CCS Technical Workshop 2025

カーボンニュートラル実現に向けての
CO_2地中貯留技術の社会実装

The Technologies We Have and Innovations We Need in CO_2 Storage

二酸化炭素地中貯留技術研究組合 技術部長
Geological Carbon Dioxide Storage Technology Research Association

公益財団法人 地球環境産業技術研究機構（RITE）
CO_2貯留研究グループリーダー

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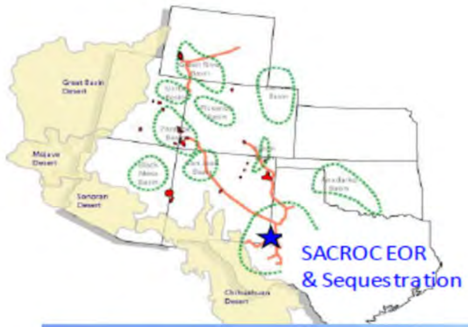
RITE
Research Institute of Innovative Technology for the Earth

温故知新–CO_2-EOR/ CO_2地中貯留

Before Looking Ahead, Let's Review the Journey so far



Enhanced Oil Recovery - US *(DOE, 2020)*

- First US patent for CO_2 EOR issued in 1952
- First field test in 1964
- First commercial project (SACROC) in 1972

実用化？

Sleipner Project- Norway

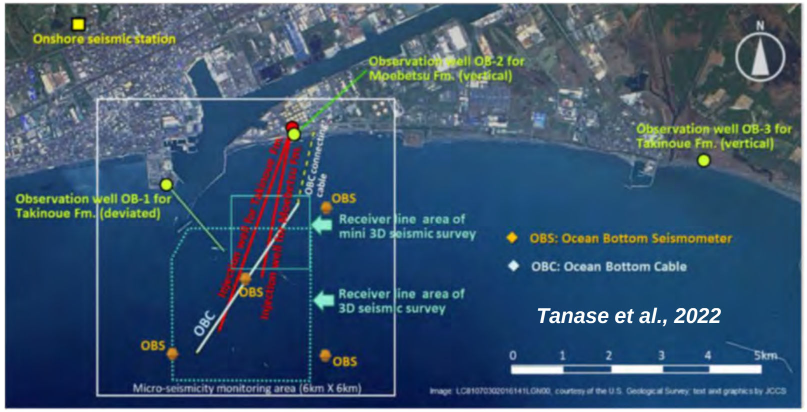
- CO_2 removed from natural gas produced on production platform in North Sea
- Injection into saline reservoir under sea
- Started 1996

圧入規模：100万トン/年

Weyburn – Saskatchewan

- EOR project with 50 wells
- Uses CO_2 from coal gasification plant
- Started 2000

Pilot-scale Projects in 2000s： 日本： 長岡CO2圧入実証プロジェクト始動　米国： テキサスFrioプロジェクト始動

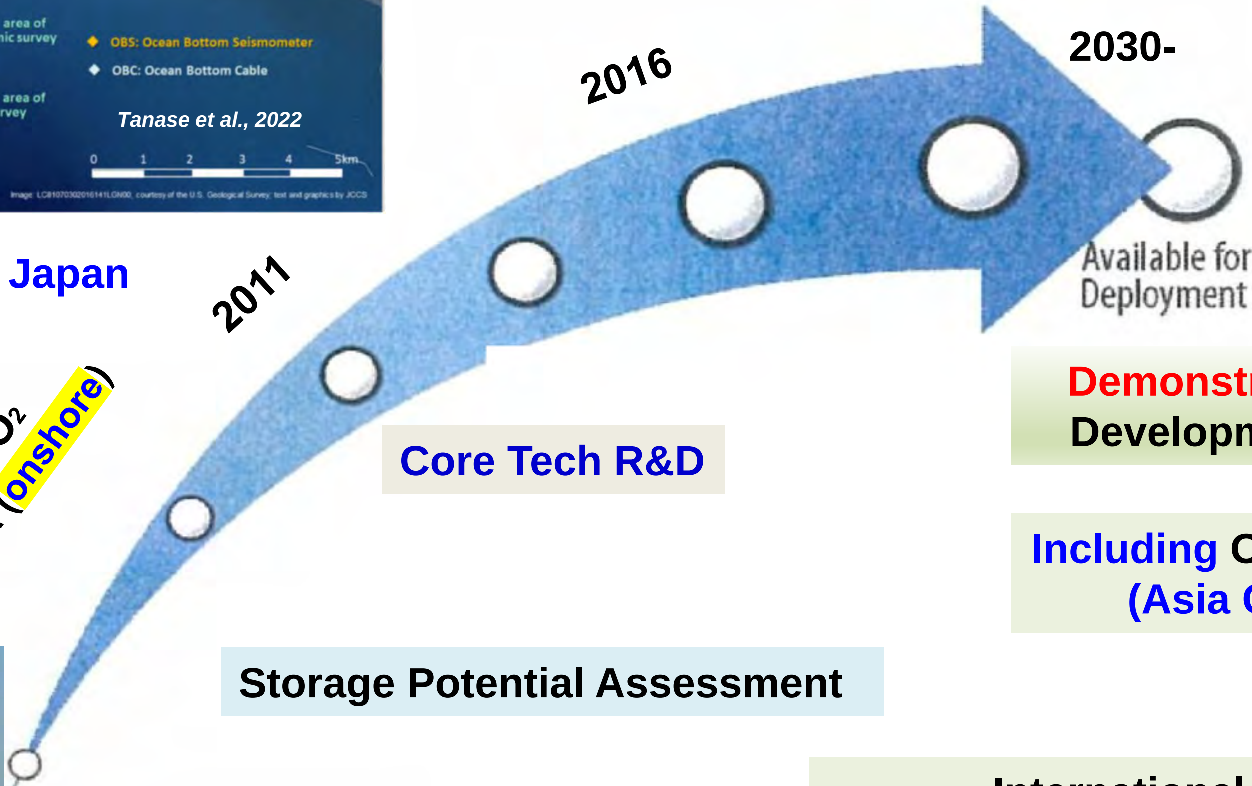


CCUS Activities in Japan

300kt-CO_2
Tomakomai (offshore)

Scaling up to Commercial (1Mt-CO_2/y)

2030-



2016

2011

10kt-CO_2
Nagaoka (onshore)

