

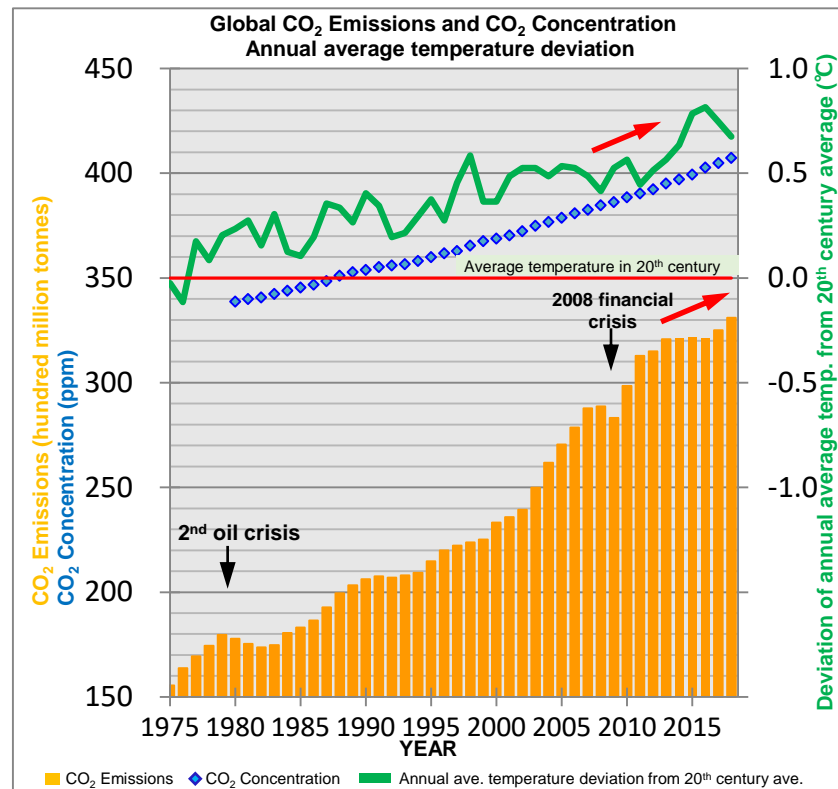
## What's New

Mr. Koichi Hagiuda, Minister of Economy, Trade and Industry visited Tomakomai CCS Demonstration Project Center.

- January 29, 2022



# Status of global warming



CO<sub>2</sub> Emissions: made by JCCS from data of "Global CO<sub>2</sub> emissions in 2019", IEA  
<https://www.iea.org/articles/global-co2-emissions-in-2019>  
CO<sub>2</sub> Concentration: made by JCCS from the data of "Change of CO<sub>2</sub> Concentration over the years", Japan Meteorological Agency  
[https://ds.data.jma.go.jp/ghg/kanshi/ghgp/co2\\_trend.html](https://ds.data.jma.go.jp/ghg/kanshi/ghgp/co2_trend.html)  
[https://gaw.kishou.go.jp/publications/global\\_mean\\_mole\\_fractions#content1](https://gaw.kishou.go.jp/publications/global_mean_mole_fractions#content1)  
Annual average temperature deviation from 20<sup>th</sup> century average: made by JCCS from the data of "Global annual average temperature", Japan Meteorological Agency  
[http://www.data.jma.go.jp/cpdinfo/temp/an\\_wld.html](http://www.data.jma.go.jp/cpdinfo/temp/an_wld.html)  
[http://www.data.jma.go.jp/cpdinfo/temp/list/an\\_wld.html](http://www.data.jma.go.jp/cpdinfo/temp/list/an_wld.html)



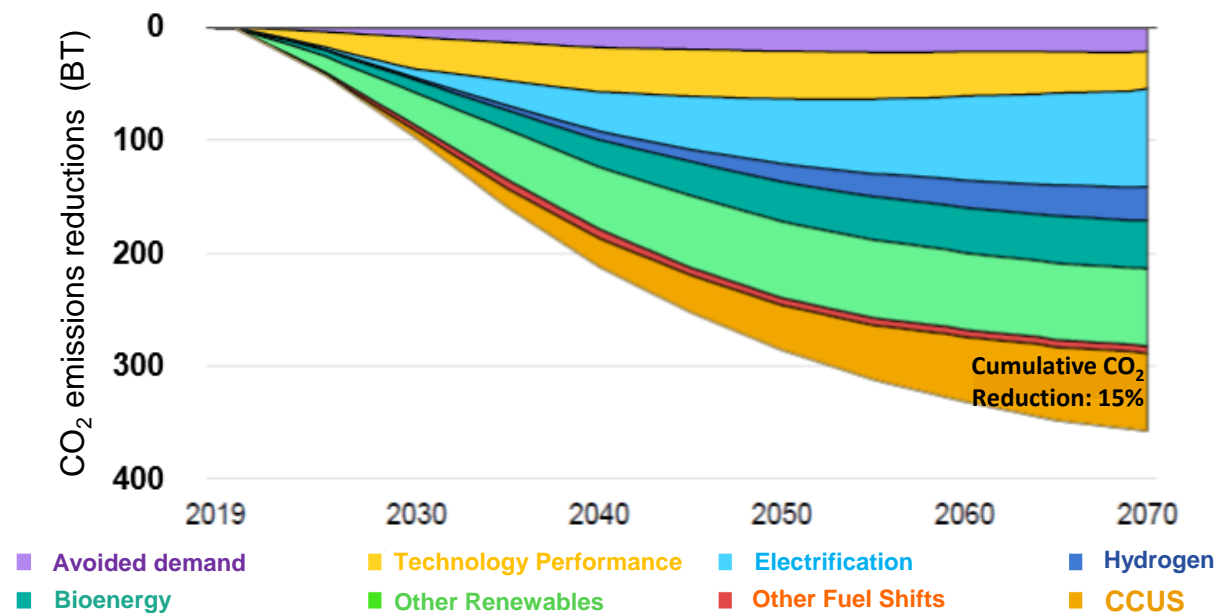
The increase in the concentration of greenhouse gases in the atmosphere is said to be the cause of global warming. In particular, the effect of carbon dioxide (CO<sub>2</sub>) is large.

Global CO<sub>2</sub> emissions have been on the rise since the Industrial Revolution, and as a result, CO<sub>2</sub> concentrations in the atmosphere have increased as well as global average annual temperatures.

In Japan, the number of days of heavy rain and hot days shows an increasing trend, which may be the effect of global warming.

# Reducing greenhouse gas emissions

Global energy sector CO<sub>2</sub> emission reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2019-70



Source: IEA 2020, Energy Technology Perspectives 2020. All rights reserved; as modified by Japan CCS Co., Ltd.

