Carbon Storage R&D Project Review Meeting
Developing the Technologies and Building the Infrastructure for CCUS
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Nagaoka Post-injection Monitoring Update and Recent Research Activities in Japan

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Research institute of Innovative Technology for the Earth (RITE)

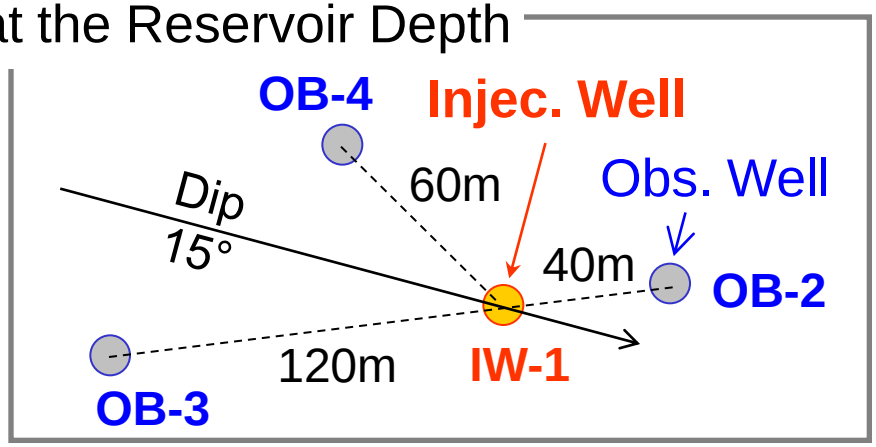
Contents

- Nagaoka Post-injection Monitoring Update
  - Overview of the Nagaoka pilot-scale injection test
    + Results of geophysical monitoring
      (well loggings, cross-well seismic tomography)
    + Results of geochemical reactions
      (formation fluid sampling, pH, mineralization)
    + Field survey results after the two earthquakes

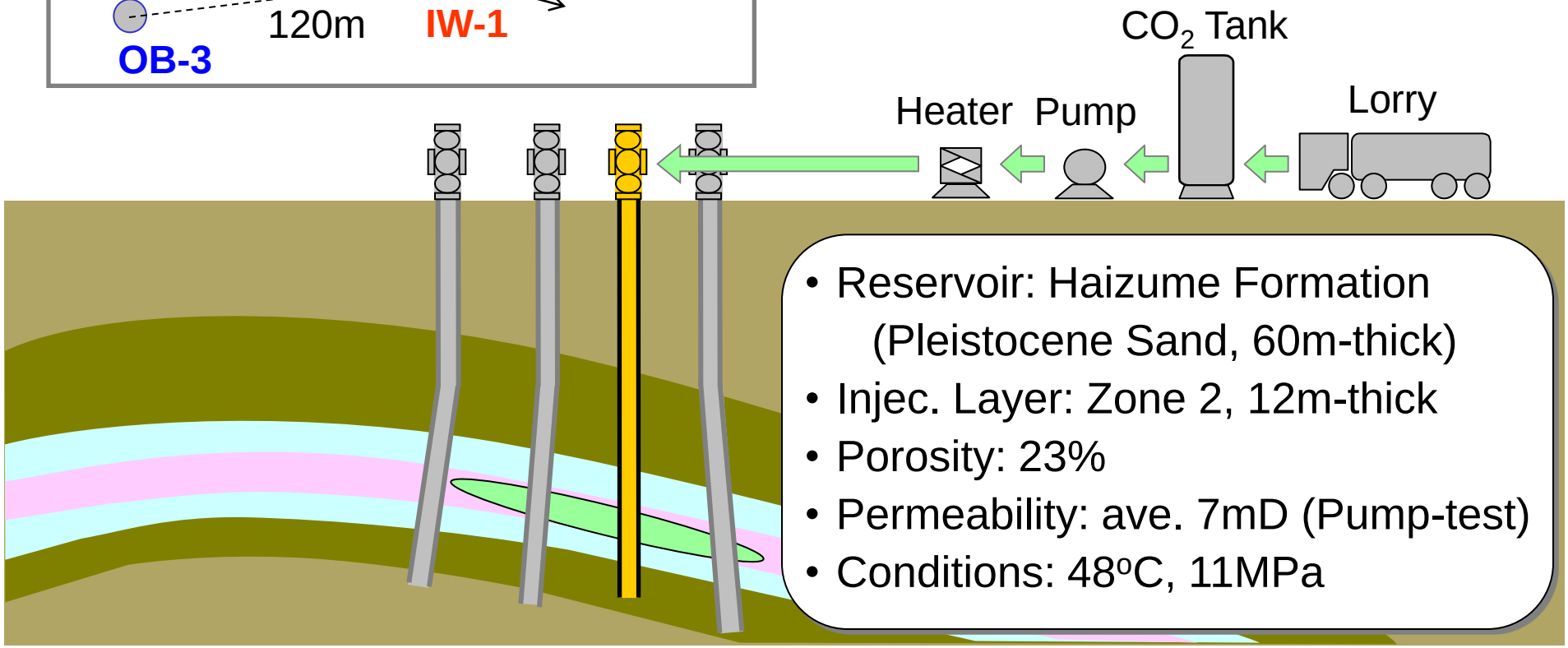
- Recent Research Activities in Japan
  - Large scale demonstration at off-shore aquifers, Tomakomai

Nagaoka Pilot-scale Injection Test

Well Configuration
at the Reservoir Depth



- Injec. Period; Jul. 2003~Jan. 2005
- Total amount; 10,400 ton CO_2
- Rate; 20~40 ton/day



- Reservoir: Haizume Formation
  (Pleistocene Sand, 60m-thick)
- Injec. Layer: Zone 2, 12m-thick
- Porosity: 23%
- Permeability: ave. 7mD (Pump-test)
- Conditions: 48°C, 11MPa

