Tomakomai CCS Demonstration Project

CSLF PIRT MEETING

October 3, 2016

Japan CCS Co., Ltd. (JCCS)

JCCS

JCCS Company Profile and CCS Project Framework

Company Profile

Date of Incorporation: May 26, 2008

Business Description:
Comprehensive investigation for and implementation of CCS Demonstration Projects in Japan

Capital: 243 MM JPY

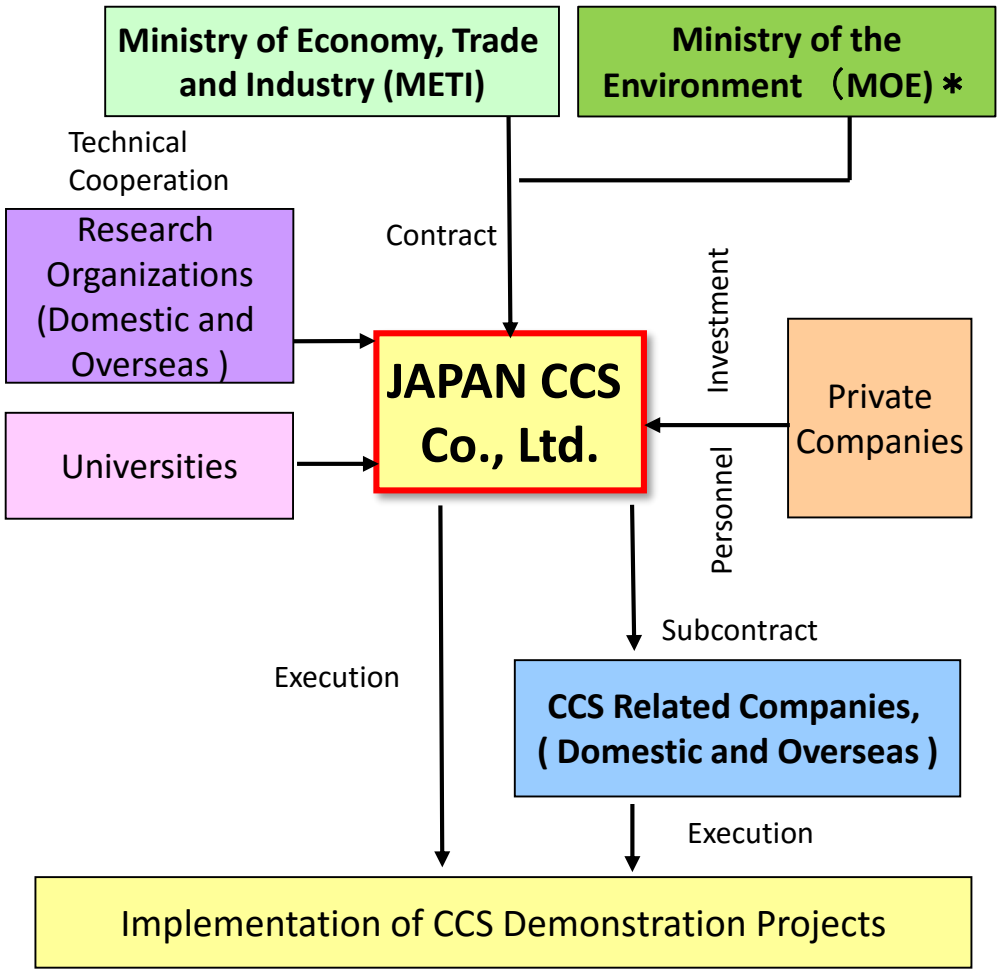
Shareholders: 35 companies
11 electric power, 5 engineering, 4 petroleum, 3 petroleum resource developing, 4 general trading, 2 iron and steel, 2 city gas, 1 chemical, 1 non-ferrous metal and cement, 1 steel pipe, 1 special trading

President: Shoichi Ishii, JAPEX

Directors: 8 representing the shareholders' industries

No. of Staff: approx. 100

Project Framework - Functions of JCCS



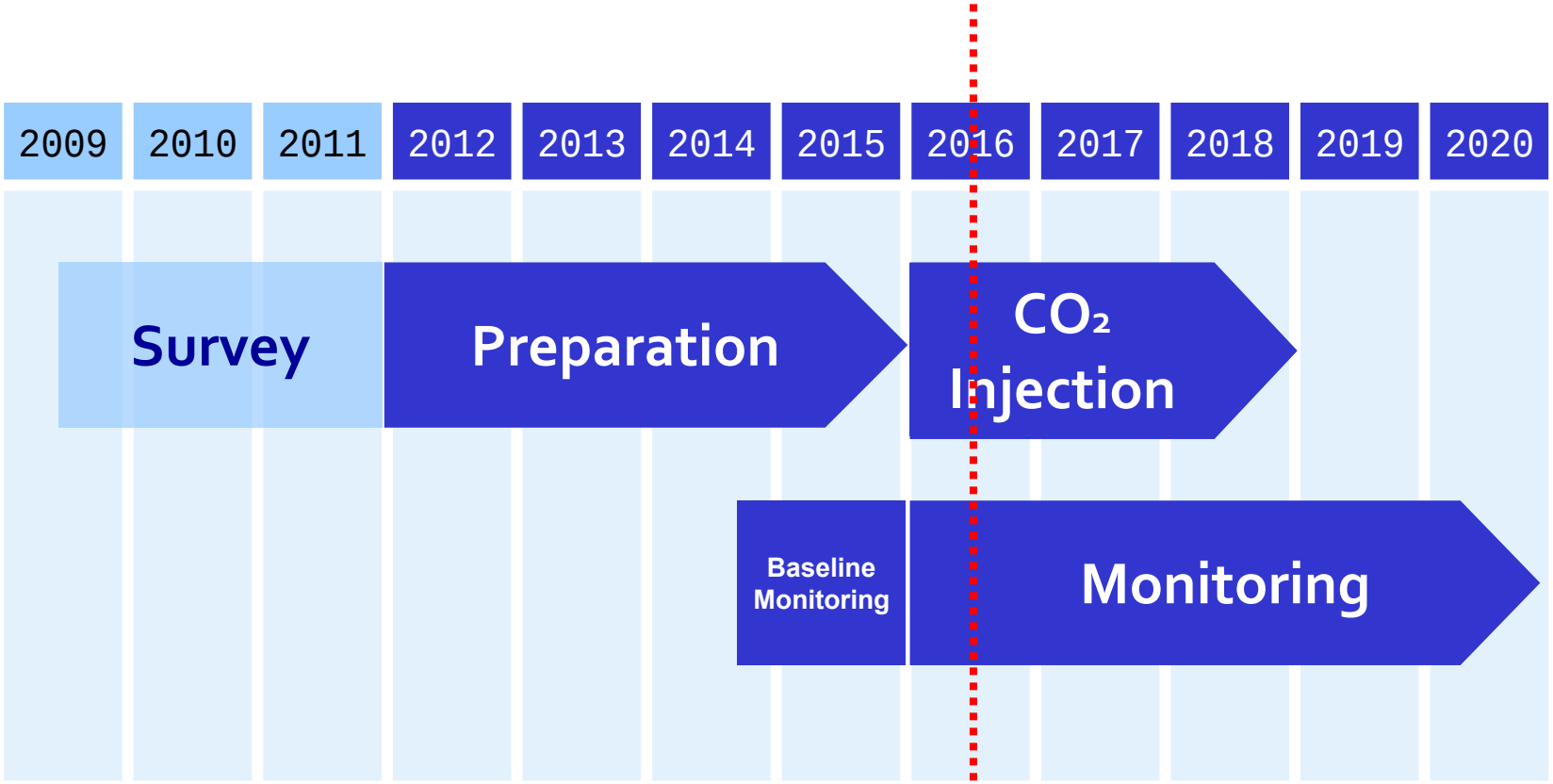
* MOE is a co-sponsor of "Investigation of Potential Sites for CO2 Storage, Offshore Japan".

Outline of Presentation

- Overview of Tomakomai Demonstration Project
- Demonstration Facilities
- Monitoring
- Test Injection and Public Outreach

Overview of Tomakomai Demonstration Project

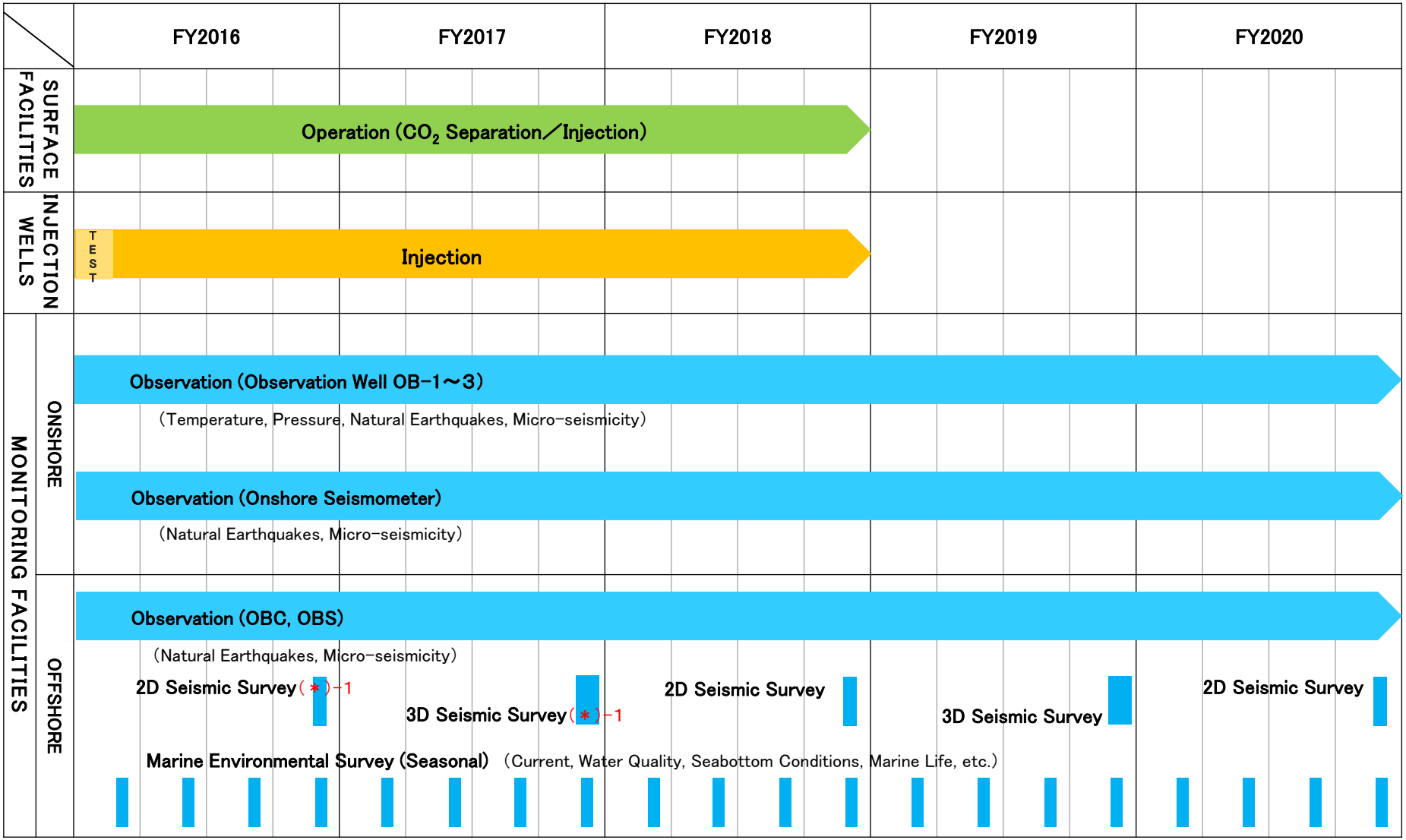
Tomakomai CCS Demonstration Project Schedule