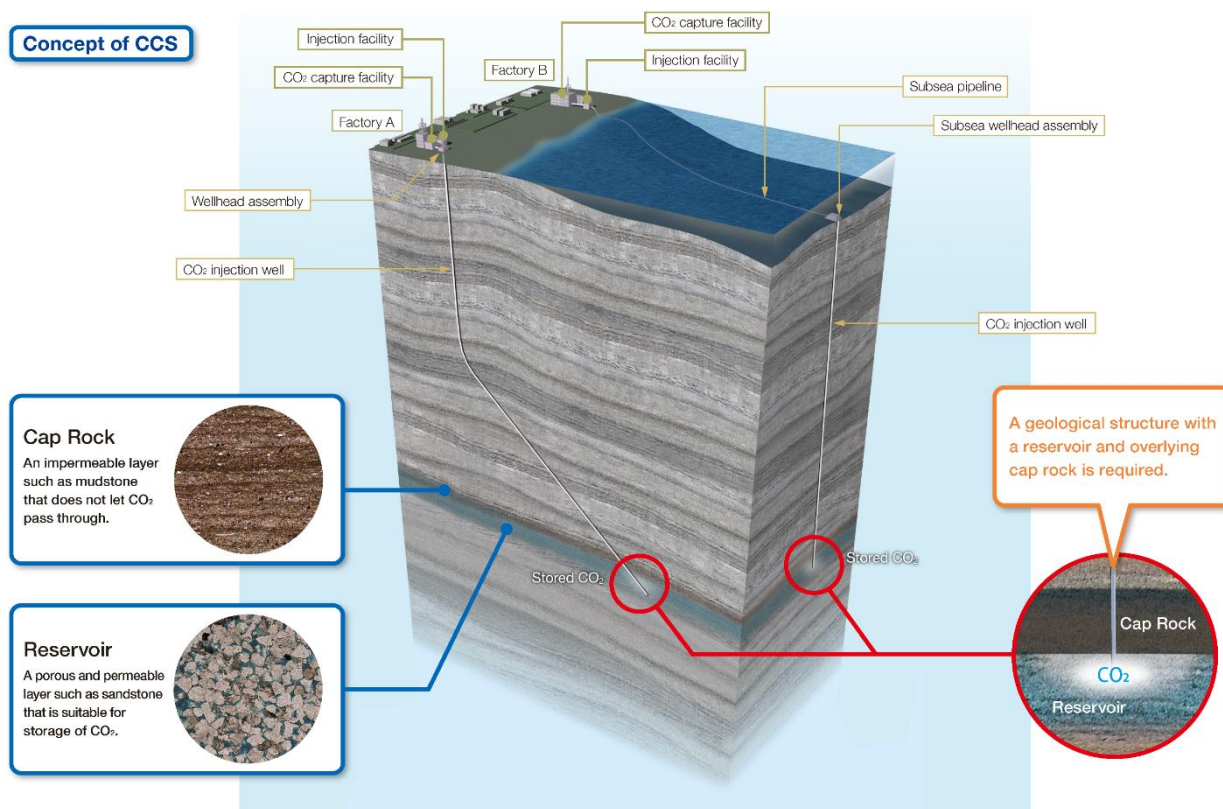
The Paris Agreement, an international framework on climate change, has taken effect in 2020. In order to achieve the greenhouse gas reduction targets, significant technological innovation is needed. One such technology is carbon capture, utilization and storage (CCUS), a technology that involves the capture of CO<sub>2</sub> and either utilizes it as a resource or stores it permanently in deep underground geological formations. According to a report by the International Energy Agency (IEA), 15% of the cumulative CO<sub>2</sub> emission reductions from 2019 to 2070 in the Sustainable Development Scenario relative to the Stated Policies Scenario will be contributed by CCUS.



# What is CCS?

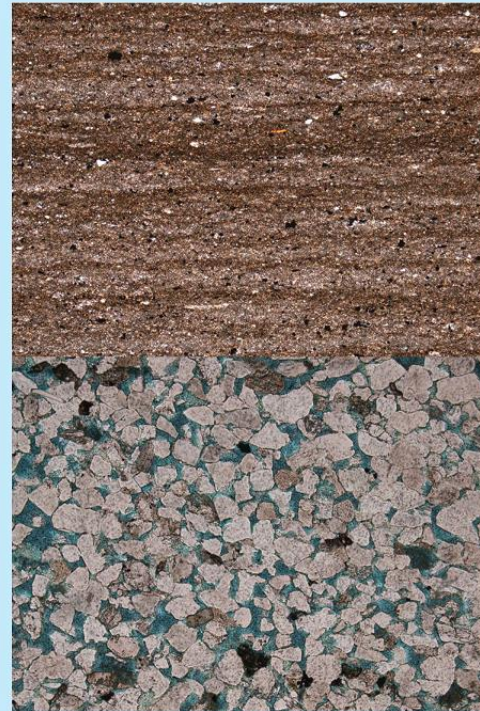
## Carbon dioxide **C**apture and **S**torage

### Concept of CCS



CCS is a technology to prevent carbon dioxide (CO<sub>2</sub>) released into the atmosphere emitted by facilities such as power plants and factories. The technology involves capturing the CO<sub>2</sub>, injecting it into underground geological formations and storing it permanently. Along with energy efficiency and renewable energy, CCS helps to tackle global warming.

# How to store CO<sub>2</sub>



## ■ Features of Caprock

Mudstone etc., made of fine mud grains

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

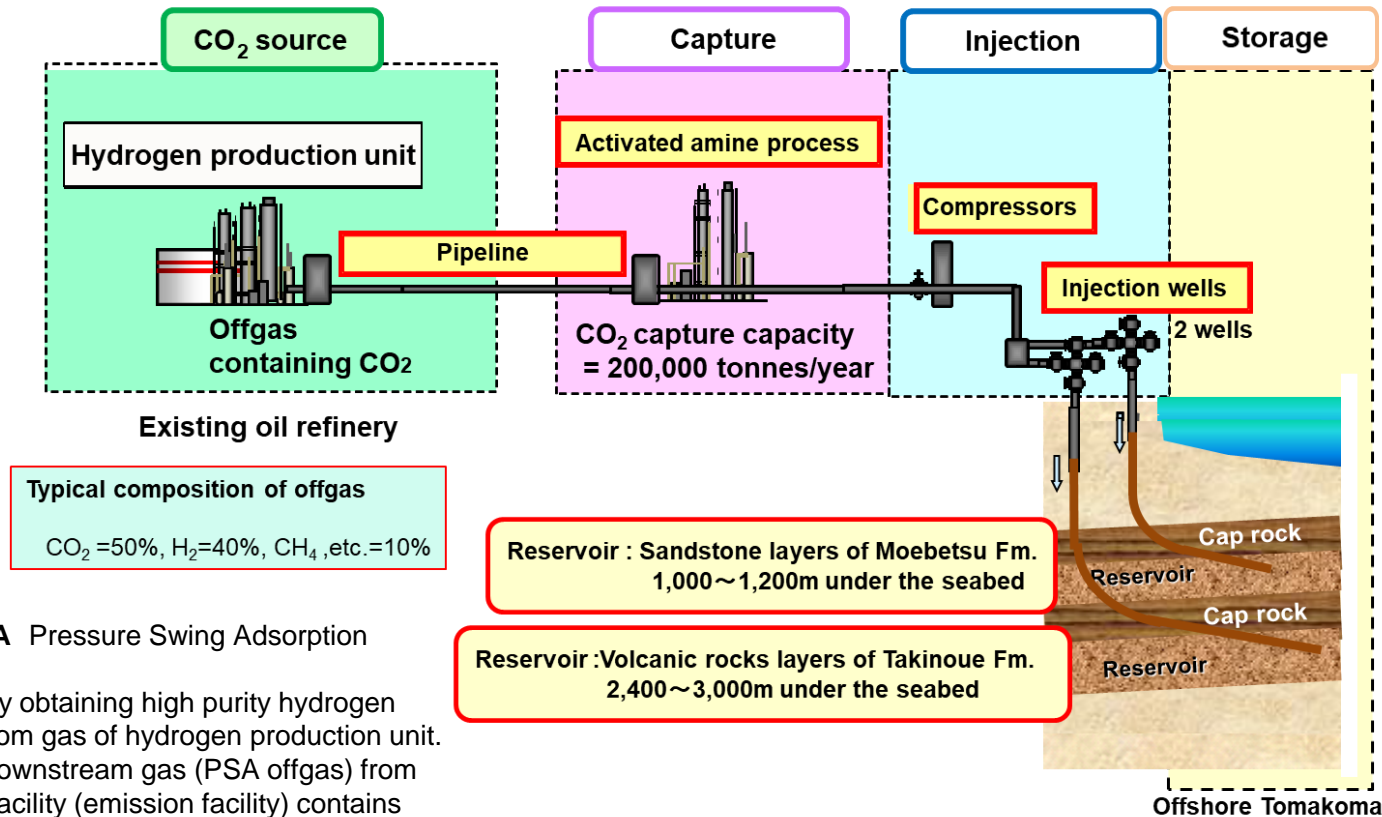
## ■ Features of Reservoir

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

- Sufficient pore spaces to store CO<sub>2</sub>
- Pervious

In order to store CO<sub>2</sub> in the subsurface under the seabed, a geological structure where a reservoir is overlain by a cap rock is required. The cap rock blocks the leakage of injected CO<sub>2</sub> from the reservoir.

