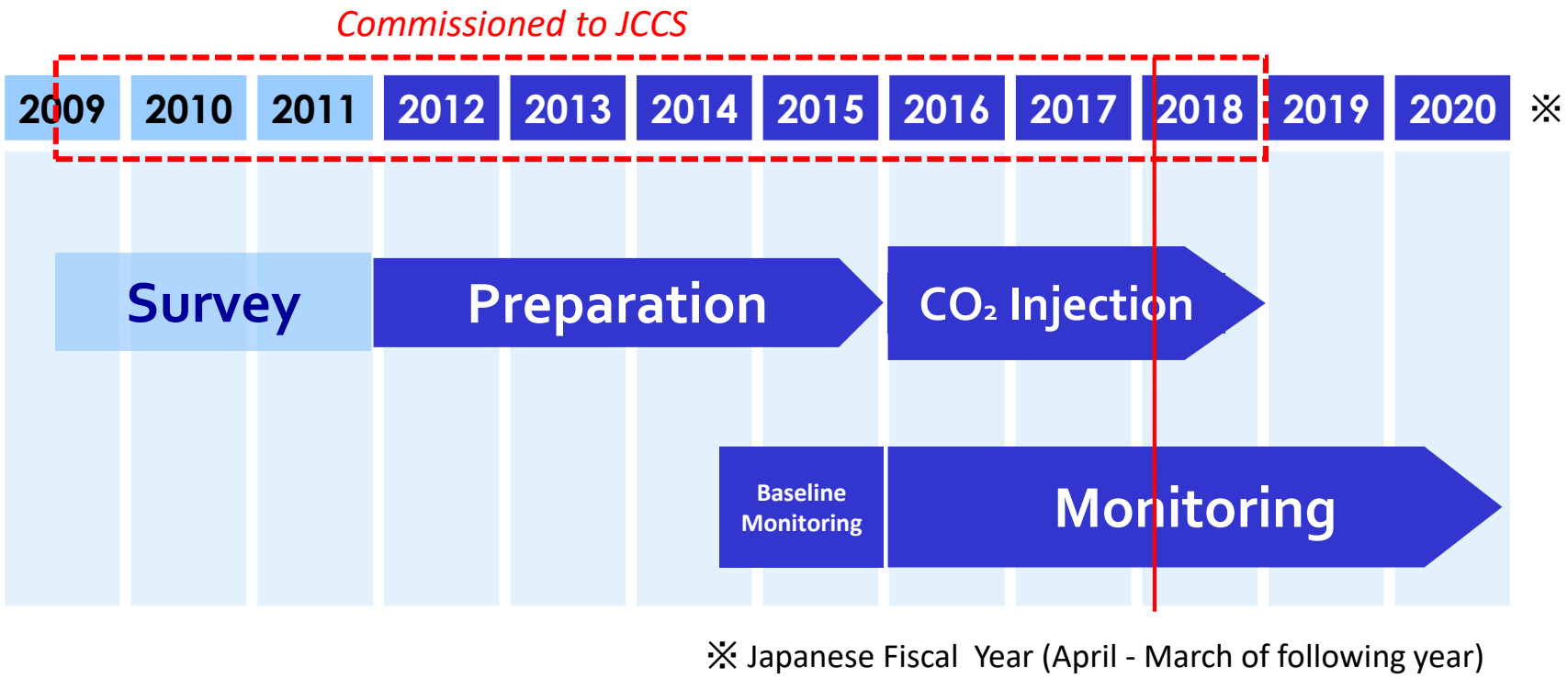
Outline of Presentation

- **Overview of Tomakomai Project**
- **Preliminary Results**
- **Project Summary**

Overview of Tomakomai Project

Project Schedule

- **Preparation (JFY2012-2015)**
  - Design and construction of facilities
  - Drilling of injection and observation wells
  - Installation of monitoring system
- **CO_2 Injection and Monitoring (JFY2016-2020)**
  - CO_2 Injection (JFY2016-2018)
  - Monitoring (JFY2016-2020)



※ Japanese Fiscal Year (April - March of following year)

Objectives and Tasks of Tomakomai CCS Project

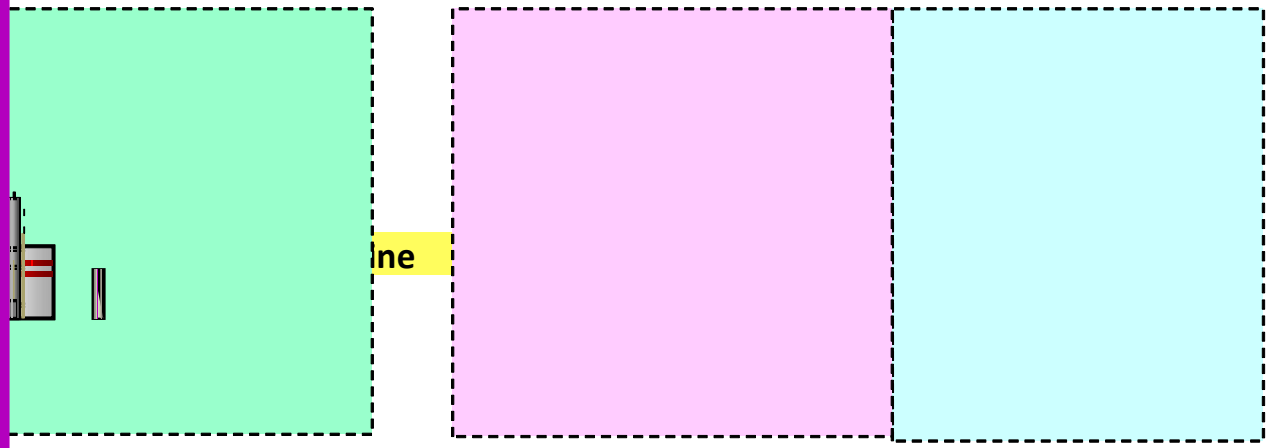
Develop practical CCS technology by around 2020

- demonstrate full cycle CCS system from capture to storage
- confirm existing technologies adopted in the system work properly and efficiently

Tasks

- demonstrate CCS system is safe and reliable
- confirm effectiveness of site selection guideline prepared by METI by demonstrating no leakage
- remove concerns about earthquakes by the data collected;
  - no influence by natural earthquakes on CO_2 stored
  - no perceptible earth tremors induced by CO_2 injection
- confirm guidelines for geological models (building and improvement)
- prepare technical standards regarding operation and safety of CCS projects
- disclose project information & data and enhance understanding of CCS by local residents
- clearly define areas to be improved or solved toward commercialization

w Scheme of CCS Demonstration Project



re Swing Adsorption）

of PSA Offgas

10%

Positional Relation of Injection & Monitoring Systems

Onshore Seismometer

Observation well OB-1 for Takinoue Form. converted from survey well (deviated)

Injection well for Takinoue Form.

Injection well for Moebetsu Form.

OBC Connecting Cable

Observation well OB-2 for Moebetsu Form. (vertical)

Observation well OB-3 for Takinoue Form.（vertical）

OBS

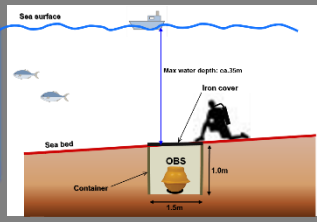
OBS

OBS

OBS

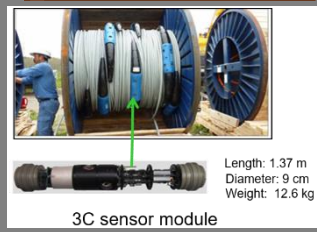
OBC

Working area of 3D seismic survey



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.

