

Stepping- and Mile-stones of Monitoring at Tomakomai





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Monitoring Techniques at Tomakomai

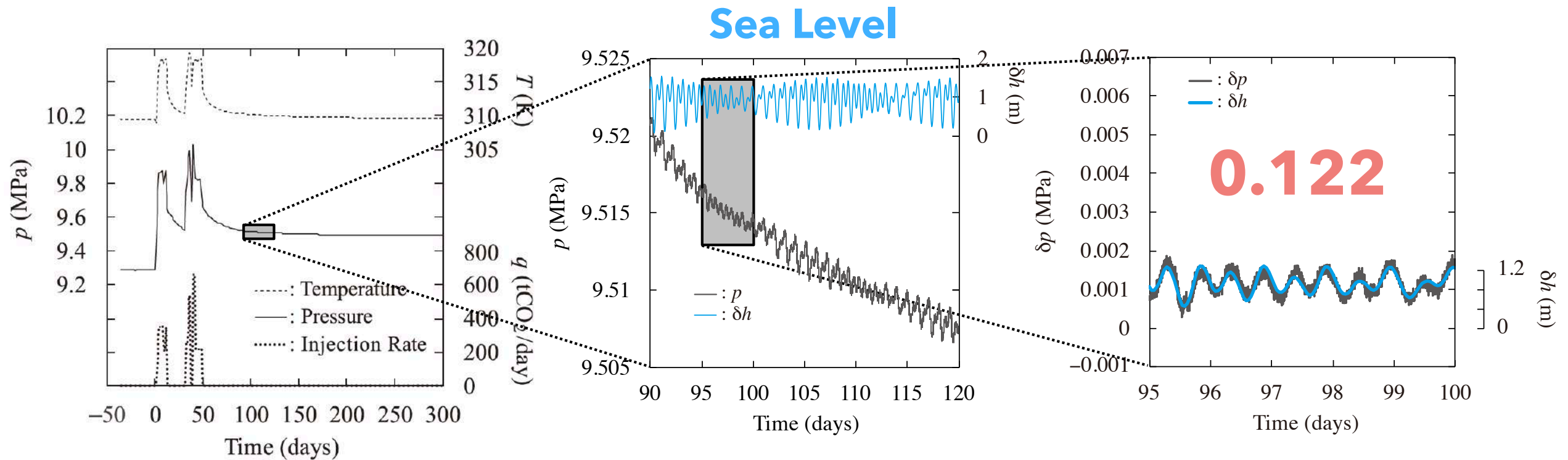
current  **long-term**

Monitoring Purpose	Injection Controls	Containment Assurance	Conformance Assurance	Environmental Impacts
 Downhole Pres./Temp.	A	O	A	
2D/3D Seismic		A	A	
 OBC/OBS	O			A
 Surrounding Seismometry	O			A
 Water Column Chemistry				A

 Deep
 Shallow

 **A** Appropriate
 **O** Occasional

Tidal Signals in Pressure Transients



Resolution: 0.00005% FS

0.00001 MPa (0.00145 psi)

$$R = \frac{1}{\rho_w g} \frac{\delta p}{\delta h}$$

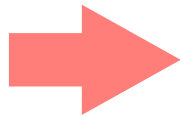
Monitoring Techniques at Tomakomai

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Surrounding Seismometry	O			A
Water Column Chemistry				A