# Flow Scheme of Tomakomai Demonstration Project



CO<sub>2</sub> is captured from the offgas containing CO<sub>2</sub> generated by a hydrogen production unit of a refinery, pressurized (up to 23 MPa) to the pressure required for injection, injected at a scale of about 100,000 tonnes of CO<sub>2</sub> per year and stored in two sub-seabed reservoirs offshore Tomakomai.

※PSA Pressure Swing Adsorption

Facility obtaining high purity hydrogen gas from gas of hydrogen production unit. The downstream gas (PSA offgas) from PSA facility (emission facility) contains high concentration of CO<sub>2</sub>.

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



# Schedule of Tomakomai Demonstration Project

**Contract Period: From JFY2012 to JFY2023**

■ From JFY2012 to JFY2015: Preparation

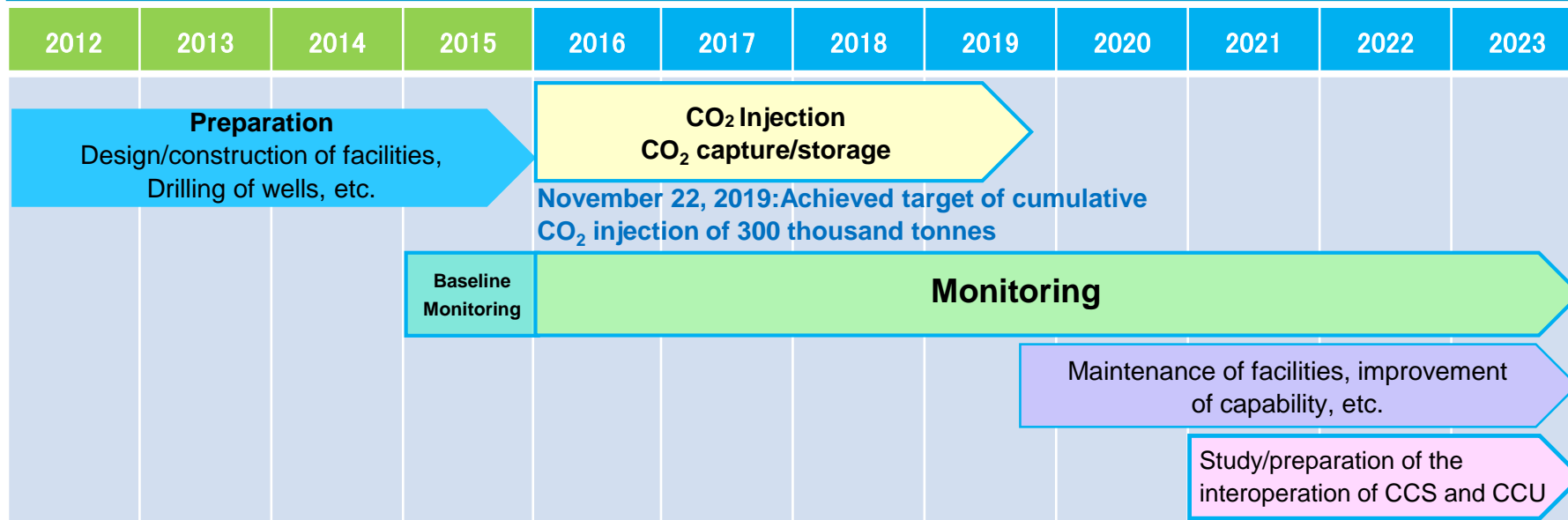
Activities including the design and construction of facilities, drilling of wells, and preparation for demonstration operation were carried out.

■ From April 2016 to November 2019: CO<sub>2</sub> injection (On November 22, 2019, the target of 300 thousand tonnes of CO<sub>2</sub> injection was achieved, and injection was terminated.)

■ From JFY2016: Monitoring of CO<sub>2</sub>(\*) ; being continued.

■ From November 2019: Maintenance of facilities, improvement of capability, etc.

■ From JFY2021: Study/preparation of the interoperation of CCS and CCU

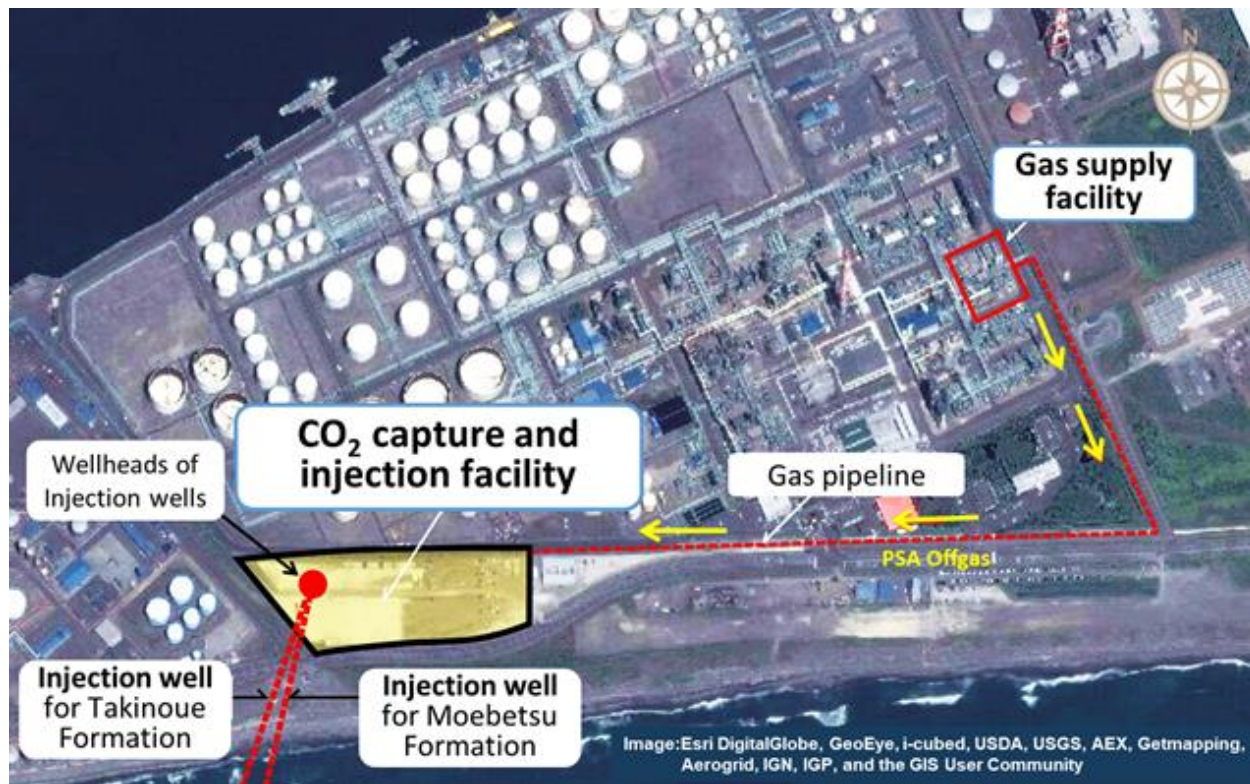


(\*) Monitoring the behavior (migration, distribution) of the injected CO<sub>2</sub>, continuous monitoring of micro-seismicity and natural earthquakes, marine environmental monitoring to detect for possible CO<sub>2</sub> seepage are being conducted.

