CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

Information from Japan CCS Co., Ltd.

【Site Visit】

Rooftop on Control Building

Visit to Injection Well

【CCS Forum】

Eco experiment performance by environmental performer “Ramma-sensei”.

Presentation by Ministry of the Environment

Presentation by Ministry of Economy, Trade and Industry

• What’s New

CCS Forum was held on March 17, 2018.

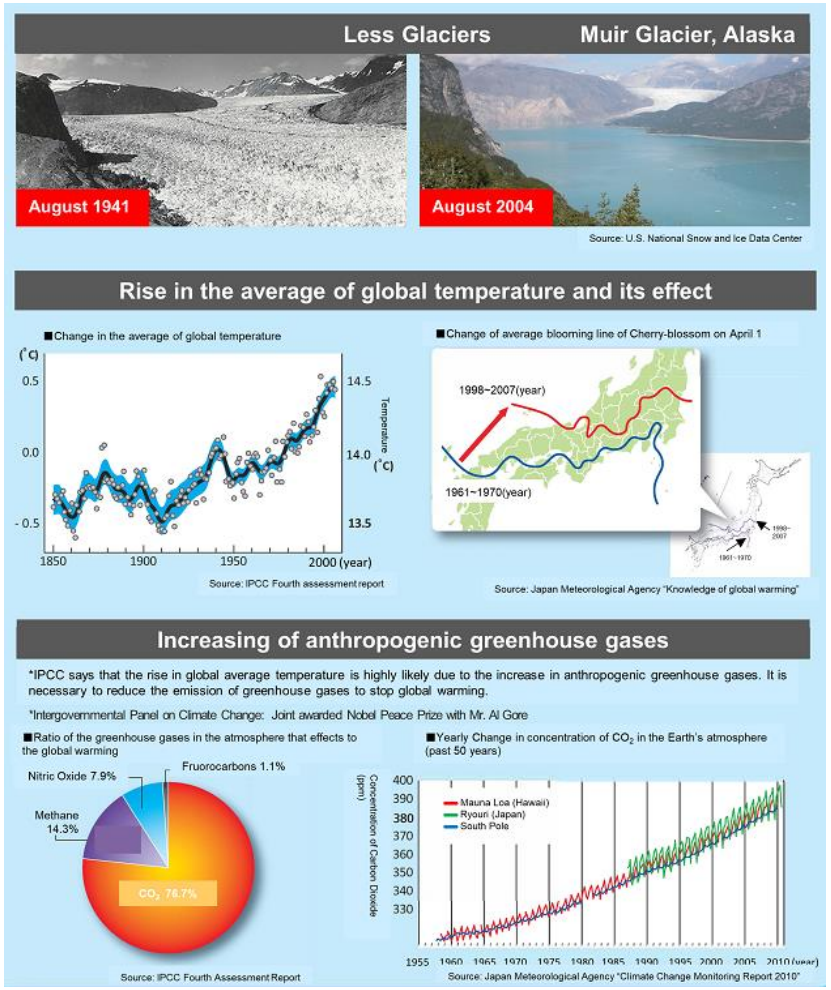
The annual CCS Forum, sponsored by Ministry of Economy, Trade and Industry, was held at Grand Hotel New Oji (Tomakomai, Hokkaido), with a total of 315 participants.

The program consisted of the following:
Part 1: Presentations on “Global Warming” by Ministry of the Environment, and “CCS Demonstration Project” by Ministry of Economy, Trade and Industry
Part 2: Eco experiment performance by environmental performer “Ramma-sensei”.

In the morning of the same day, a site tour to Tomakomai CCS Demonstration Center for the citizen was held. There were various questions by them such as safety and economy of CCS, and they deepened their understanding on CCS.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

Global warming continues



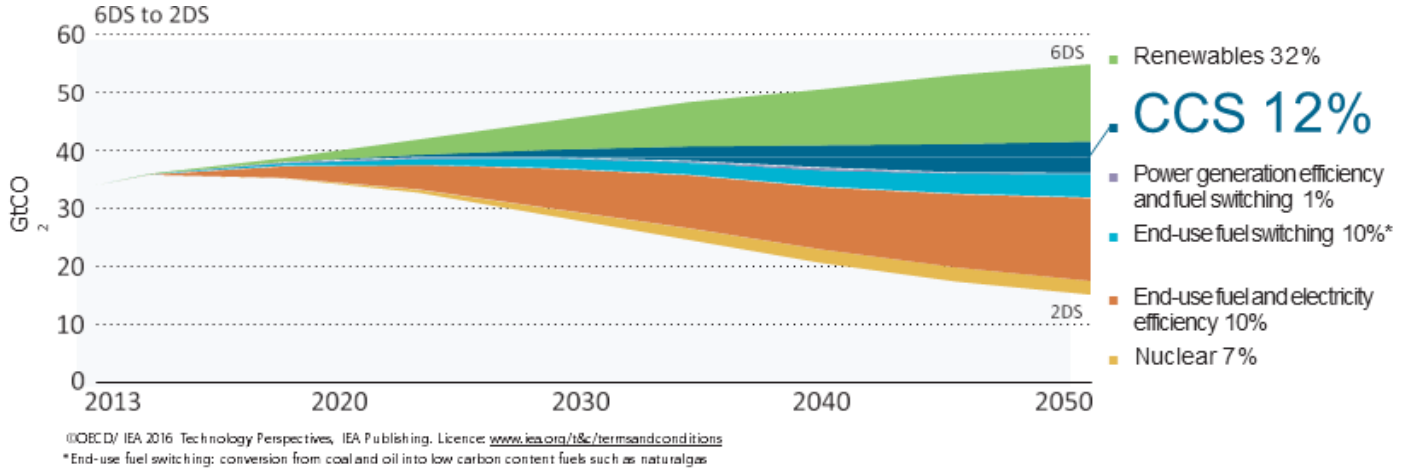
The natural environment has been changing without our knowing, for example, the decrease of glacier and the rise of average temperature.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

To reduce greenhouse gases

■Energy conservation and renewable energy

Eco-friendly cars　Sunlight　Wind power　Geothermal heat　Biomass



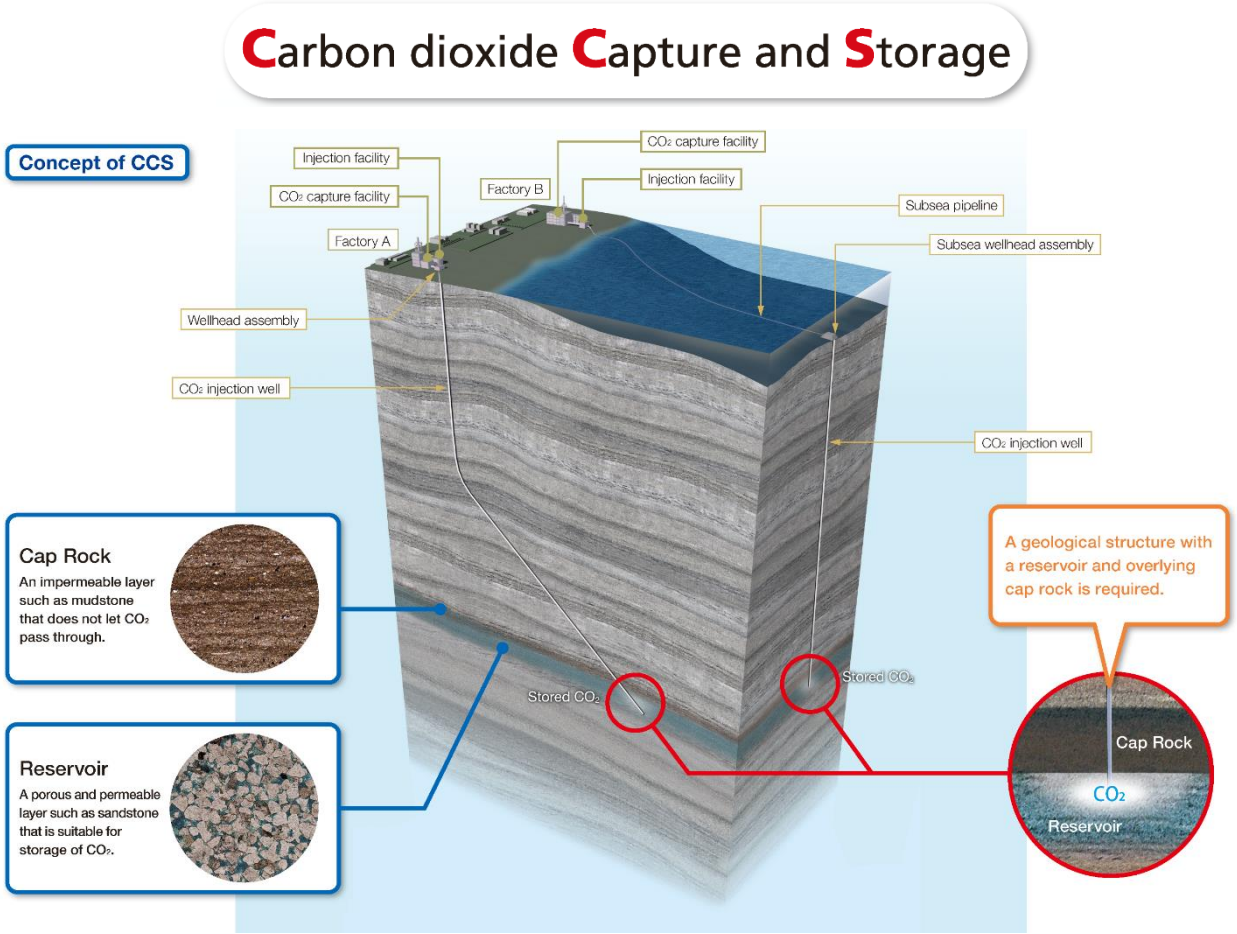
*End-use fuel switching: conversion from coal and oil into low carbon content fuels such as natural gas