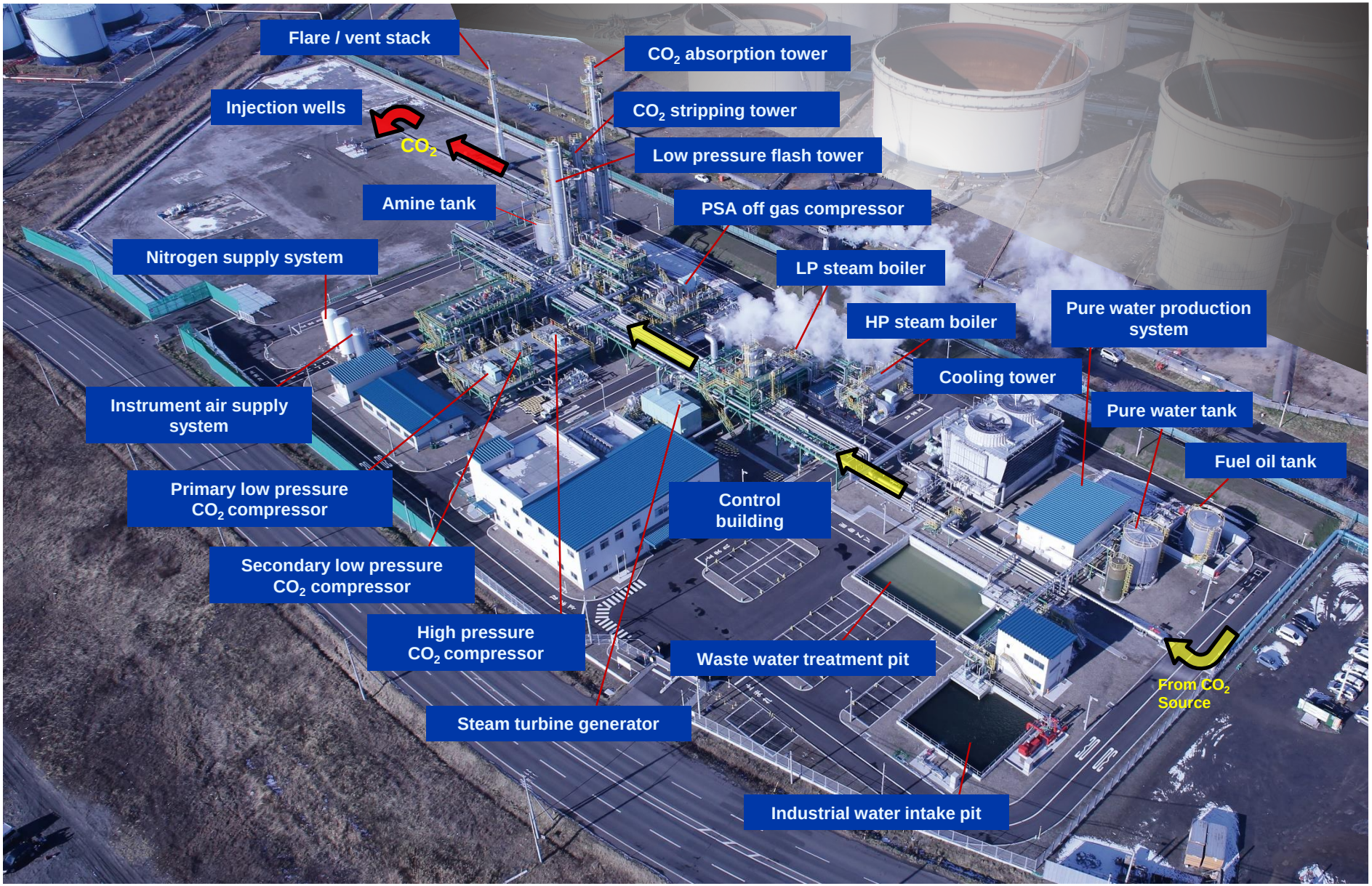


0 1 2 3 4 5km

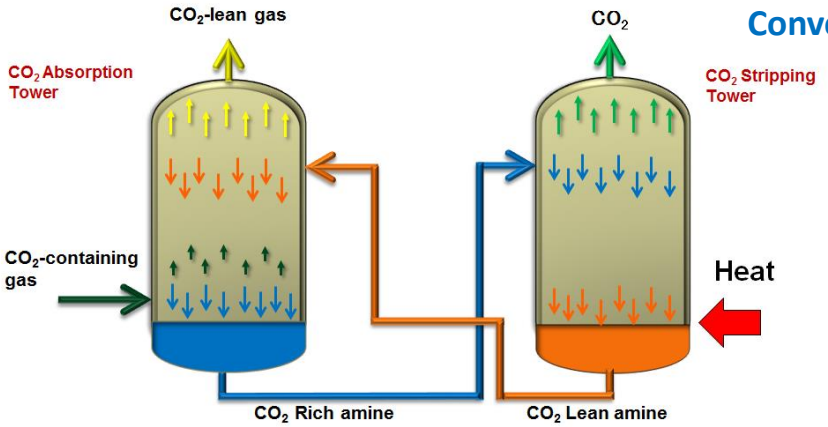
Image: LC81070302016141LGN00, courtesy of the U.S. Geological Survey, text by JCCS

JCCS

Bird's Eye View of Capture and Injection Facilities



CO_2 Capture Process

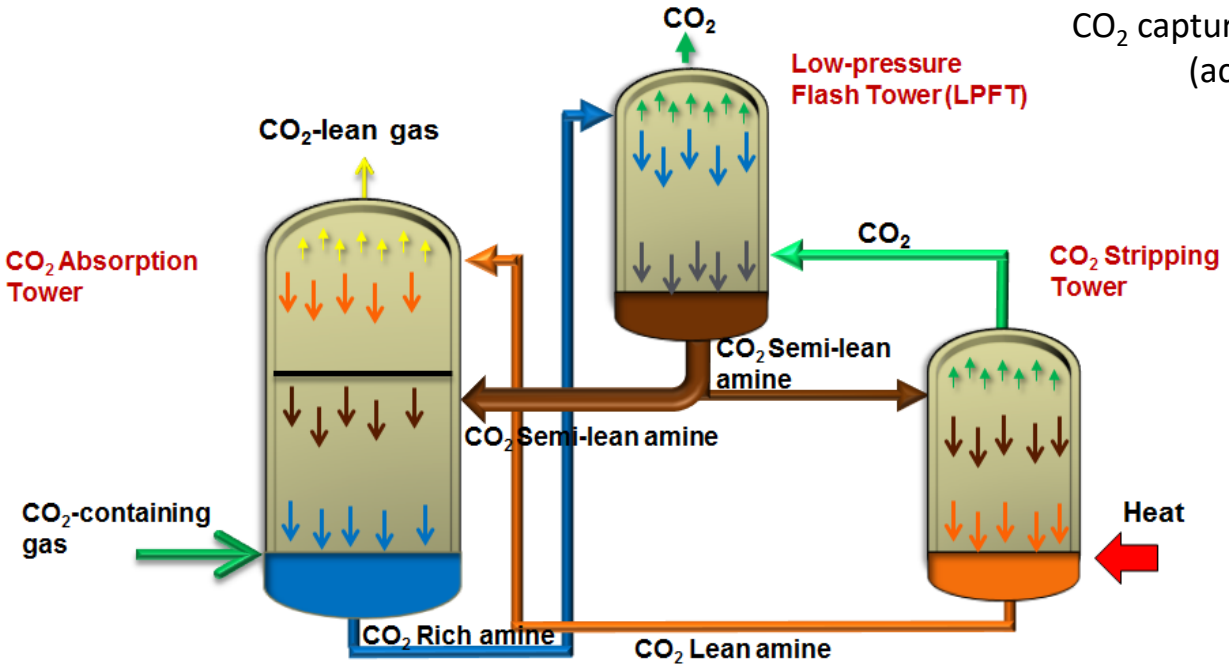


Conventional CO_2 Capture Process (Hydrogen Production)