※ Years are in Japanese Fiscal Years  
(JFY - April of calendar year to March of  
following year)

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## Positional Relation of Onshore Facilities



In the "Gas supply facility", PSA offgas (CO<sub>2</sub> containing gas) is generated in the hydrogen production process of the refinery and sent to the Tomakomai Project "Capture and injection facility" via a 1.4 km gas pipeline.

At the "Capture and injection facility", CO<sub>2</sub> is captured at purity of 99% or more from the PSA offgas sent through the Gas pipeline, pressurized by compressors, and injected by 2 injection wells into offshore sub-seabed reservoirs for storage.



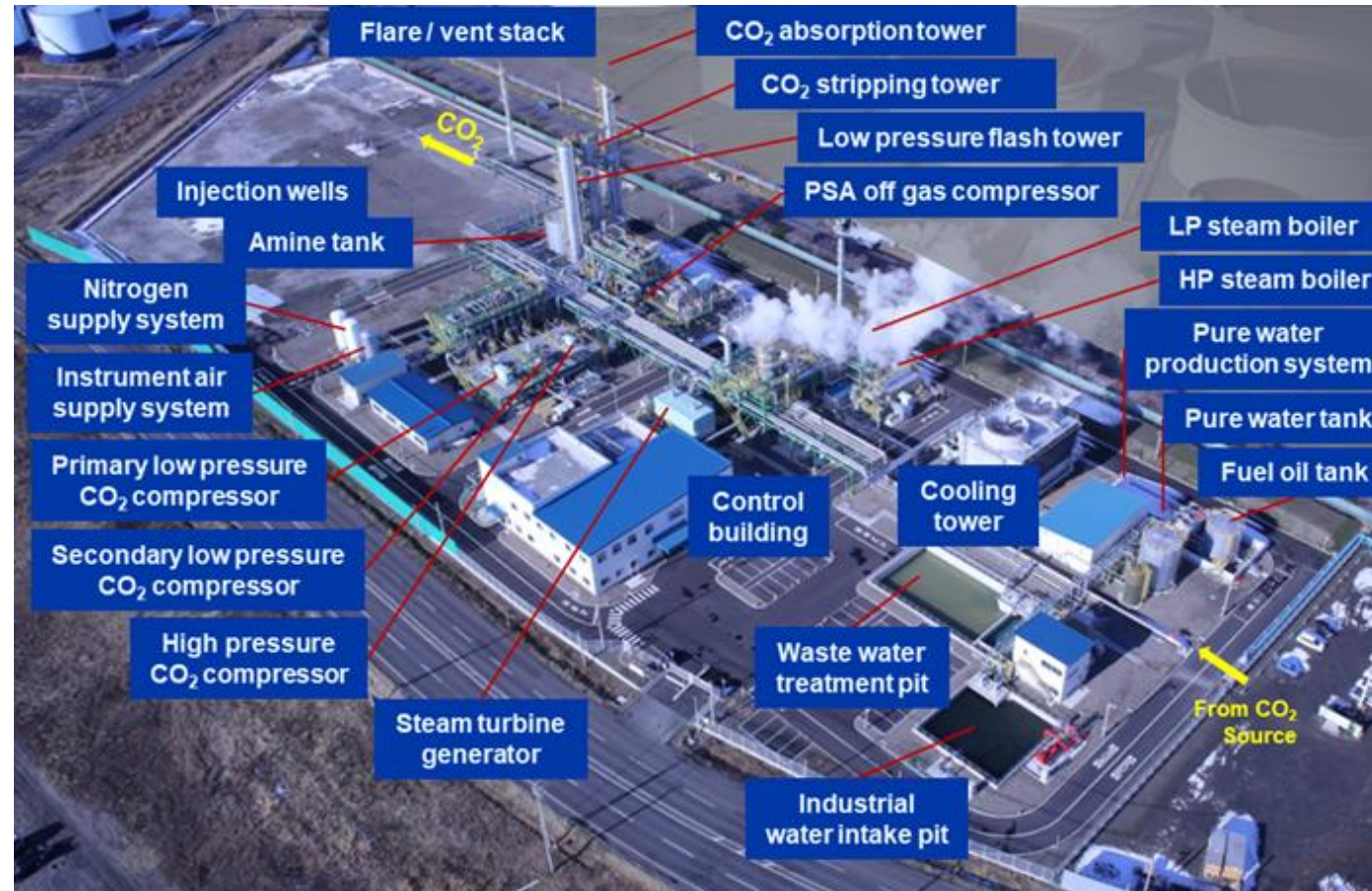
# Schematic Geological Section



This is a schematic geological section showing how the CO<sub>2</sub> is injected by two injection wells extending to the two reservoirs, the Takinoue Formation T1 Member (volcanic rocks) and Moebetsu Formation (sandstone).

The Takinoue Formation injection well is a directional well with a total depth of 5,800m and maximum inclination of 72 degrees. The Moebetsu Formation injection well is a directional well with a total depth of 3,650m and maximum inclination of 83 degrees.

# Bird's Eye View of Capture and Injection Facilities





# CO<sub>2</sub> Capture Facilities and Compressors

## 3 stage CO<sub>2</sub> Compressors

Increases pressure  
of captured CO<sub>2</sub> to  
the pressure  
required for injection



CO<sub>2</sub> Capture Facility  
Captures CO<sub>2</sub> from PSA  
Offgas



# CO<sub>2</sub> Injection Report

Injection was suspended on November 22, 2019.

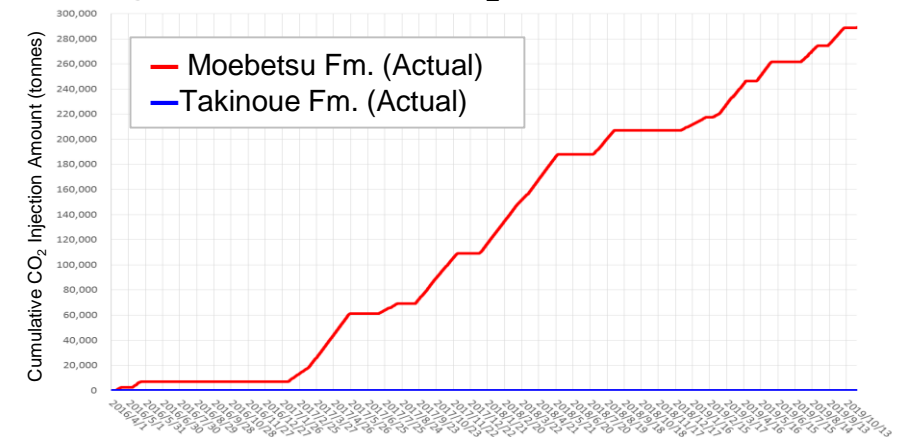
Cumulative CO<sub>2</sub> Injection amount  
(April 06, 2016~November 22, 2019)