2000

Demonstrating core tech for Development & Deployment

Core Tech R&D

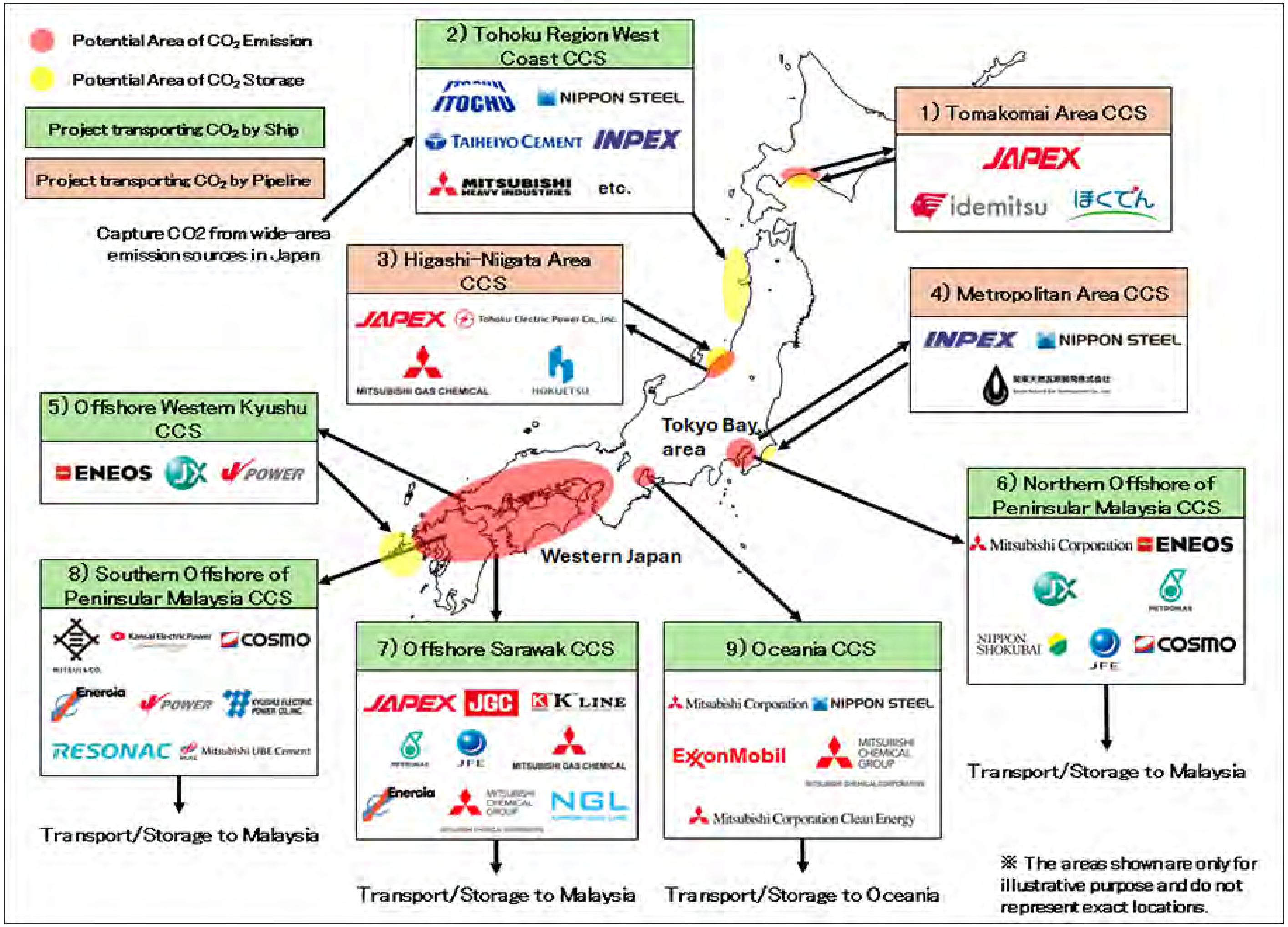
Including Overseas Deployment (Asia CCUS Network)

Storage Potential Assessment

Fundamental Research

International Collaborations (USA, Australia, Canada, Norway, Indonesia, Malaysia)

Advanced Efforts for Commercialization of CCS
- Nine projects Awarded as Japanese Advanced CCS Projects in 2024 -



https://www.jogmec.go.jp/english/news/release/news_10_00072.html

Final Investment Decisions (FID) by FY2026, to achieve Japanese government target of 6 to 12 Mtpa of CO_2 storage by 2030.

If cost issues lie with capture, risk issues lie with storage.

Questions about Scale-up, Social License, Business models for Commercialization of CCS in Japan.

（参考）二酸化炭素の貯留事業に関する法律【CCS事業法】の概要

令和６年５月成立

背景・法律の概要

- ✓ **2050年カーボンニュートラル**に向けて、今後、脱炭素化が難しい分野におけるGXを実現することが課題。こうした分野における**化石燃料・原料の利用後の脱炭素化を進める手段**として、CO2を回収して地下に貯留する**CCS**（Carbon dioxide Capture and Storage）**の導入が不可欠**。
- ✓ **我が国としては、2030年までに民間事業者がCCS事業を開始するための事業環境を整備**することとしており（GX推進戦略　2023年7月閣議決定）、公共の安全を維持し、海洋環境の保全を図りつつ、その事業環境を整備するために必要な**貯留事業等の許可制度等を整備**する。

１．試掘・貯留事業の許可制度の創設、貯留事業に係る事業規制・保安規制の整備

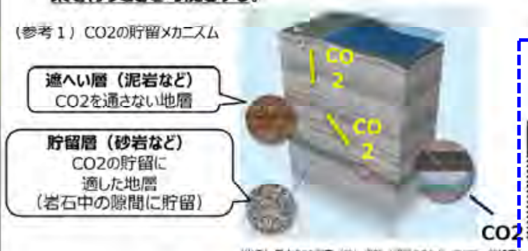
（１）試掘・貯留事業の許可制度の創設

- **経済産業大臣は**、貯留層が存在する可能性がある区域を「**特定区域**」として**指定**※した上で、特定区域において**試掘やCO2の貯留事業**を行う者を**募集**し、これらを**最も適切に行うことができると認められる者**に対して、**許可**※を与える。

※　海域における特定区域の指定及び貯留事業の許可に当たっては環境大臣に協議し、その同意を得ることとする。

- 上記の許可を受けた者に、**試掘権**（貯留層に該当するかどうかを確認するために地層を掘削する権利）や**貯留権**（貯留層にCO2を貯留する権利）を**設定**する。CO2の安定的な貯留を確保するための、**試掘権・貯留権は「みなし物権」**とする。
- **鉱業法に基づく採掘権者**は、上記の**特定区域以外の区域（鉱区）**でも、経済産業大臣の許可を受けて、**試掘や貯留事業を行うことを可能とする**。

（参考１）CO2の貯留メカニズム



（出典）日本CCS調査（株）資料（資源エネルギー庁にて一部加工）

（２）貯留事業者に対する規制

- **試掘や貯留事業の具体的な「実施計画」**は、**経済産業大臣（※）の認可制**とする。

※　海域における貯留事業の場合は、経済産業大臣及び環境大臣

- 貯蔵したCO2の漏えいの有無等を確認するため、**貯留層の温度・圧力等のモニタリング義務**を課す。
- **CO2の注入停止後に行うモニタリング業務等に必要な資金**を確保するため、**引当金の積立て等**を義務付ける。
- 貯留した**CO2の挙動が安定**しているなどの要件を満たす場合には、**モニタリング等の貯留事業場の管理業務をJOGMEC**（独法エネルギー・金属鉱物資源機構）**に移管**することを可能とする。また、**移管後のJOGMECの業務に必要な資金**を確保するため、貯留事業者に対して**拠出金の納付**を義務付ける。
- 正当な理由なく、**CO2排出者からの貯留依頼を拒むこと**や、**特定のCO2排出者を差別的に取扱うこと**等を禁止するとともに、**料金等の届出義務**を課す。
- **技術基準適合義務、工事計画届出、保安規程の策定**等の**保安規制**を課す。
- 試掘や貯留事業に起因する**賠償責任**は、被害者救済の観点から、**事業者の故意・過失によらない賠償責任（無過失責任）**とする。