※Years are in Japanese Fiscal Years (April of calendar year thru March of following year)

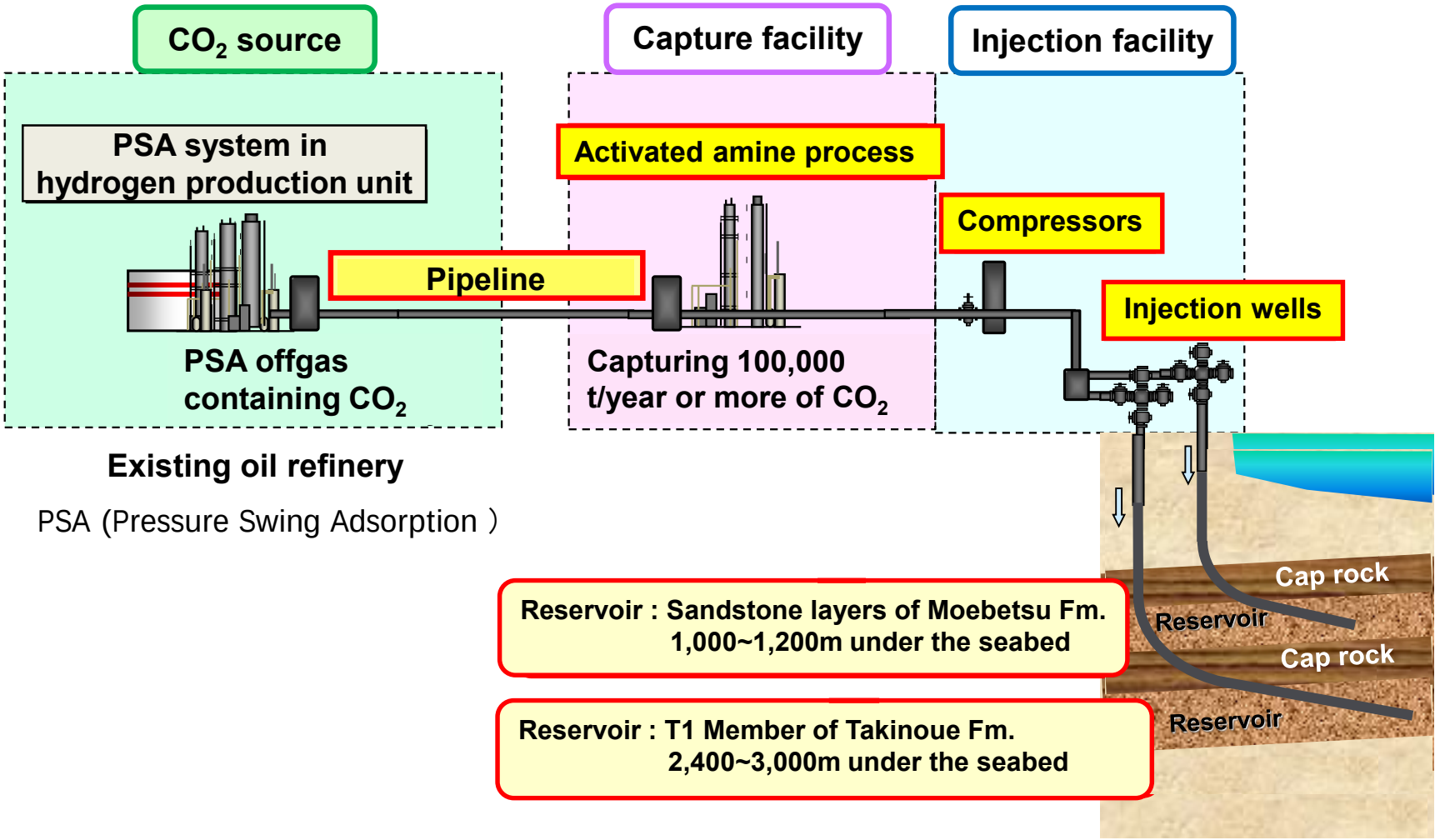
Demonstration Project Operation Schedule

As of May 2016



(＊)-1 2D･3D Seismic Survey: survey method utilizing seismic reflection waves discharged from a seismic source of a seismic exploration vessel in order to delineate the subsea geological structure and/or formation characteristics. In this case, the data acquired is used to estimate the CO2 storage distribution by 2D cross sections or arbitrary planal diagrams in 3D space.

Flow Scheme of CCS Demonstration Project



Project Goal, Objectives and Tasks

【Project Goal】

- **Demonstrate the technical viability of a full cycle CCS system from capture to injection and storage in saline aquifers on a practical scale, contributing to the establishment of CCS technology for practical use by 2020 and future deployment of CCS projects in Japan**

【 Objectives】

- **In order to demonstrate technical viability, safety and reliability of CCS system;**
  - **Capture and inject 100,000 tonnes/year or more of CO_2 for 3 years**
  - **Monitor by the installed monitoring system and surveys for 5 years**

【Tasks】

- Prepare capture and injection facilities, injection wells with a design capacity of 200,000 tonnes of CO_2 per year
- Prepare monitoring systems and gather data for geological storage and seismicity
- Estimate CO_2 behavior in the reservoirs by analysis of seismic and well data
- Confirm that existing technologies adopted in the system work properly and efficiently
- Confirm effectiveness of site selection guideline of METI by demonstrating no CO_2 leakage
- Establish guidelines for building and improving geological models
- Prepare technical standards of operation and safety for practicalization of CCS technology
- Share information and data obtained from the project with the public and relevant community groups in order to increase awareness and understanding of the benefits and viability of CCS

Anticipated Outcomes

【 Outcomes】

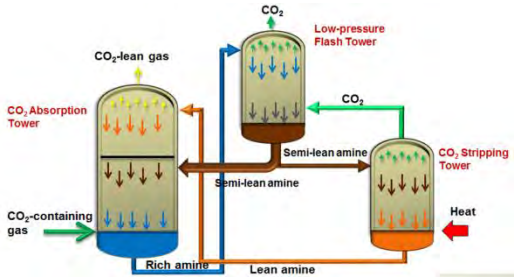
- Confirmation of the technical viability of a full CCS system in Japan
- Clarification of technical and social areas to be improved or solved for commercialization
- Mitigation of public concerns about earthquakes
  - Natural earthquakes do not influence or negatively impact stored CO_2
  - CO_2 injection does not cause any perceptible increase in earth tremors
- Enhancement of awareness and understanding of CCS technology and its benefits

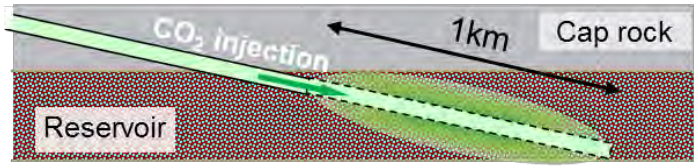
【Other Considerations】

- Verification of onshore to offshore injection model
  - Lower drilling and maintenance costs
  - Securing public acceptance for offshore storage may be easier than onshore
  - Potentially smaller impact on environment in worst case leak scenario
  - Applicability to island nations

Main Features of Tomakomai CCS Project

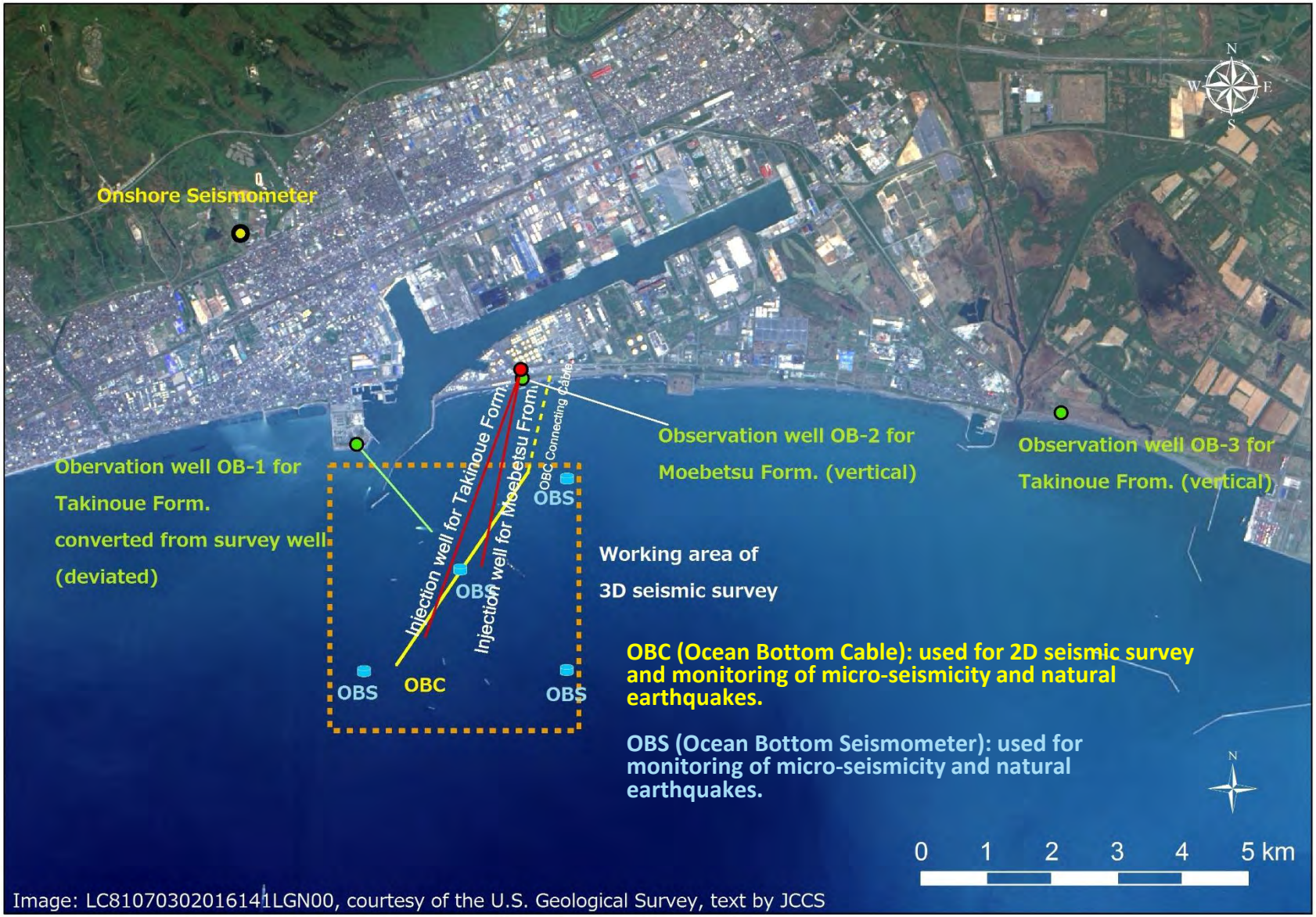
- First full cycle CCS system deployed in Japan
- Two-stage CO_2 capture system providing for low energy consumption
- Deviated CO_2 injection wells drilled into offshore reservoirs from an onshore site.
- Injection interval length exceeding 1,100m to enhance injection efficiency
- Extensive monitoring system to address concerns about earthquakes
- CO_2 storage governed by Japanese law reflecting London 1996 Protocol
- First case of CCS near urban area requiring extensive stakeholder engagement