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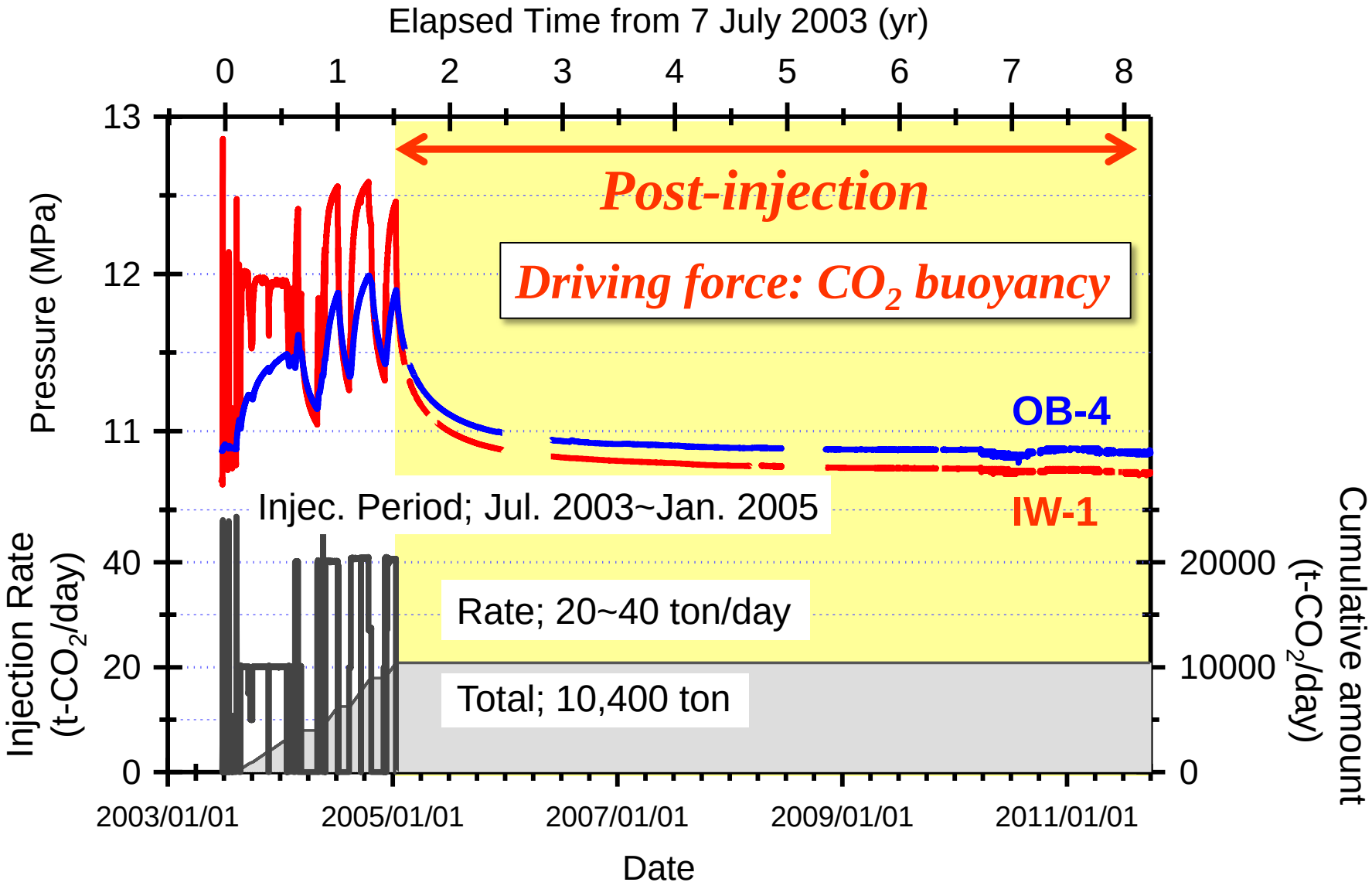
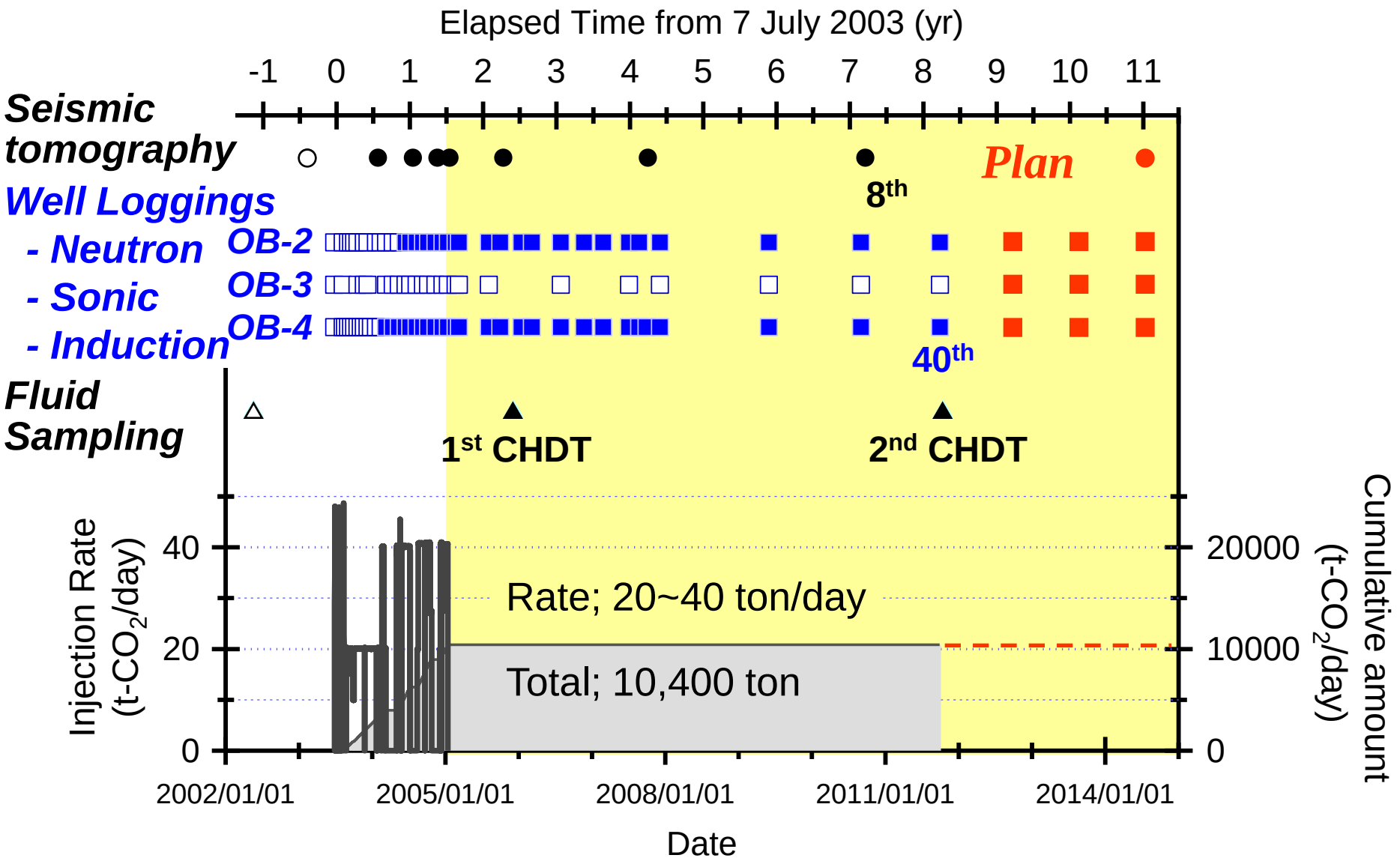
Injection History and Pressure Response