**300,110.3**  
tonnes

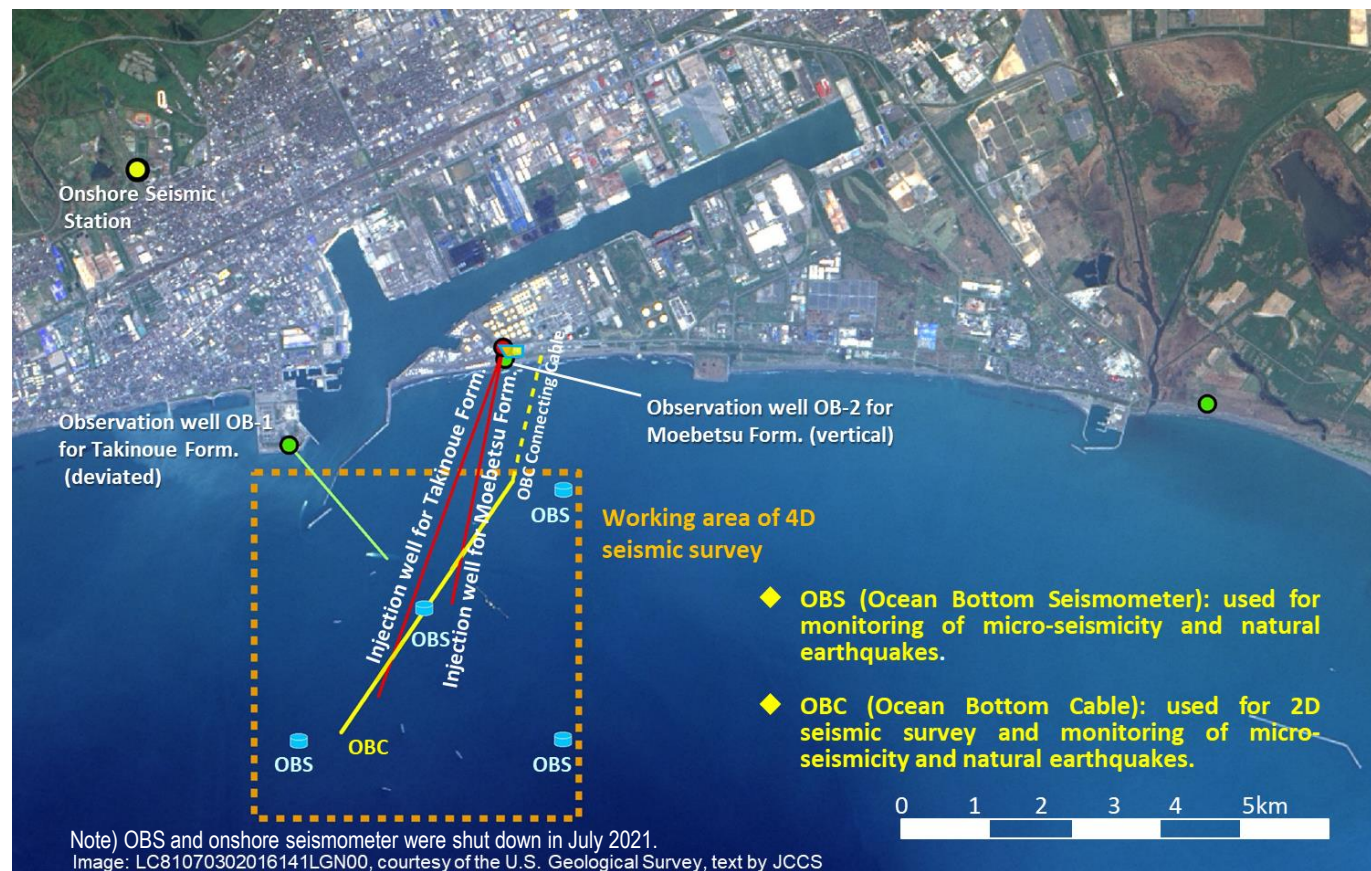
## Injection Amount in November 2019

	Injection Amount/month (November 2019)	Cumulative CO <sub>2</sub> Injection Amount (As of November 22)
Moebetsu Fm.	10,793.5 tonnes	300,012.2 tonnes
Takinoue Fm.	0.0 tonnes	98.2 tonnes