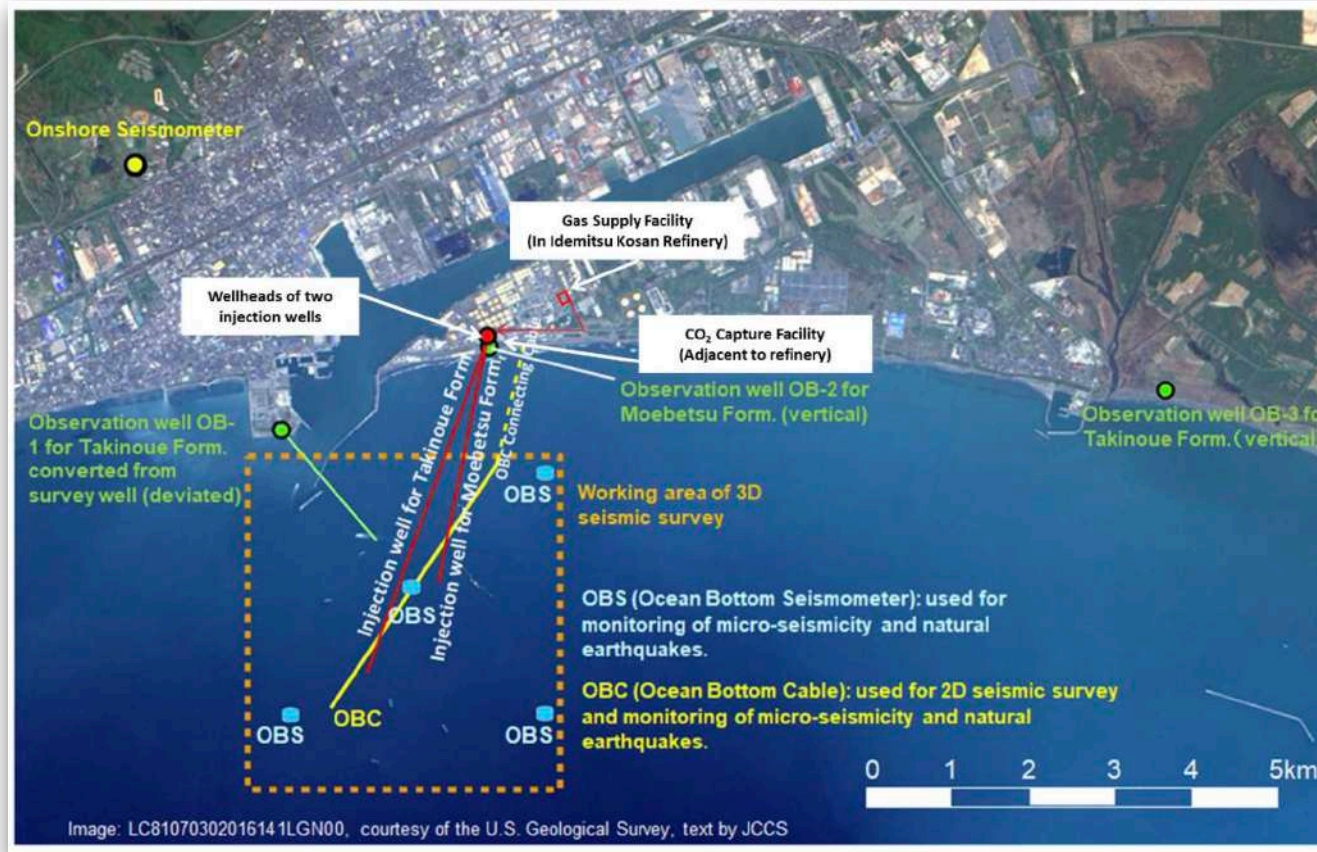


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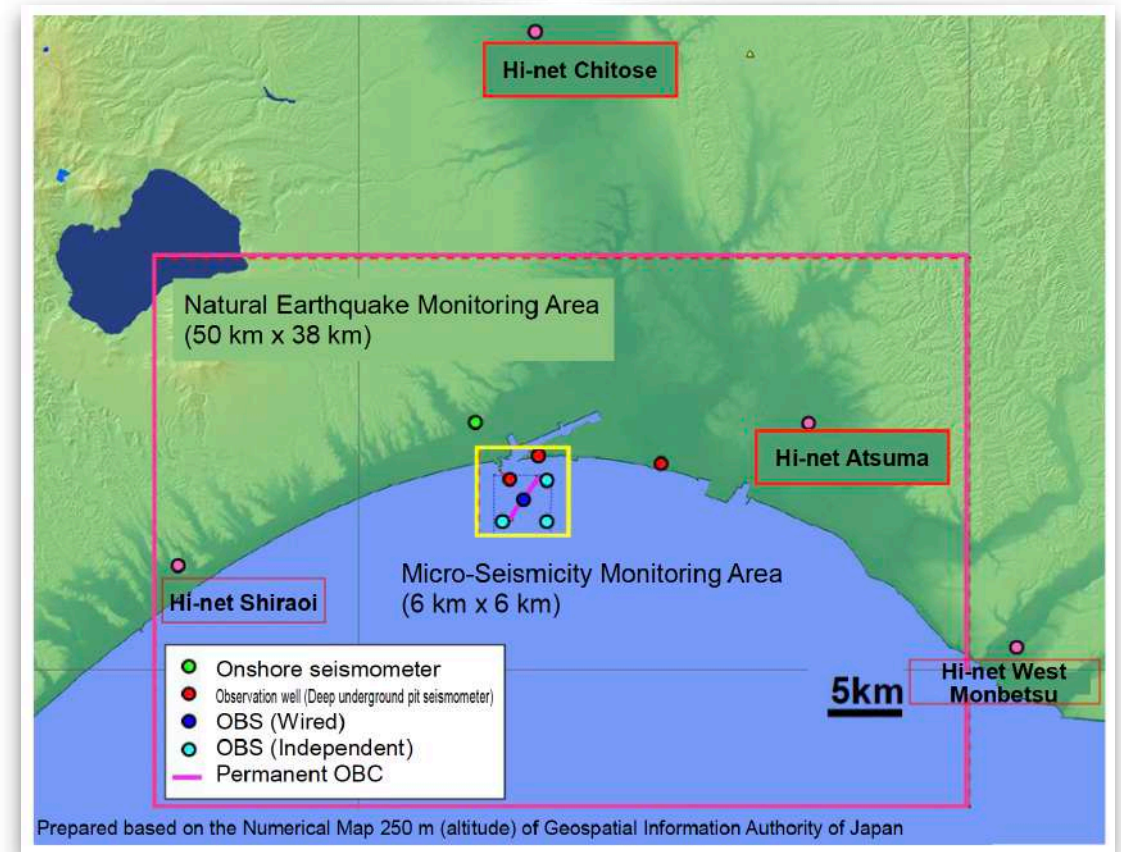
Comprehensive Monitoring of Seismic Activity