（参考２）貯留事業に関するフロー

	実施計画認可	CO2注入停止	業務移管
操業前	操業中	CO2の注入停止後	移管後
国の取組	貯留事業者の義務		JOGMECの業務
●特定区域の指定 ●事業者の募集 ●試掘・貯留事業の許可（試掘権・貯留権の設定）　等	●モニタリング義務 ●貯留義務、差別的取扱い禁止、料金届出 ●モニタリング引当金等による資金確保 ●移管後モニタリング拠出金（JOGMECに拠出）　等	●モニタリング義務　等 引当金等を取崩し	●モニタリング義務　等 業務遂行のための費用は拠出金から支弁

２．CO2の導管輸送事業に係る事業規制・保安規制の整備

（１）導管輸送事業の届出制度の創設

- CO2を貯留層に貯留することを目的として、**CO2を導管で輸送する者は**、**経済産業大臣に届け出なければならない**ものとする。

（２）導管輸送事業者に対する規制

- 正当な理由なく、**CO2排出者からの輸送依頼を拒むこと**や、**特定のCO2排出者を差別的に取扱うこと**等を禁止するとともに、**料金等の届出義務**を課す。
- **技術基準適合義務、工事計画届出、保安規程の策定**等の**保安規制**を課す。

※海洋汚染防止法におけるCO2の海底下廃棄に係る許可制度は、本法律に一元化した上で、海洋環境の保全の観点から必要な対応について環境大臣が共管する。

先進CCS事業
CCS事業法成立
改正ロンドン議定書受諾承認
→ 支援制度のあり方検討
→ 2026年頃　最終投資決定（FID）
→ 2030年　CCS事業開始
→ ~2040年　CCS事業の本格展開期

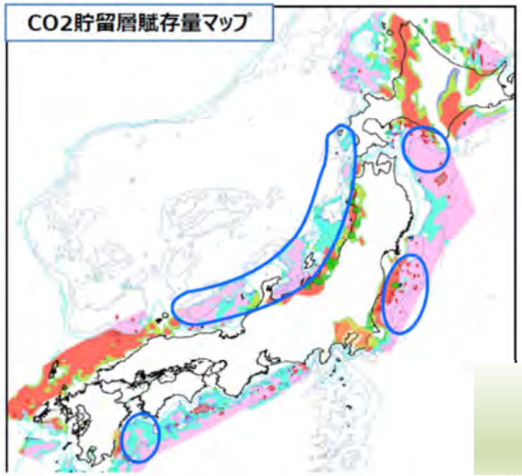
＜試掘許可の手続フロー＞

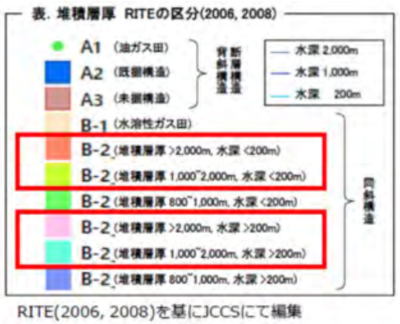
- 国の発案 ／ 事業者の提案（法第11条）
- ↓ 有識者からの助言聴取
- ↓ 経済産業大臣による特定区域の指定（法第３条第1項）
- ↓ 事業者の公募（法第３条第８項）
- ↓ 事業者からの申請（法第４条第１項）
- ↓ 有識者からの助言聴取
- ↓ 試掘者の選定（法第５条第１項・第２項）
- ↓ 関係都道府県知事協議・公衆縦覧（法第６条～第8条）
- ↓ 試掘の許可（法第5条第４項）

Storing CO_2 in Saline Aquifers (1/2)

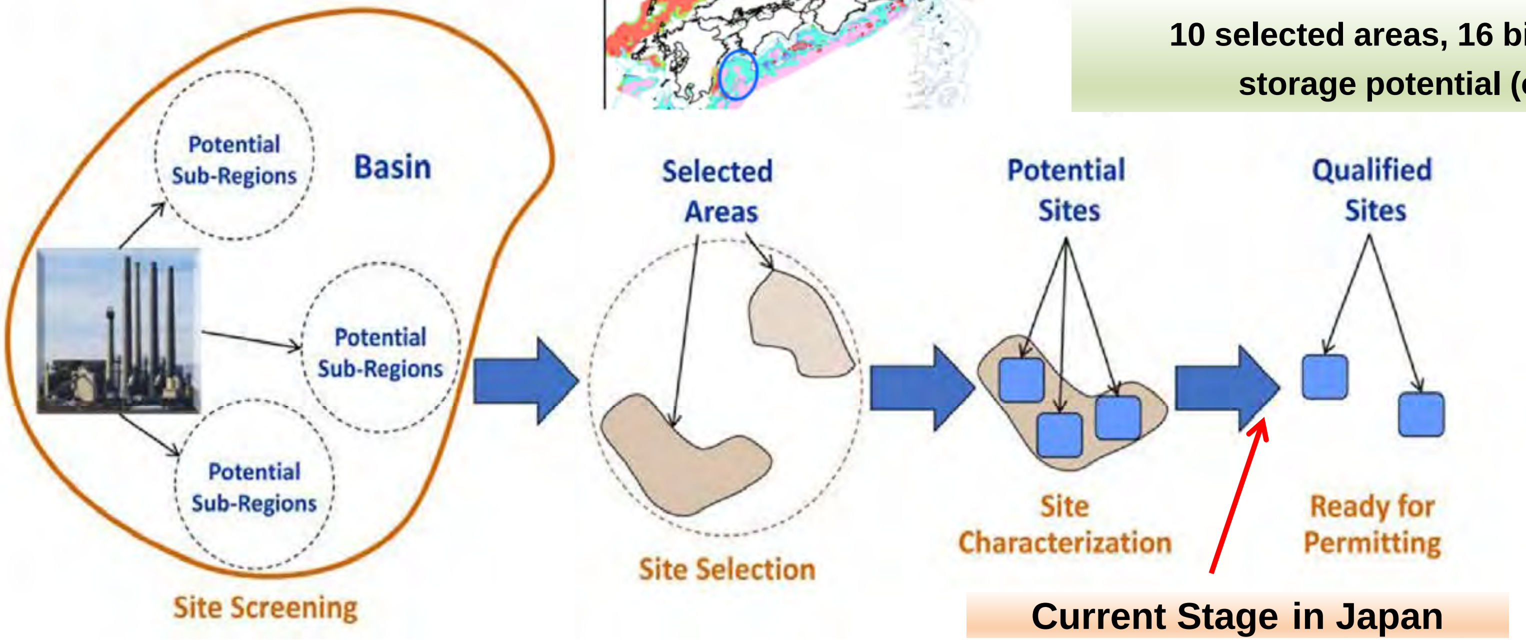
***Major Steps** in Process of **Finding** and **Developing** Qualified Sites*