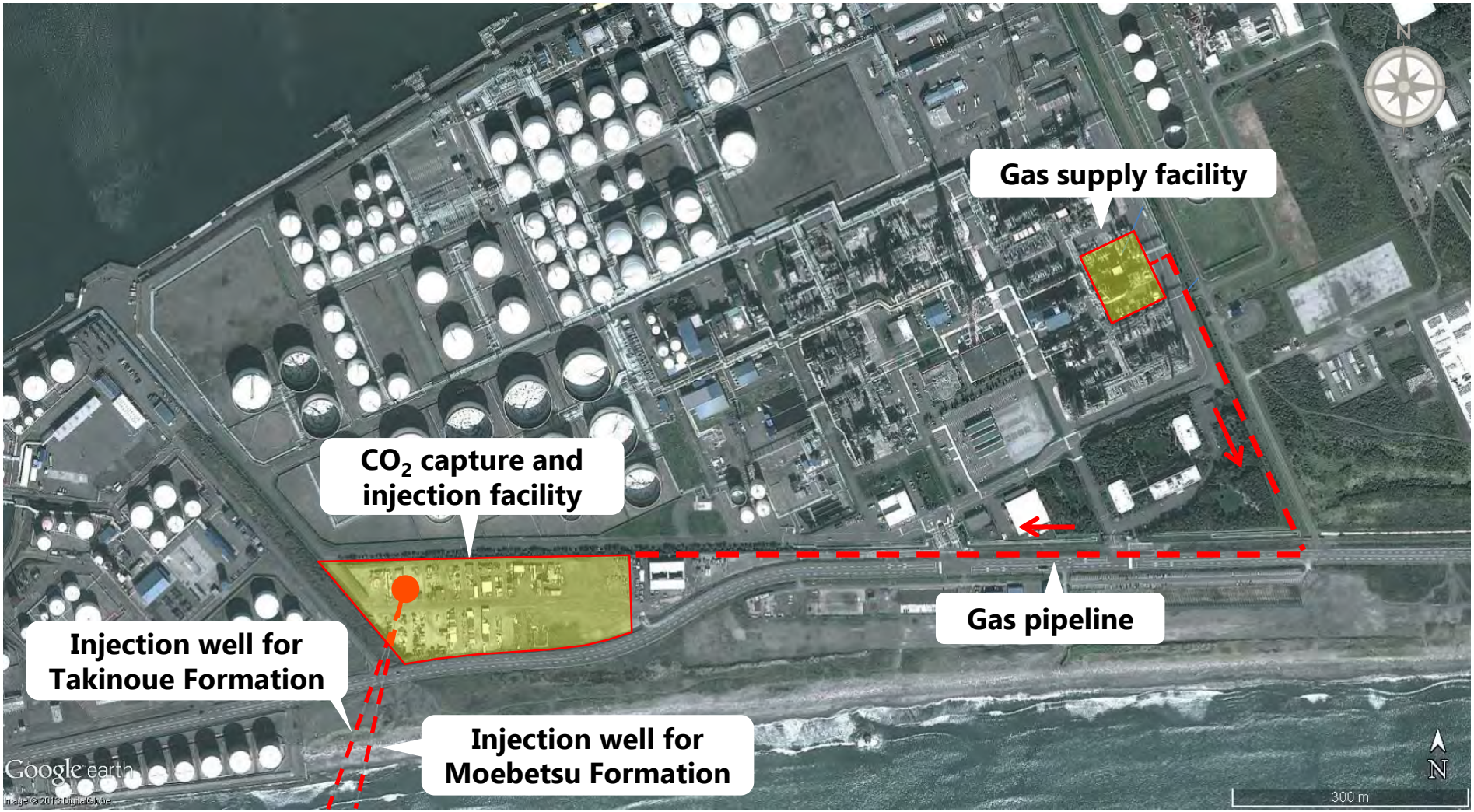
Demonstration Facilities

Positional Relation of Injection & Monitoring Systems



JCCS

Positional Relation of Onshore Facilities

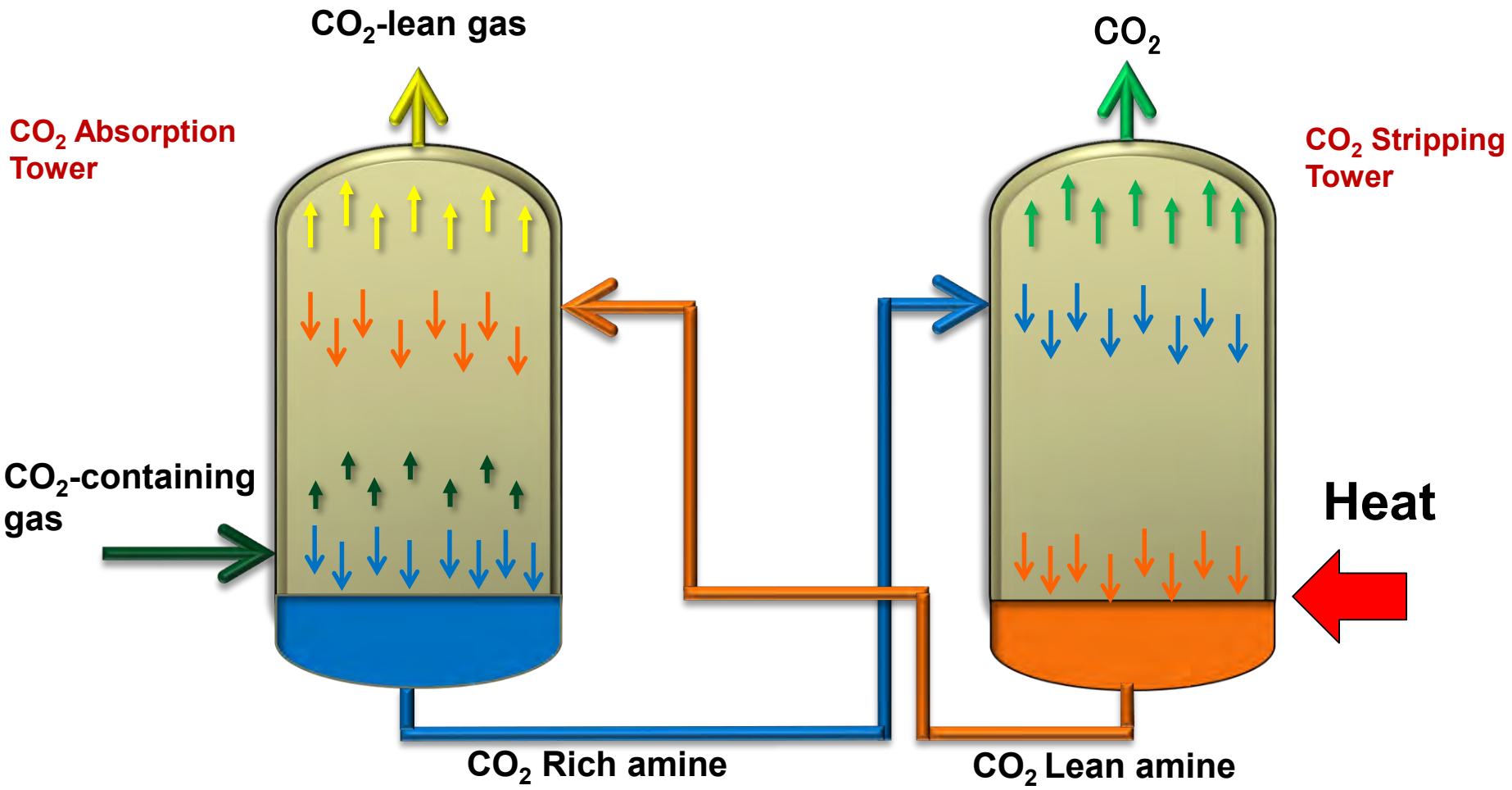


JCCS

Bird's Eye View of Capture and Injection Facilities

JCCS

Conventional CO_2 Capture Process



Note: Reboiler duty
primary and secondary amine:3.0~3.5 GJ/t-CO_2
activated amine: 2.5~3.0 GJ/t-CO_2

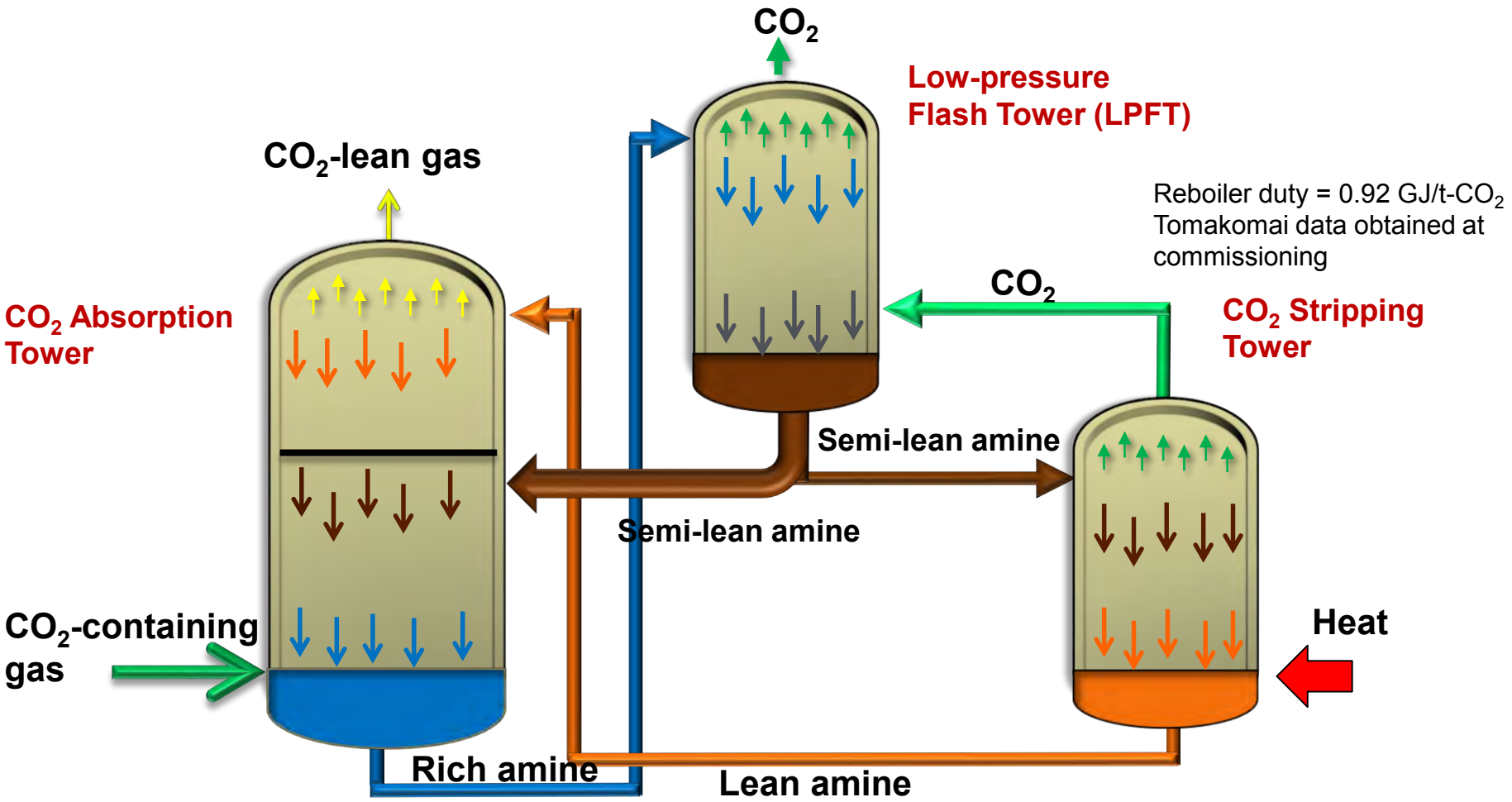
Reboiler duty ≒ 2.5 ~3.5GJ/t-CO_2
See note