It is believed that in order to significantly reduce the amount of CO_2 emissions, it is essential to implement all global warming mitigation measures in accordance with the role of each technology.

CCS is the technology to bridge between now and the next generation with the new energy.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

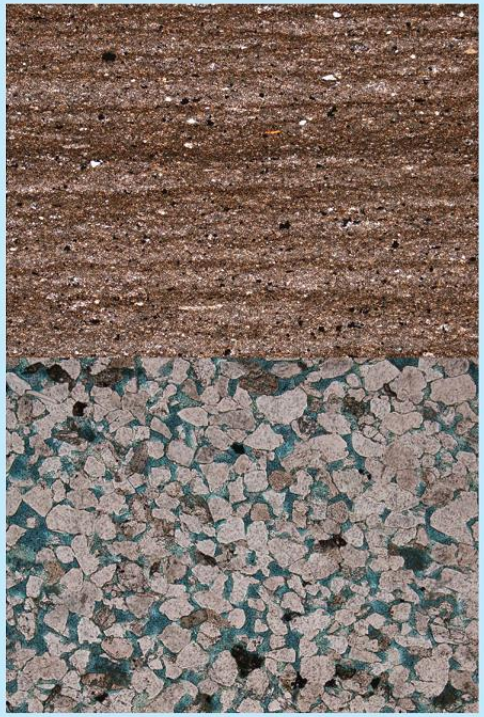
What is CCS?



CCS is a technology to prevent carbon dioxide (CO_2) released into the atmosphere emitted by facilities such as power plants and factories. The technology involves capturing the CO_2, injecting it into underground geological formations and storing it permanently. Along with energy efficiency and renewable energy, CCS helps to tackle global warming.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

How to store CO_2



■Features of Caprock

Mudstone etc., made of fine mud grains

- Impervious
- Sufficient blocking ability
- Covering reservoir layer widely and thickly

■Features of Reservoir

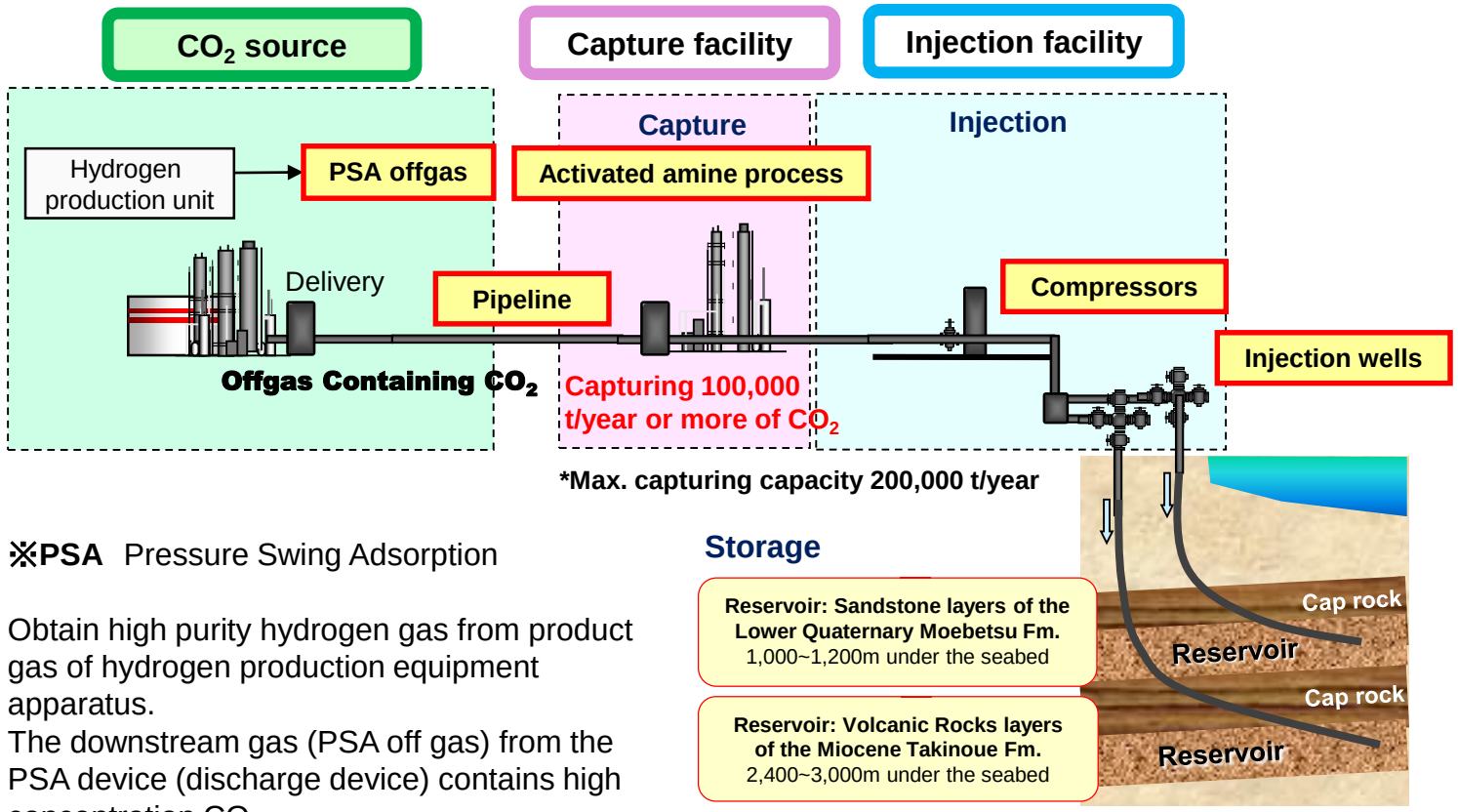
Sandstone, volcanic rock, etc., made of coarse grains

- Sufficient pore spaces to store CO_2
- Pervious

Injecting the CO_2 into reservoirs at depths of 1,000 meters or more. The reservoirs are overlain by thick cap rocks that prevent the CO_2 from moving upwards.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

Flow Scheme of CCS Demonstration Project



※**PSA** Pressure Swing Adsorption

Obtain high purity hydrogen gas from product gas of hydrogen production equipment apparatus.
The downstream gas (PSA off gas) from the PSA device (discharge device) contains high concentration CO_2.

CO_2 is captured from the offgas containing CO_2 generated from the refinery's hydrogen production unit during commercial operation, pressurized (up to 23 MPa) to the pressure required for the injection, and more than 100,000 tonnes of CO_2 per year is injected and stored under the two layers of reservoir at offshore Tomakomai.