CO_2 capture energy = approx. 2.5 GJ/t-CO_2

Tomakomai CO_2 Capture Process (Hydrogen Production)

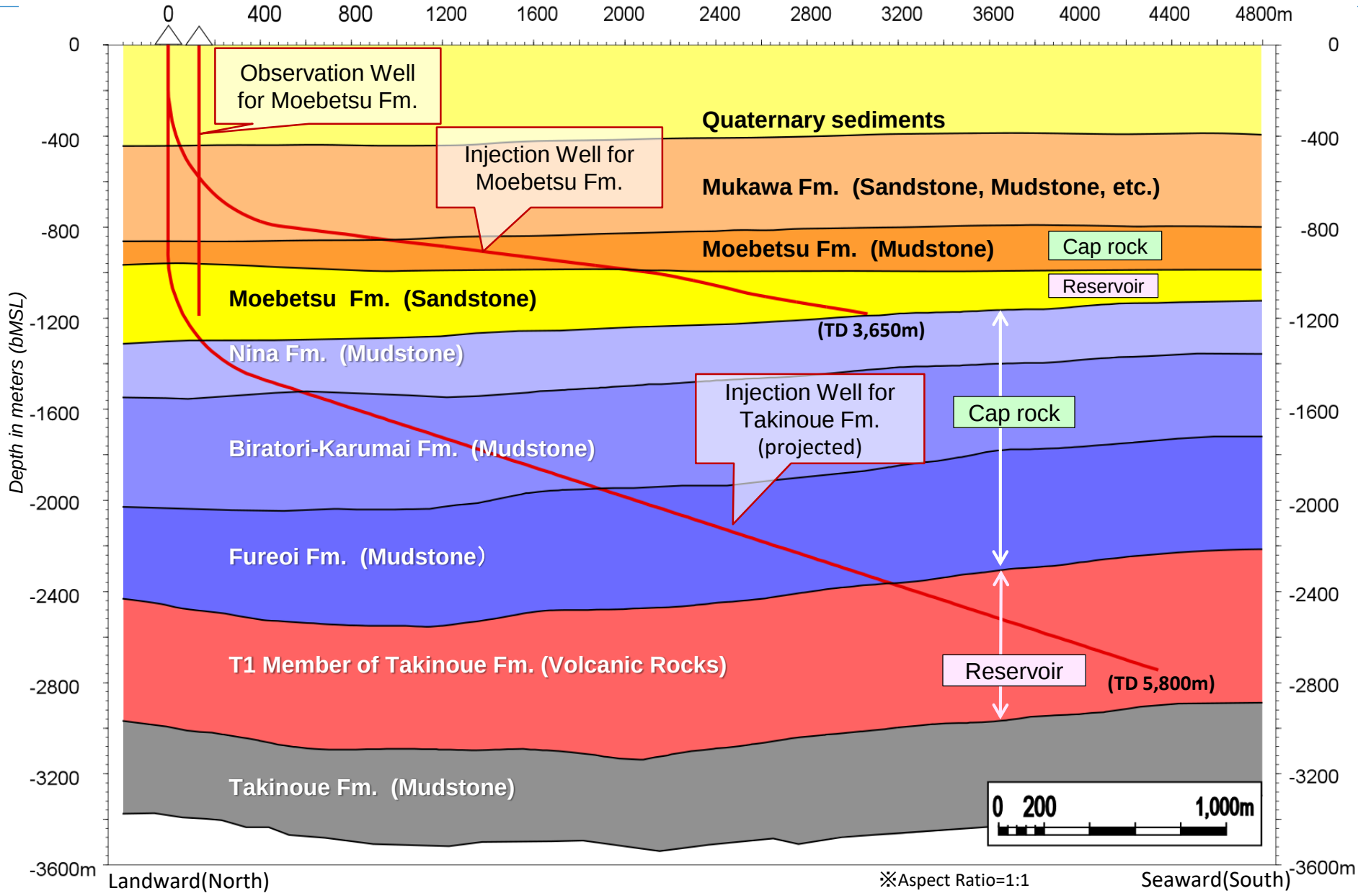
CO_2 capture energy = 1.16 GJ/t-CO_2
(actual measurement)



Note1 : CO_2 capture energy =[reboiler heat(steam) consumption / steam boiler efficiency + pump electricity consumption x electricity-heat conversion factor / power generation efficiency] / CO_2 flow rate

Note2 : Two-stage Absorption and Low-pressure Flash Tower ⇒ Applicable to high pressure CO_2-containing gas and high partial pressure of CO_2 case

Schematic Geological Section

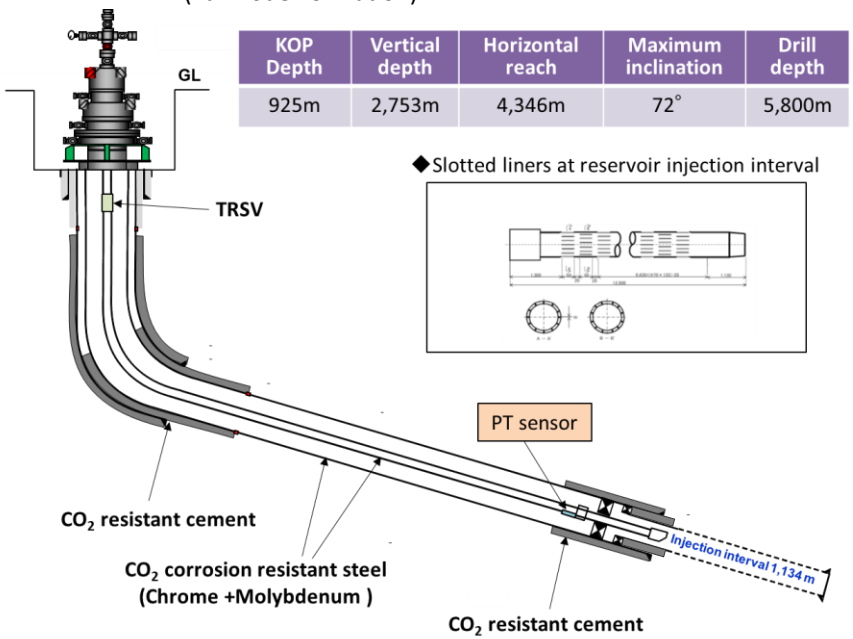


Deviated CO_2 Injection Wells

- **Deviated CO_2 injection wells drilled into offshore reservoirs from an onshore site**
  - 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