## Change of cumulative CO<sub>2</sub> Injection Amount



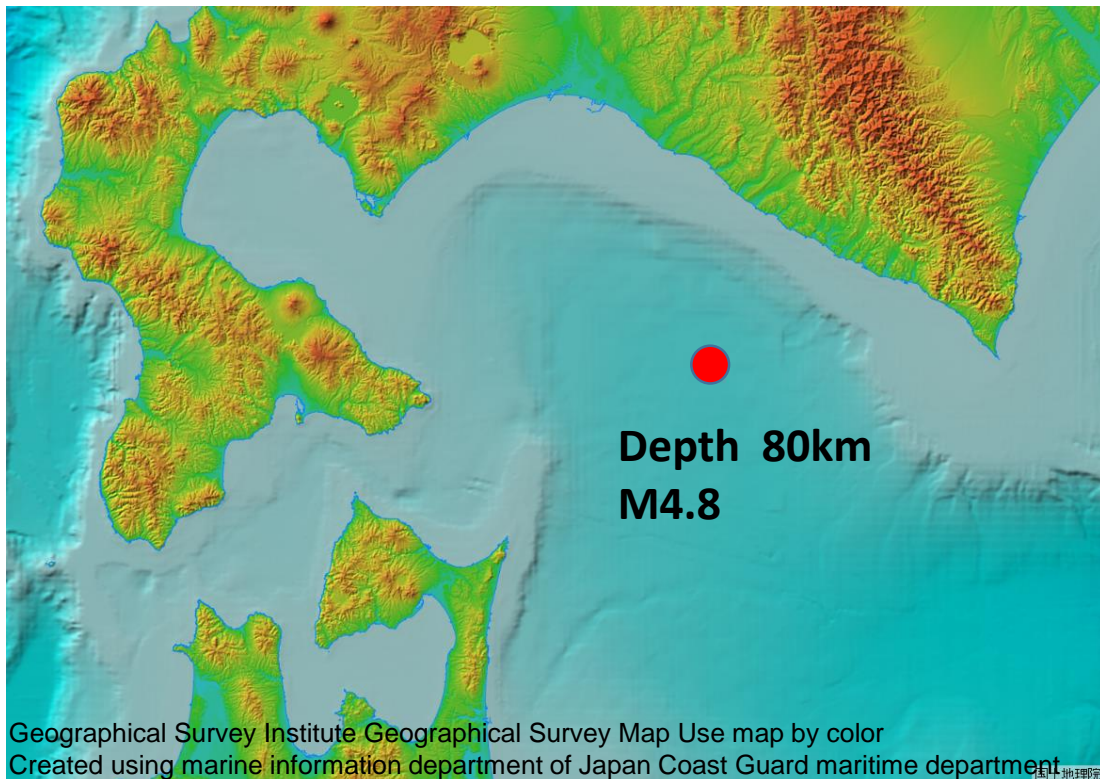
# Layout of Monitoring Network



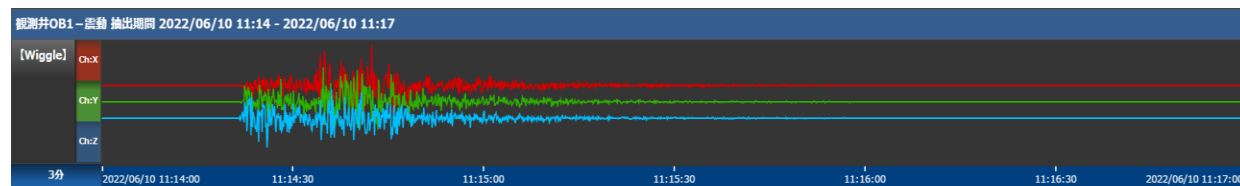
- A monitoring network was constructed near and around the CO<sub>2</sub> injection point, and continuous monitoring over six years comprising before CO<sub>2</sub> injection (1 year), during CO<sub>2</sub> injection (3 years) and after termination of injection is being carried out.
  - The formation pressures and temperatures of the wells - observation wells (3 wells) drilled around the CO<sub>2</sub> injection point and CO<sub>2</sub> injection wells (2 wells) are being monitored.
  - Seismometers were installed in the observation well and on the seabed to monitor earthquakes (including micro-seismicity - minute tremors that cannot be felt by humans).
  - Observed data is controlled centrally at the Tomakomai Demonstration Center and constant monitoring for the presence of abnormal conditions is carried out.



# The most recent noticeable tremors observed in Tomakomai



## Observation record of Seismometer in Observation Well



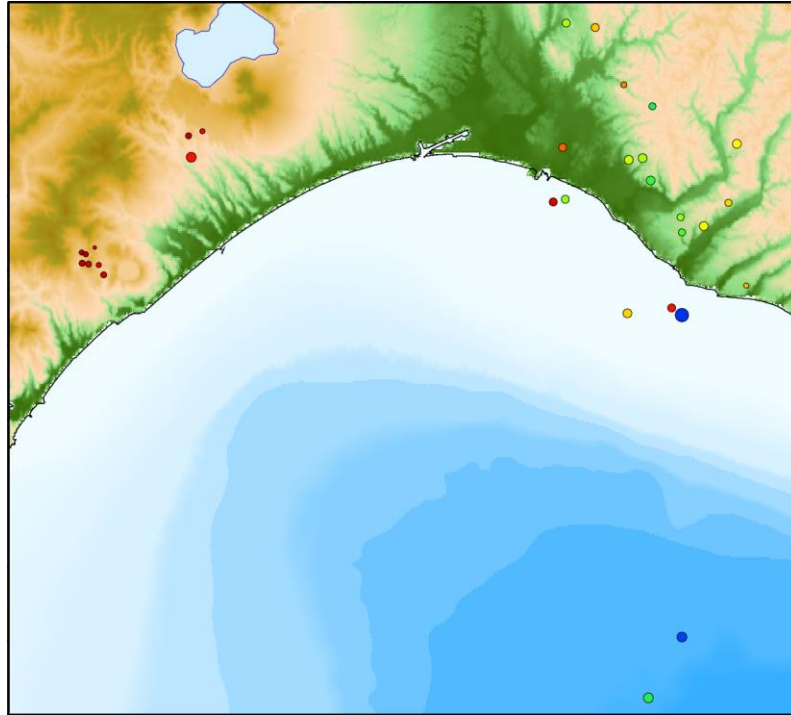
### Earthquake Information

Announced by the Japan Meteorological Agency

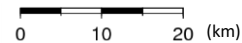
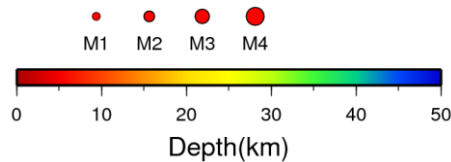
Time & Date	11:14 (JST) 10 Jun, 2022		
Hypocenter	Lat.	41°	54'N
	Lon.	142°	12'E
	Depth	80km	
Magnitude	4.8		
Seismic Intensity at Tomakomai-city	1		



# Distribution of Natural Earthquakes around Tomakomai



Natural earthquake hypocenter distribution in May 2022



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

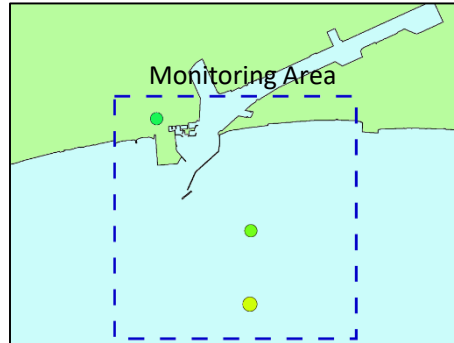


Natural earthquake hypocenter distribution occurred from 2001 to 2010

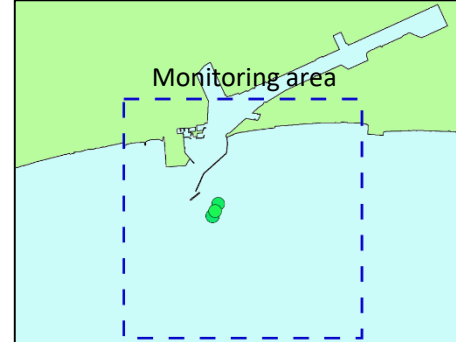
The hypocenters in the figure is from the JMA Unified Hypocenter Catalog.  
Earthquakes with the hypocenter depth of 50 km or less are displayed.

# Micro-seismic events nearby injection point

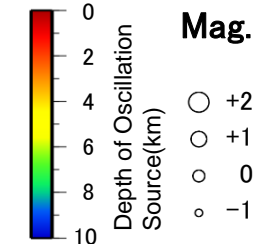
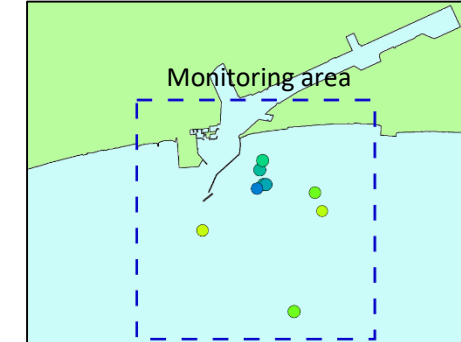
Distribution; post-injection (2019/11/23-2022/5/31)



During injection period (2016/4/6-2019/11/22)

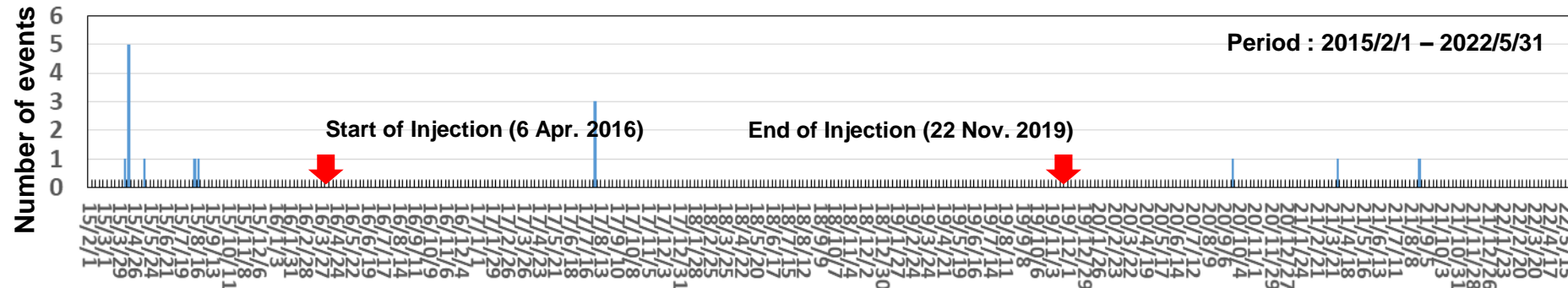


Distribution over 14 months pre-injection (2015/2/1-2016/3/31)



