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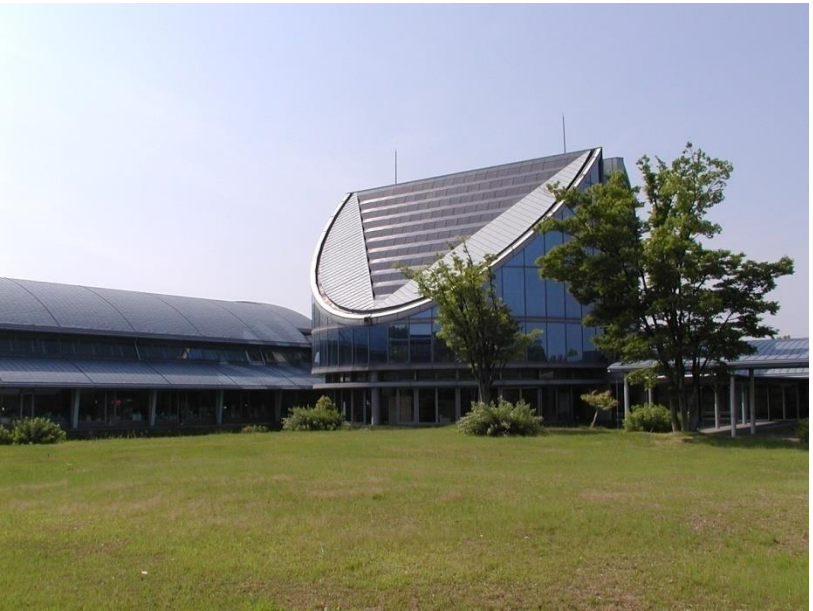
Research Institute of Innovative Technology for the Earth

Tomakomai lessons learned in offshore CO_2 storage regulations

May 3, 2018



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Background

Japan's Tomakomai CCS demonstration project had to suspend CO_2 injection in its offshore site due to natural fluctuation in seawater parameters larger than conservative threshold. Injection was resumed after the revision of its monitoring plan to allow for more comprehensive judgement when irregularity is detected.

This presentation is to share its brief story and lessons learned, based on a case study included in a CSLF report publicized on November 7, 2017:

"Practical Regulations and Permitting Process for Geological CO_2 Storage"


Carbon Sequestration Leadership Forum
www.cslforum.org

Practical Regulations and Permitting Process for Geological CO_2 Storage

Report Prepared for the Policy Group of the Carbon Sequestration Leadership Forum (CSLF)