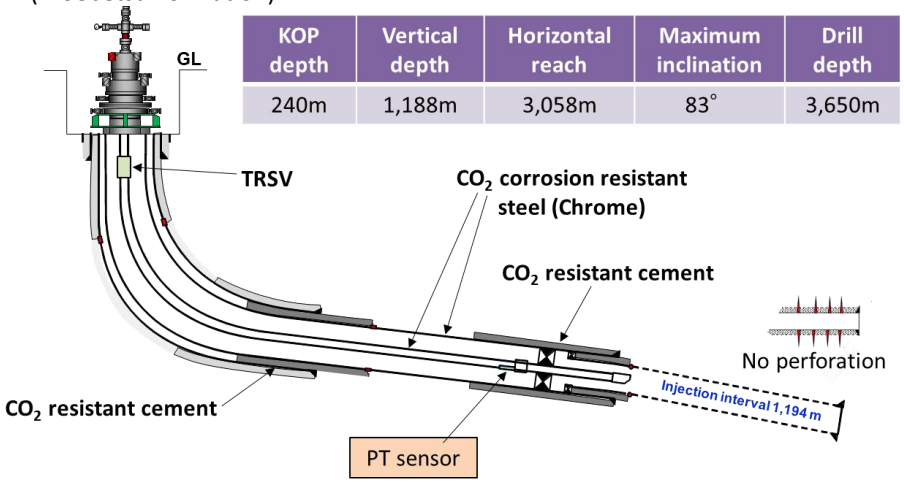
IW-1 (Takinoue Formation)

KOP Depth	Vertical depth	Horizontal reach	Maximum inclination	Drill depth
925m	2,753m	4,346m	72°	5,800m

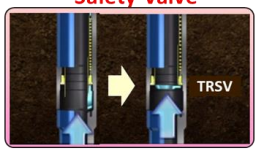


IW-2 (Moebetsu Formation)

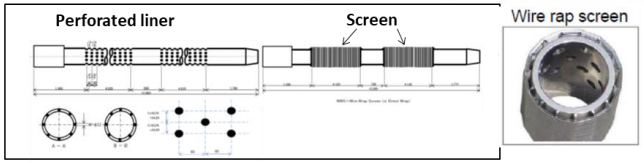
KOP depth	Vertical depth	Horizontal reach	Maximum inclination	Drill depth
240m	1,188m	3,058m	83°	3,650m



TRSV:Tubing-Retrievable Safety Valve

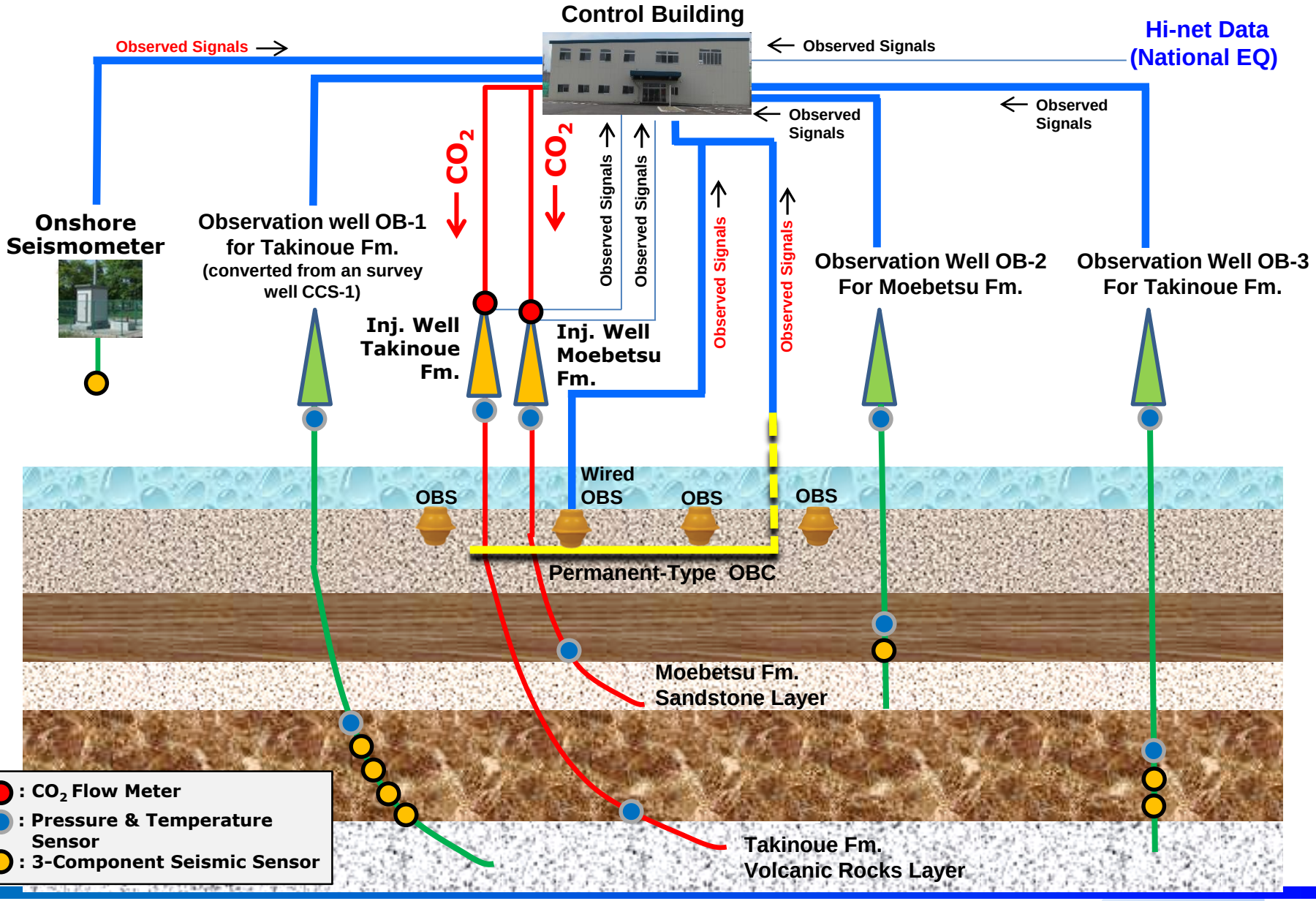


◆Perforated liner covered by screens at injection interval



These wells achieved new Japanese records respectively.

Schematic Diagram of Monitoring System



Marine Environmental Survey

- Japanese domestic law “Act on Prevention of Marine Pollution and Maritime Disaster” was amended to reflect London Protocol.
- Marine environment is surveyed based on this Act, by which geological storage of CO_2 under the seabed is regulated.