OBC (3.6 km)



4 OBS

Surface S. + 4 Hi-net

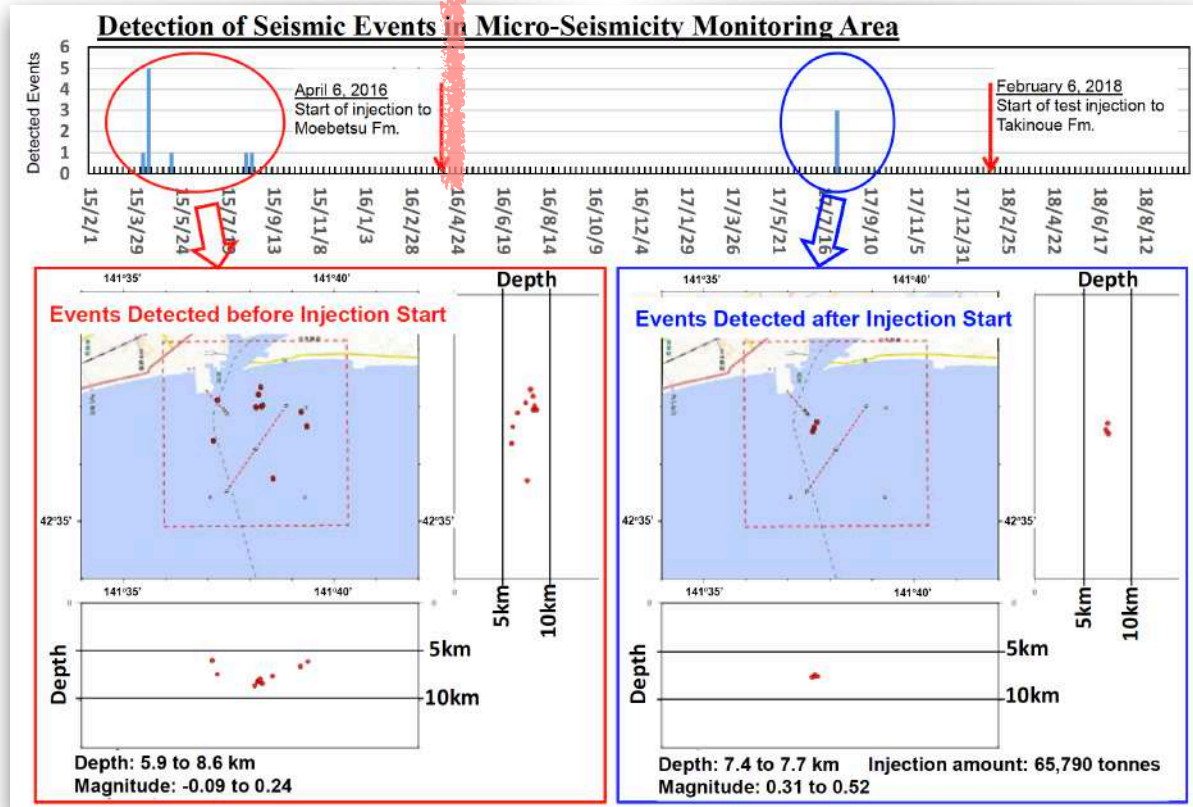


3 Monitoring Wells

(JCCS: Summary Report on Tomakomai CCS Demonstration Project, 2020)