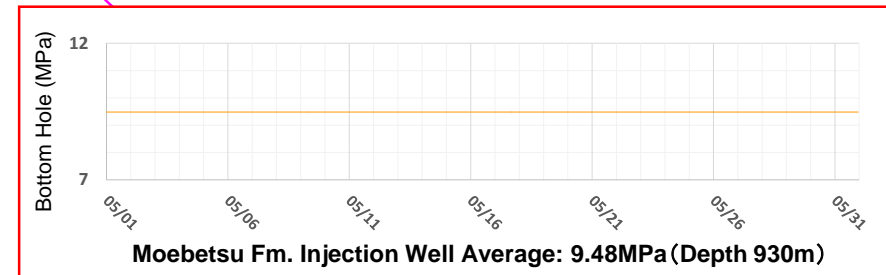
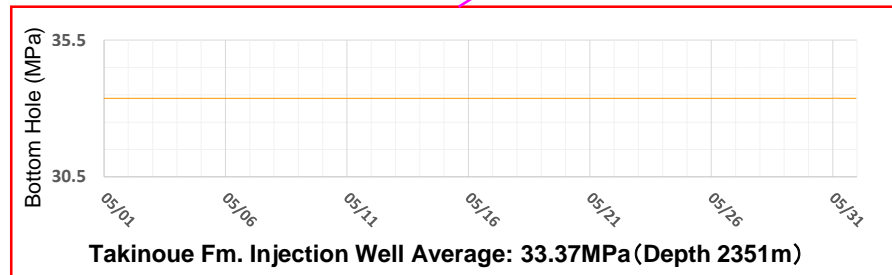
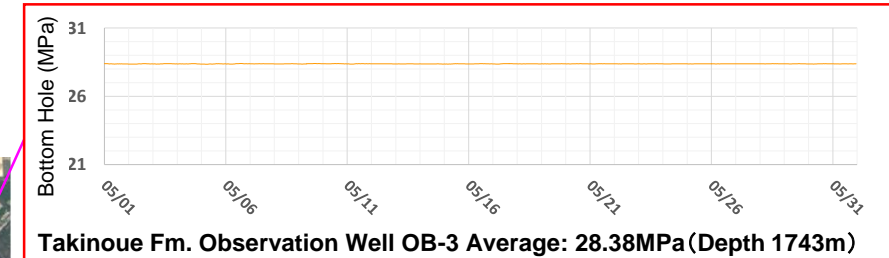
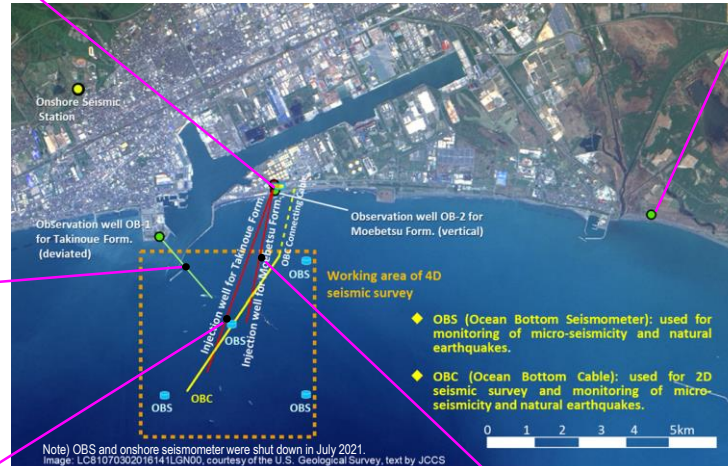
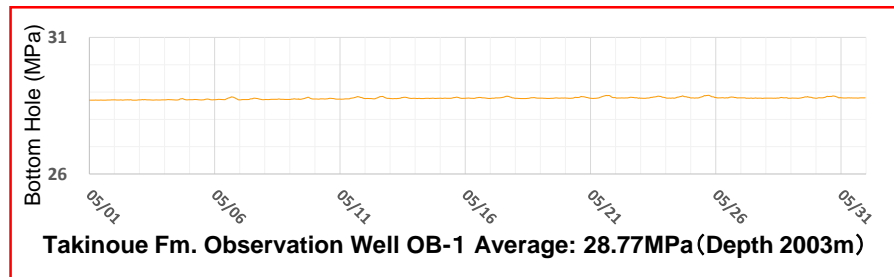
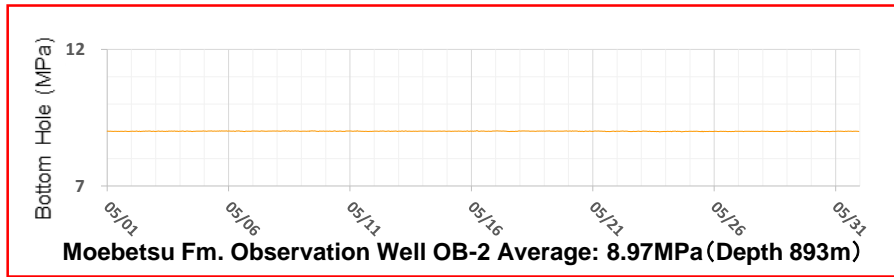
The left map is created based on the base map Information coastline data of Geospatial Information Authority of Japan.

Detection of micro-seismic events (weekly)