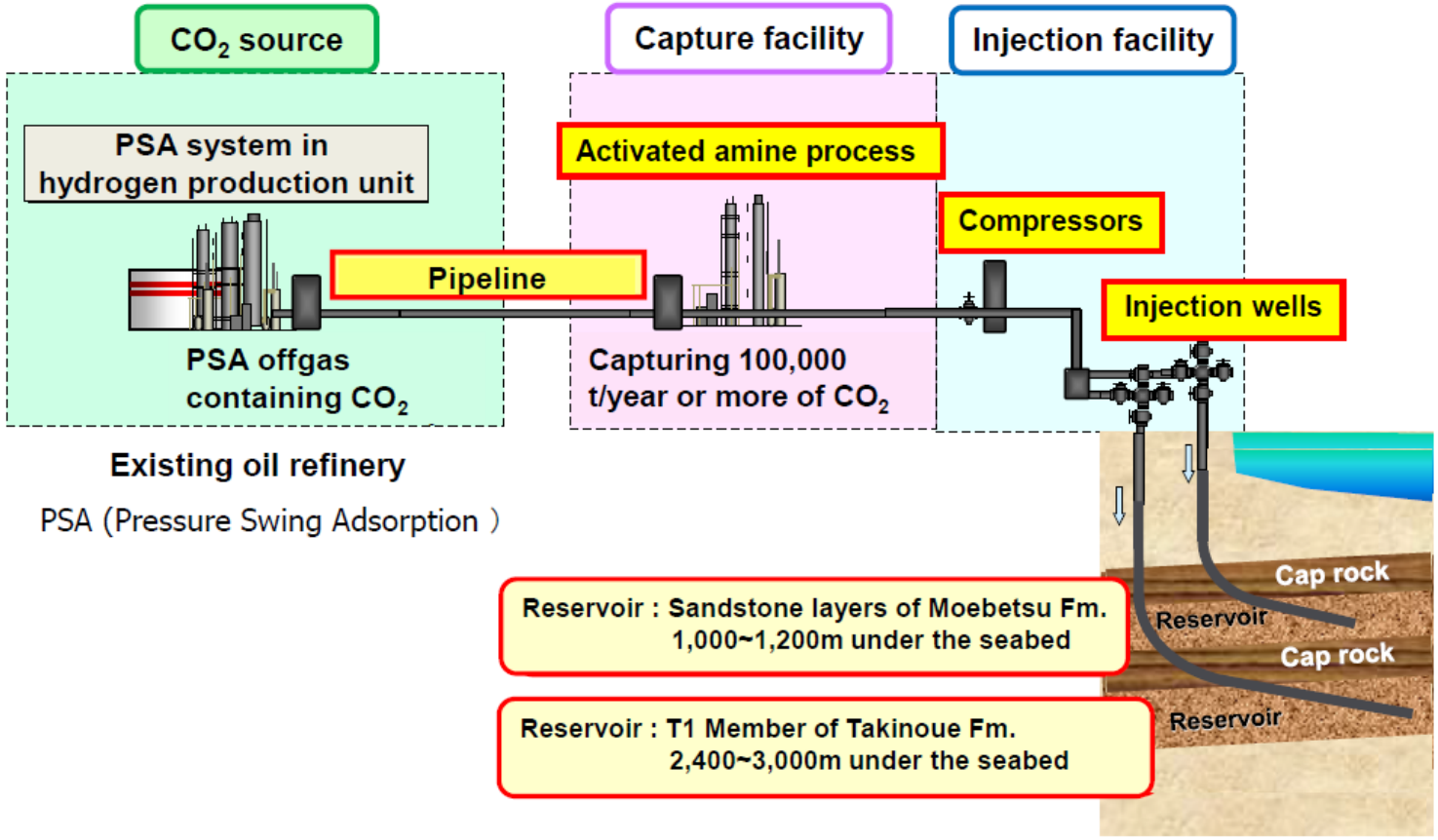
By the CSLF Regulation Task Force

November 7, 2017

https://www.cslforum.org/cslf/sites/default/files/documents/7thMinUAE2017/7thMinAbuDhabi17-PG-RegulationTaskForceReport.pdf

Overview of the Tomakomai Project

- Funded and owned by the Ministry of Economy, Trade and Industry (METI); and developed and operated by Japan CCS Company (JCCS)
- Storage permit in March 2016
- 3-year CO_2 injection started in April 2016



Source: JCCS, CSLF PIRT Meeting, Oct 2016

Offshore CO_2 Storage Regulations (1)

2. The regulatory framework of CO_2 sub-seabed storage under the *Marine Pollution Prevention Law*

LP Annex I Amendment

Implementation of LP within country

Marine Pollution Prevention Law Amendment

- Regulatory framework aimed to "protect marine environment"
- Does NOT intend to "promote CCS"

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Source: MOE, Sep 2011

Offshore CO_2 Storage Regulations (2)

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Outline of amendment (1)

(1) Prohibition of disposal of oil, hazardous liquid substances, and wastes under the seabed

No one shall dispose oil, hazardous liquid substances, and wastes under the seabed, except for CO_2 stream storage under the seabed with permit from Minister of the Environment (Article 18.7)

(2) Provisions for the permit for CO_2 stream storage under the seabed

1) Anyone intending to dispose CO_2 stream under the seabed must obtain a permit from Minister of the Environment (Article 18.8.1)

2) Minister of the Environment shall not issue a permit for the CO_2 stream storage under the seabed unless it meets all conditions required such as "the storage site under the seabed and the method taken for the storage will not harm marine environmental protection at the storage site" and "there is no other appropriate disposal is available other than storage under the seabed" (Article 18.9)

3) A person holding a permit for CO_2 stream storage under the seabed must monitor status of the pollution at the storage site and report monitoring results to Minister of the Environment (Article 18.12)

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Source: MOE, Sep 2011

Offshore CO_2 Storage Regulations (3)

Monitoring phase

Phase 1 : Routine monitoring

Monitoring to implement for the cases other than Phase 2 and 3

Phase 2 : Precautionary Monitoring

Monitoring to implement for determining whether drawback to marine environment caused by CO2 streams has been occurred or not.