Source: Ministry of Economy, Trade and Industry Edited from the verification test plan at Tomakomai point

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

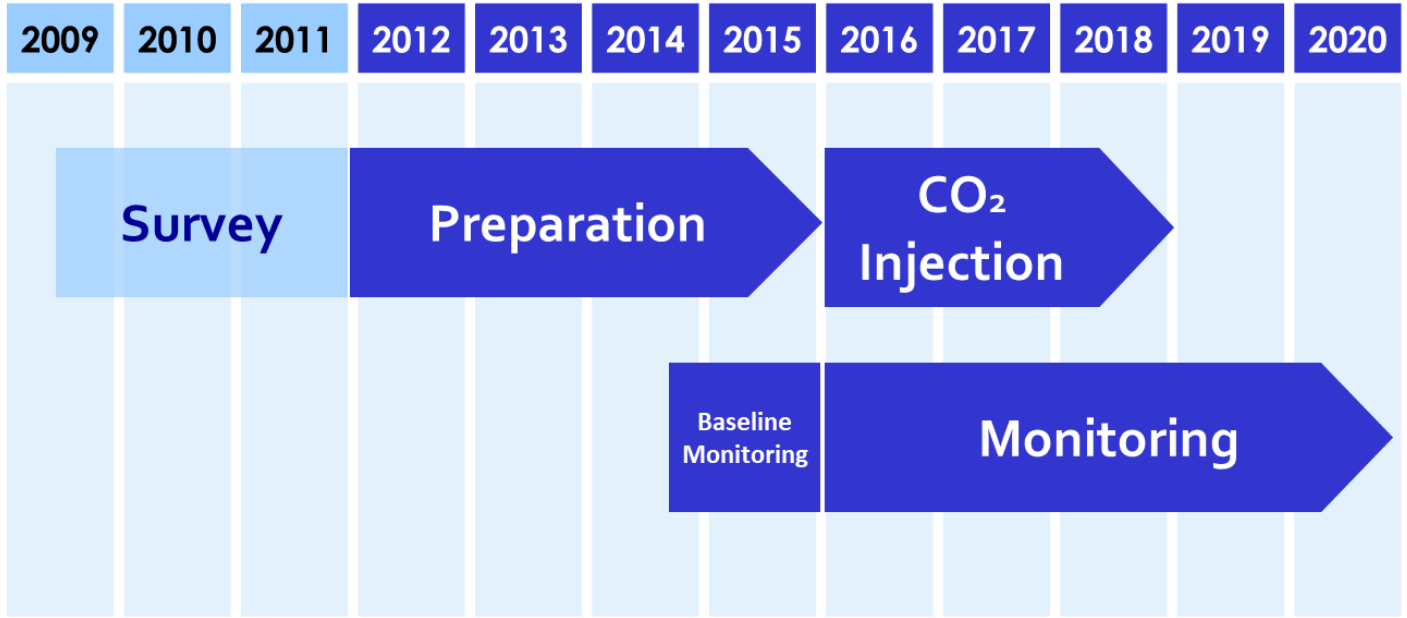
Tomakomai CCS Demonstration Project Schedule

■From JFY2012 to JFY2015 : Preparation

Drilling of design and construction of facility, drilling of a injection well (a well for pressurizing CO2 to underground), preparation for demonstration operation, etc. were carried out.

■From JFY2016 to JFY2020 : Monitoring

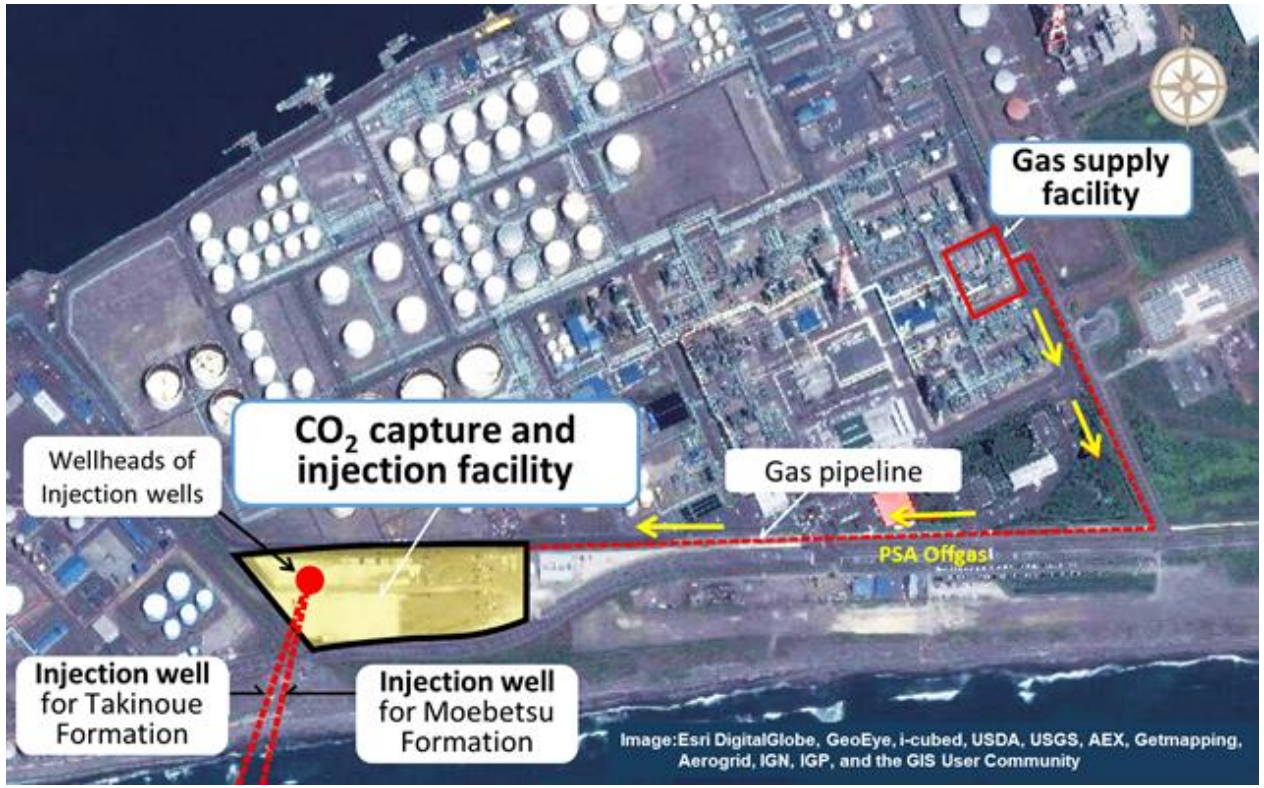
On April 1, 2016, Japan CCS Co., Ltd. was commissioned by METI to conduct “Tomakomai CCS Demonstration Project (FY2016)”, and on April 6, CO_2 injection has commenced. We plan to inject more than 100,000 tonnes of CO_2 per year for 3 years from 2016 to 2018. Even after termination of the injection, we will continue monitoring of CO_2 behavior for two years.