1. Survey Area

- 12 survey points in Tomakomai Port Area

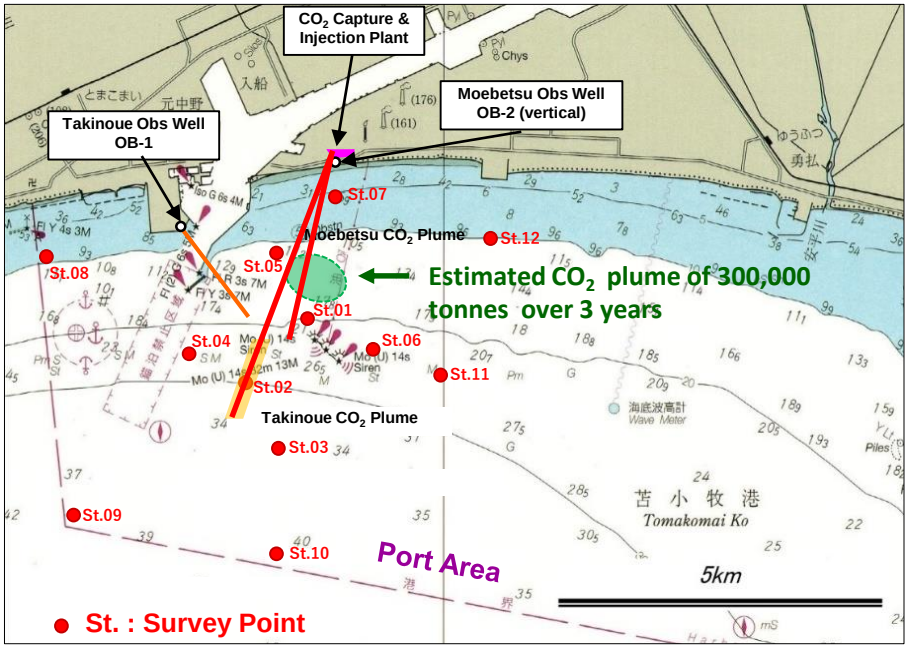
2. Methods of Survey

- Seabed survey by Side-Scan Sonar and Sub-bottom Profiler
- Current direction and speed survey by Current Meter
- Sampling of seawater by Water Sampler for concentration of CO_2 etc. and plankton observation
- Seabed mud survey by Bottom Sampler
- Collection of benthos by Net or Dredge Unit
- Observation of benthos by divers or ROV

3. Surveys in Three Stages

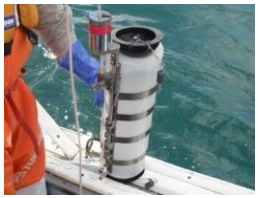
- During EPC period
- During demonstration operation
  - During CO_2 injection
  - After CO_2 injection
- After demonstration operation