Performance & Plan of Post-injection Monitoring



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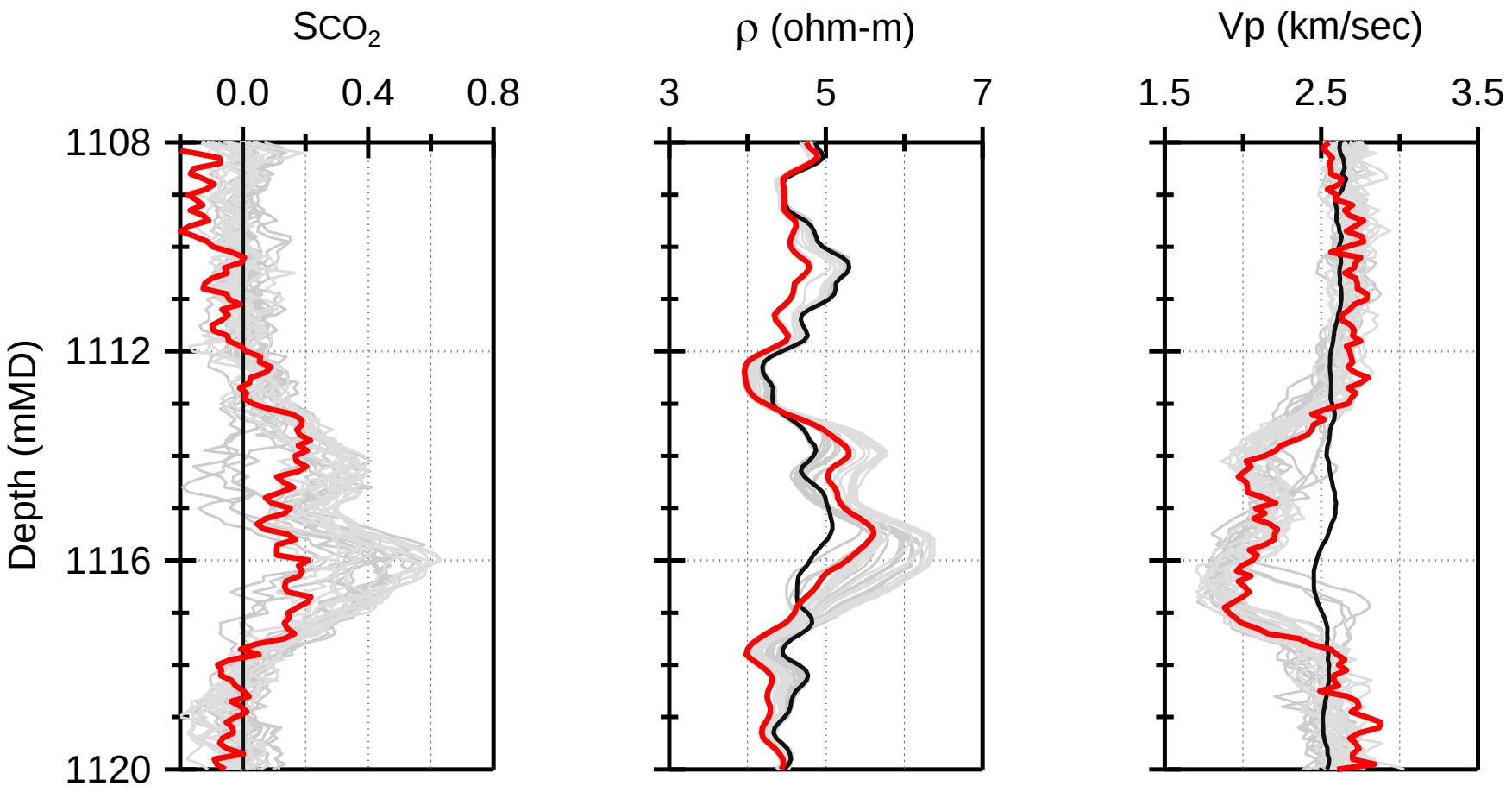
Well logging results at OB-2

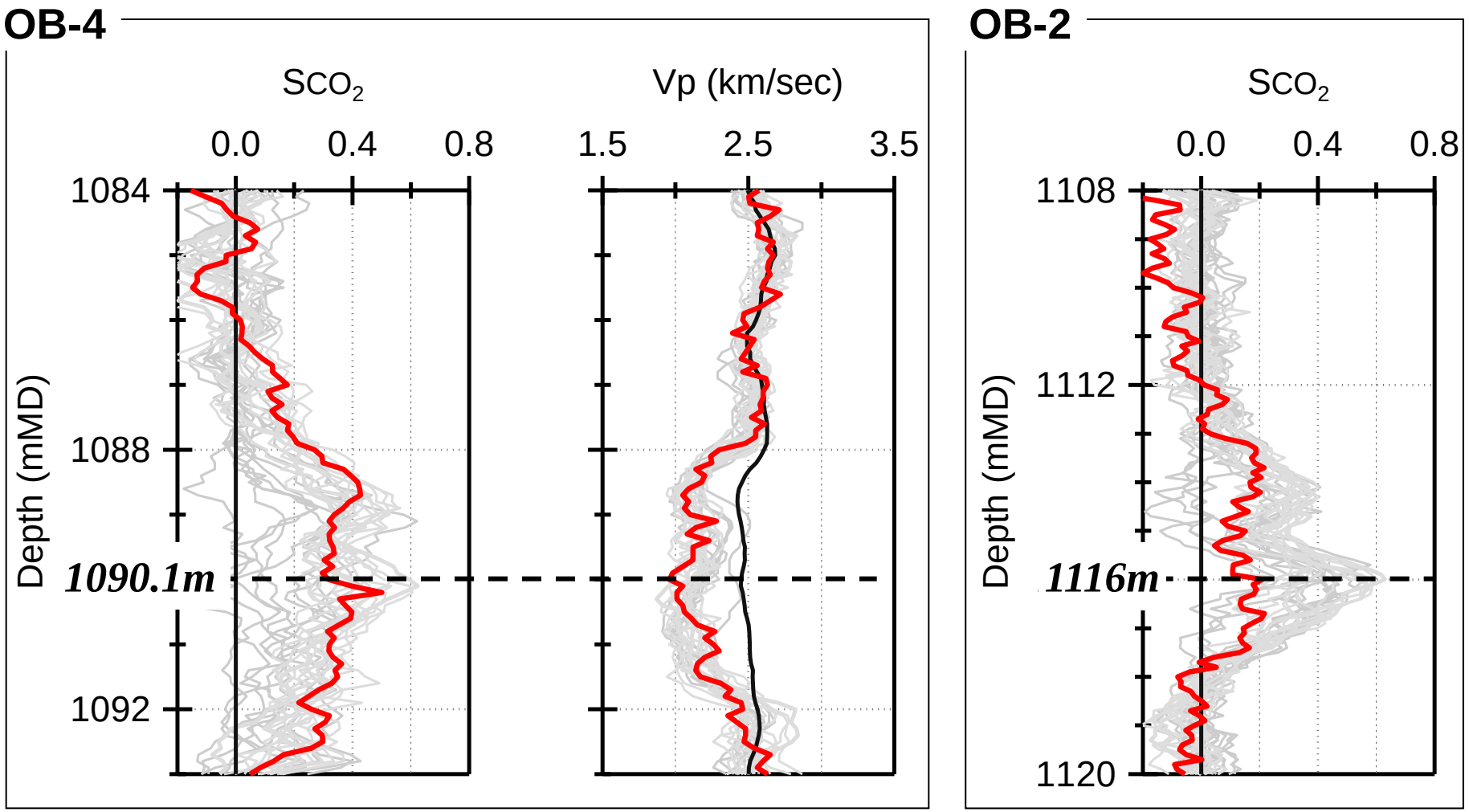


Base line, ave. of 1-13th

Latest, 40th (2011.9)

$S_{CO_2}=(NLP_{BL}-NLP_n)/NLP_{BL}$

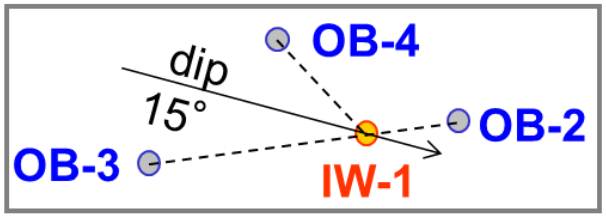
Well logging results at OB-4



Base line, ave. of 1-16th $SCO_2=(NLP_{BL}-NLP_n)/NLP_{BL}$

Latest, 40th (2011.9)