NETL, 2007





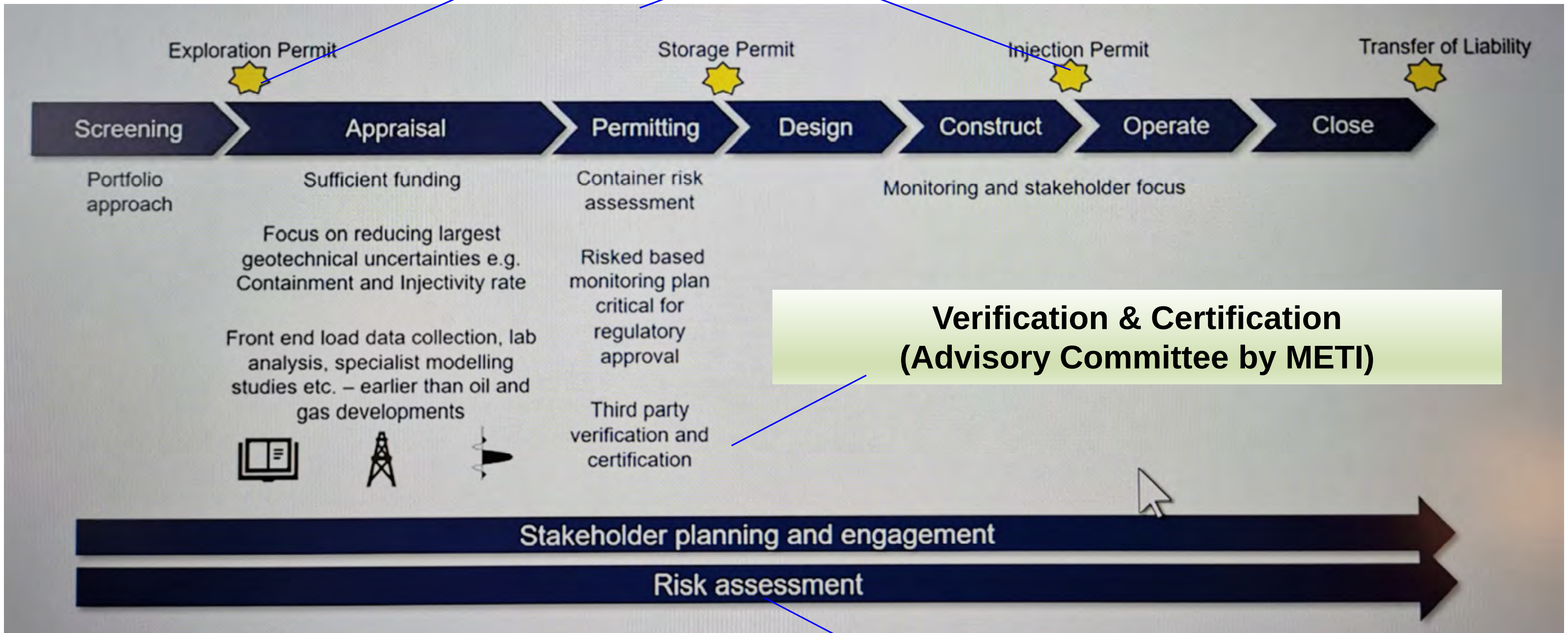
10 selected areas, 16 billion ton-CO_2 storage potential (offshore)



Current Stage in Japan

Storing CO_2 in Saline Aquifers (2/2)

Permits (by Japanese Government, METI)



Verification & Certification (Advisory Committee by METI)

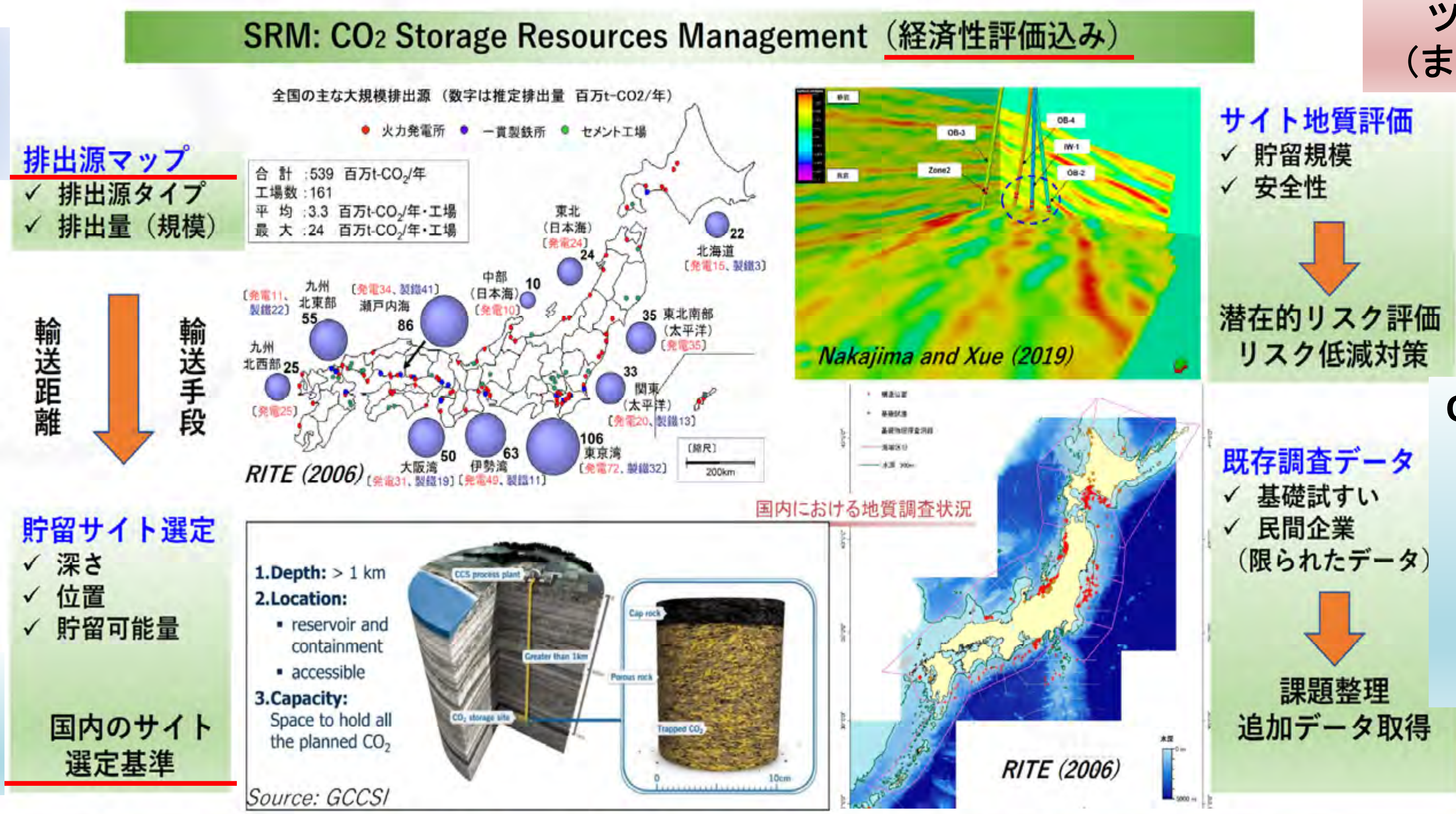
Community Concern, Risk Communication →→ Public Support