Environmental Survey Points



Plotted on Japan Coast Guard nautical chart


Side-Scan Sonar


Water Sampler

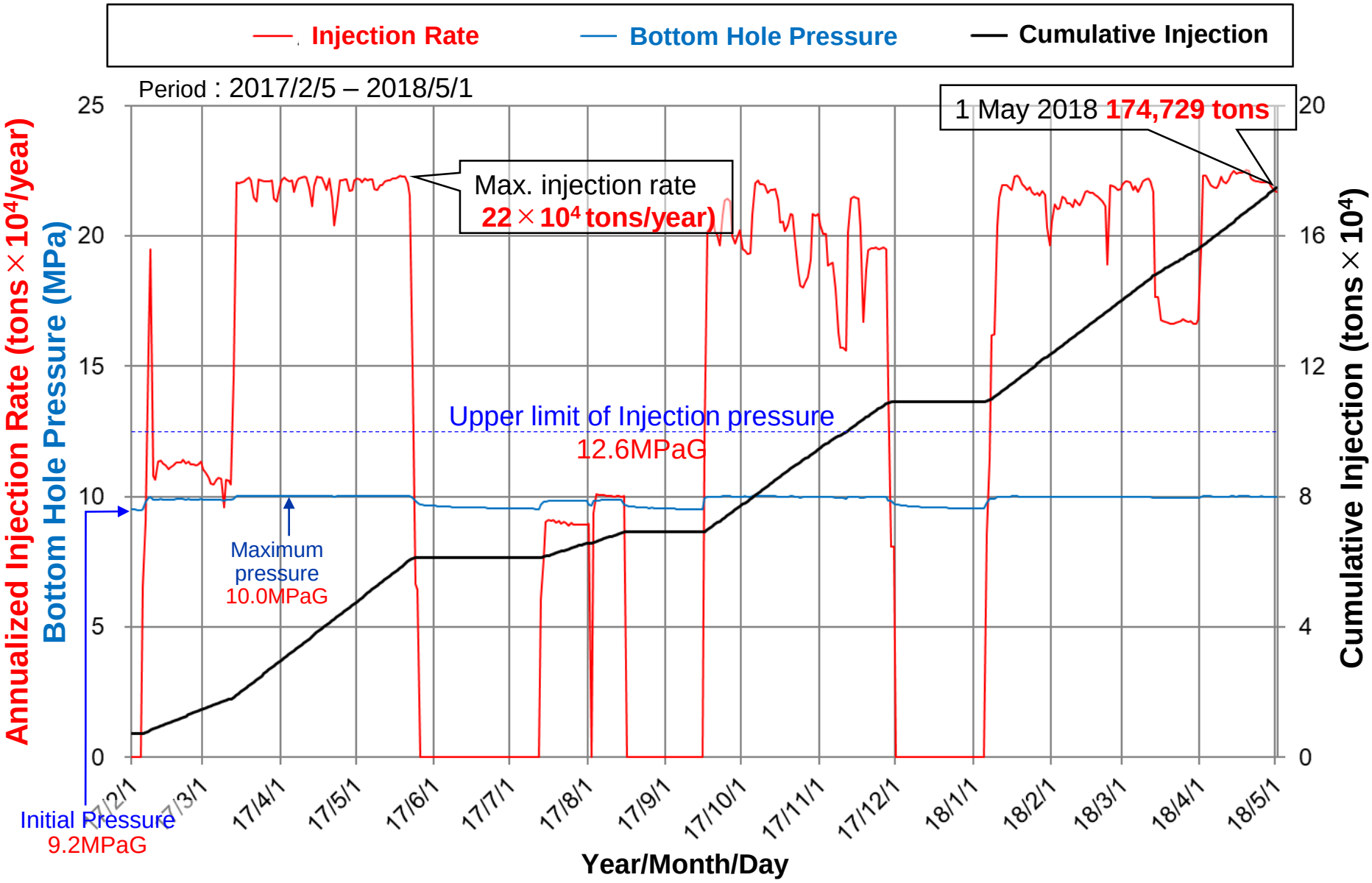

Bottom Sampler


Dredge Unit

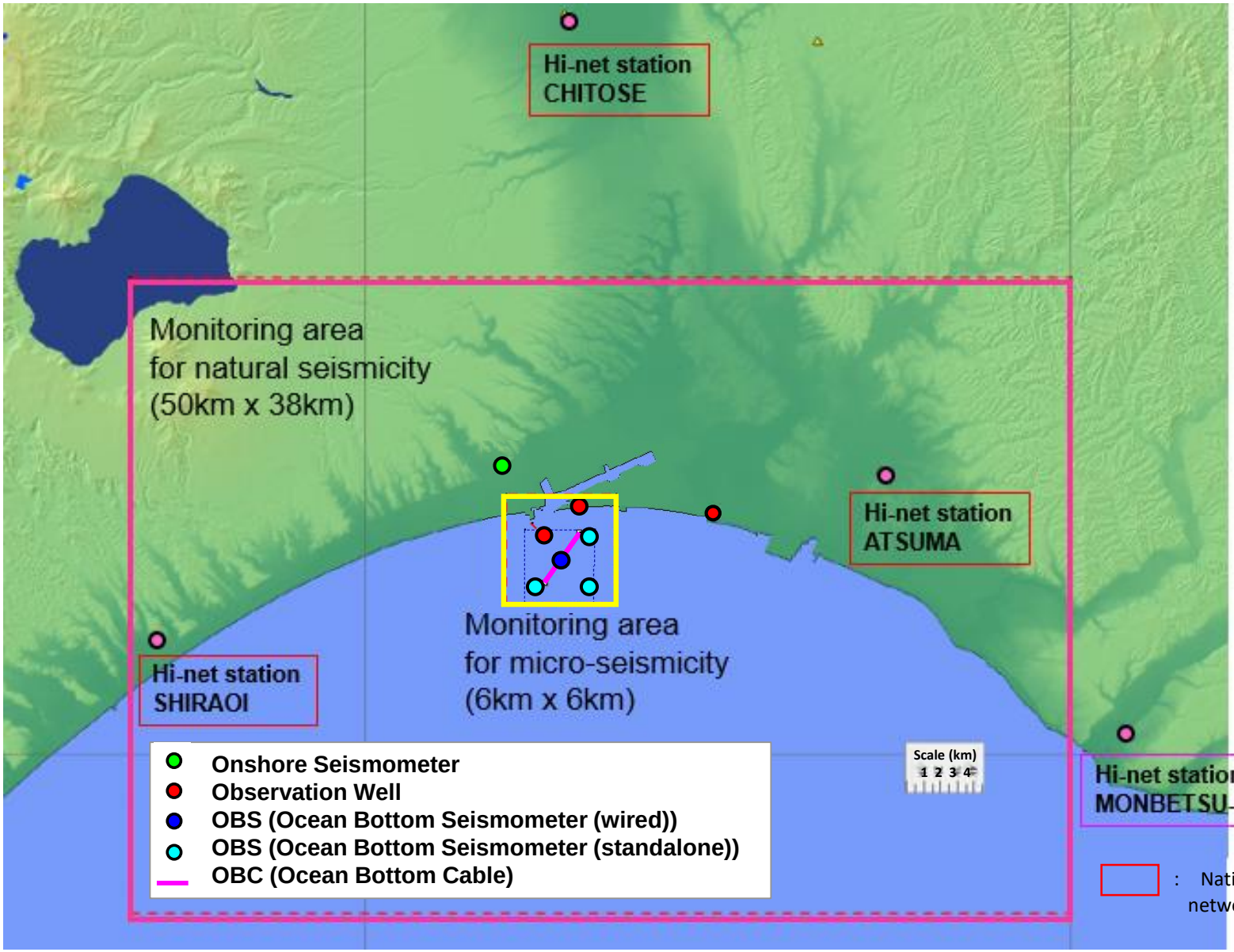

ROV

Preliminary Results

CO_2 Injection Record：Moebetsu Formation

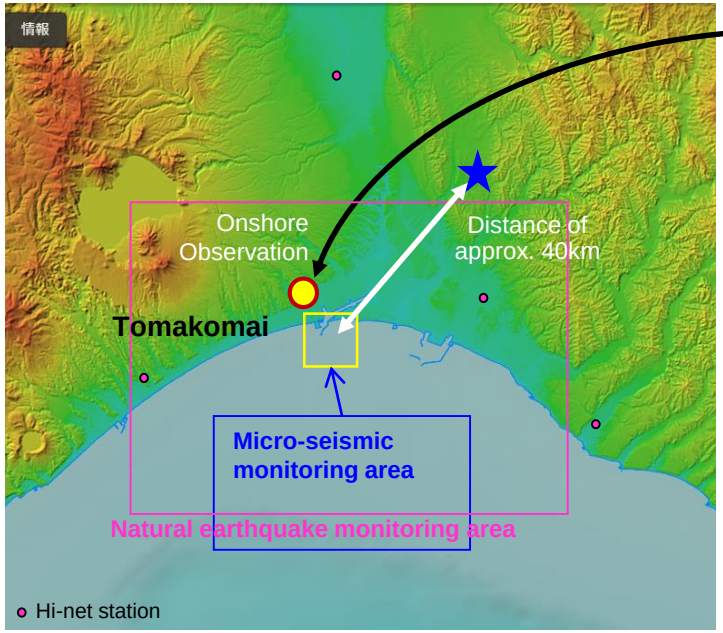


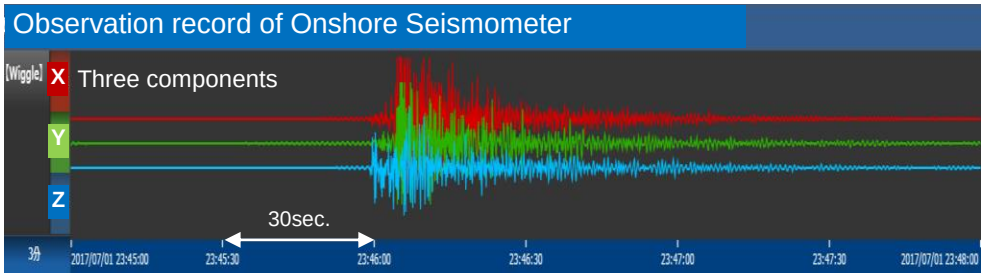
Monitoring Area of Seismicity

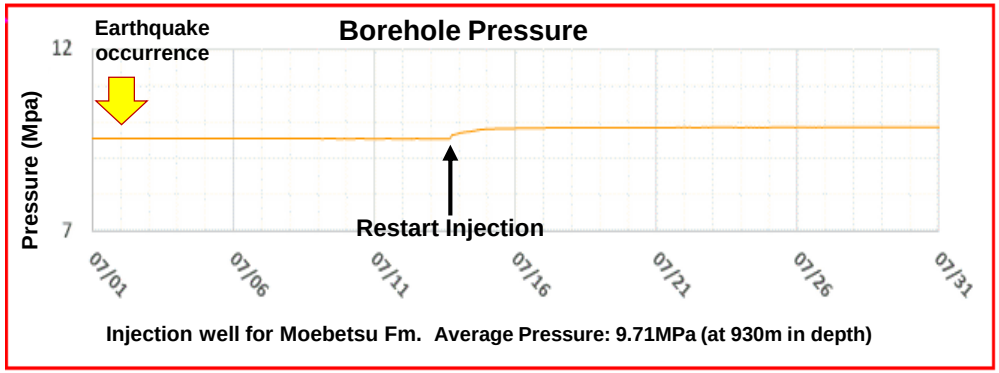


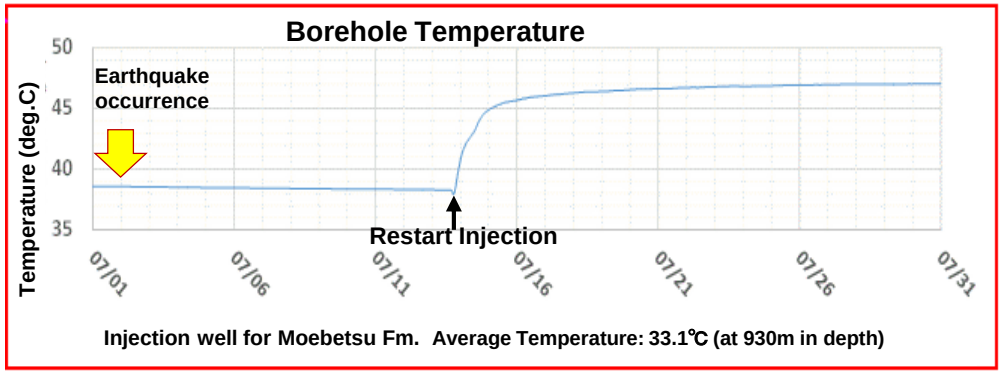
Source of base drawing: Geographical Survey Institute