JCCS

Tomakomai CO_2 Capture Process

- In LPFT, CO_2 is stripped by depressurization; thermal energy of water vapor of CO_2 Stripping Tower is also utilized to strip CO_2
- Greater part of semi-lean amine from LPFT is returned to CO_2 Absorption Tower for CO_2 absorption; as only the remaining smaller portion is sent to CO_2 Stripping Tower, reboiler heat required can be reduced

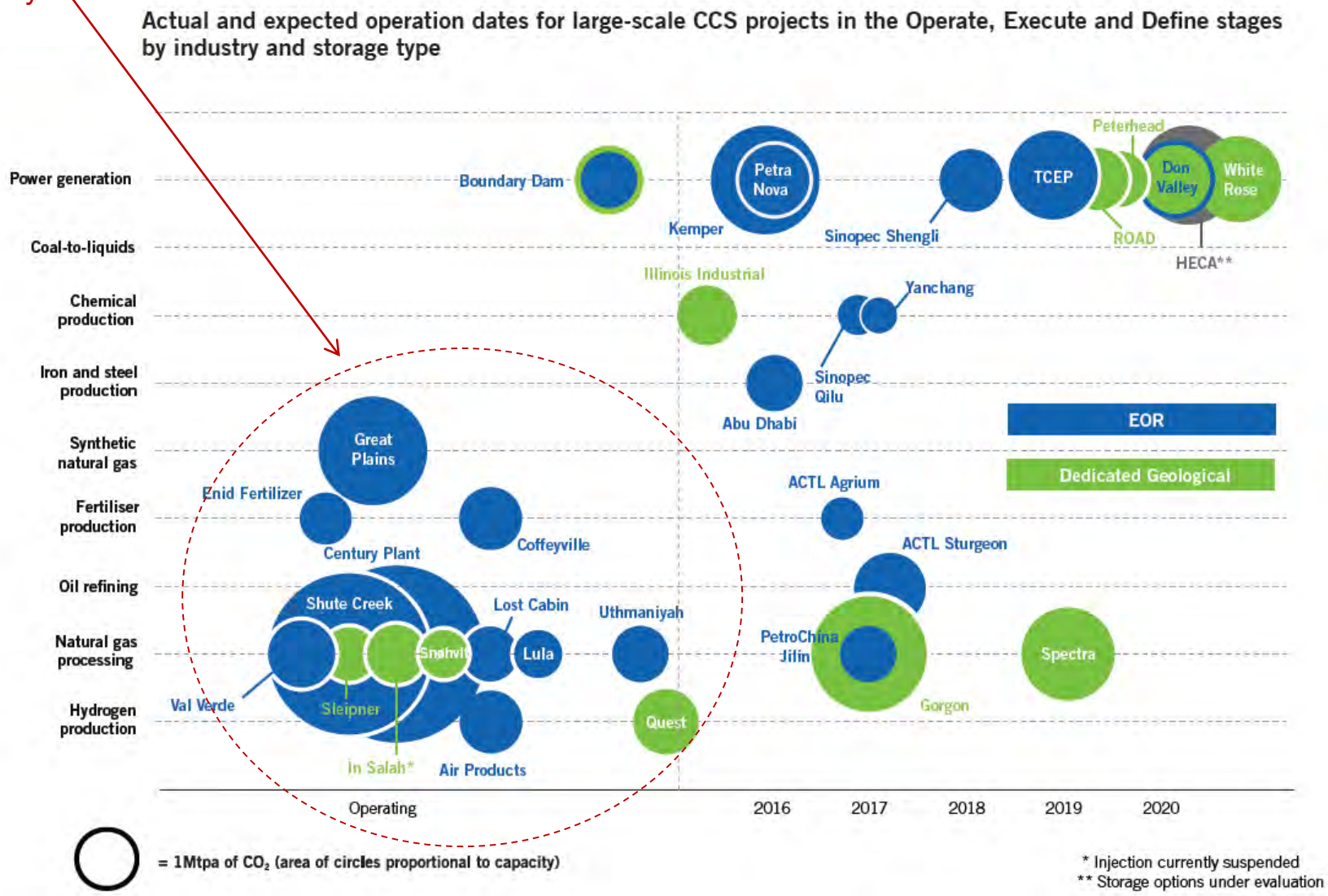
If pressure of gas containing CO_2 and partial pressure of CO_2 are relatively high, amine reboiler heat consumption is only 1/3～1/2 of conventional capture process



JCCS

World CCS Trend

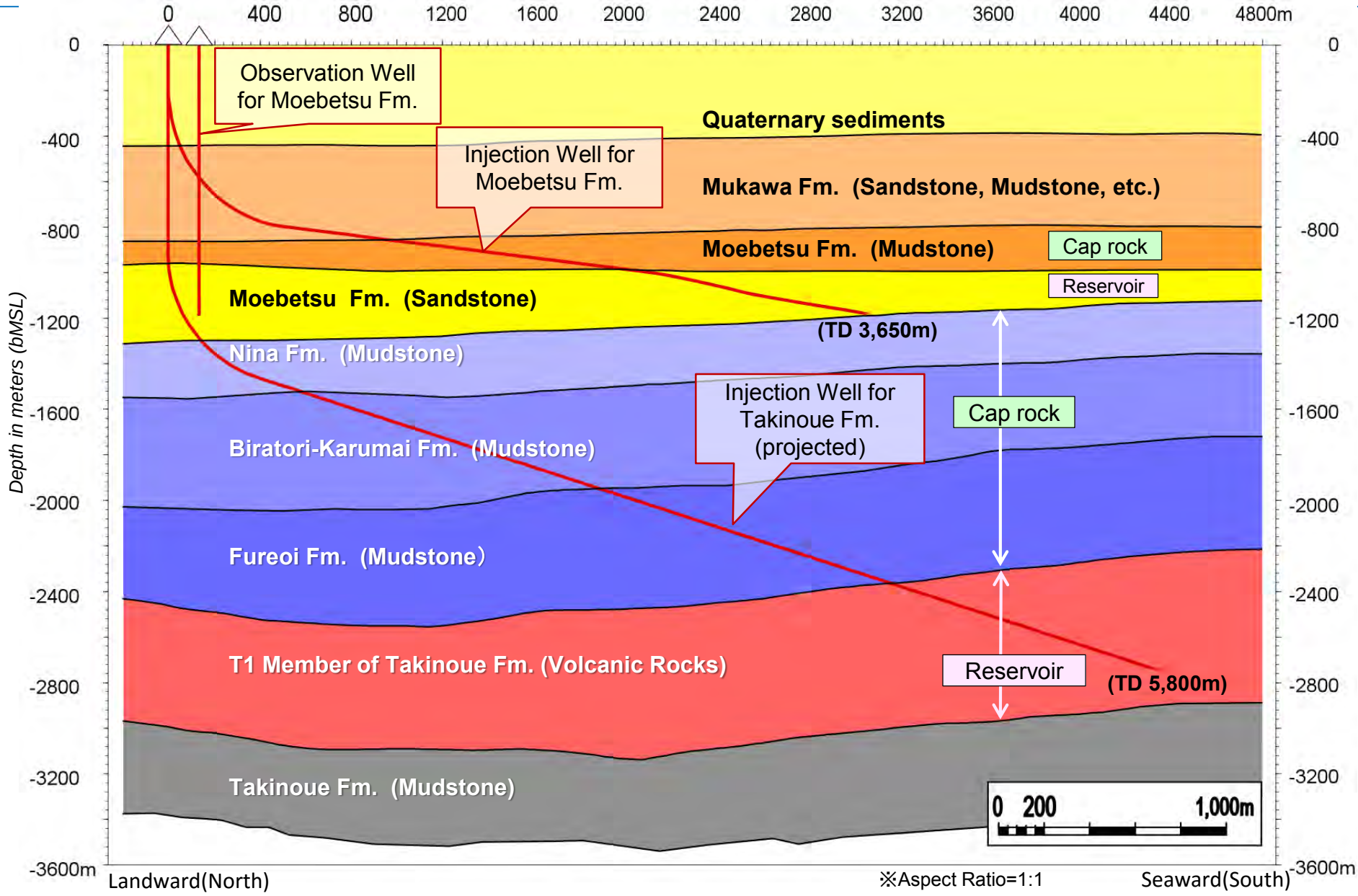
Tomakomai Demonstration Project falls into “high pressure CO_2-containing gas with high CO_2 partial pressure” category.