複数の実想定サイトを選定し、事業開発シナリオを検討してきた！

2021-2023年度のNEDO事業（技術研究組合）

CCSコスト試算ツール作成（まもなく公開）

排出源データベース作成（公開中）



苫小牧事業事例分析中（技組-JCCS連携）

CCS技術事例集（作成・公開中）

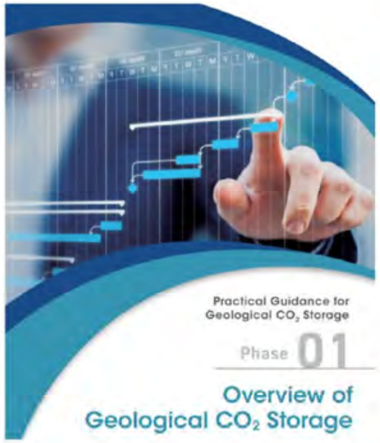
国内外の地中貯留事業の事例分析
技術的総括

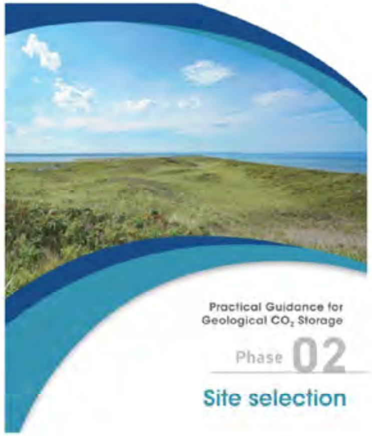
ポスター展示中

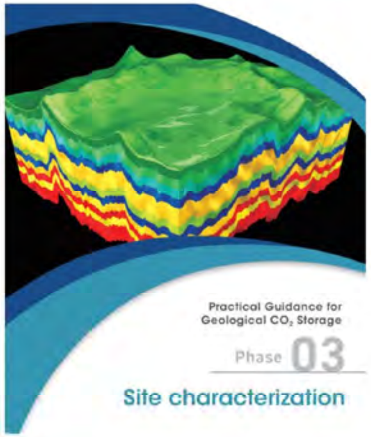
貯留可能量、排出源（排出量、距離）、輸送手段、貯留規模、経済性、社会的受容性（SLO）、複数の実想定サイトを選定！

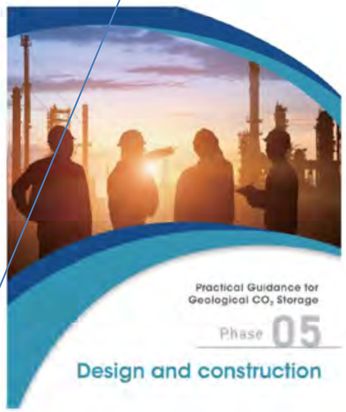
Geological Carbon Dioxide Storage Technology Research Association

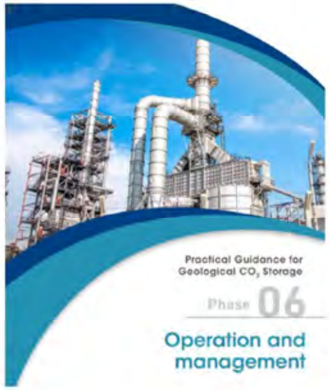
Practical Guidance for Geological CO_2 Storage











日本語版・英語版
（**download free**）

想定読者：

- CO_2地中貯留事業者（経営層、技術者）
  - 行政機関（推進や規制、地方自治体）
    - 地元関係者（住民、漁協）や環境保護団体
- 銀行・保険会社（投融資、事業保険）
- 認証機関（排出権取引）
- 海外事業（日本企業の海外進出、日本技術の海外展開）