CO_2 Saturation Changes at OB-2 & OB-4



Injection

Post-injection

1116.0m@OB-2

1090.1m@OB-4

Breakthrough

SCO_2

0.8

0.4

0.0

0 1 2 3 4 5 6 7 8 9

Time since injection started (year)

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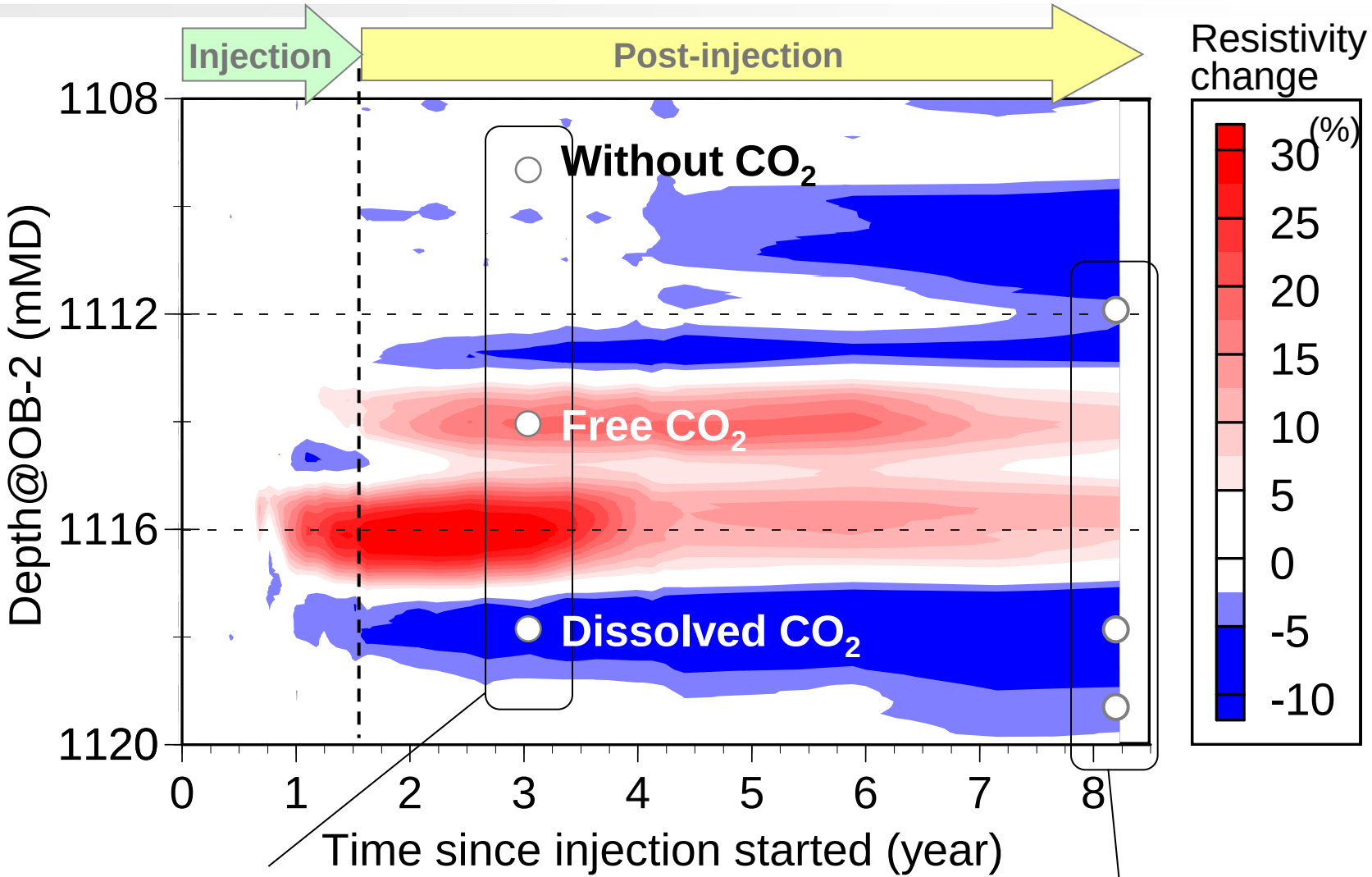
Resistivity Change and Formation Fluid Sampling at OB-2



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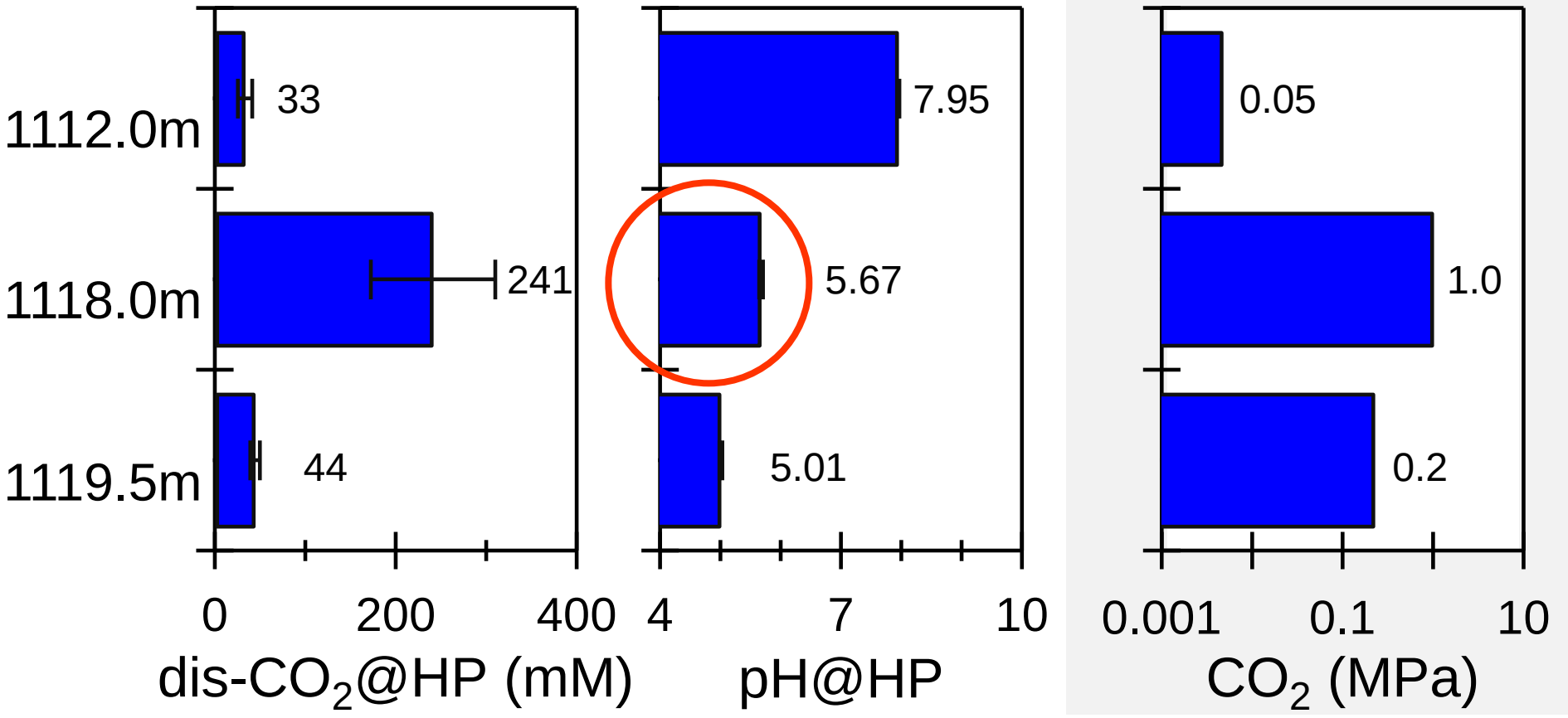
Successful measurement of dis-CO_2 & pH under high pressure condition