Source : GCCSI, THE GLOBAL STATUS OF CCS 2015

Note in red : added by JCCS

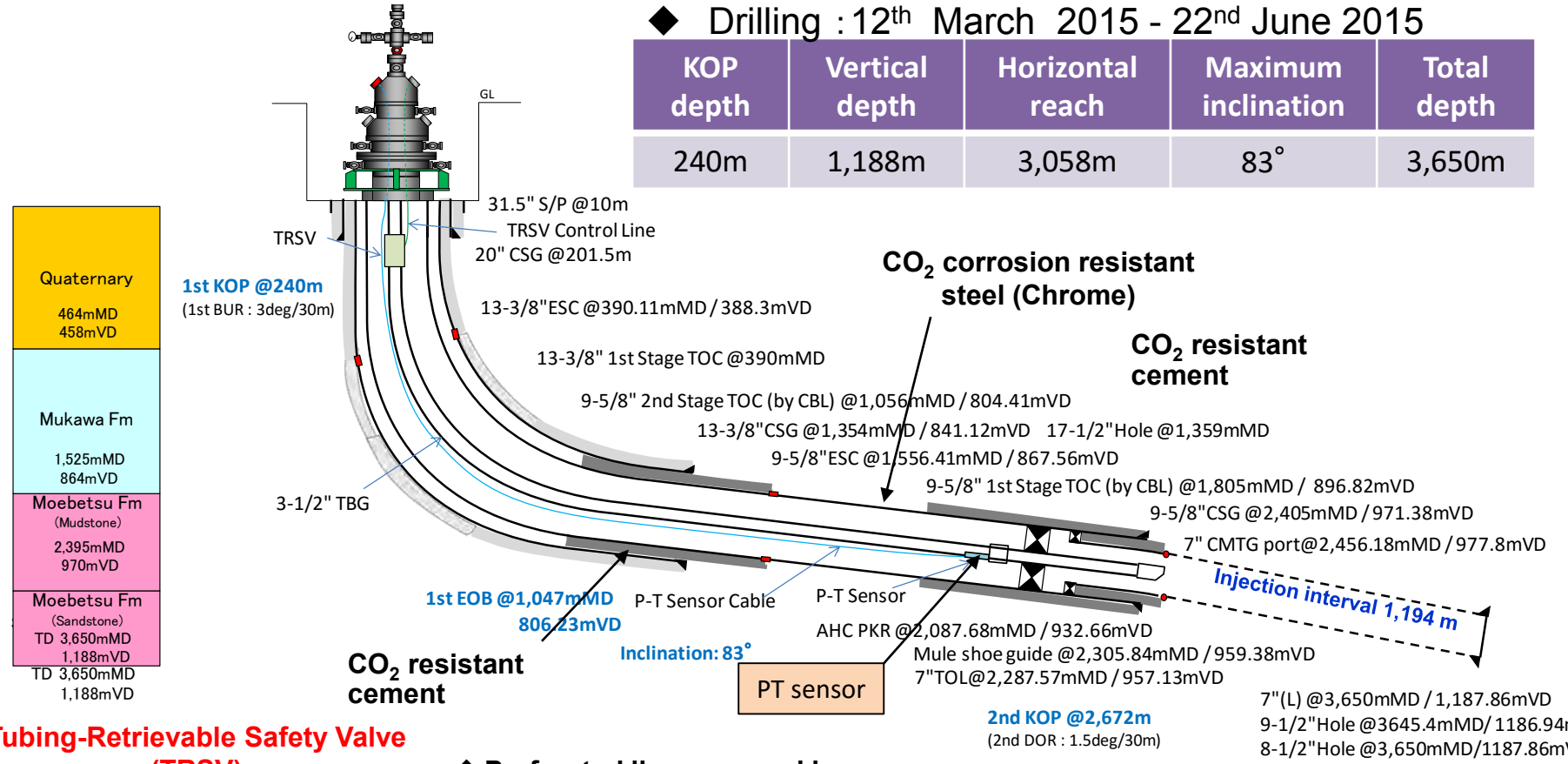
Schematic Geological Section



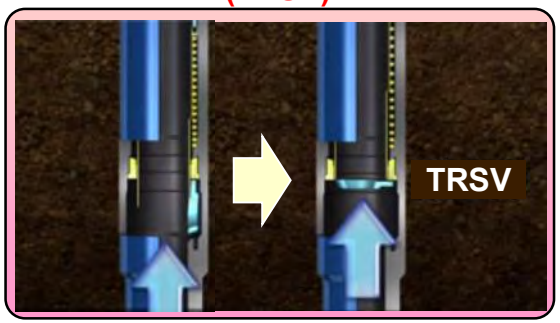
Injection well for Moebetsu Formation

◆ Drilling : 12th March 2015 - 22nd June 2015

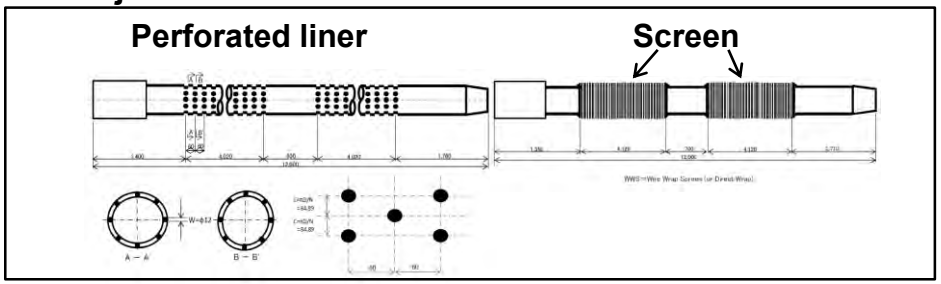
KOP depth	Vertical depth	Horizontal reach	Maximum inclination	Total depth
240m	1,188m	3,058m	83°	3,650m



Tubing-Retrievable Safety Valve (TRSV)



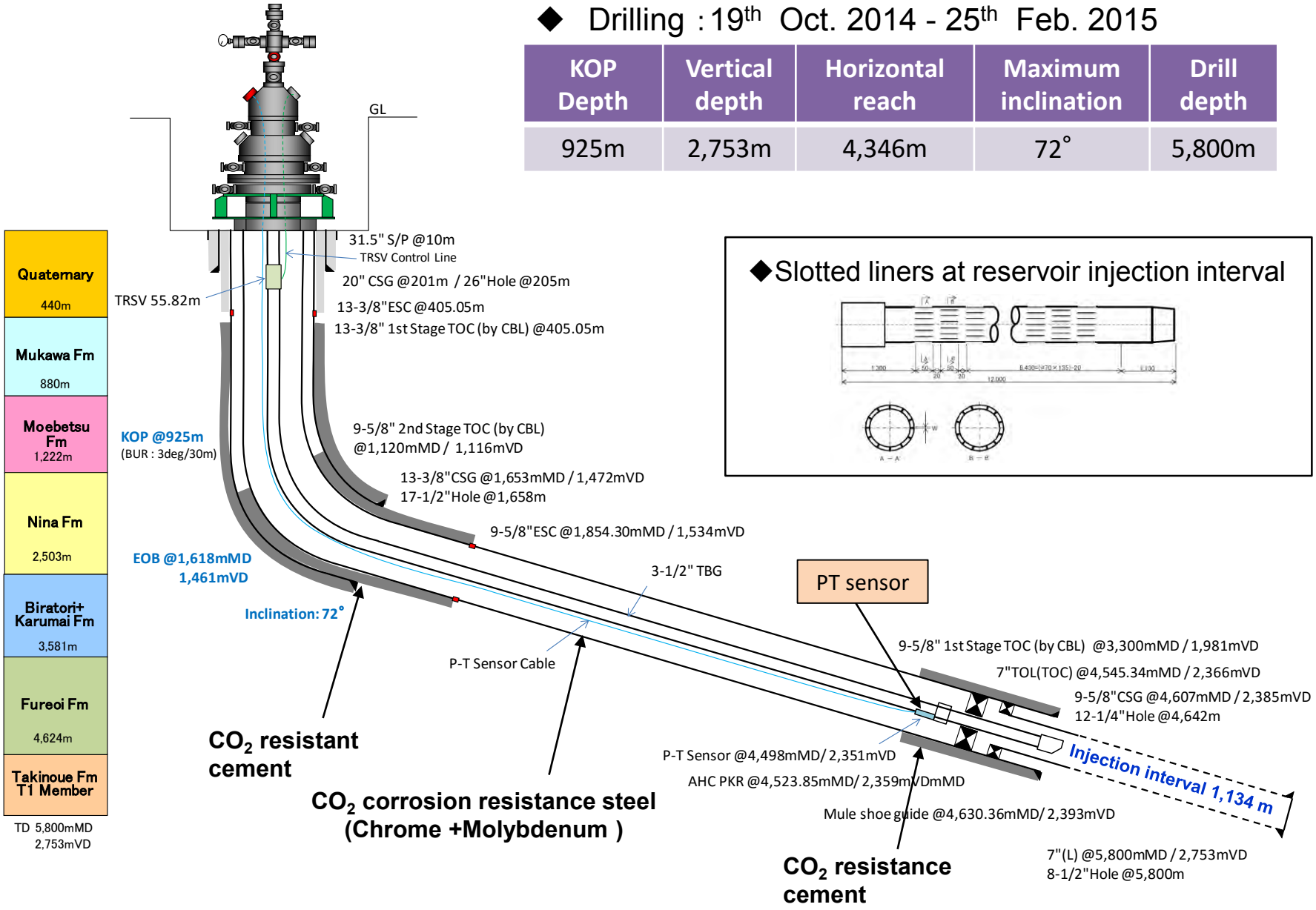
◆ **Perforated liner covered by screens at injection interval**



Injection Well for Takinoue Formation

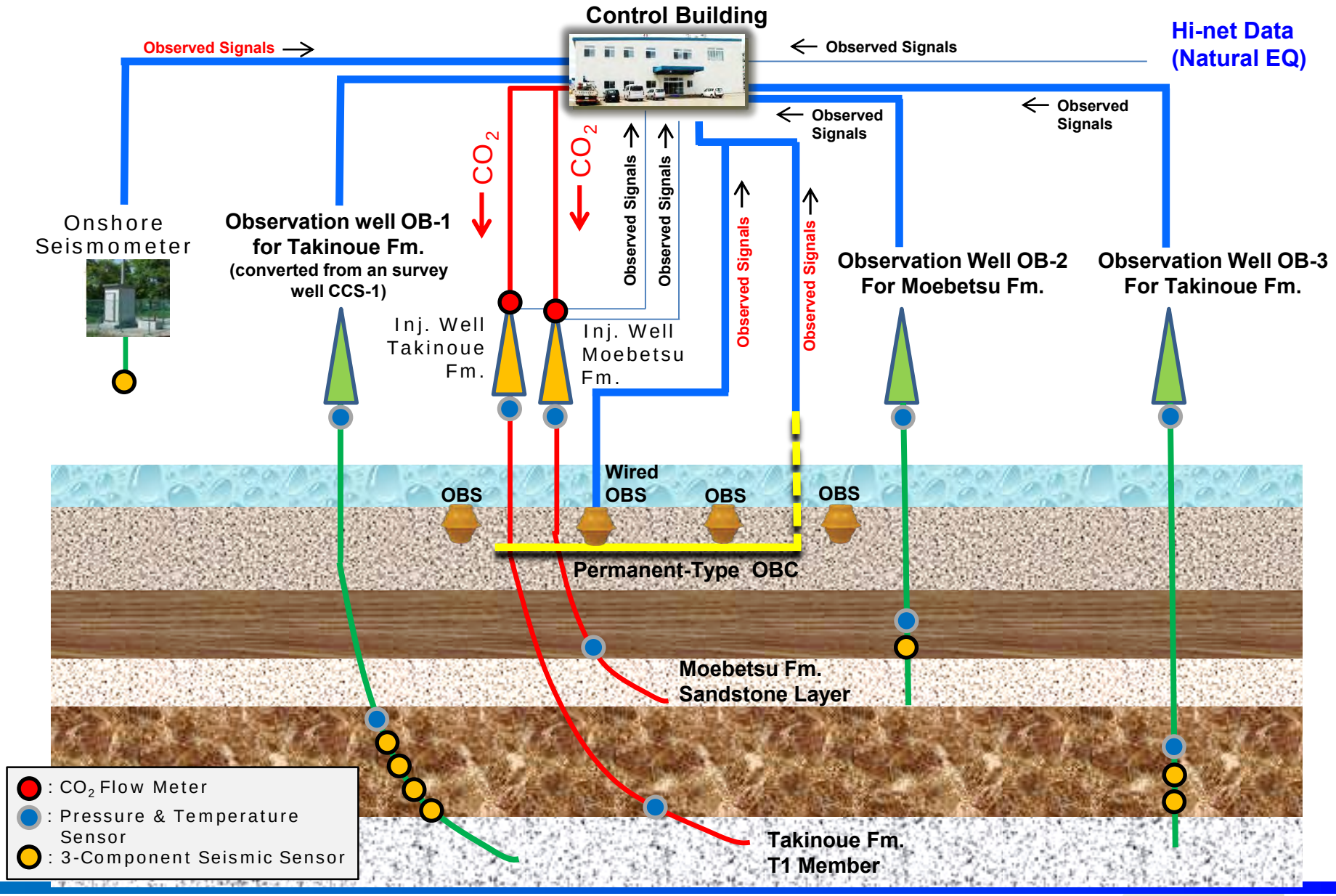
◆ Drilling : 19th Oct. 2014 - 25th Feb. 2015

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



◆Slotted liners at reservoir injection interval

Schematic Diagram of Monitoring System



JCCS

Marine Environmental Survey

Marine environment shall be surveyed based on "Act on Prevention of Marine Pollution and Maritime Disaster" by which geological storage of CO_2 under the seabed is regulated.