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

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

Positional Relation of Onshore Facilities

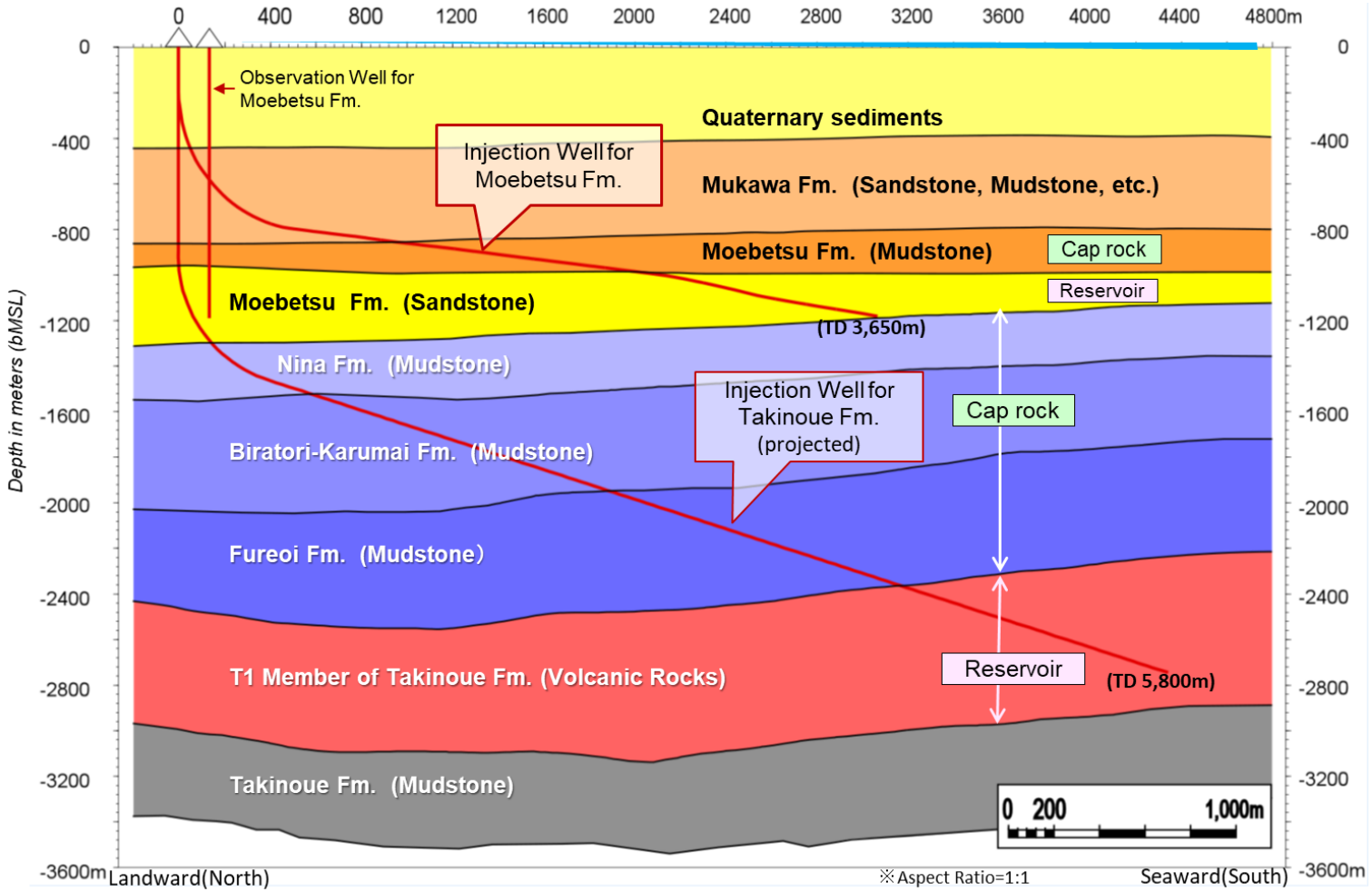


"Gas supply facility" is a facility to send PSA offgas (CO_2 containing gas) generated in the hydrogen production process of refinery to “Capture and injection facility" through a 1.4 km Gas pipeline.

At “Capture and injection facility", CO_2 is captured with a purity of 99% or more from CO_2 containing gas sent through the Gas pipeline, then increased pressure by the compressor, and injected through 2 injection wells into the reservoir under the seabed for storage.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

Schematic Geological Section

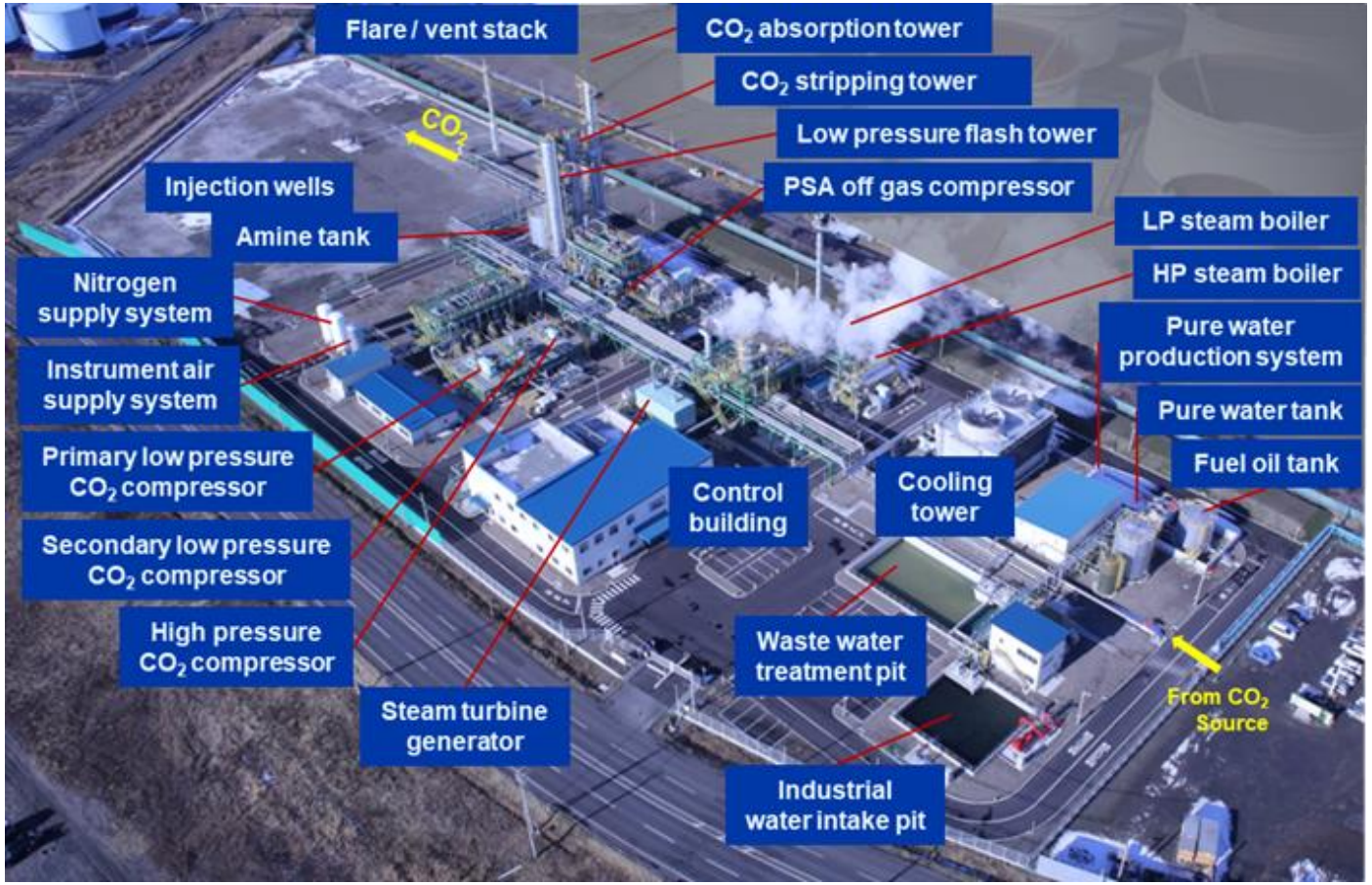


This is the Schematic Geological Section of the CO_2 storage point.
CO_2 is injected into two reservoirs Takinoue Formation T1 and Moebetsu Sandstone Formation by two separate deviated wells.

The Takinoue Formation Injection Well is a sloping well with an excavation length of 5,800m and a maximum inclination of 72 degrees. Moebetsu Formation Injection Well is a sloping well with an excavation length of 3,650 m and a maximum inclination of 83 degrees.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

Bird's Eye View of Capture and Injection Facilities



CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

CO_2 Capture Facilities and Compressors

CO_2 Capture Facility
Capture CO_2 from PSA Offgas

3 staged CO_2 Compressors
Increase pressure to the required pressure for captured CO_2 injection

CO_2 Injection Report

CO_2 injection summary

CO_2 Injection rate of July 30, 2018

485.0 ton

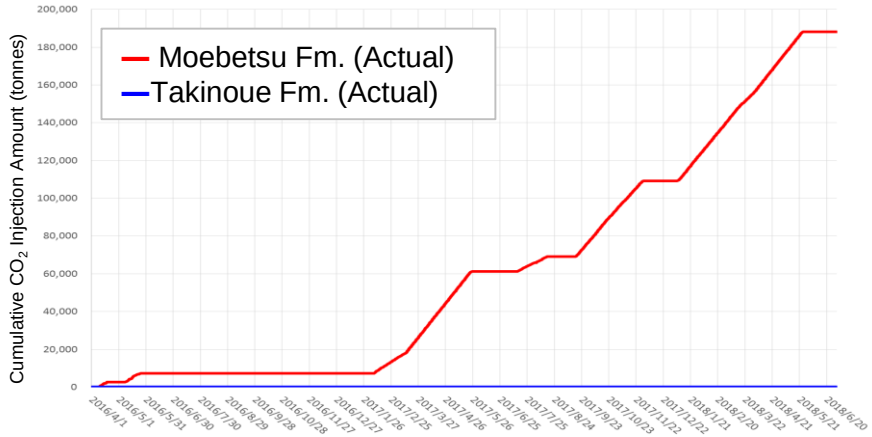
Cumulative CO2 Injection amount
(April 6, 2016 - July 30, 2018)