Phase 3 : Emergency monitoring

Monitoring to continuously implement during such a period that the fact or situation likely of drawback to marine environment caused by CO2 streams has been occurred.

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CO_2 injection should be suspended.

Source: MOE, GCCSI Forum, Jan 2016

Regulator's Preparation for Application (1)

Difficulty in setting a threshold

Main monitoring methods for detection of CO2 leakage

- Seismic reflection survey
- Monitoring downhole temperature and pressure

  ⇒Conventional monitoring methods in other fields
  ex) oil and gas exploration
- Water column sampling

  ⇒The unique monitoring method in offshore CCS projects
  Little experience so far

In chemical analysis of water column sampling,

What is an appropriate parameter?

What is an appropriate threshold?

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Source: MOE, 11th Meeting of Scientific Group of the London Protocol, Mar 2017

Regulator's Preparation for Application (2)

Comparison of parameters in Tomakomai area

- DIC (Dissolved Inorganic Carbon)
  - Increased linearly with the amount of leaked CO2
  - Strongly affected by air-sea exchange of CO2
  - Differed from year to year even in the same season
- pCO2 (carbon dioxide partial pressure)
  - Fluctuated due to respiration and photosynthesis of marine organism
  - Increased non-linearly with the amount of leak CO2
- Relationship between pCO2 and DO (dissolved oxygen saturation[%])
  - pCO2 is inversely correlated with DO.
  - Stable throughout a year

➡ Relationship between pCO2 and DO seems to be valid for the threshold.

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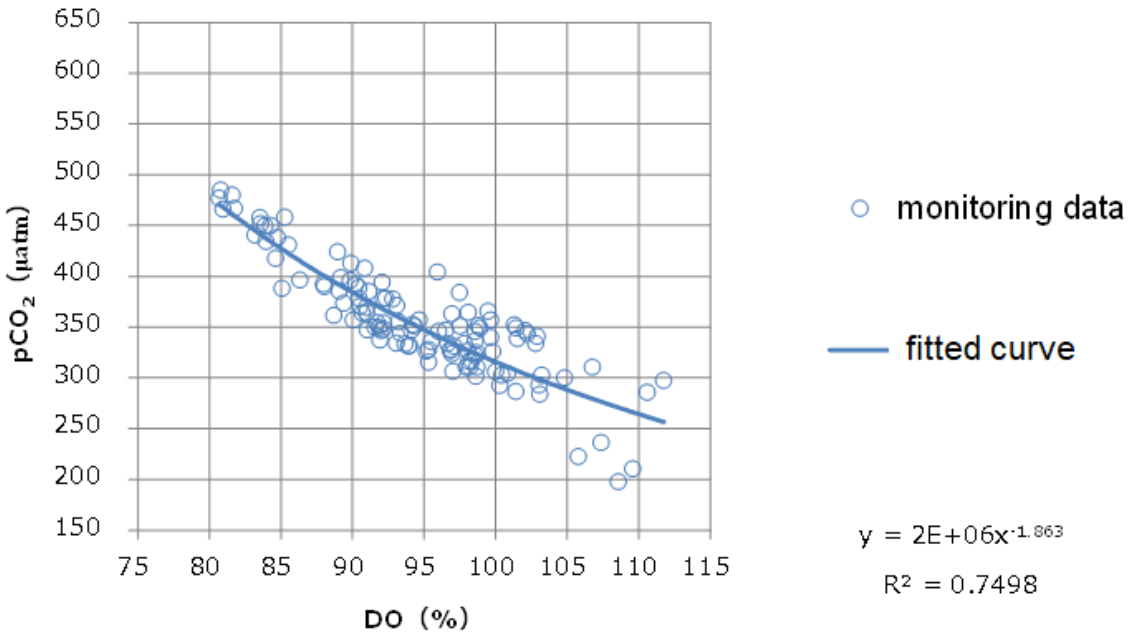
Source: MOE, 11th Meeting of Scientific Group of the London Protocol, Mar 2017

Regulator's Preparation for Application (3)

Setting the threshold of pCO2 and DO

Field monitoring data in Tomakomai area (4 years) and fitted curve



The values are stable throughout a year.
pCO2 is inversely correlated with DO.
Monitoring data for several years can be used for curve fitting.