対象範囲

輸送の一部（圧入サイト内）と、地下でのCO2貯留が対象

作成方針

長岡実証試験（陸域）、苫小牧大規模実証試験（海域）、海外の大規模圧入プロジェクトの知見を取り入れ、日本の地質的・社会的事情に適した事例集を作成

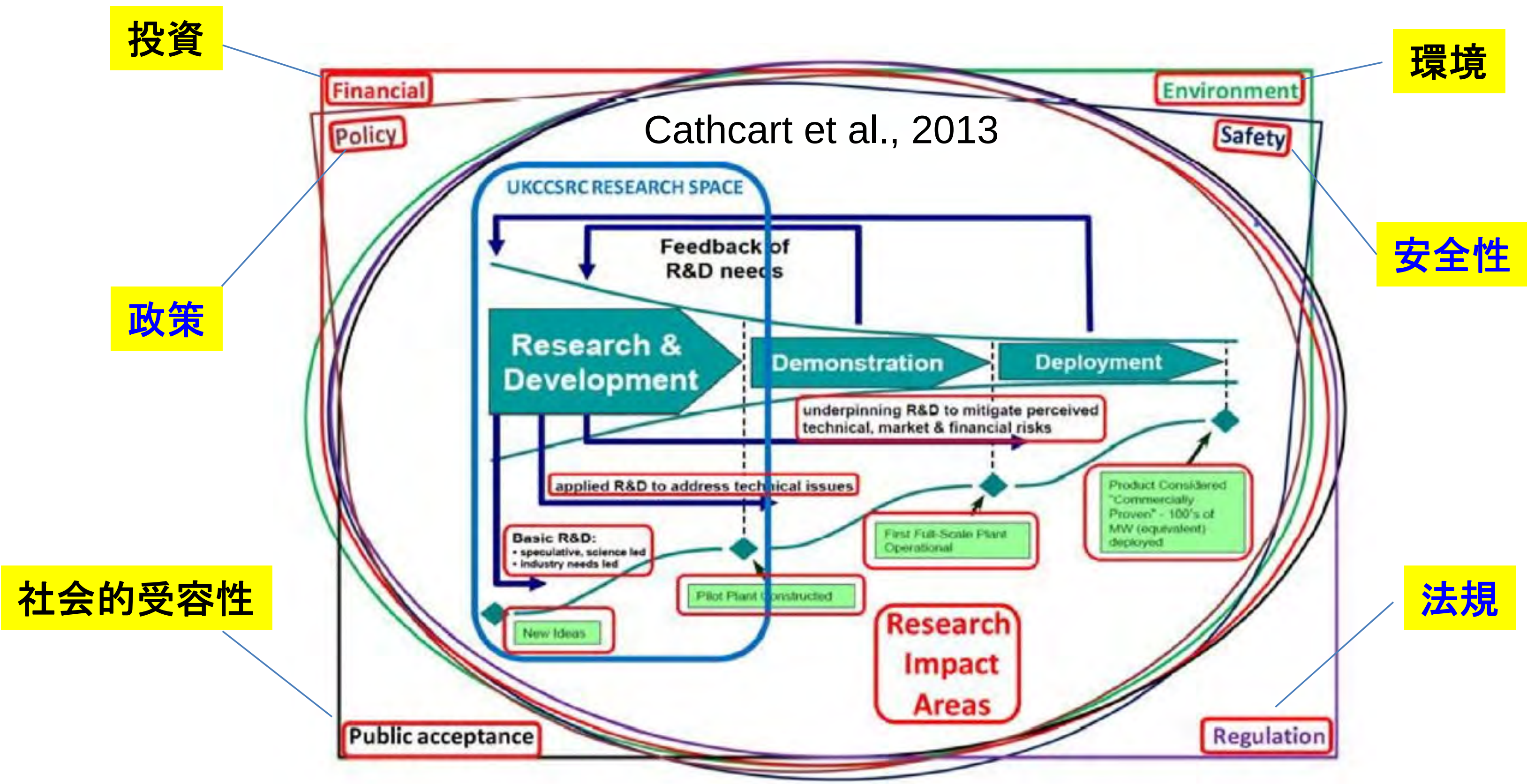
期待効果

・技術的に安全なCCS事業の実施
・法令遵守、社会合意形成、CCS普及障壁の低減
・海外への発信（国際標準化との連携）、共同研究への参画等

https://www.co2choryu-kumiai.or.jp/cms/wp-content/uploads/2021/10/practical-guidance-01-e.pdf
https://www.co2choryu-kumiai.or.jp/cms/wp-content/uploads/2021/10/practical-guidance-02-e.pdf
https://www.co2choryu-kumiai.or.jp/cms/wp-content/uploads/2021/10/practical-guidance-03-e.pdf

CO_2地中貯留技術の実用化・事業化(社会実装)へ

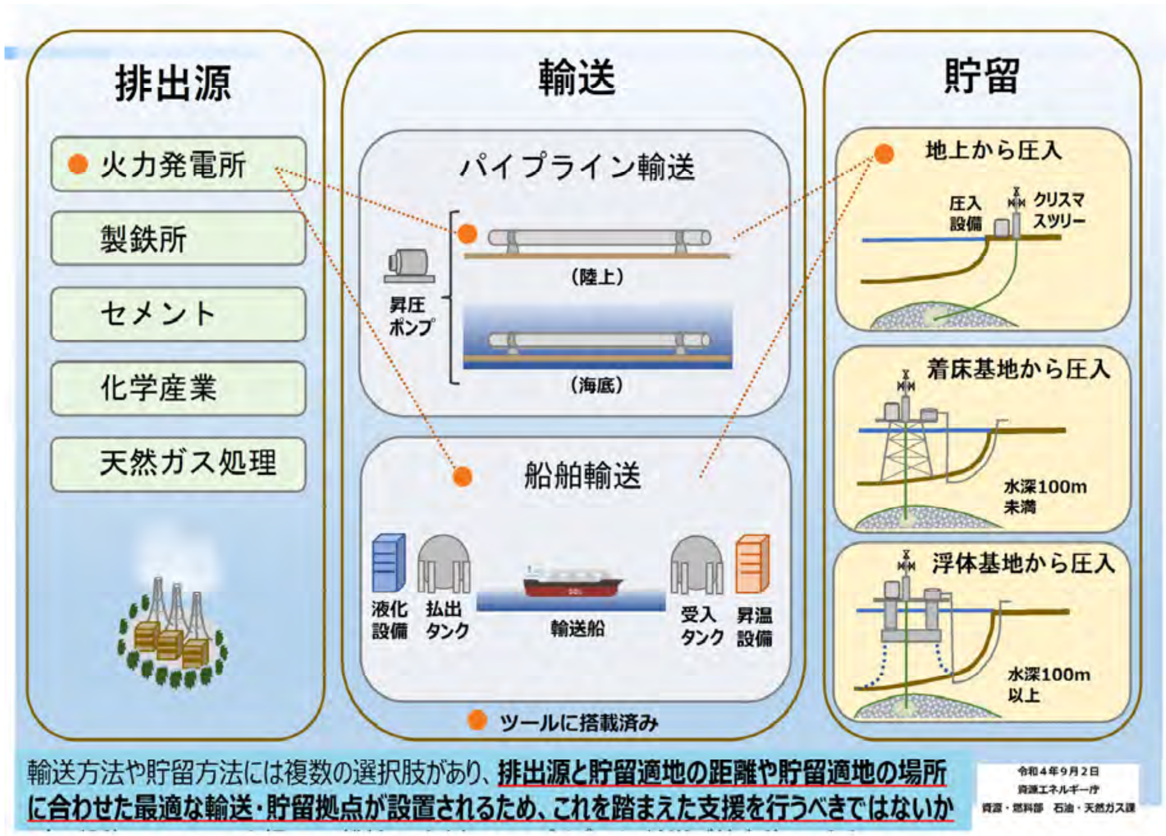
Challenges to Commercial Scale CO_2 Storage