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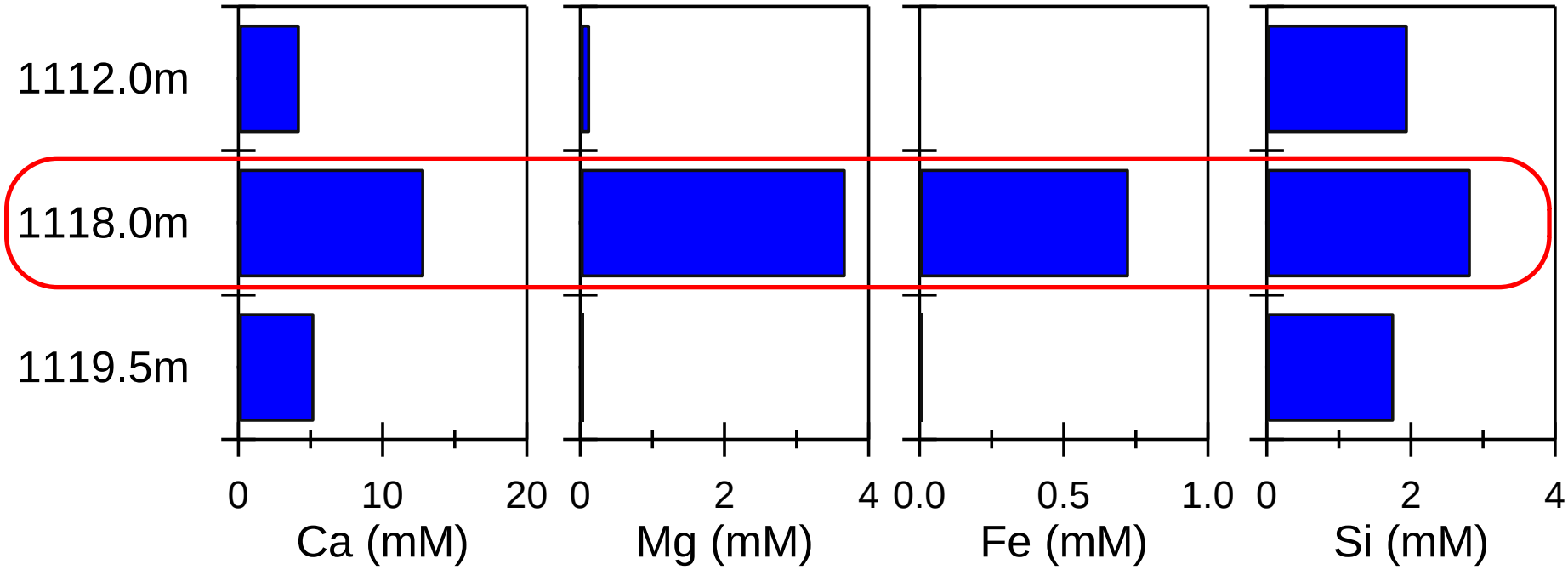
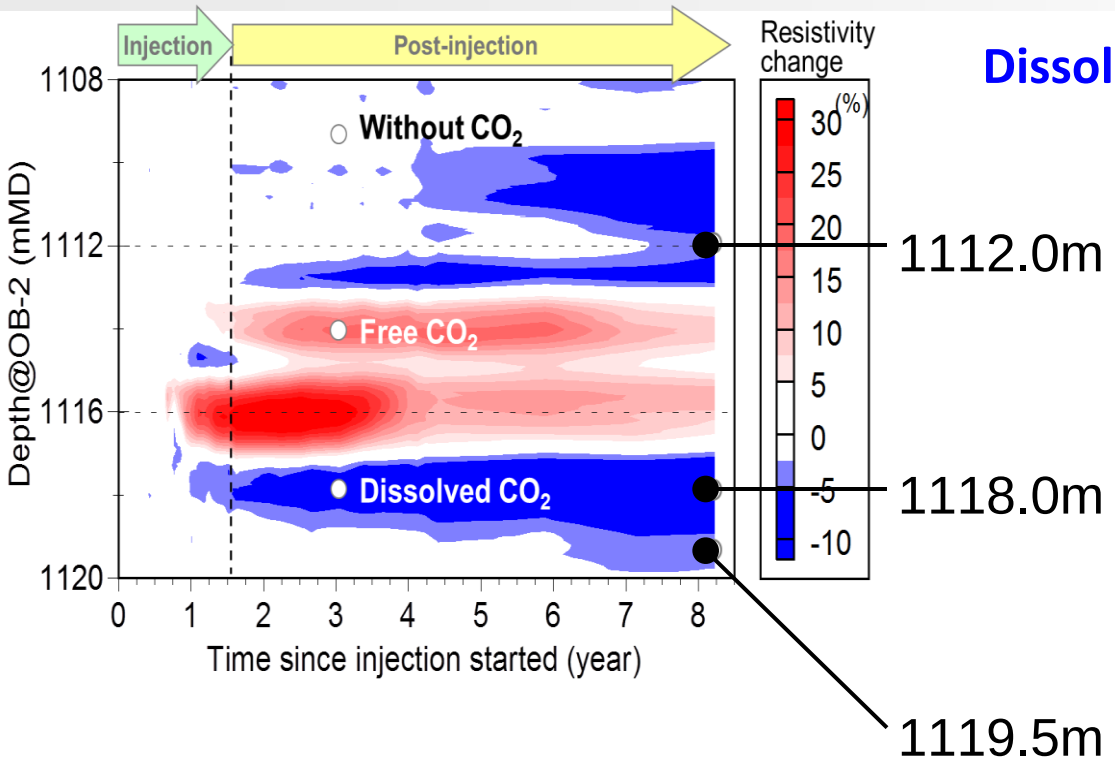
Dissolution of Minerals