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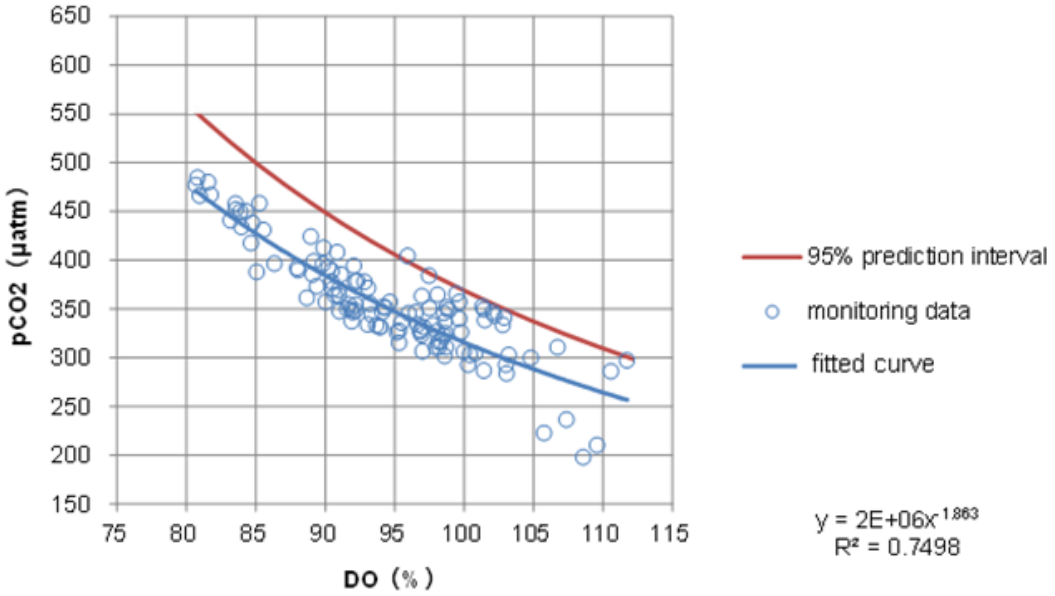
Source: MOE, Scientific Group of the London Protocol – 11th Meeting, Mar 2017

Regulator's Preparation for Application (3)

The threshold in Tomakomai Area

- The method of setting the threshold for water column sampling in Tomakomai area considered by MOE
  - Relationship between pCO2 and DO
    - Baseline monitoring for more than a year
    - Upper bound of 95% prediction interval based on fitted curve



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Source: MOE, 11th Meeting of Scientific Group of the London Protocol, Mar 2017

Threshold for pCO_2-DO Data in Tomakomai (1)

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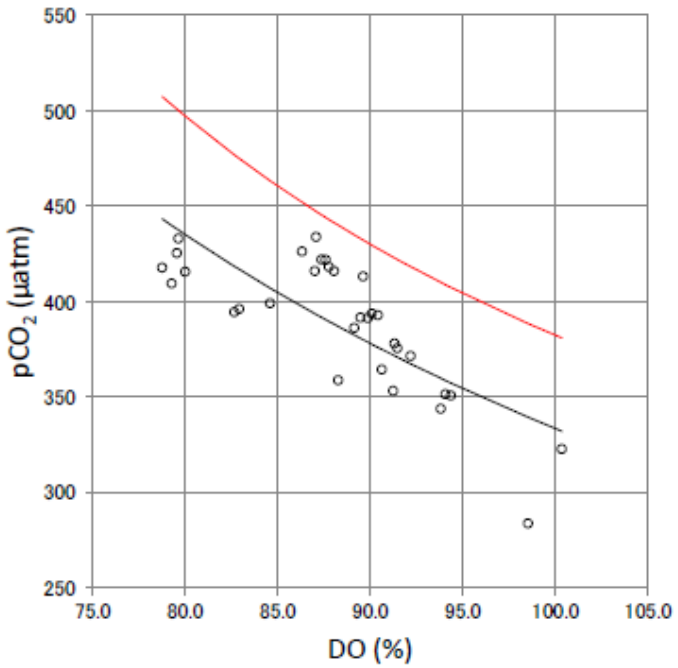
Setting the threshold (2)