Seismic Monitoring Results : Natural Earthquakes









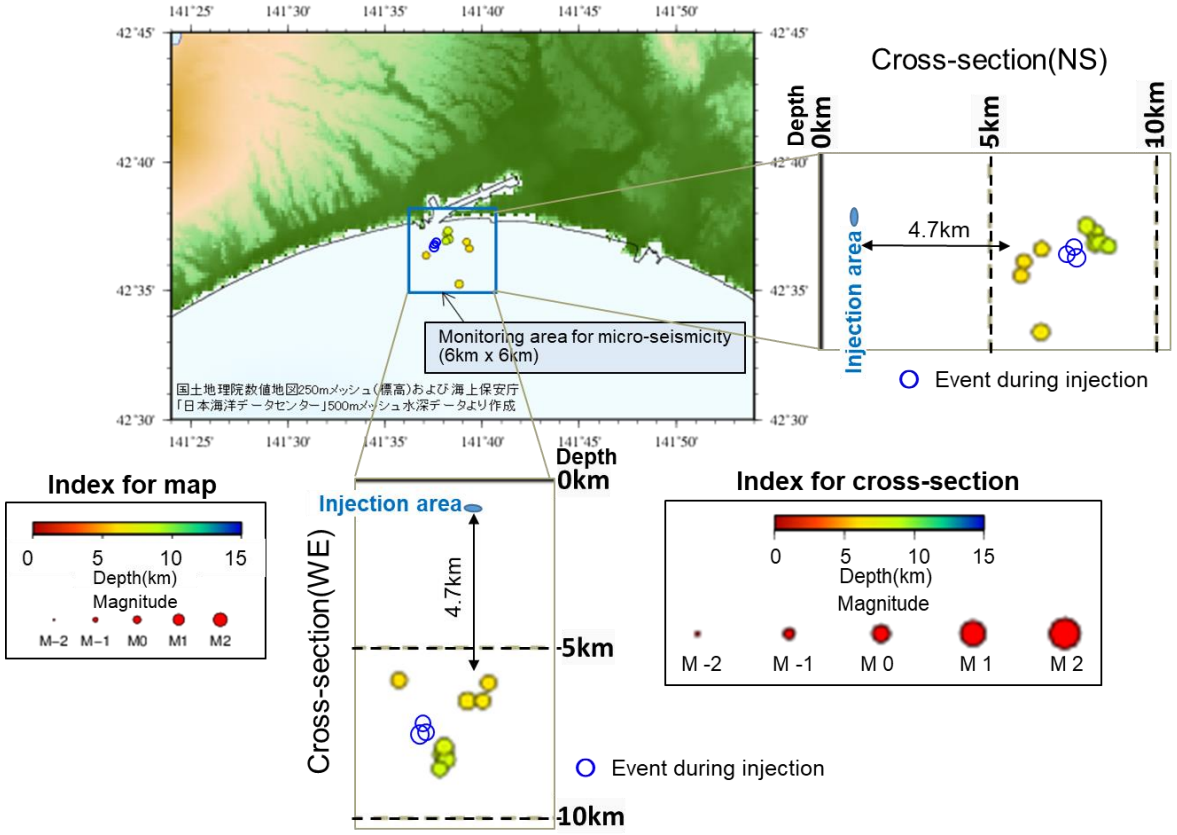
Earthquake Information

Announced by the Japan Meteorological Agency

Time & date	23:45:52.9(JST) 1 July, 2017
Epicenter	Lat. 42° 47.2′N Lon. 141° 51.5′E
Depth	27 km
Magnitude	5.1
Seismic Intensity at near epicenter and Tomakomai	Lower 5- and 3 on Japanese seismic scale approx. Ⅵ and approx. Ⅳ on Mercalli intensity scale

This earthquake had no influence on temperature and pressure of the cap rock strata.

Seismic Monitoring Results : Micro-seismicity



◆ **No micro-seismicity (Mw > -0.5) in/around the depth range of the reservoirs before and after the start of injection**