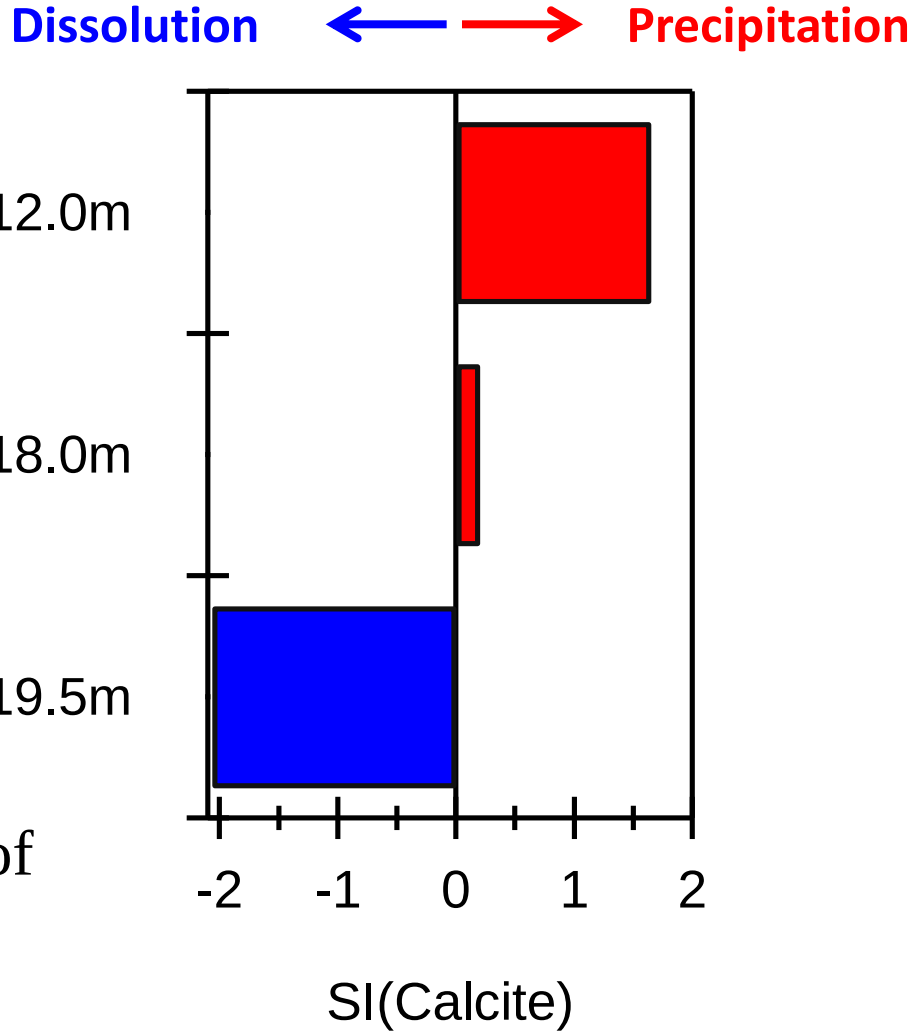


Concentrations of Ca, Mg, Fe and Si in fluid sample at 1118.0m are much higher than other two depths.

→ ***Neutralization of pH by mineral dissolution***

Saturation Index (SI) of Calcite ($CaCO_3$)

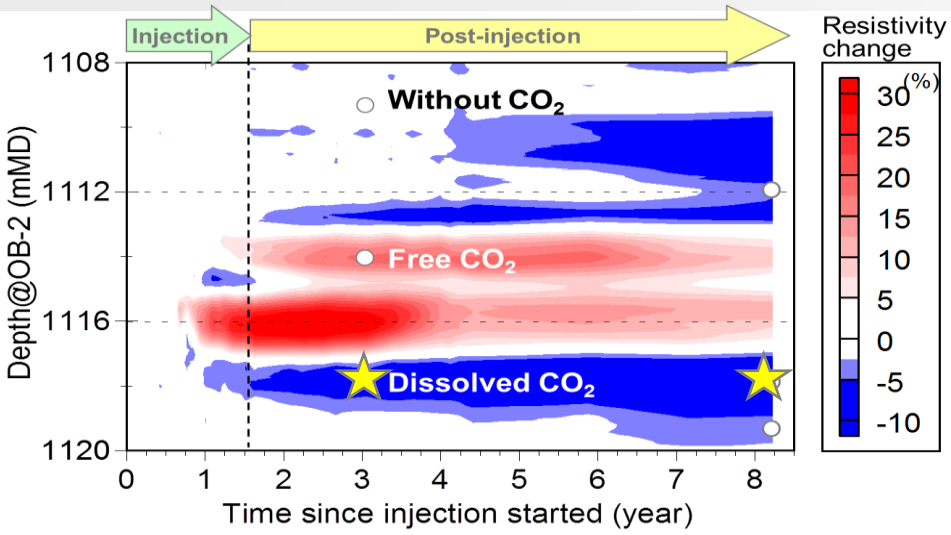


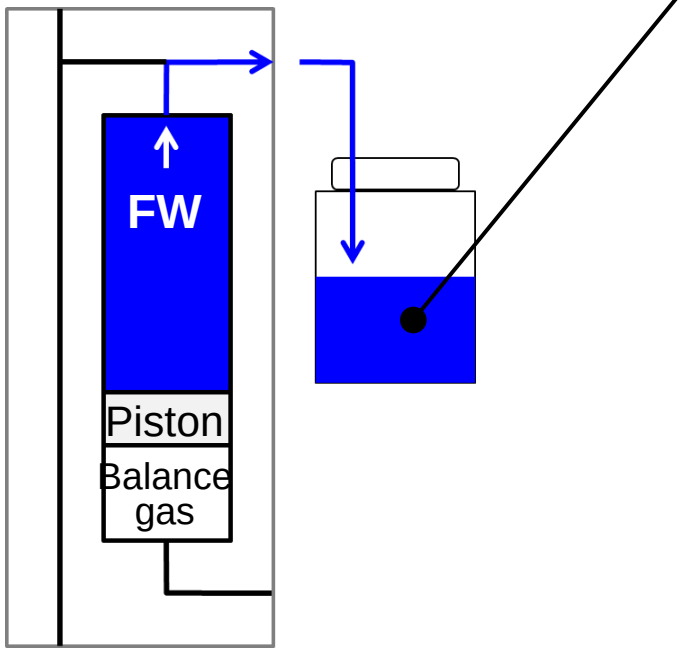


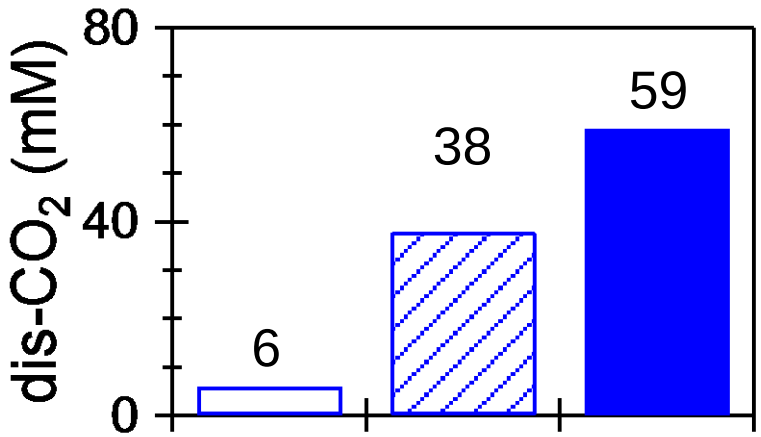
Calcite may have a tendency of reprecipitate at 1118.0m.