As the result of the consultation of MOE:



Threshold was set by background monitoring data **for 1 year period** in accordance with **MOE guideline** (8 points, 4 seasons = **32 data**)

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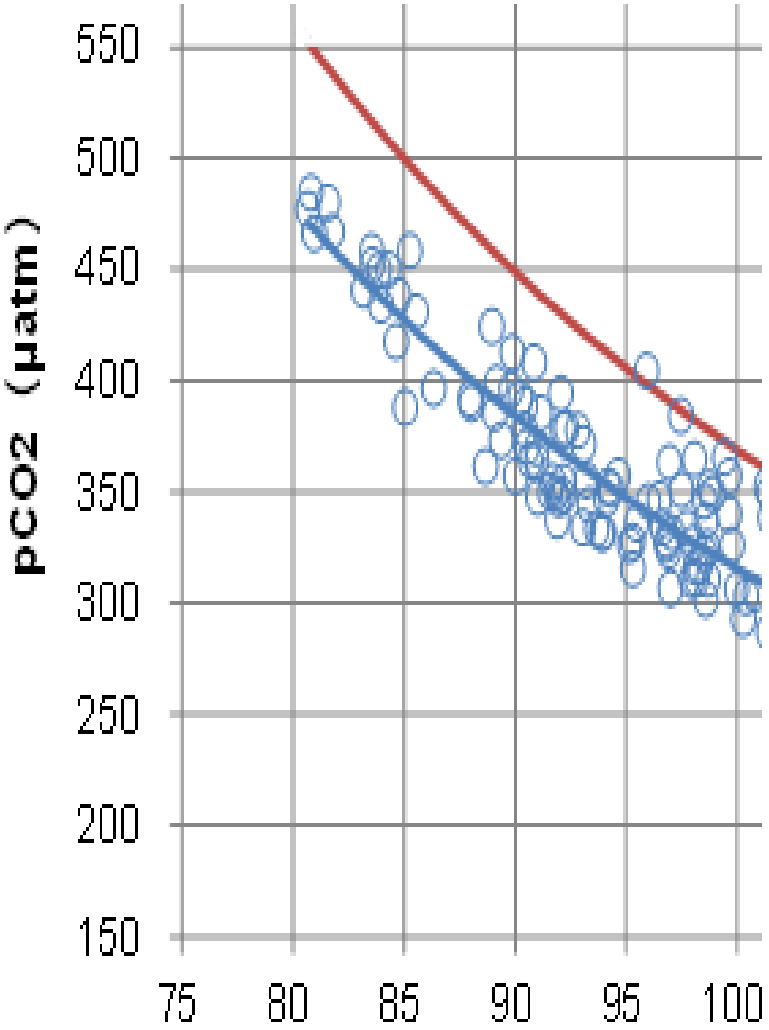
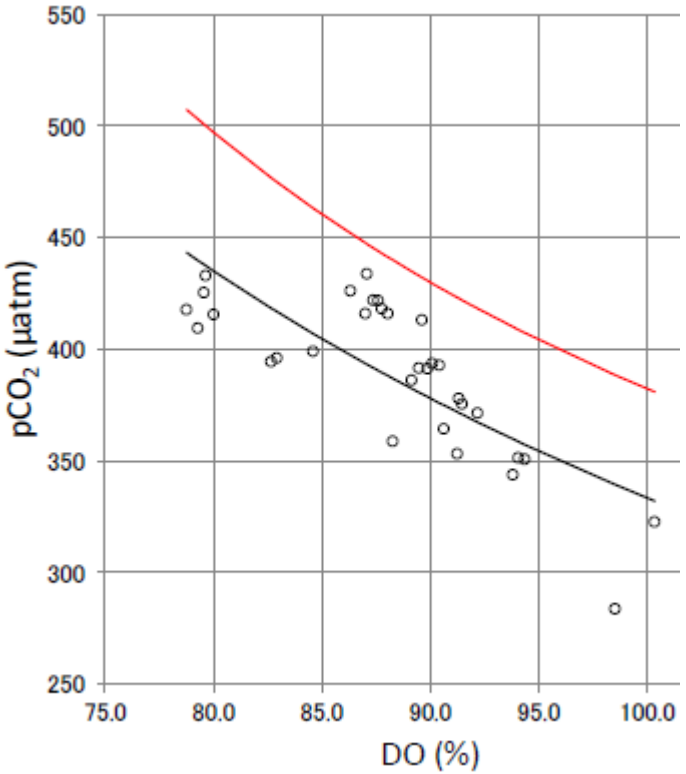
Source: METI, CSLF Policy Group Meeting, May 2017