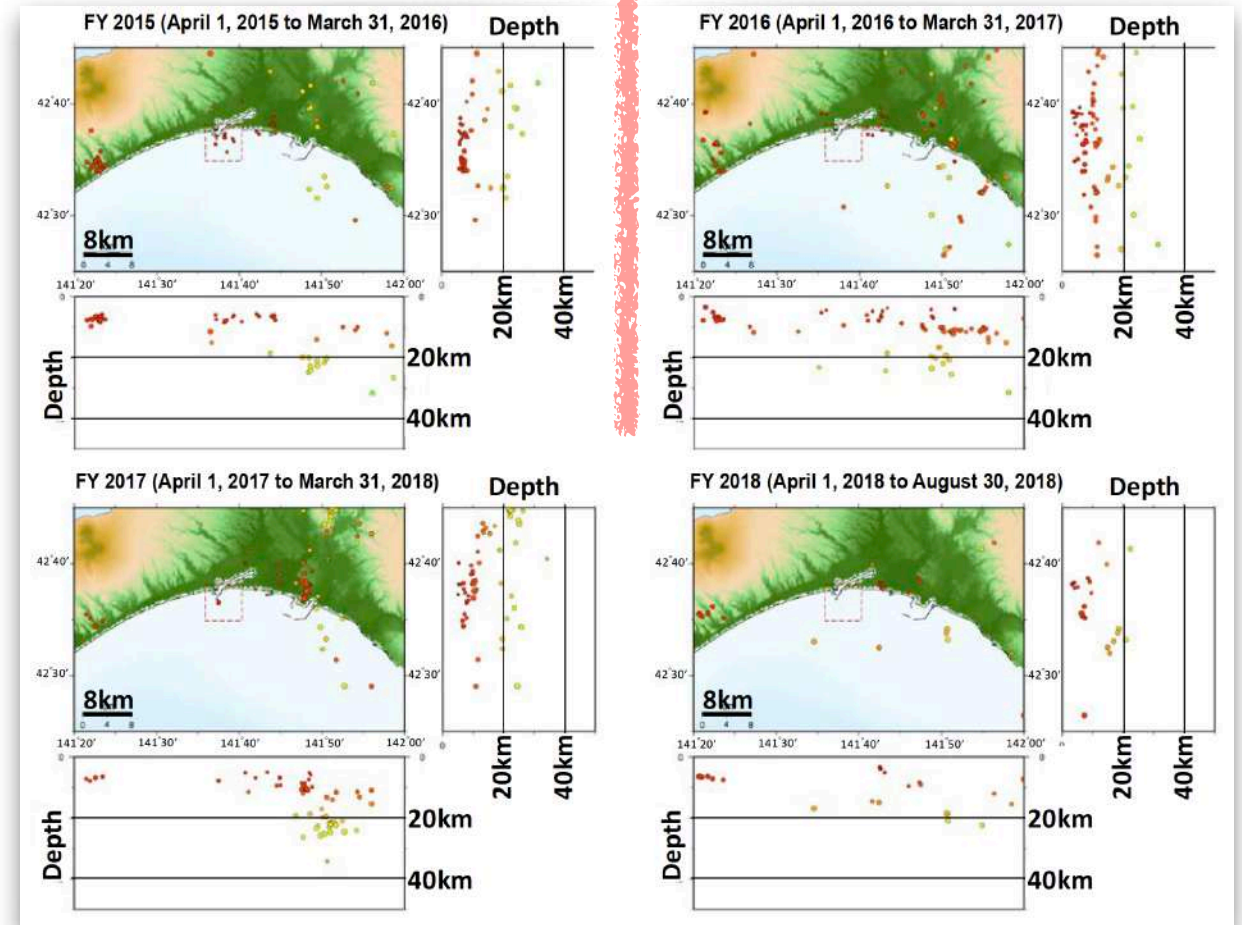
Accumulation of "Defensive" Baselines

9 vs. 3 events



> 6 km


< M 0.52

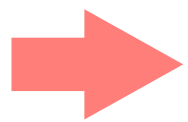