190,760.5 ton

Injection Amount in June 2018 & Injection Plan in July 2018

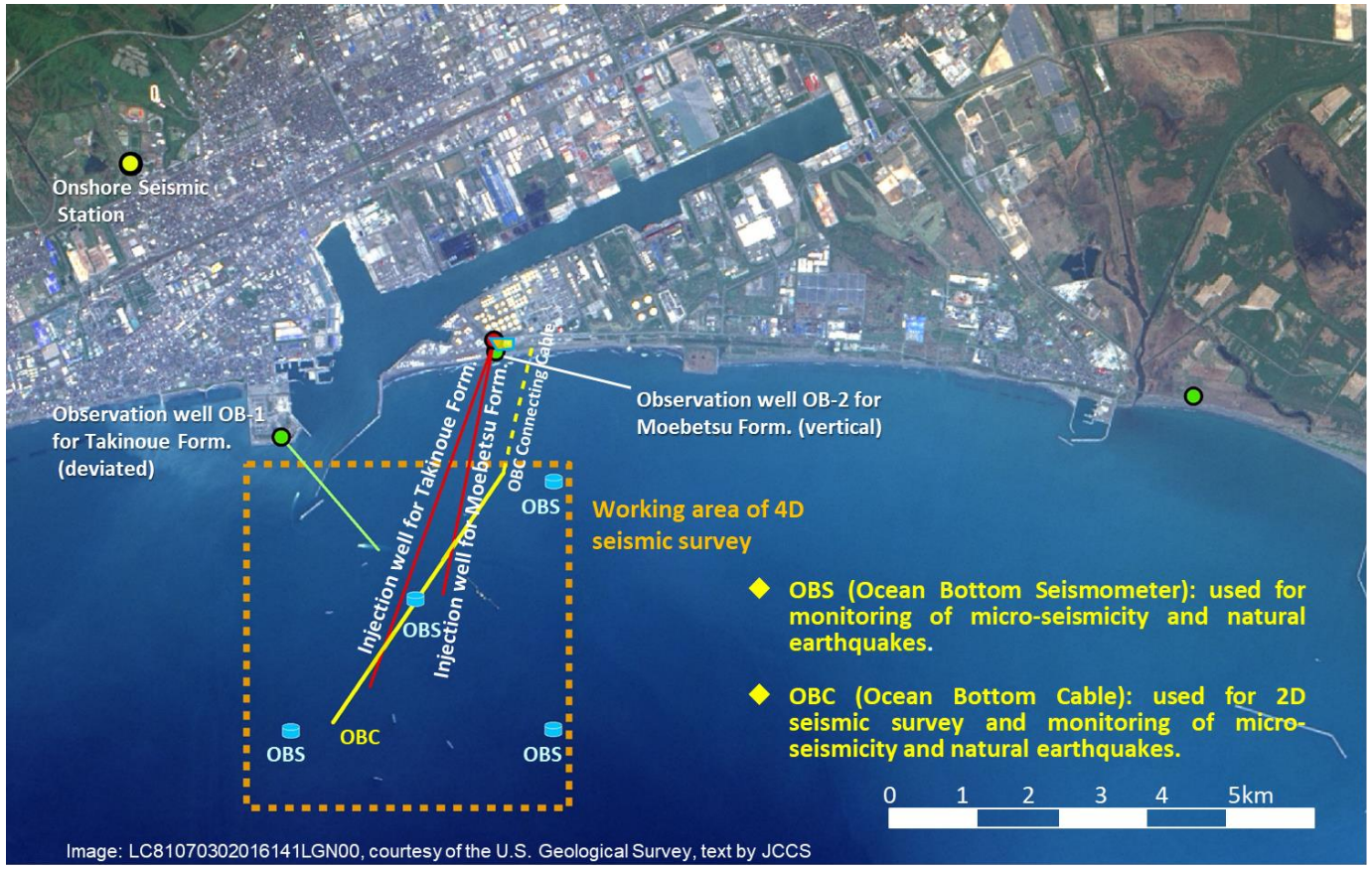
	Injection Amount/month (June 2018)	Injection Plan/month (July 2018)	Cumulative CO_2 Injection Amount (As of end June 2018)
Moebetsu Fm.	0 tonnes	6,190 tonnes	188,136.1 tonnes
Takinoue Fm.	0 tonnes	10 tonnes	37.2 tonnes

Change of cumulative CO_2 Injection Amount



CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

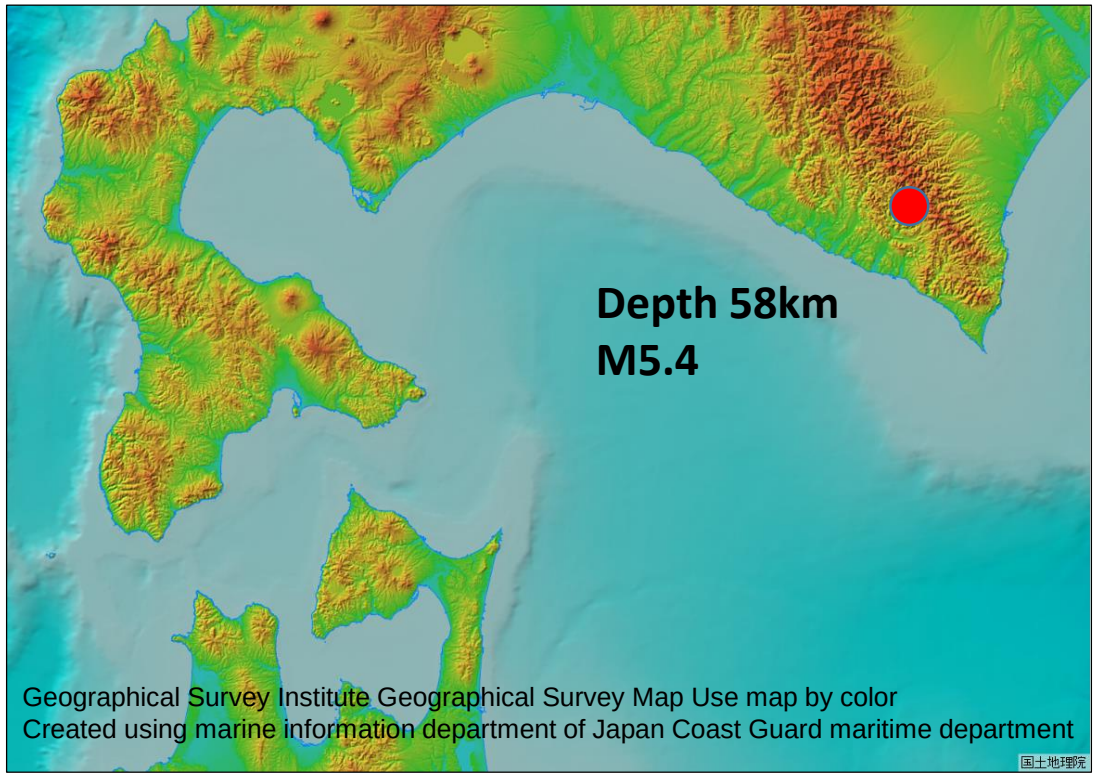
Monitoring Facilities : Location Relation



- Monitoring networks are constructed near and around the CO_2 injection point and continuously monitored over the six years before the implementation of CO_2 injection (1 year), during CO_2 injection (3 years) and after the termination of injection (2 years).
  - We survey the pressure and temperature of the formation in the wells - the observation well (3 wells) excavated around the CO_2 injection point and the CO_2 injection well (2 wells).
  - We installed a seismograph in the observation well and under the seabed to observe earthquakes (including minute vibrations that will not be felt by the body).
  - Survey data is centrally controlled at Tomakomai Demonstration Center and constantly monitored the presence or absence of abnormality.