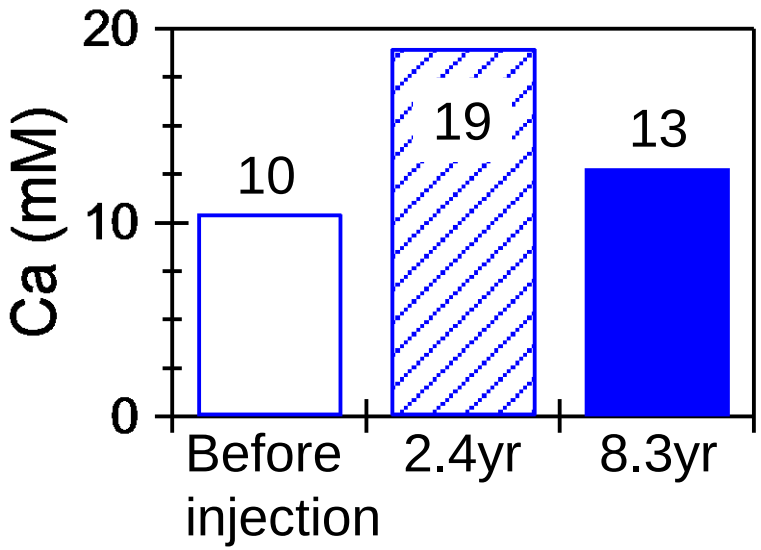
→ ***Mineralization?***

Temporal changes of dis-CO_2 and Ca at 1118.0m (★)









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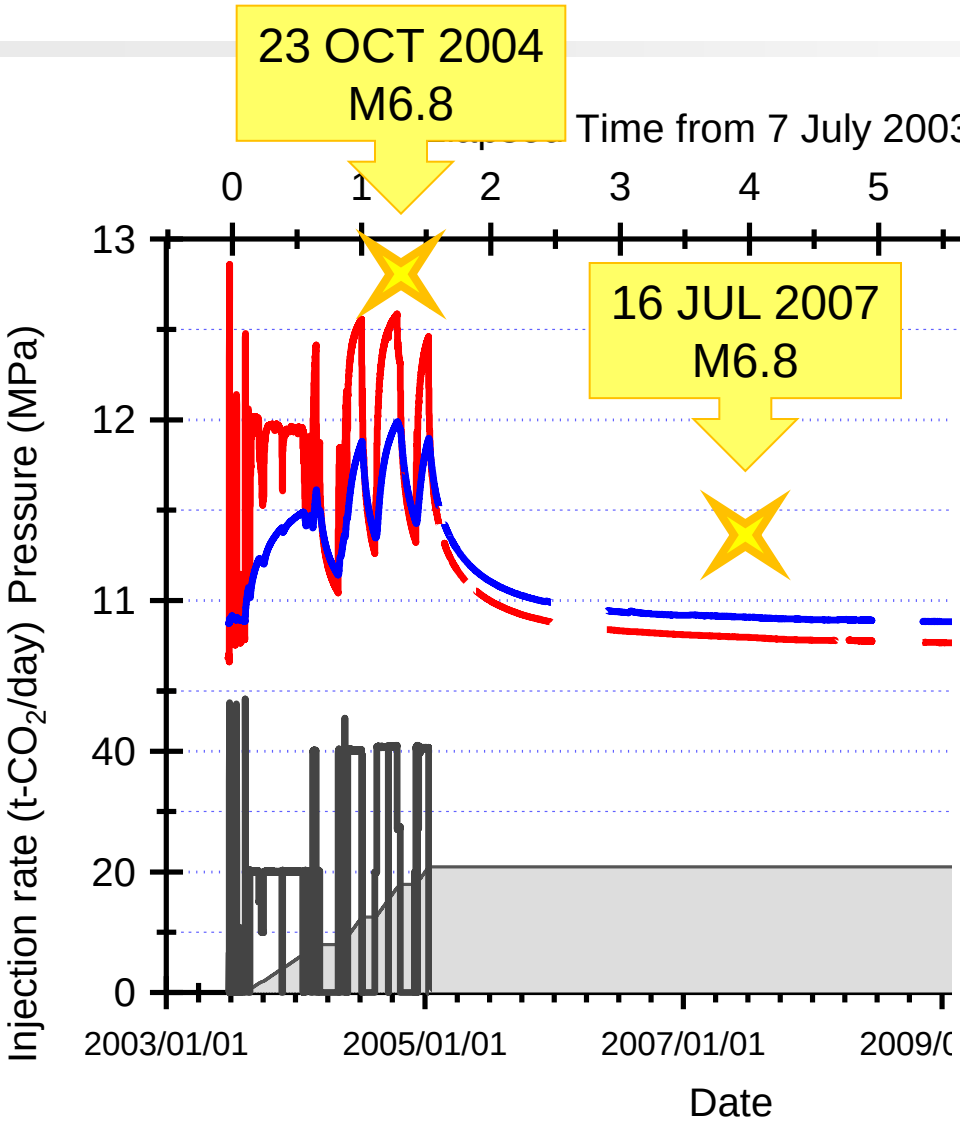
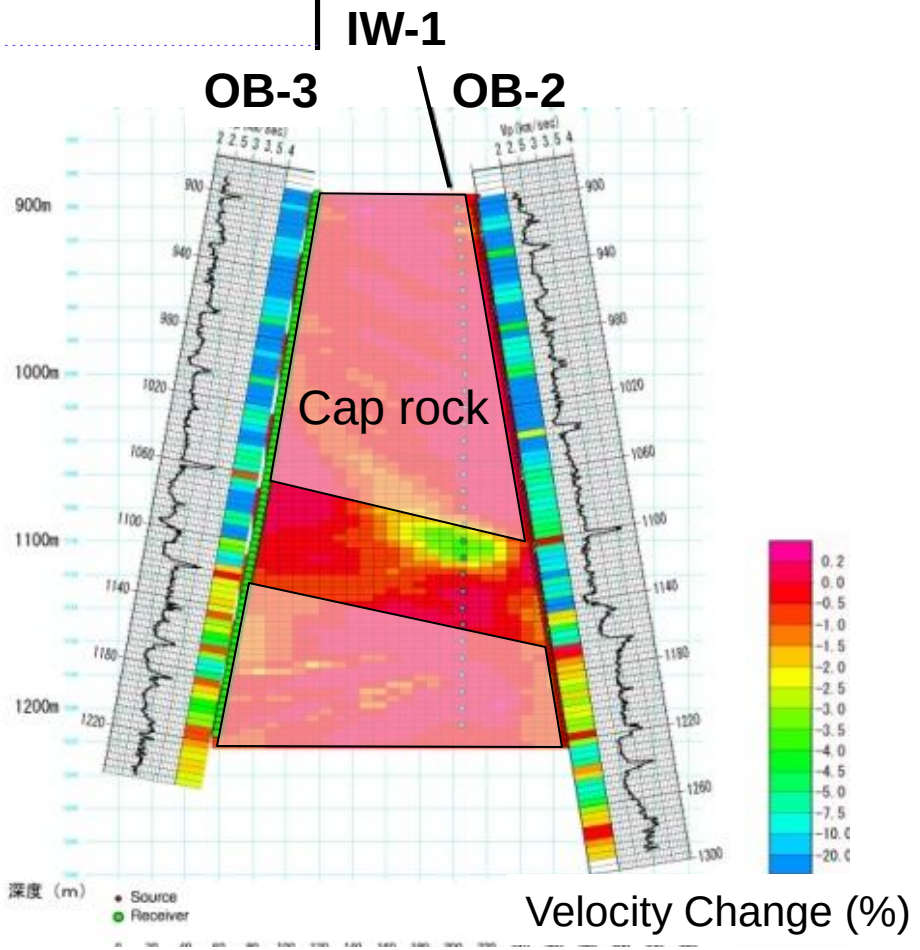
Seismic Tomography confirmed no leakage





Summary of Post-injection Monitoring at Nagaoka

- Well based time-laps monitoring results showed the detailed behavior of injected CO_2.
- The first dataset of residual CO_2 saturation may be obtained from the Nagaoka site.
- Successful water analysis provided concentration of dissolved CO_2 and indicated potential of mineralization.
- Field surveys confirmed safety of CO_2 storage as evidenced by no sign of leakages from the reservoir.