社会実装には、技術開発(安全性)、経済性、社会的受容性、法整備

CCS事業構成・コスト構造・コスト削減

どの部分が、コスト削減できるか、
どう削減する（組合せ・最適化）か



- ✓ 貯留可能量
- ✓ 排出源
  （排出量、距離）
- ✓ 輸送手段

- ➢ 貯留規模
- ➢ 経済性（コスト）
- ➢ 複数ケーススタディ

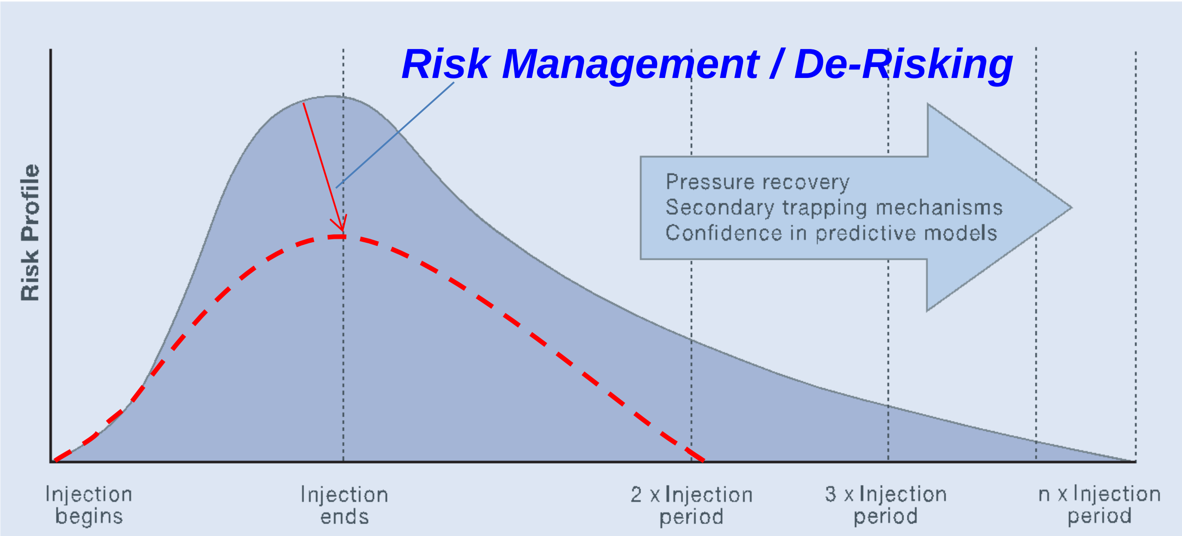
最適な事業構成

技術的

経済性

経営的
意思決定

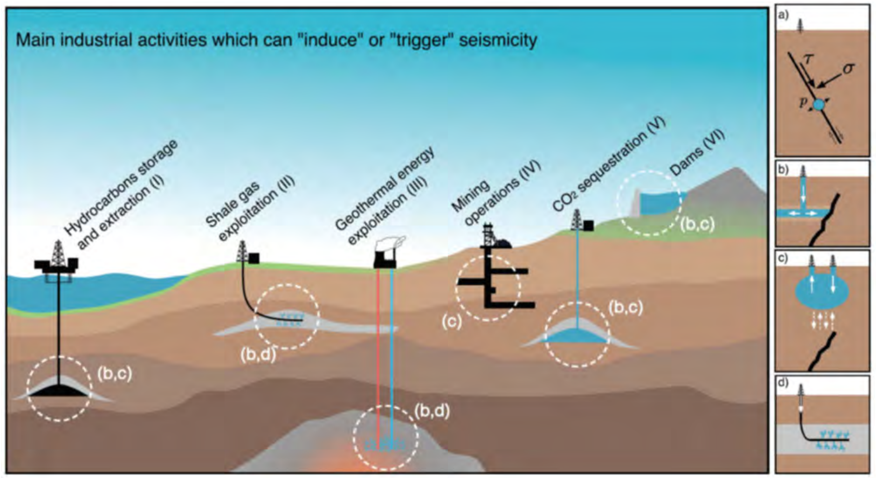
Subsurface Uncertainty, Potential Risk, Risk Management



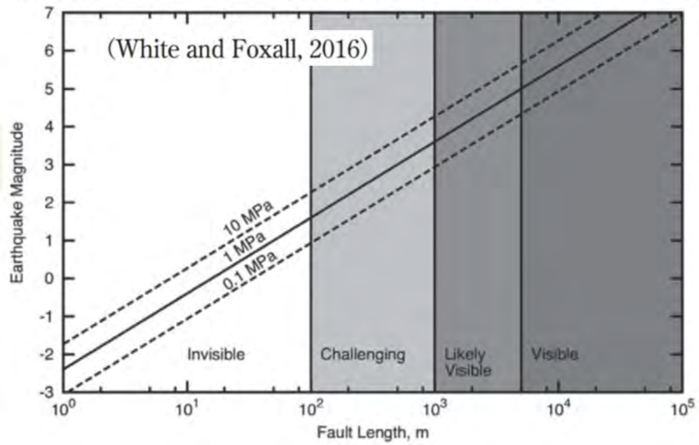
Risk profile @CO_2 injection site（site-specific）

[Illustration source: Benson, 2007]

流体圧入サイトの誘発地震発生メカニズム（Grigoli *et al.*, 2017）



断層の規模や応力降下量と地震のマグニチュードとの関係



Reducing Uncertainty／Mitigating Risks to the Manageable Levels !

Loses of Injectivity, Capacity and Containment, Induced Seismicity (fault), Environmental Impacts

Carbon Storage Program

Improving and Optimizing Performance

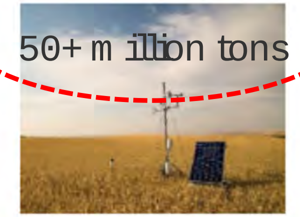
US/DOE (2020)

Regional Carbon Sequestration Partnerships (RCSPs)

地域特性を考慮

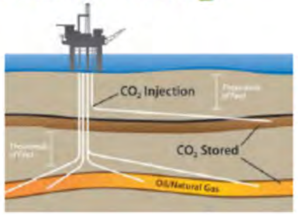
2005-2011
1 million tons

CarbonSAFE



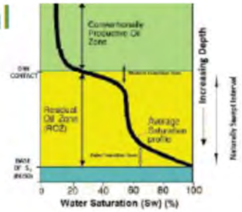
2011- (new regional initiative)

Offshore Storage

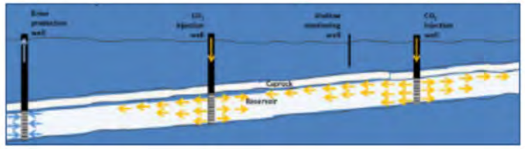


Unconventional EOR

Shale Oil EOR



Brine Extraction Storage Tests (BEST)



地層水汲み上げによる圧力緩和法

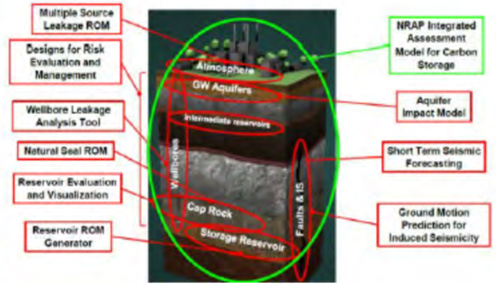
Advancing monitoring and measurement tools: improving characterization and reducing the uncertainty about the CO_2 and pressure fronts.