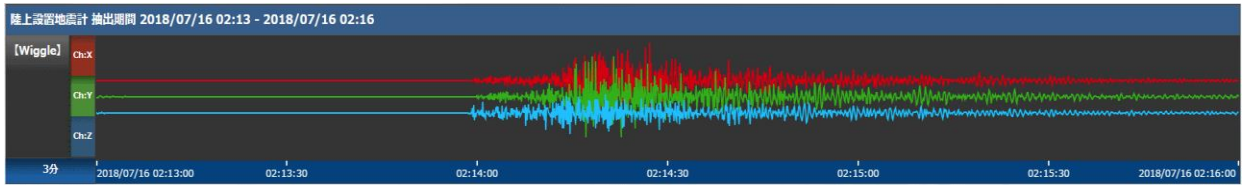
CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

The most recent noticeable tremors observed in Tomakomai



Observation record of Onshore Seismometer

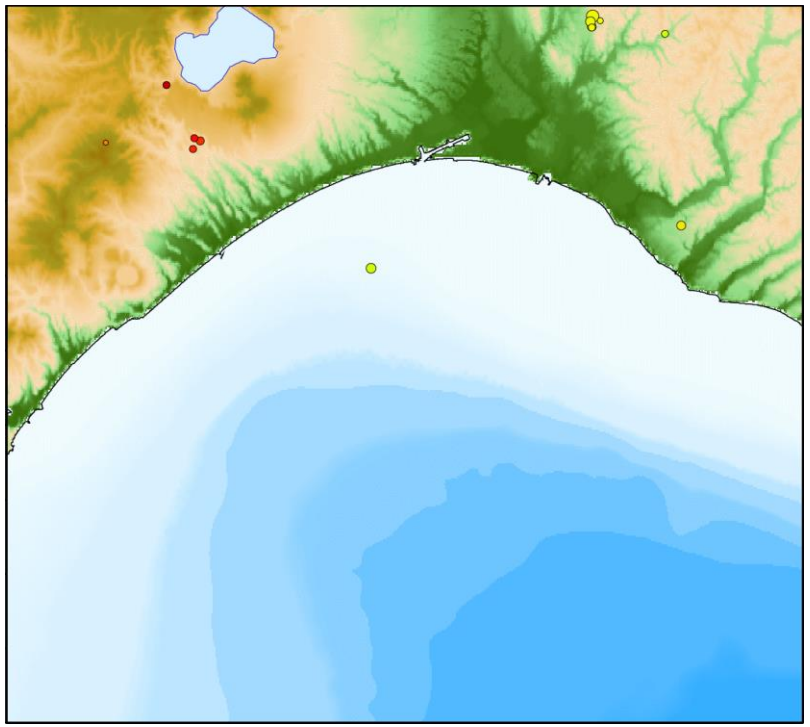
Observation record at Midorigaoka Park



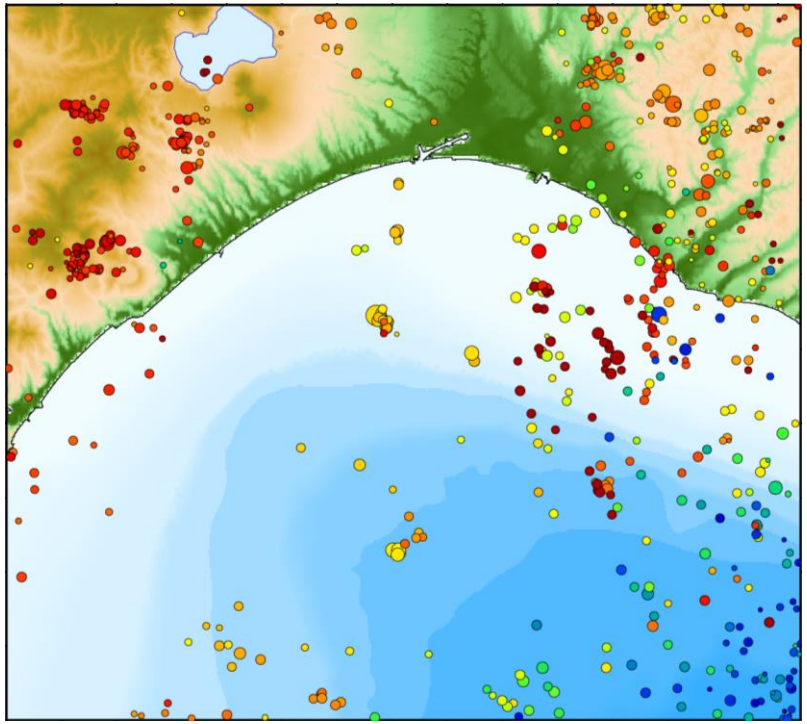
Earthquake Information Announced by the Japan Meteorological Agency	
Time & Date	02:13:39 (JST) 16 July, 2018
Hypocenter	Lat. 42° 18.8'N Lon. 142° 58.7'E Depth 58 km
Magnitude	5.4
Seismic Intensity at Tomakomai-city	1

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

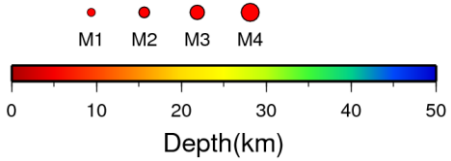
Distribution of Natural Earthquakes around Tomakomai

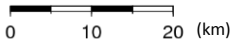


Natural earthquake hypocenter distribution in June 2018



Natural earthquake hypocenter distribution occurred from 2001 to 2010





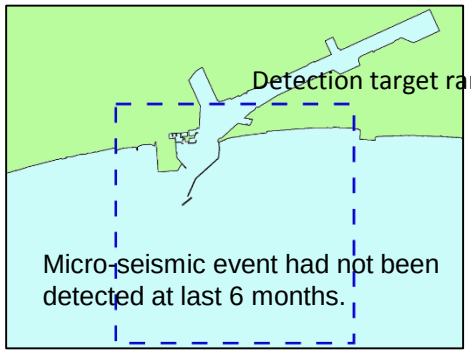
The hypocenters in the figure is from the JMA Unified Hypocenter Catalog.
Earthquakes with the hypocenter depth of 50 km or less are displayed.

Geomorphic map is prepared from Geographical Survey Institute numerical map 250 m mesh (altitude) and Japan Marine Safety Agency 'Japan Oceanographic Data Center' 500 m mesh water depth data

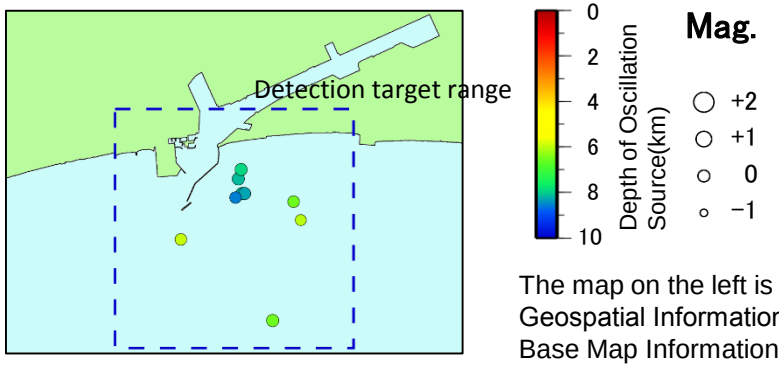
CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

Micro-seismic events nearby injection point

Distribution of the last 6 months (2018/1/1 – 2018/6/30)

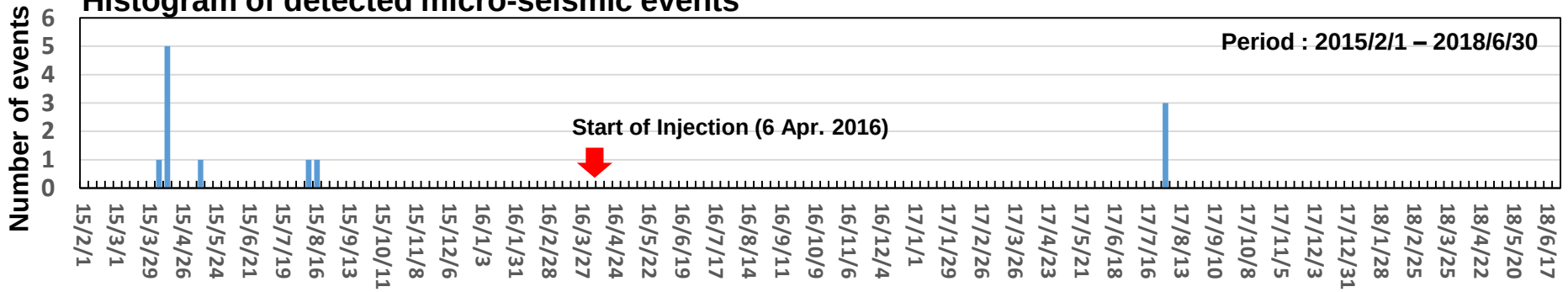


Distribution of 12 months before injection (2015/2/1 – 2016/2/28)



The map on the left is created using Geospatial Information Authority of Japan's Base Map Information Coastline Data.