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Toward to Commercial CCS in Japan

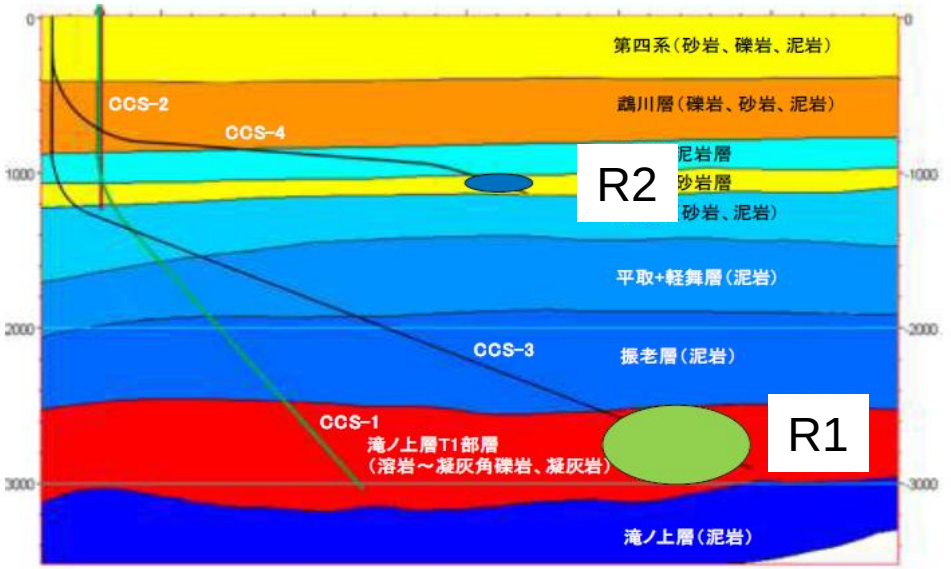
1. Established Japan CCS Co., Ltd as a new undertaker of CCS (2008)
2. Developed Safety Guideline for CCS Demonstrations by Ministry of Economy, Trade and Industry (2009)
3. Revised the Marine Pollution Prevention Law for regulatory framework of sub-seabed storage management by Ministry of the Environment (2007)
4. Demonstrate total system of CCS at an off-shore aquifer, Tomakomai (2012~2021)

Conceptual Plan at Tomakomai

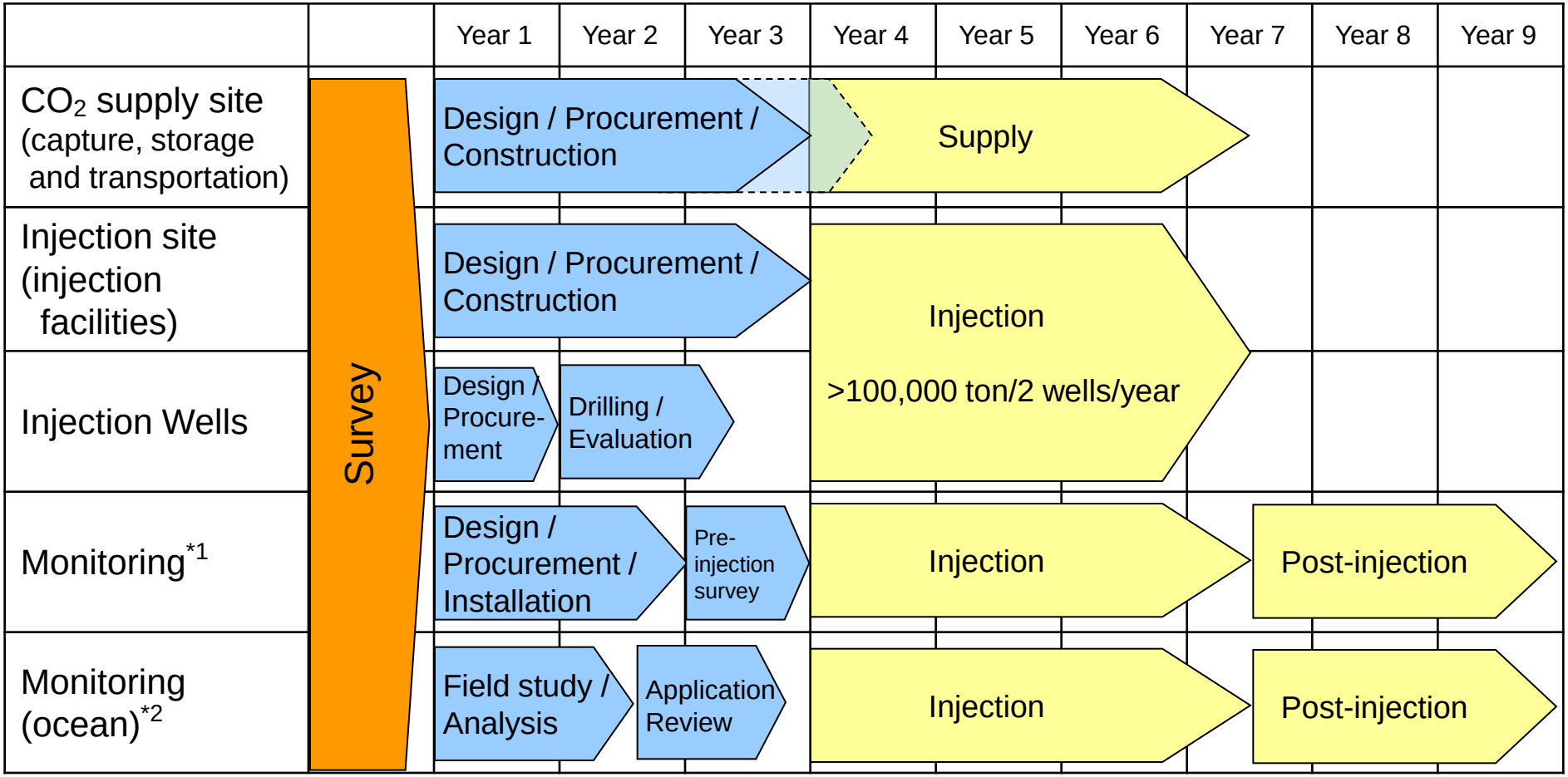
- 1 capture site
  (Oil refinery)
- Transport: pipeline
- 2 injection wells
- 2 monitoring wells
- 2 reservoirs

Reservoir 2
Moebetsu Fm.
(Pleistocene, Sandstone)
Depth: ca.1.1km
Rate: > 50k ton/yr
Max. press: 15MPa

Reservoir 1
Takinoue Fm., T1
(Early Miocene, Tuff)
Depth: ca.2.7km
Rate: > 100k ton/yr
Max. press: 44MPa



Operation schedule



*1: T & P monitoring / 2D & 3D seismic survey / Micro and natural seismicity monitoring by surface facility, wireline sensor, OBC (Ocean Bottom Cable) and OBS (Ocean Bottom Seismometer)

*2: Monitoring of stream regime, water and sediment quality, and marine organisms / Information research of marine usage and ecosystem

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Thank you for your attention!