1. Survey Area

- 12 survey points in Tomakomai Port Area

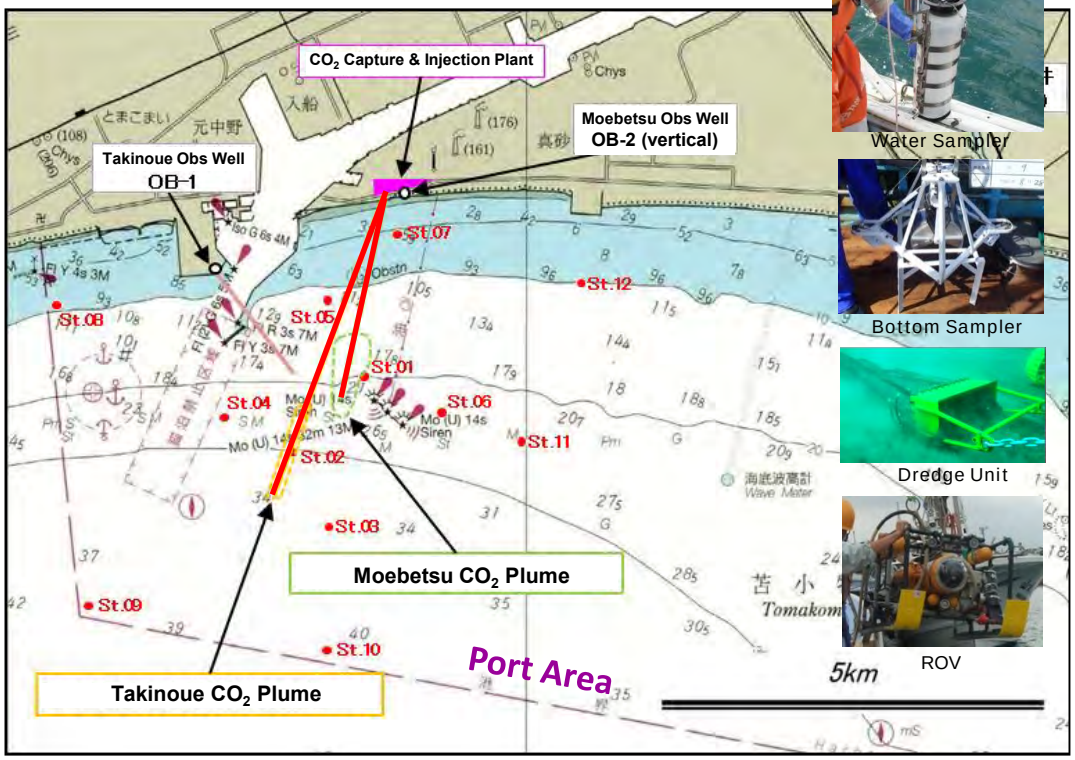
2. Methods of Survey

- 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 salt 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



St : Survey Point

Plotted on Japan Coast Guard nautical chart


Side-Scan Sonar

Water Sampler

Bottom Sampler

Dredge Unit

ROV

JCCS

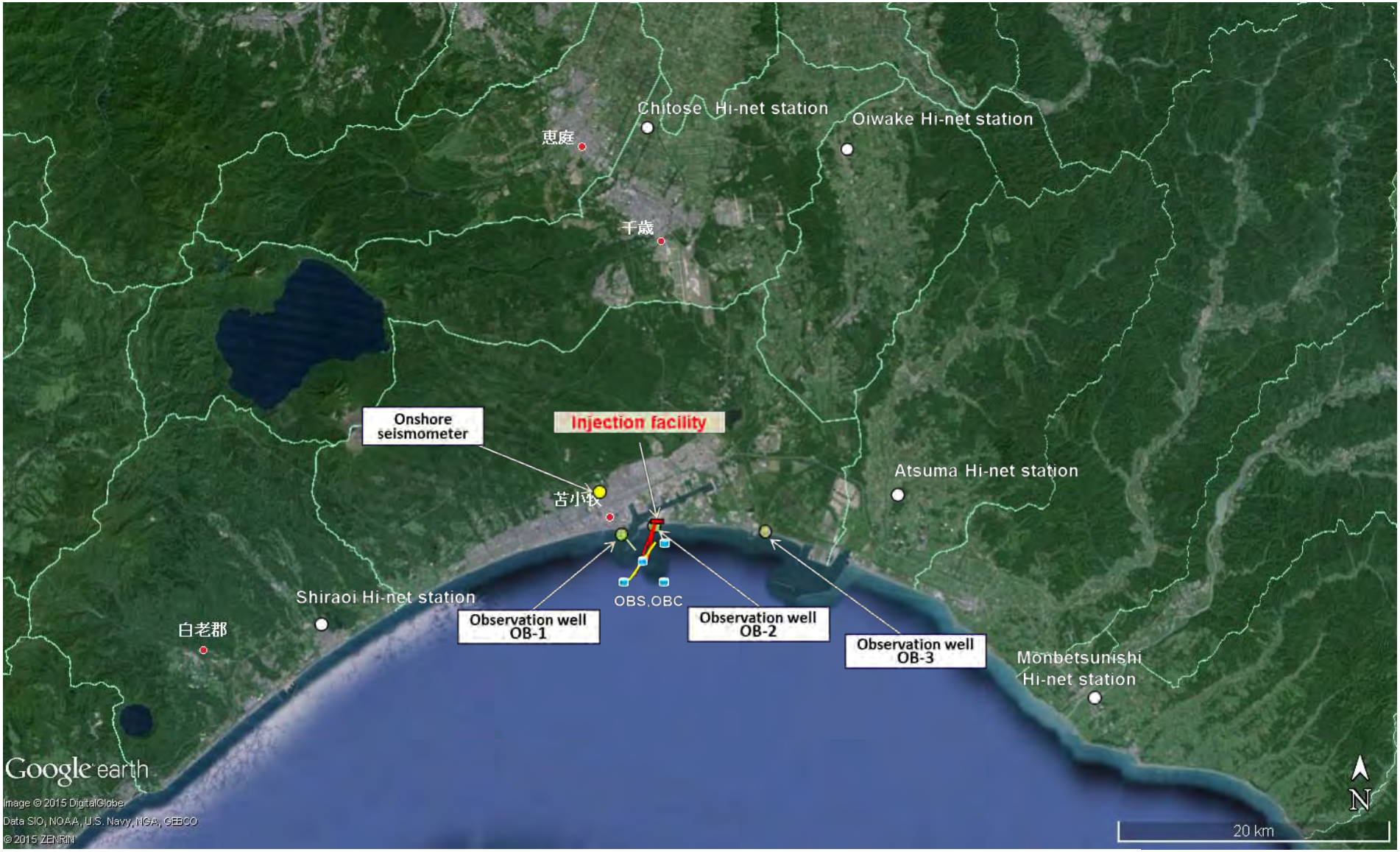
Monitoring

Monitoring Items

Items	Observed objects	Observation frequency	Remarks
Injection well	◆ Downhole : Temperature and pressure ◆ Wellhead : Pressure, Injection rate of CO_2	Continuous	• Injection well for Takinoue Formation • Injection well for Moebetsu Formation
Observation well	◆ Downhole : Temperature and pressure, micro-seismicity and natural earthquakes	Continuous	• Observation well OB-1 for Takinoue Formation converted from an survey well CCS-1 • Observation well OB-2 for Moebetsu Formation • Observation well OB-3 for Takinoue Formation
OBC : Ocean Bottom Cable	◆ Micro-seismicity and natural earthquakes ◆ Signal of 2D seismic survey	Continuous	• OBC line passes directly above the injection points of reservoirs.
OBS : Ocean Bottom Seismometer	◆ Micro-seismicity and natural earthquakes	Continuous	• One wired OBS above the injection points • Three stand-alone OBSs at the surrounding area of injection points of reservoirs
Onshore seismometer	◆ Micro-seismicity and natural earthquakes	Continuous	• West region of Tamakomai city
2D seismic survey	◆ Distribution of CO_2	Periodic	• Utilizing OBC as seismic sensors
3D seismic survey	◆ Distribution of CO_2	Periodic	• A baseline survey was completed during the investigation period.
Marine environmental monitoring	◆ Chemical, physical and biological data	Periodic	• Monitoring plan is to be drawn up after the baseline survey and marine environmental impact assessment.

JCCS

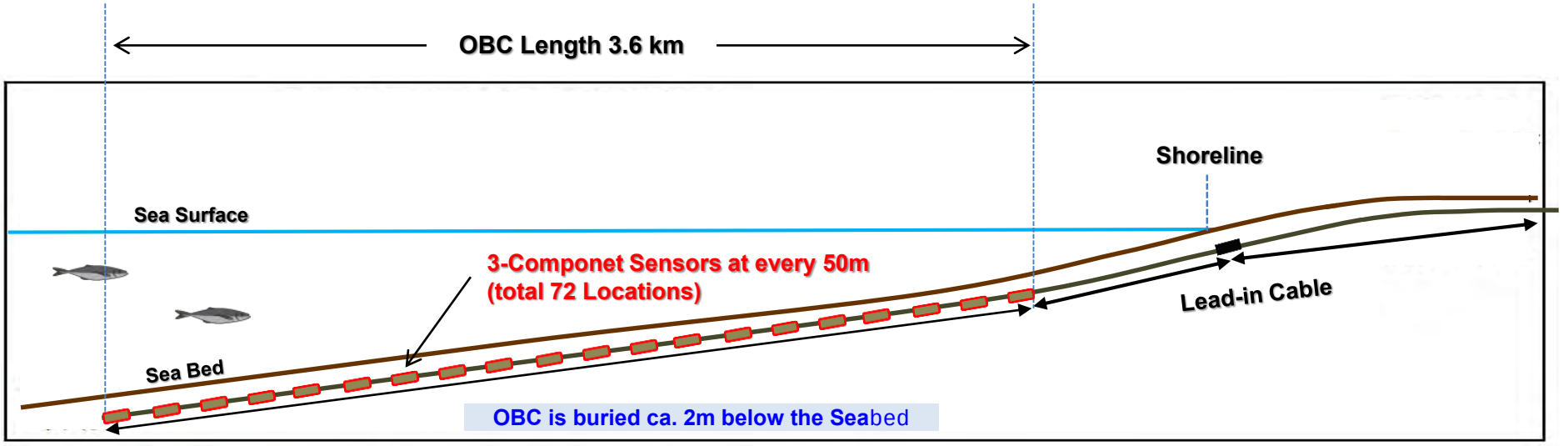
Layout of Seismicity Monitoring Facilities