Threshold for pCO_2-DO Data in Tomakomai (2)



Threshold based on MOE's 4-year Data

Source: MOE, Scientific Group of the London Protocol – 11th Meeting, Mar 2017



Threshold based on 1-year Data in Application

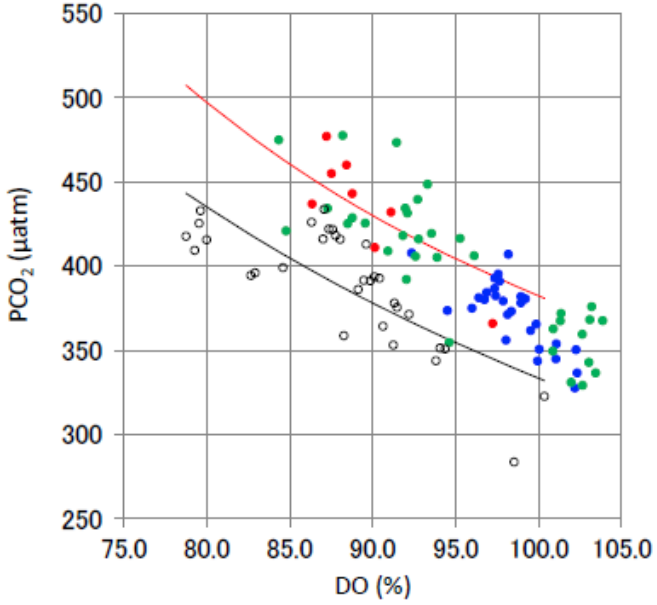
Source: METI, CSLF Policy Group Meeting, May 2017

What happened after CO_2 Injection Started?

In 2016, CO_2 injection started in April and the 1st marine routine survey was conducted during a scheduled injection interruption in early June.

Actual Monitored Data

The fact is … :



Early June: 5 data exceeded, resurvey required

Late June: 2 data exceeded, moved to the precautionary phase and injection required to postpone