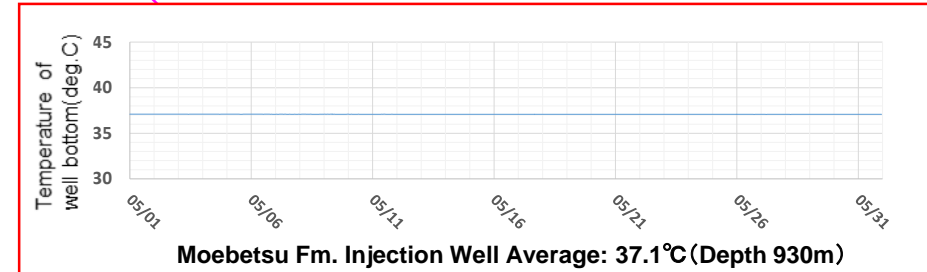
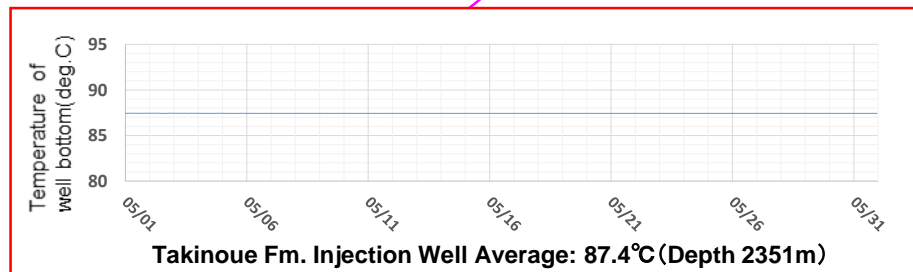
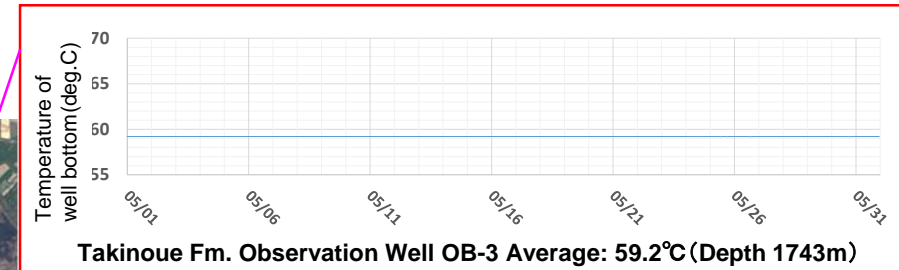
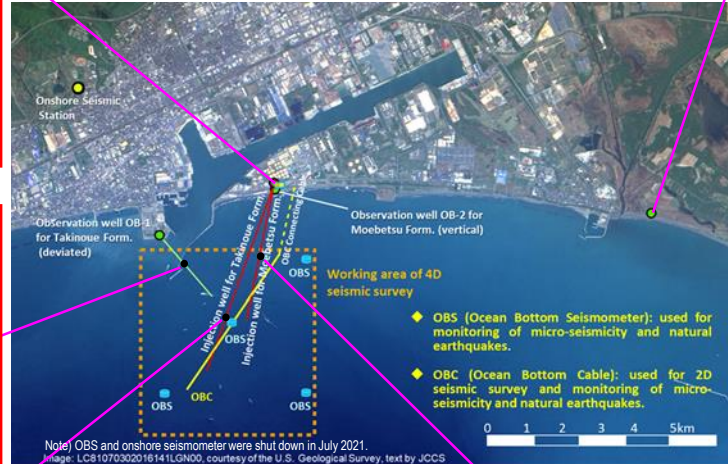
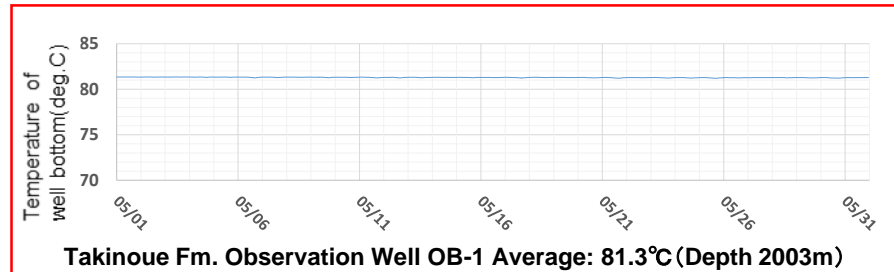
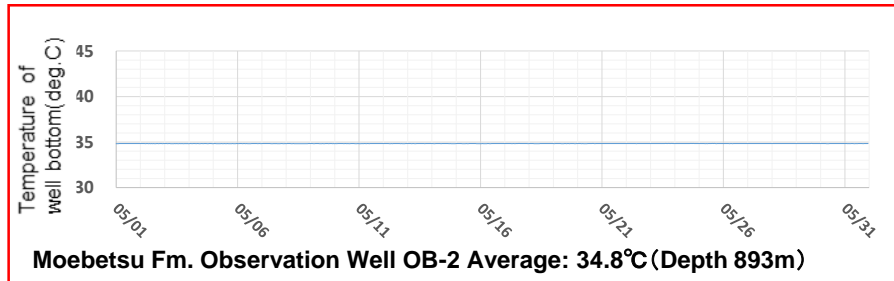
- There are perceptible earthquakes that can be felt, and imperceptible earthquakes that cannot be felt even though there are actual vibrations.
- In this project, particularly small (less than magnitude 1) imperceptible earthquakes are defined as micro-seismicity.
- In this project, micro-seismicity 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 points, and constraints on seismograph detection capability, etc.

# Observation of pressure in the wells (May 2022)

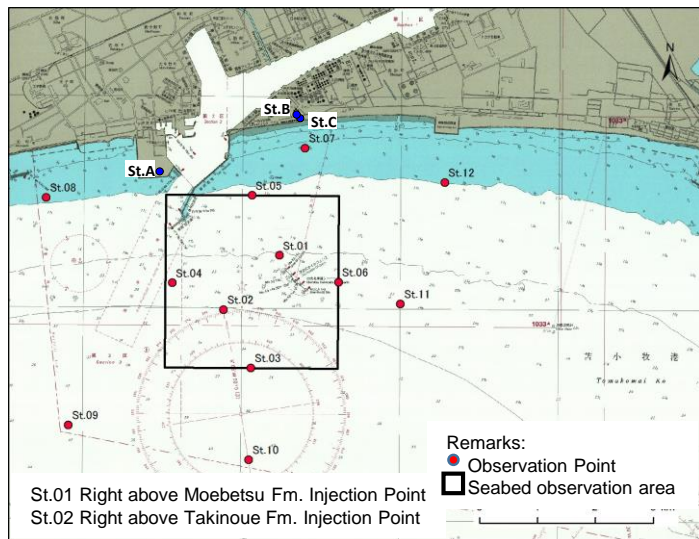




# Observation of temperature in the wells (May 2022)



# CO<sub>2</sub> Concentration around injection point (seasonal)



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

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

	2013				2014				2015				2016				2017				2018				2019				2020			
	Spring	Smnr	Fall	Winter	Spring	Smnr	Fall	Winter	Spring	Smnr	Fall	Winter	Spring	Smnr	Fall	Winter	Spring	Smnr	Fall	Winter	Spring	Smnr	Fall	Winter	Spring	Smnr	Fall	Winter	Spring	Smnr	Fall	Winter
St.01		323	425	388	424								372	401		339	228	474	410	403	301	386	348	304	351	402	528	359	413	378	300	244
St.02		364	432	393	428								475	389		351	255	484	440	399	308	454	371	307	346	415	497	389	452	402	295	275
St.03		343	410	377	420								477	386		347	254	431	424	390	328	450	355	280	427	415	550	388	412	371	287	267
St.04		351	399	393	436								432	394		335	239	485	440	395	312	384	355	248	324	428	499	388	387	370	291	256
St.05		326	352	387	430								370	416		309	247	354	372	369	256	348	356	261	300	360	562	353	328	371	289	241
St.06		283	417	395	424								411	366		332	259	450	426	390	306	408	356	303	325	435	545	382	398	368	297	256
St.07		314	353	368	424								358	517		316	273	371	384	366	270	343	355	216	307	364	530	364	338	379	281	236
St.08		370	349	366	327								360	439		316	277	320	366	375	276	356	327	228	313	409	510	349	326	375	289	257
St.09		358	395	379	417								437	391		335	276	423	428	391	346	437	369	302	417	407	544	390	485	382	292	278
St.10		353	395	372	415								477	394		333	266	423	420	374	337	423	353	269	407	412	565	386	532	391	289	279
St.11		350	415	394	418								443	391		338	264	448	436	384	310	397	353	330	319	408	542	394	397	387	293	240
St.12		317	377	383	420								334	447		334	252	349	383	389	260	348	344	263	305	400	556	369	371	365	295	252
St.A					396	379	412	400	397	394	399	424	417	404	407	432	414	404	414	413	411	395	401	419	430	411	454	445	471	442	421	421
St.B					365	382	405	407	400	394	388	415	411	397	405	417	413	392	408	414	412	395	423	424	425	411	429	444	446	463	426	426
St.C					403	395	403	403	392	406	396	409	423	410	412	403	413	417	428	417	427	404	421	421	430	414	438	440	450	427	419	441

\* Offshore observation was not conducted in fall 2016.

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