JCCS

OBC : Ocean Bottom Cable

Schematic Diagram of Permanent-type OBC



Length: 1.37 m
Diameter: 9 cm
Weight: 12.6 kg

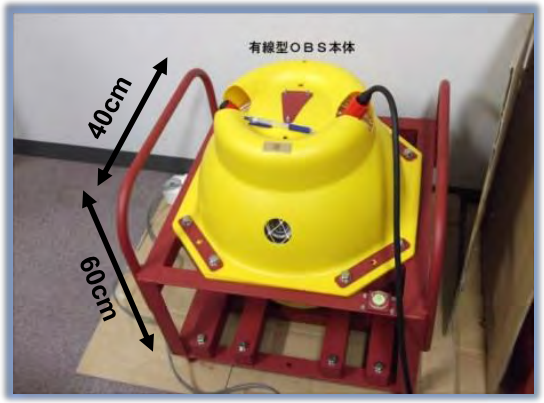
3C sensor module

Cable burying machine（water-jet tool）

JCCS

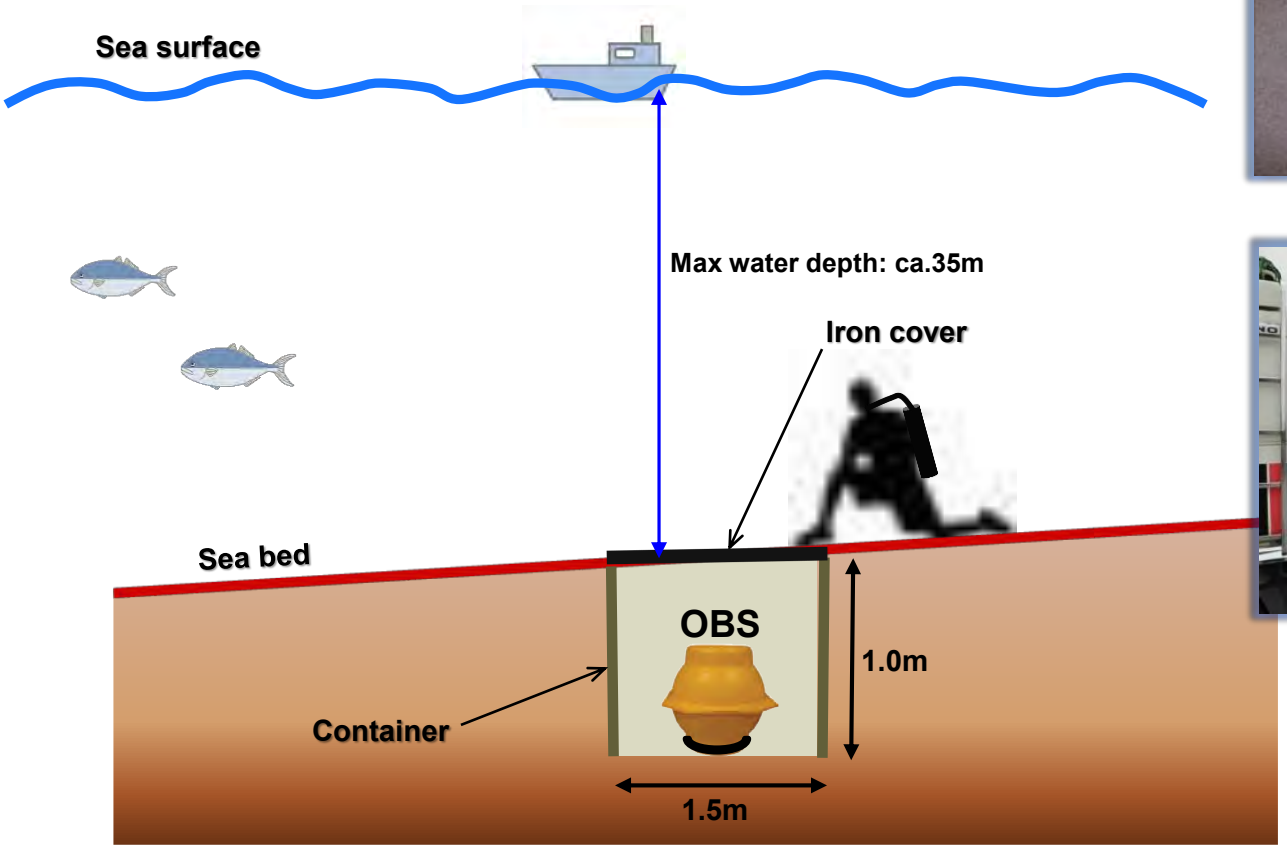
OBS : Ocean Bottom seismometer

- One unit of wired OBS : Replacing at one year interval for maintenance
- Three units of stand-alone OBS : Replacing at four months interval for date acquisition and maintenance