Late July: a number of data exceeded, moved to the emergency phase

An emergency phase survey, late August: no data exeedance

Injection Suspended (under the regulation by the Act); even no CO_2 leakage

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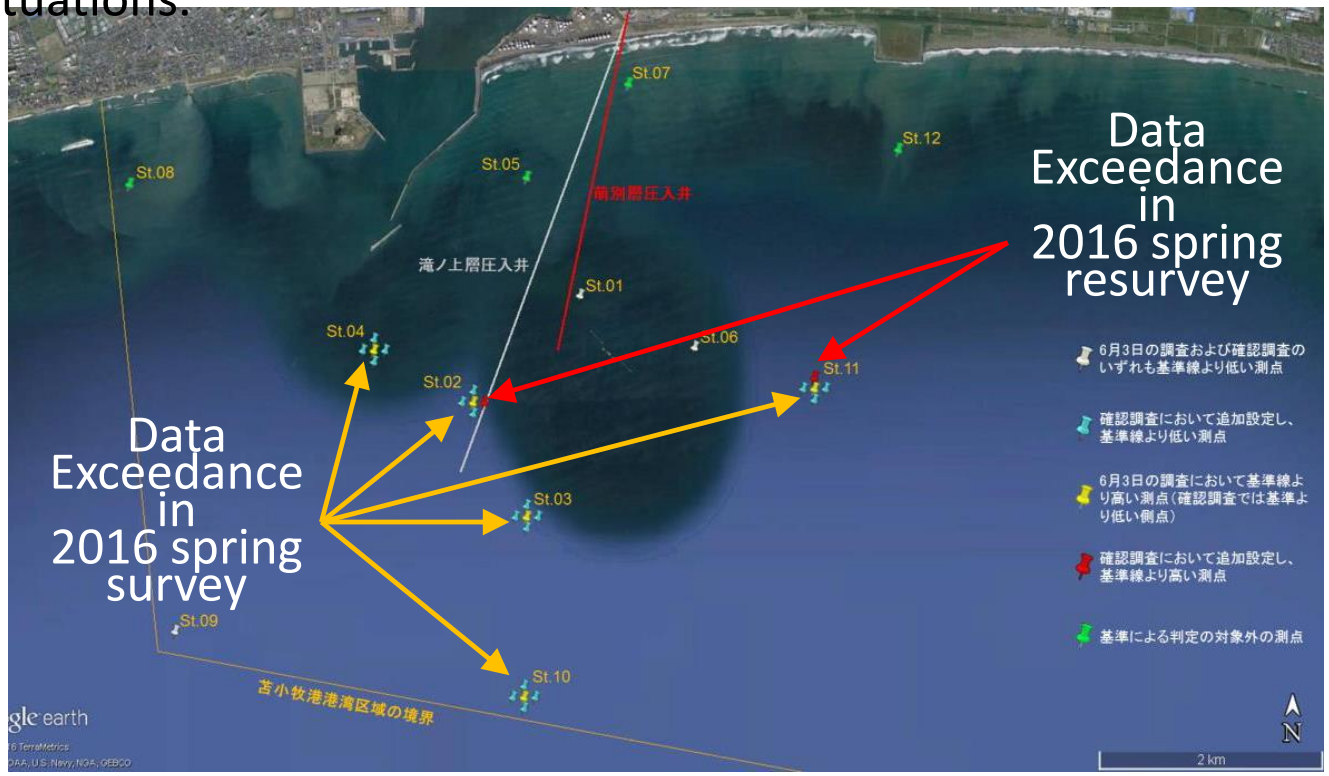
Source: METI, CSLF Policy Group Meeting, May 2017; Arrows and descriptions added

JCCS' Interpretation on the Data Exceedance

In August 2016, JCCS' interpretation on the data exceedance was announced:

Sampling points with irregular data in the 2016 spring survey and resurvey were spatially and temporally discontinuous.

- The irregularities were due to natural seawater fluctuations.
- The Tomakomai threshold was insufficient to accommodate such fluctuations.



Source: JCCS, Press Release, Aug 2016; Arrows and descriptions added

MOE's View on Tomakomai Monitoring Plan

In October 2016, MOE's view on the Tomakomai monitoring plan was announced :

- The monitoring plan, as written, might result in the long-term suspension of CO_2 injection even in a case where there is no CO_2 leak.
- The process would be good for the marine environmental protection but not for public trust and public acceptance for the project.

MOE required a revision of the monitoring protocol in a case where seawater sampling data exceeded the threshold:

- In addition to water sampling, multiple methods for detecting CO_2 leakage (e.g. pH sensor towing and side-scan sonar) should be used.

METI/JCCS revised the monitoring plan accordingly without revising the disputed threshold line and obtained a permit for the revision.

CO_2 injection was restarted in early February 2017 after a six-month regulatory suspension.

Lessons Learned (1)

- **CCS regulations should be established for the purpose of promotion of safe CCS.** Regulations without such a purpose may increase the cost of CCS projects by creating unnecessary interruptions in operations or by adding additional monitoring and/or research to satisfy a conservative regulatory approach.
- **An unnecessary suspension of project operation caused by an immature plan or protocol can deteriorate public trust on a CCS project and as a result can hinder the project and future projects.**
- **Plans and protocols need to be reasonable and practical in how they respond to irregularities or potential irregularities.** Close communications and co-operation between the operator and the regulator are necessary to ensure that plans and protocols fit project and monitoring objectives to protect the environment.

Lessons Learned (2)

- Once a potential problem is identified in, for example, conditions or regulatory requirements specified in permit documents, the problem should be rectified as quickly as possible through close communication between the operator and the regulator. However, it should be noted that **it can be difficult to change conditions or regulatory requirements radically once they have been approved. This suggests the importance of communication with the regulators before a permit is issued.**
- **Monitoring parameters that are being used for critical pathways in permit compliance (*e.g.* additional costly surveys, suspension of CO_2 injection) should be selected from established technologies and monitor environments whose variations are well understood.** Those parameters should have a sufficient number of baseline data to account for natural fluctuations if any. When parameters do not meet these conditions, the determination to change permit status should incorporate multiple parameters and data sources.

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