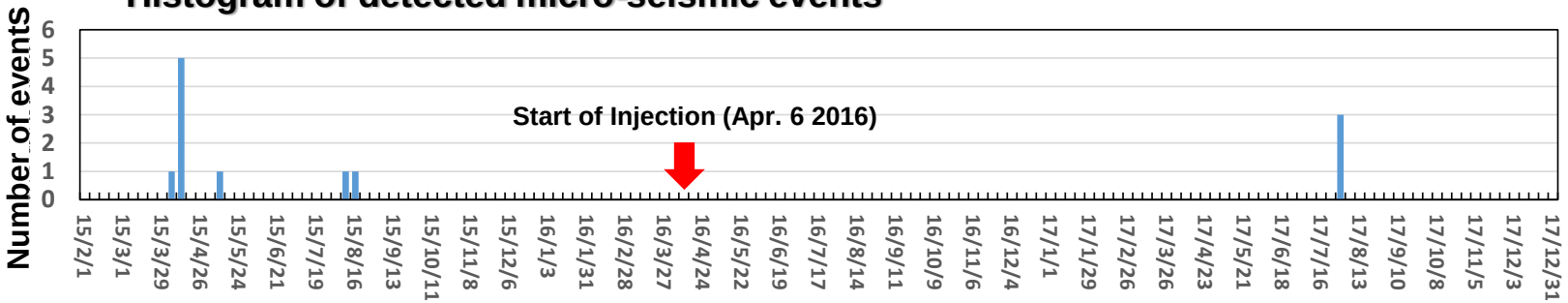
Before Injection period

Total 9 events, Mw: - 0.09 ~ 0.24
Depth: 5.9km ~ 8.6km

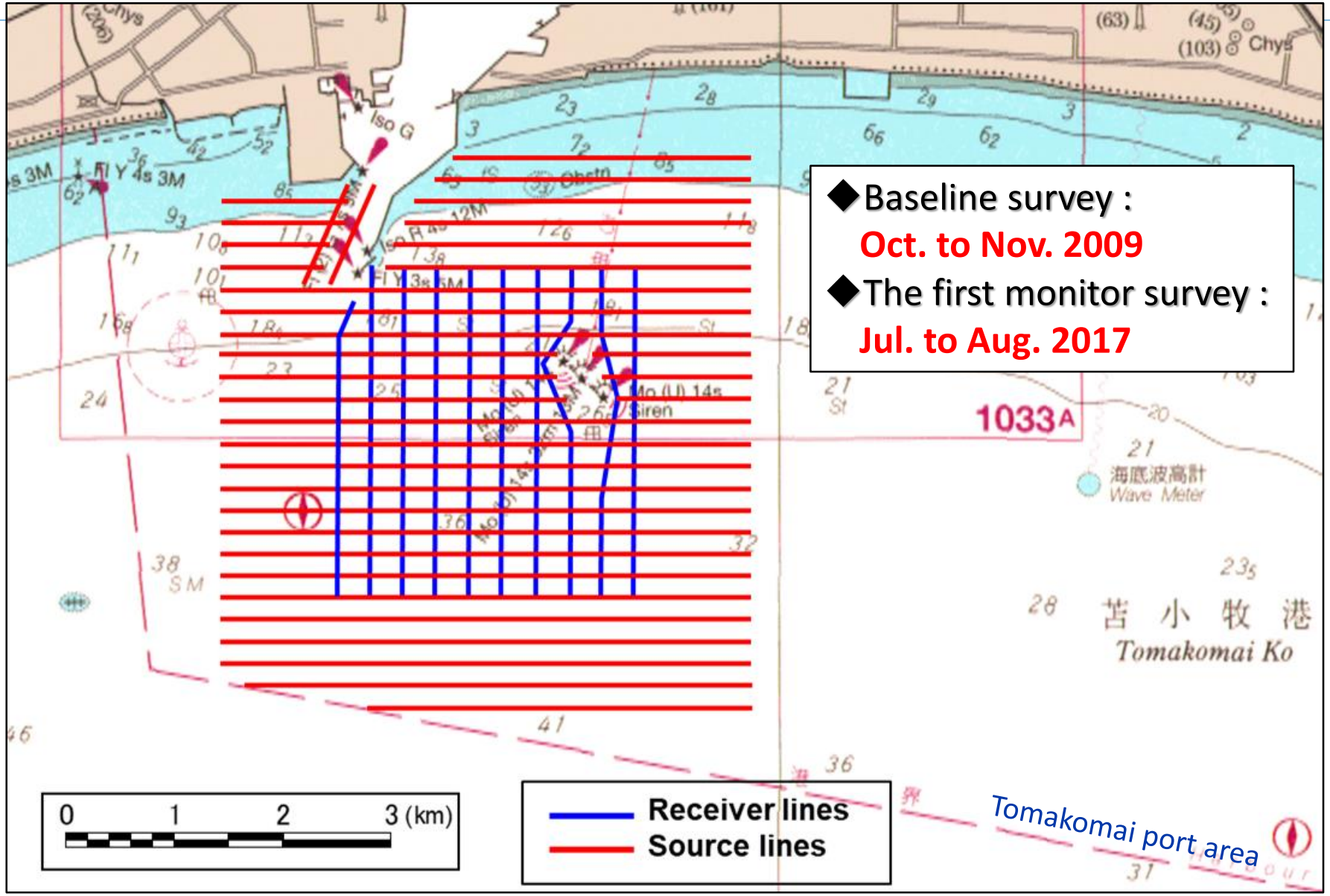
During Injection period

Total 3 events, Mw: 0.31 ~ 0.52
Depth: 7.4km ~ 7.7km
Date: Aug. 2 2017

Histogram of detected micro-seismic events

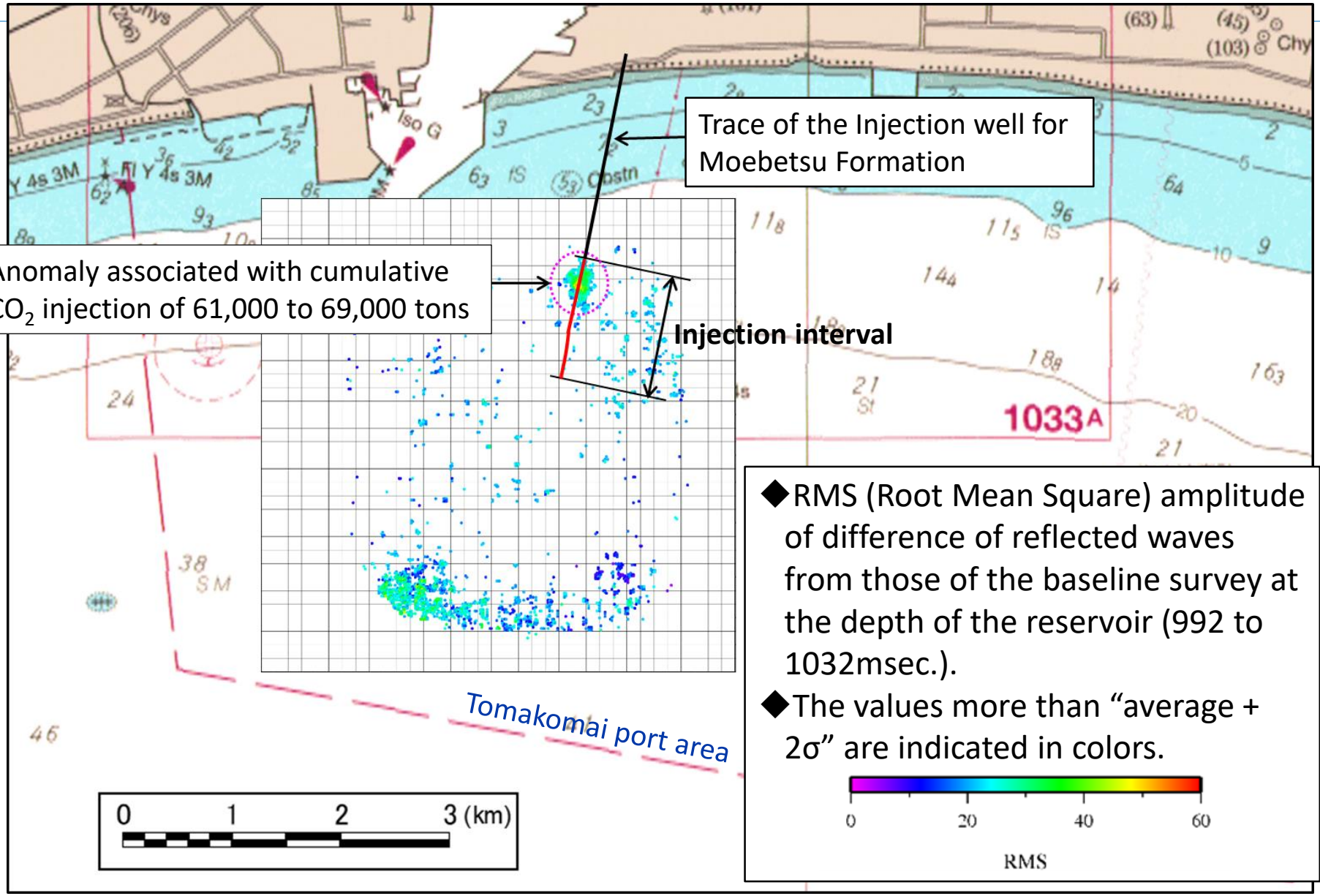


4D seismic survey : Survey lines (Baseline survey)



Plotted on Japan Coast Guard Nautical Chart

4D seismic survey : Preliminary result of the first monitor survey



Plotted on Japan Coast Guard Nautical Chart

Project Summary

Project Summary

- **Unique features of project**
  - **Capture system with two stage absorption and low-pressure flash process providing significant reduction of capture energy**
  - **Deviated injection wells from onshore site into offshore reservoirs**
  - **Extensive monitoring system**
- **Successful Operation**
  - **Demonstration of safety and reliability of CCS system**
    - **Confirmed the design performance of facilities**
    - **High reliability despite variation of supplied CO_2 volume**
    - **No effect of natural earthquakes on injected CO_2, no induced seismicity attributable to injection**
- **Superior injectivity of shallow reservoir**
- **Extensive stakeholder engagement being undertaken**


Thank you for your attention.
http://www.japanccs.com/
This presentation is based on results obtained from a project commissioned by Ministry of Economy, Trade and Industry (METI) and the New Energy and Industrial Technology Development Organization (NEDO).