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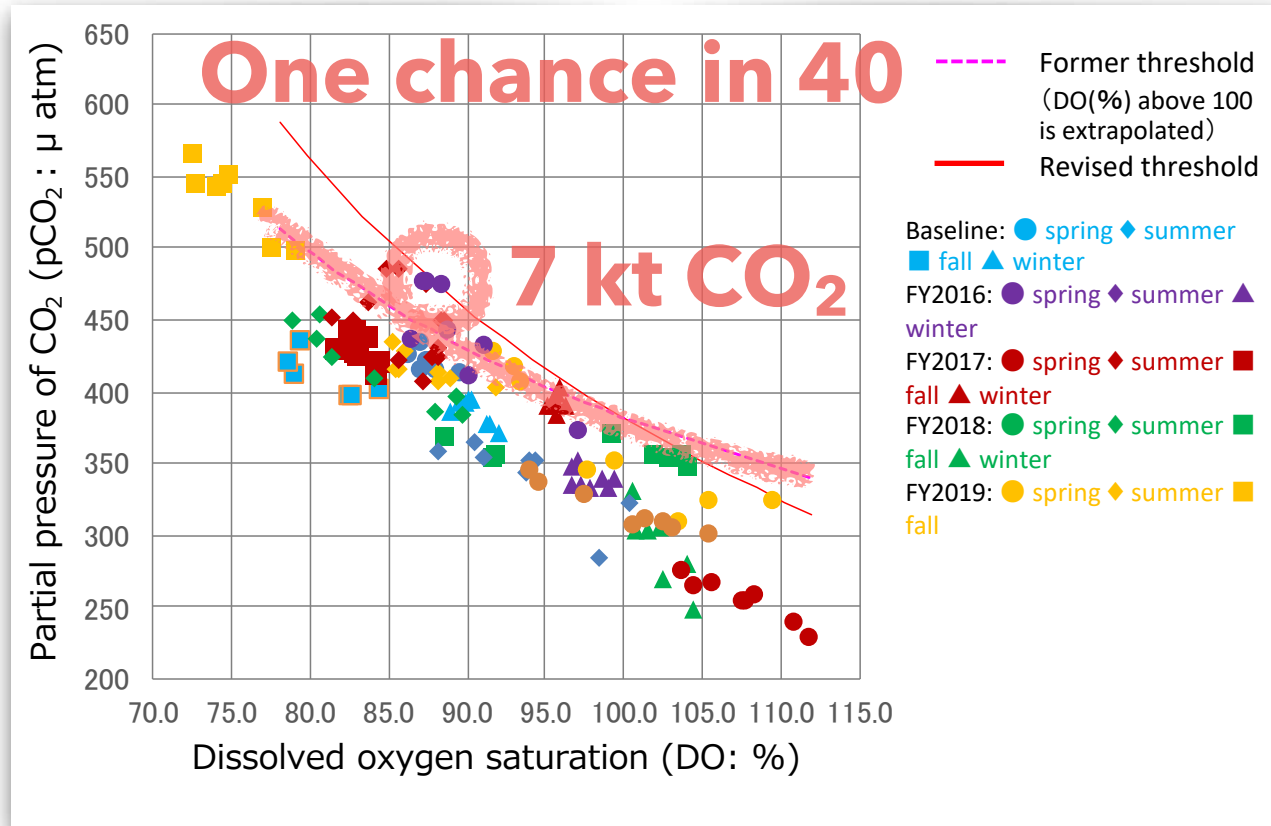


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Shallow Survey for Containment Assurance?