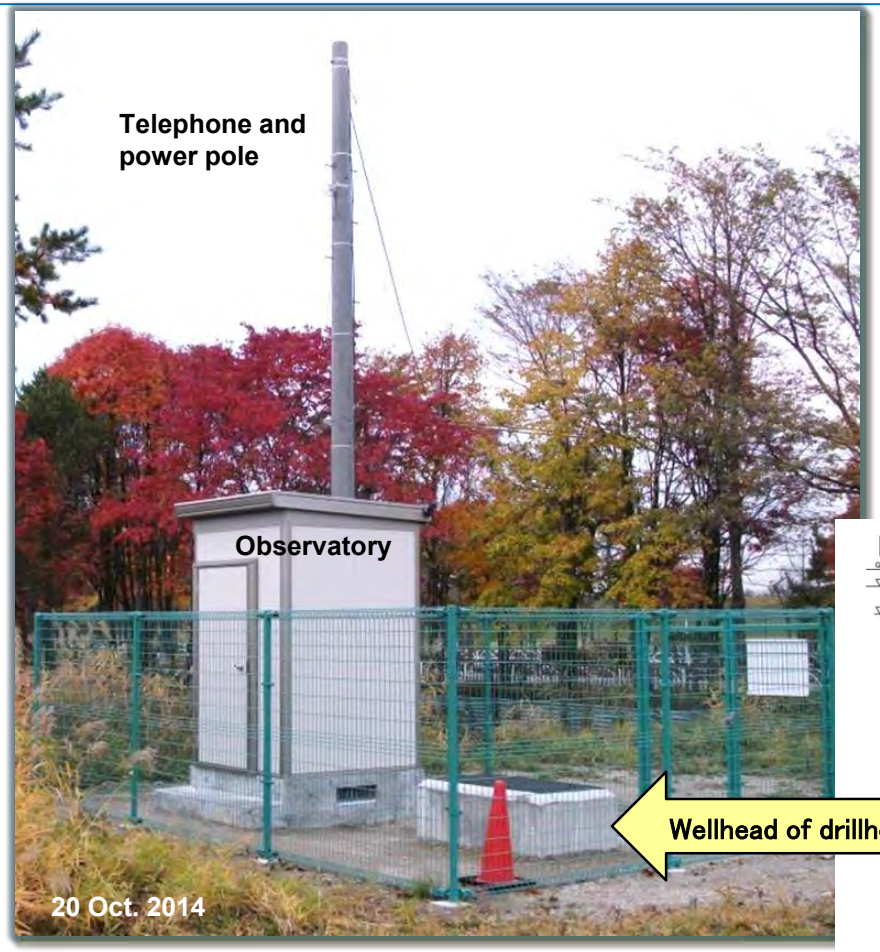
Wired OBS

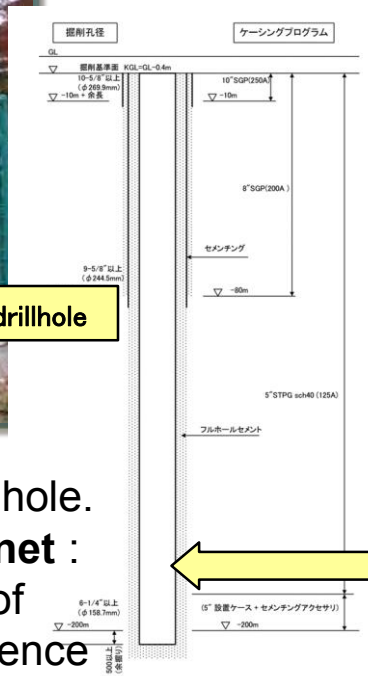
Concrete container for OBS

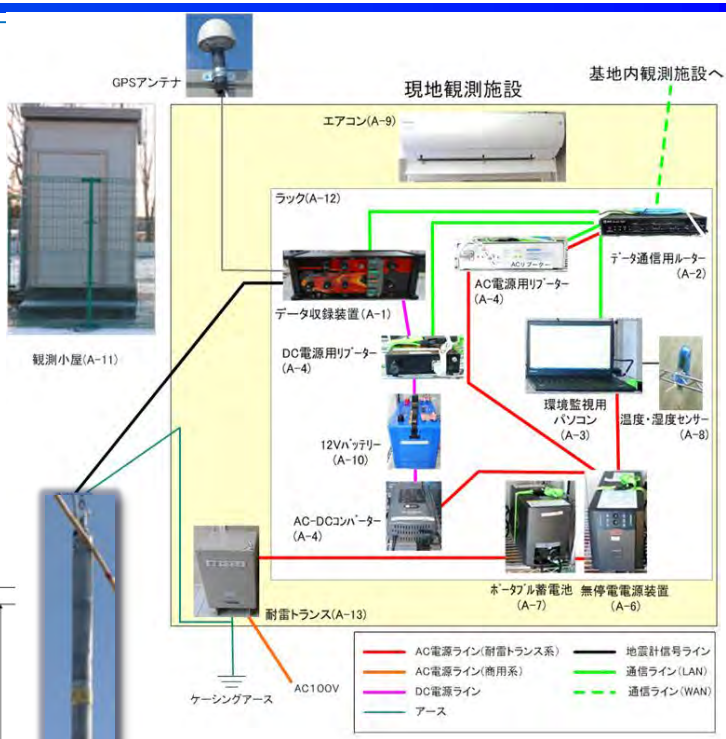


JCCS

Onshore Seismometer







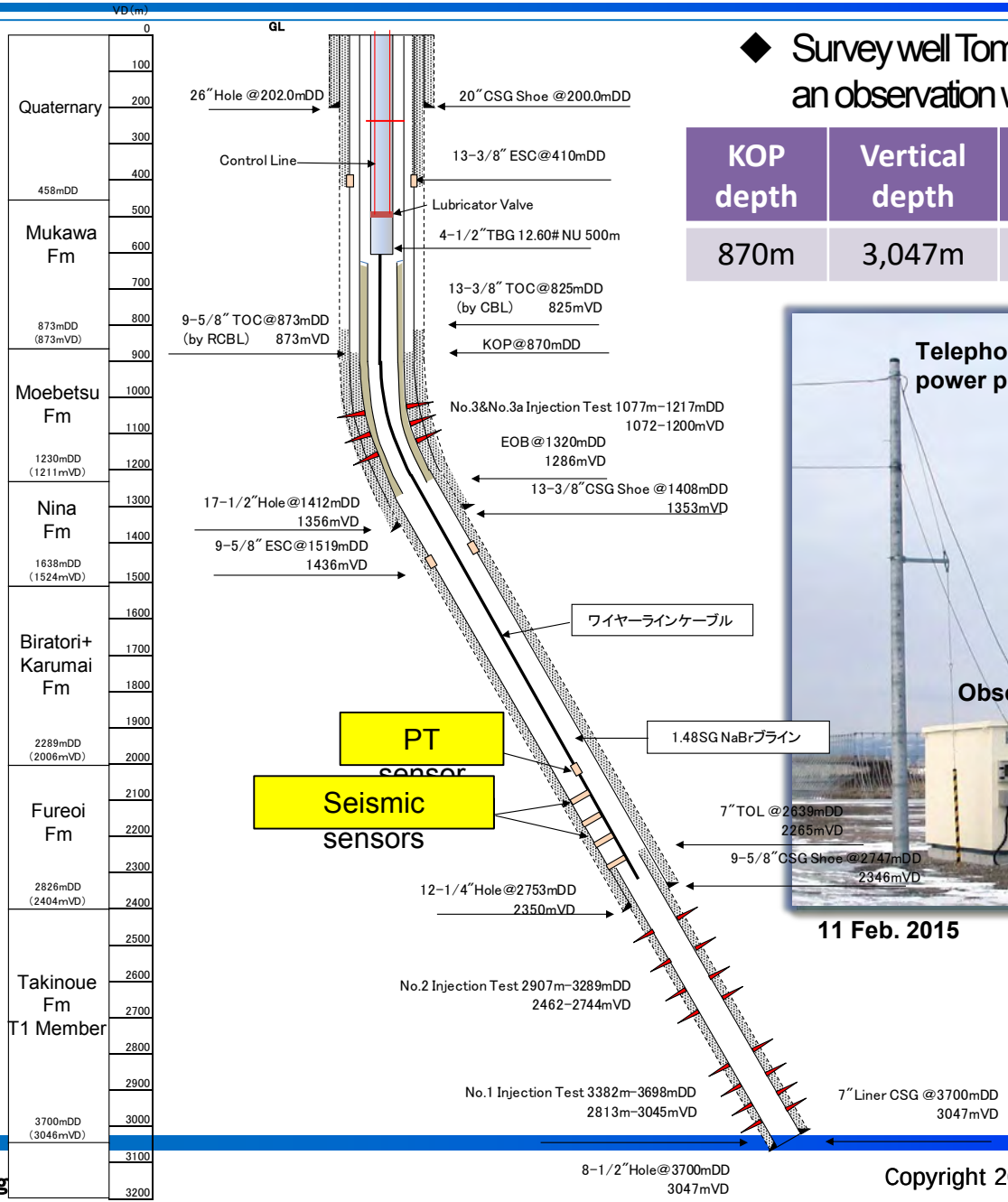
3C seismometer

L=2837 mm × φ114.3 mm

- Set at the well bottom of 200m-deep drillhole.
- The same specifications conform to “**Hi-net** : High-Sensitivity Seismograph Network” of National Research Institute for Earth Science and Disaster Prevention.

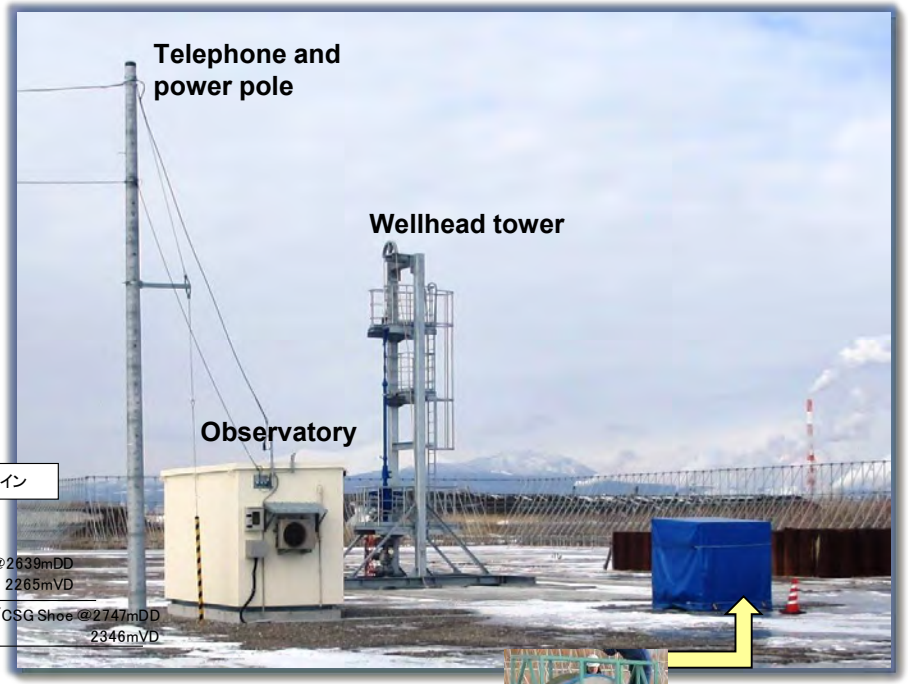
JCCS

Observation Well OB-1 for Takinoue Formation



- Survey well Tomakomai CCS-1 was refurbished to an observation well.

KOP depth	Vertical depth	Horizontal reach	Maximum inclination	Drill depth
870m	3,047m	1,757m	42°	3,700m

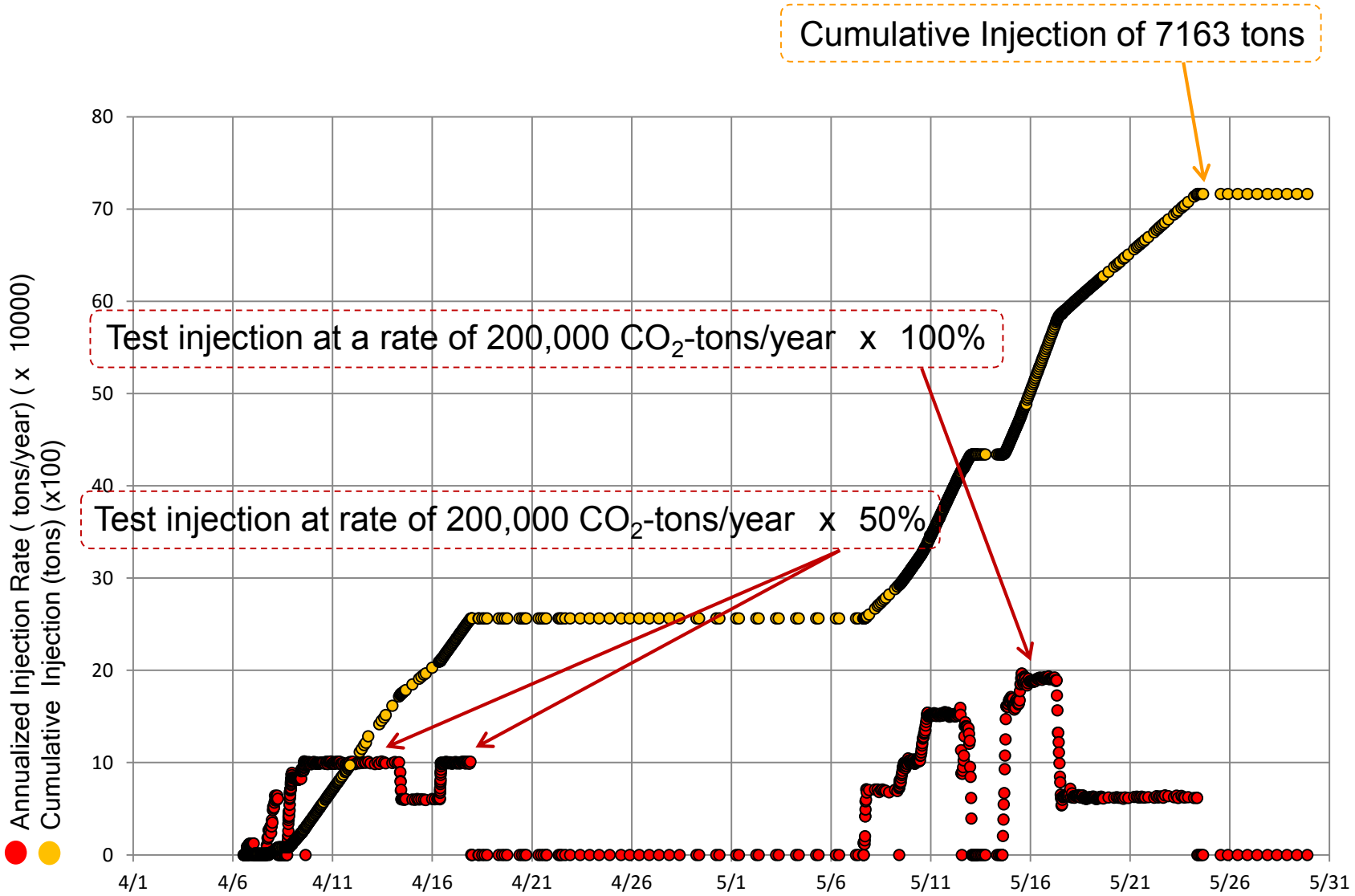


Cable drum

JCCS

Test Injection and Public Outreach

Test Injection to Moebetsu Fm. in April, May 2016



Public Outreach Activities in 2015

① **Panel Exhibitions**: totaling 5 times in Sapporo, Tomakomai and neighbor towns

② **Site Visits:** for universities, research associations, local government, etc.

③ **Environmental Exhibitions:** booths in “Eco-Products 2015” and “2015 Global Warming Prevention Exhibition” in Tokyo

④ **Kids Science Rooms:** learn about global warming, CO_2 and CCS through games and experiments, totaling 6 times in Tomakomai

⑤ **CCS Forum:** held on March 5, 2016 in Tomakomai

① Panel Exhibitions

② Site Visits

③ Env. Exhibitions

④ Kids Science Rooms

⑤ CCS Forum

Conclusion

- Full cycle CCS system from capture to storage is in operation; objective is to develop practical CCS technology by around 2020
  - Demonstrate safety and reliability of CCS system
  - Remove concerns about earthquakes
- Unique features of project
  - Efficient two-stage capture system
  - Deviated injection wells from onshore site into offshore reservoirs
  - Extensive monitoring system
- Test results indicate superior injectivity of shallow reservoir
- Extensive stakeholder engagement being undertaken
  - Maintaining close communications with Tomakomai fishery cooperative, local government

Question from BRGM (France)

Q:
Has the project developer assessed the option to valorize the captured CO_2 to optimize the operating costs of the facility, in addition to the CO_2 storage option?

For your information, this project is almost similar with the Air Liquide project in Port Jérome, France for which all the captured CO_2 can be used to meet a variety of industrial needs for carbonic gas supply (carbonation of sparkling beverages, food preservation, freezing, etc.).

A:
The Tomakomai project is not considering any usage of high purity CO_2 at this stage, and is operating as a full cycle CCS system from capture to storage.
If high purity CO_2 is to be supplied to e.g., the food industry, there would be a need to attach some additional facility to remove residual effective gases, which include CH_4, CO etc.