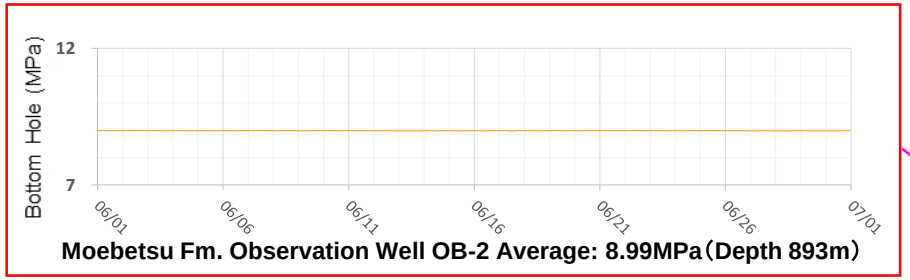
Histogram of detected micro-seismic events



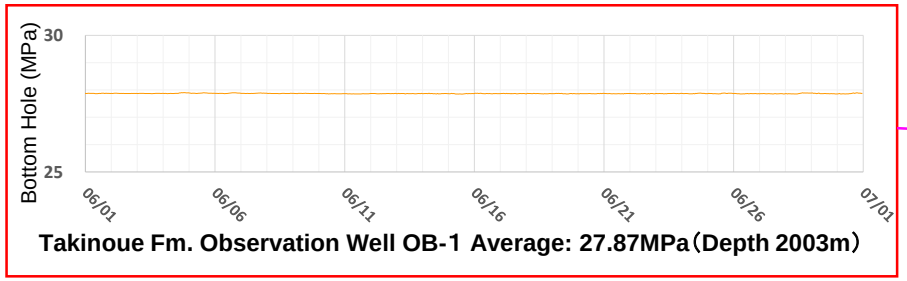
- There are perceptible earthquakes that the body feels, and imperceptible earthquakes even though actually vibrating.
- In this demonstration, the smallest (less than magnitude 1) imperceptible earthquakes are defined as micro-seismicity.
- In this demonstration, micro-seismicity with a magnitude of -0.5 or more with a depth of less than 50 km in the vicinity of the injection point are monitored, due to restrictions on the placement of observation point, constraints on seismograph detection capability, and so on.

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

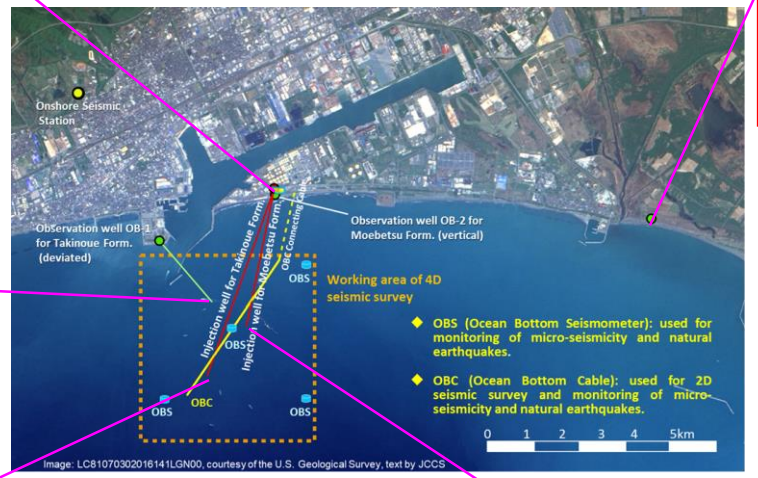
Observation of pressure in the wells (June 2018)

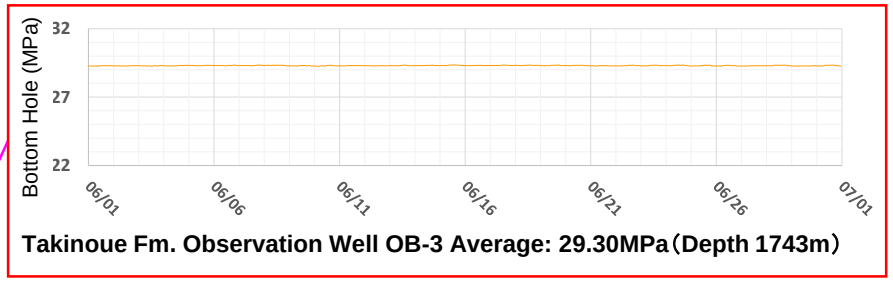


Moebetsu Fm. Observation Well OB-2 Average: 8.99MPa（Depth 893m）

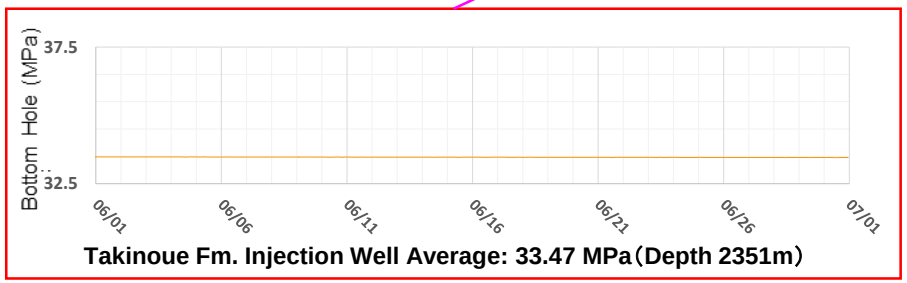


Takinoue Fm. Observation Well OB-1 Average: 27.87MPa（Depth 2003m）

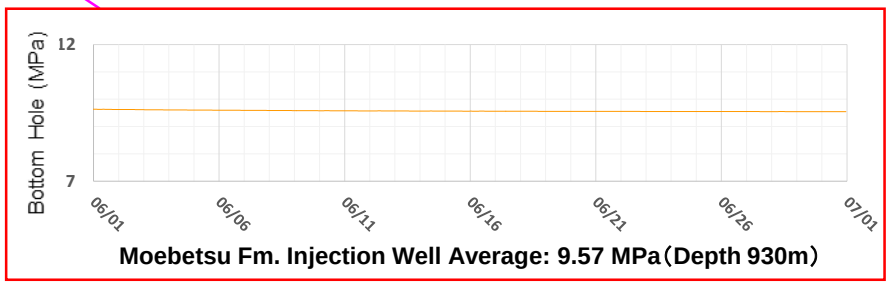




Takinoue Fm. Observation Well OB-3 Average: 29.30MPa（Depth 1743m）



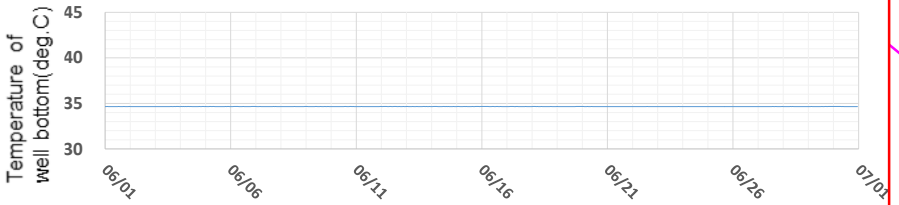
Takinoue Fm. Injection Well Average: 33.47 MPa（Depth 2351m）