95% Confidence Interval



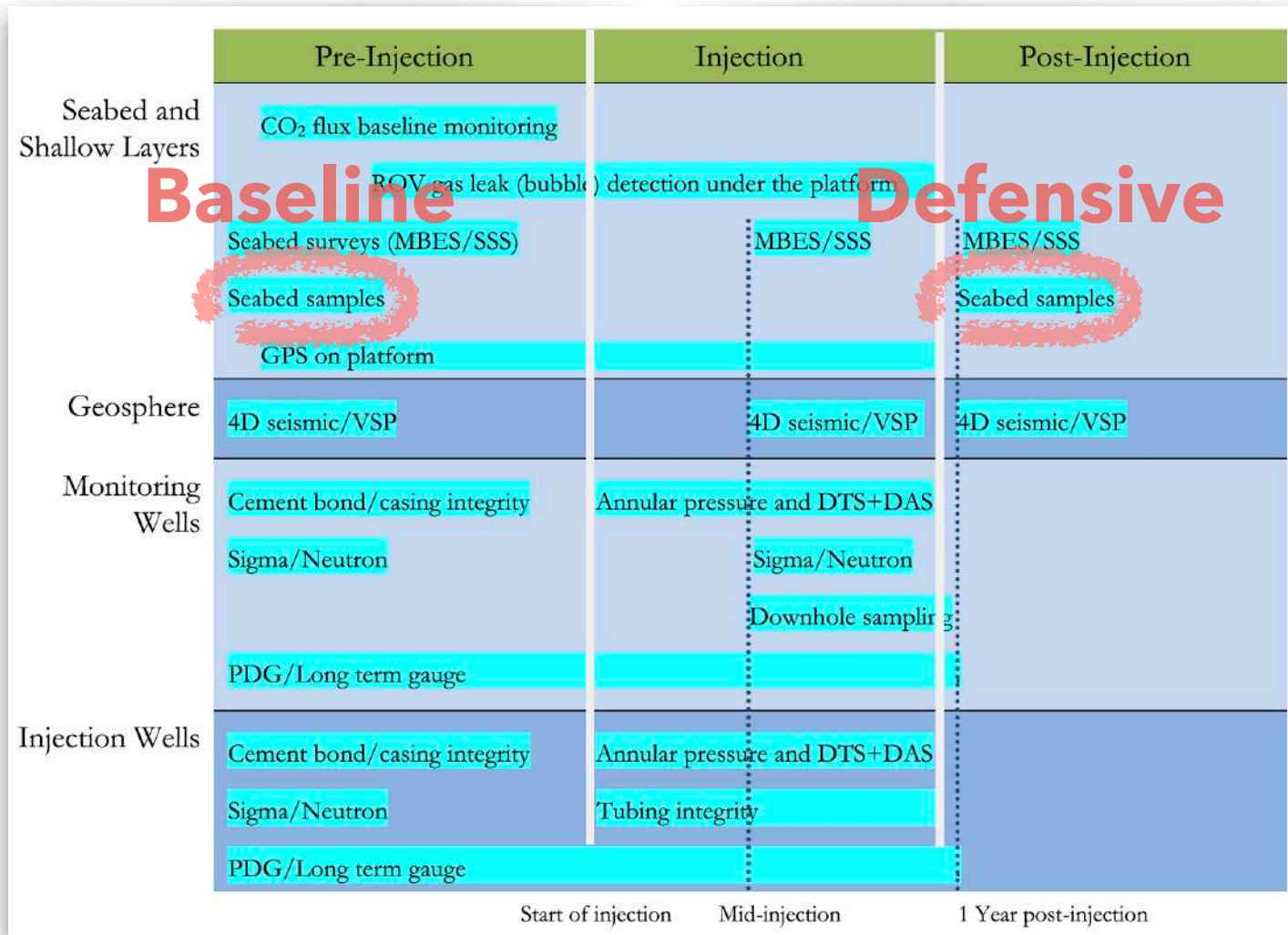
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Project Suspension (6 months) due to False Positive

Shallow properties "are all part of open systems that are perturbed by many more things than containment failure."

M&V Reviewed and Revised: Quest to Peterhead

M&V plan reviewed every 3 years



(Dean and Tucker: IJGGC 61, 2017)

“Measurements intended to detect unlikely hazards were dropped or relegated to backup status.”

“... shallow monitoring should focus mainly on assuring against environmental impacts.”

(Jenkins et al.: IJGGC 40, 2015)

(Jenkins: IJGGC 100, 2020)

Concluding Remarks (1)

- Investigative Data Acquisition
 - ▶ Invariably measured pressure (with high resolution) was successfully used for estimating CO₂ saturation changes through tidal-signal analyses.
 - ▶ Comprehensive monitoring of seismicity provides sufficient evidence to dismiss the causal relationship between the Tomakomai CCS and the 2018 Hokkaido Eastern Iburi earthquake.

Concluding Remarks (2)

- Overuse of Shallow Monitoring
 - ▶ Loose correlation between pCO₂ and DO resulted in false positive and eventually hindered the operation.
 - ▶ A well-defined issue “containment” needs to be distinguished from vague concerns “environmental impact.”

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