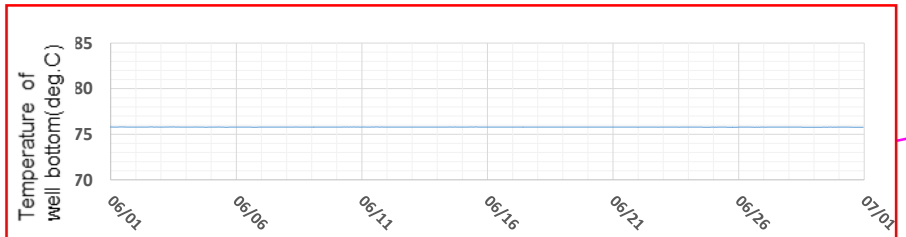
Moebetsu Fm. Injection Well Average: 9.57 MPa（Depth 930m）

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

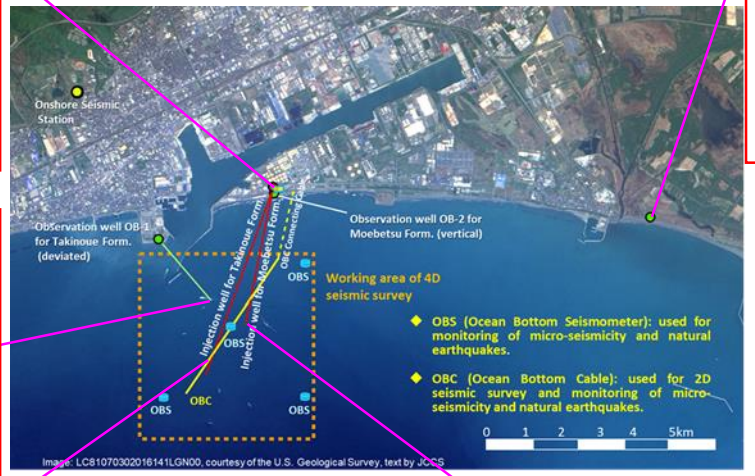
Observation of temperature in the wells (June 2018)

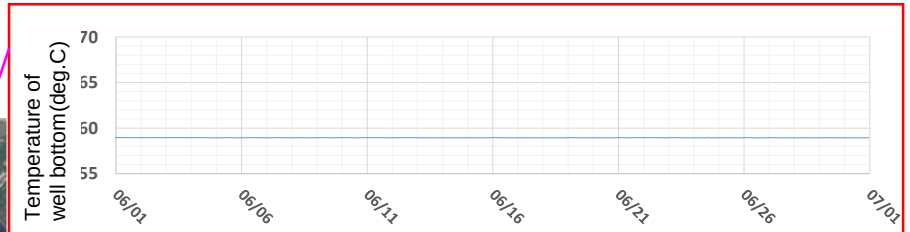


Moebetsu Fm. Observation Well OB-2 Average: 34.7℃（Depth 893m）

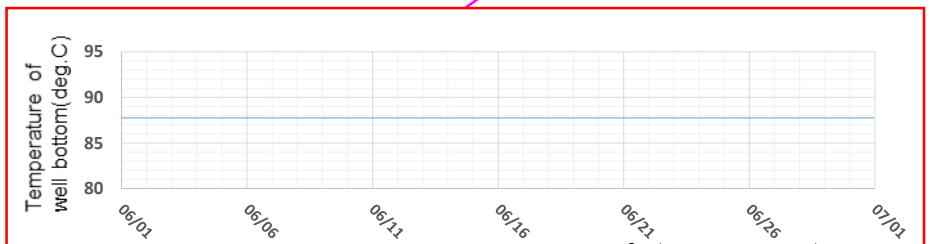


Takinoue Fm. Observation Well OB-1 Average: 75.8℃（Depth 2003m）

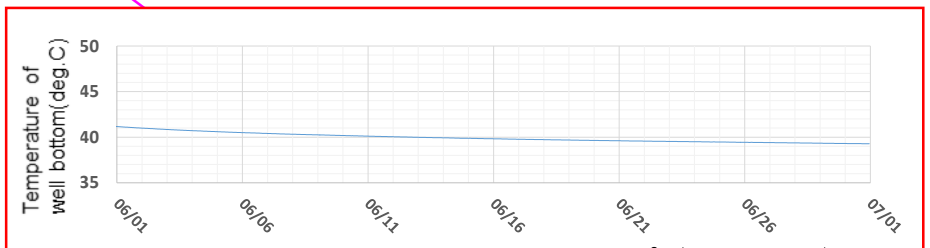




Takinoue Fm. Observation Well OB-3 Average: 58.9℃（Depth 1743m）



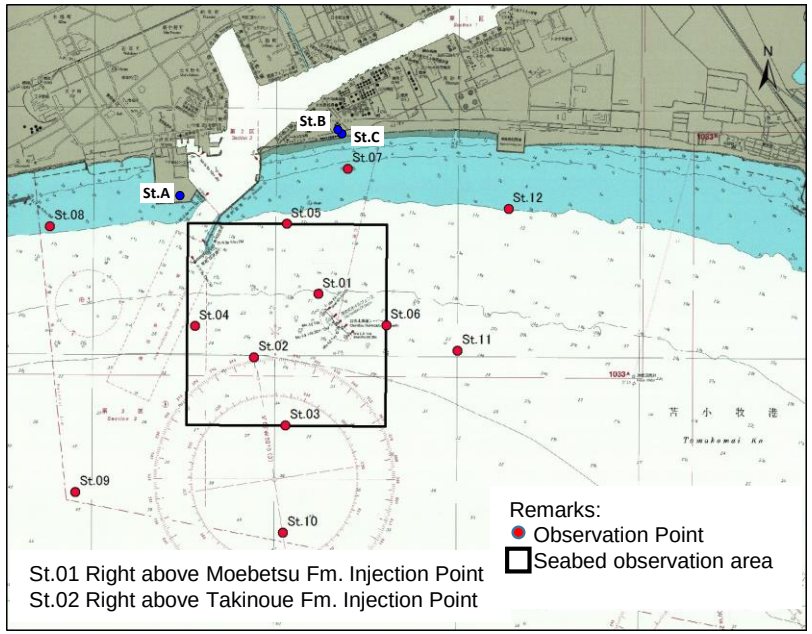
Takinoue Fm. Injection Well Average: 87.7℃（Depth 2351m）



Moebetsu Fm. Injection Well Average: 39.9℃（Depth 930m）

CO2 Injection rate of July 30, 2018	Cumulative CO2 Injection amount
485.0 ton	190,760.5 ton

CO_2 Concentration around injection point（seasonal）



Cruise to the Japan Coast Guard issue navigation chart (W1034)

	2013				2014				2015				2016				2017			
	Spring	Smmr	Fall	Winter	Spring	Smmr	Fall	Winter	Spring	Smmr	Fall	Winter	Spring	Smmr	Fall	Winter	Spring	Smmr	Fall	Winter
St.01		323	425	388	424								372	401		339	228	474	410	403
St.02		364	432	393	428								475	389		351	255	484	440	399
St.03		343	410	377	420								477	386		347	254	431	424	390
St.04		351	399	393	436								432	394		335	239	485	440	395
St.05		326	352	387	430								370	416		309	247	354	372	369
St.06		283	417	395	424								411	366		332	259	450	426	390
St.07		314	353	368	424								358	517		316	273	371	384	366
St.08		370	349	366	327								360	439		316	277	320	366	375
St.09		358	395	379	417								437	391		335	276	423	428	391
St.10		353	395	372	415								477	394		333	266	423	420	374
St.11		350	415	394	418								443	391		338	264	448	436	384
St.12		317	377	383	420								334	447		334	252	349	383	389
St.A					396	379	412	400	397	394	399	424	417	404	407	432	414	404	414	413
St.B					365	382	405	407	400	394	388	415	411	397	405	417	413	392	408	414
St.C					403	395	403	403	392	406	396	409	423	410	412	403	413	417	428	417

Seasonal observation of CO_2 concentration is conducted at three onshore points (St.A to C) and 12 offshore points (St.01 to 12). The concentration of CO_2 is indicated as Volume ratio (unit: ppm) at the onshore observation points, and as partial pressure (unit: μ atm) at the offshore points. The figures of the offshore points are based on the measurement at 2 meters above the seabed.

* Offshore observation was not conducted in fall 2016.