Fiber Optic Distributed Acoustic Sensing (DAS)

CarbonSAFE
Carbon Storage Assurance Facility Enterprise

光ファイバーセンシング技術
（分布式音響測定 - DAS）

National Risk Assessment Partnership (NRAP) is developing toolsets to reduce uncertainty and quantify potential impacts related to release of CO_2 and induced seismicity

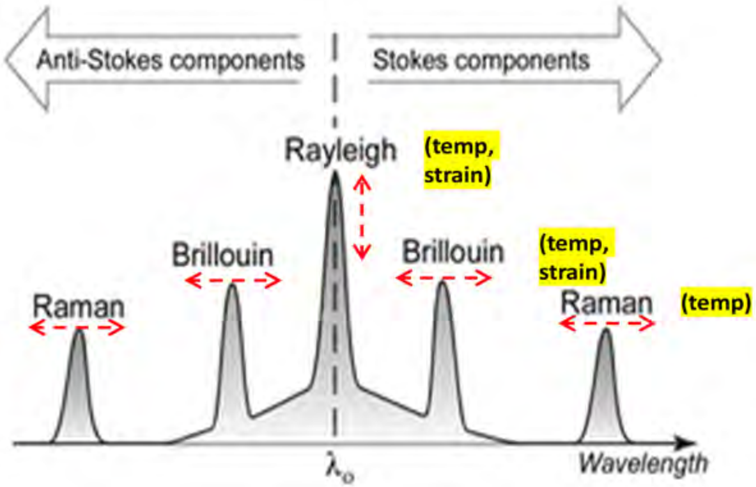


Advanced CO_2 Storage Monitoring with Fiber Optic Sensing (DTS, DAS, DSS)

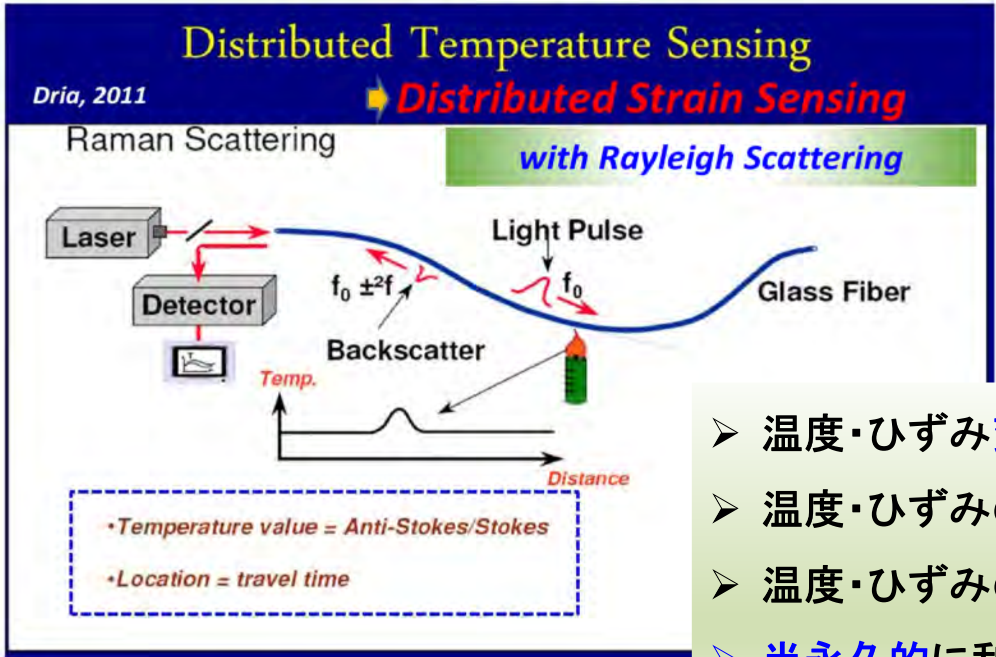
- To track the movement of CO_2 and assure permanence for geologic storage.
- To decrease the cost and uncertainty in measurements and satisfy regulations.
- To provide measurements and reservoir conditions for decision making and process optimization, calibrating and improving geological model for predication of long-term behavior of injected CO_2 in the subsurface.
- To develop skills on risk communication and public acceptance on CO_2 geological storage.

Fiber Optic Sensing (DTS, DAS, DFOSS)

Optic Fiber and Back Scattering



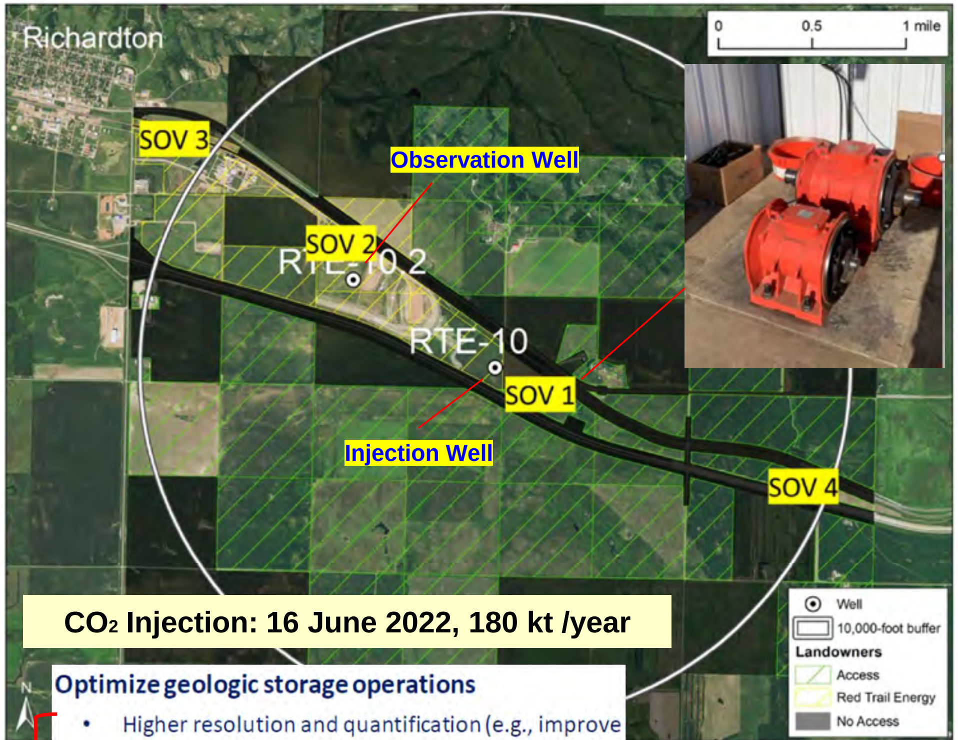
Distributed Fiber Optic Strain Sensing
(DFOSS)



- 温度･ひずみ変化点
- 温度･ひずみの大きさ
- 温度･ひずみの分離
- 半永久的に利用可

DAS: Distributed Acoustic Sensing (VSP)

Fiber Optic Sensing for **Multi-purpose** Data Acquisition (DTS, DAS, **DSS**) and **Permanent Monitoring** for CO_2 Storage, North Dakota, United States



US/DOE

Optimize geologic storage operations

- Higher resolution and quantification (e.g., improve characterization of faults and fractures)
- Geomechanics (pressure and state of stress)
- Enabling real-time decision making

Class VI Approved (Oct. 2021)

US/DOE-JAPAN/METI CCUS Collaboration

- ***Optic fiber cables* (designed by RITE) installed behind casing of two deep wells (Injection & Observation, depth: 2.1 km) and two ground water wells (depth: 600 m).**
- ***SOV-DAS/VSP* for CO2 plume monitoring (180kt/year x 20 years)**
- ***Coupled analysis of InSAR and DSS from the shallow water wells***
- ***Which depth & how much the deformation occurs in subsurface and how it migrates to ground surface***

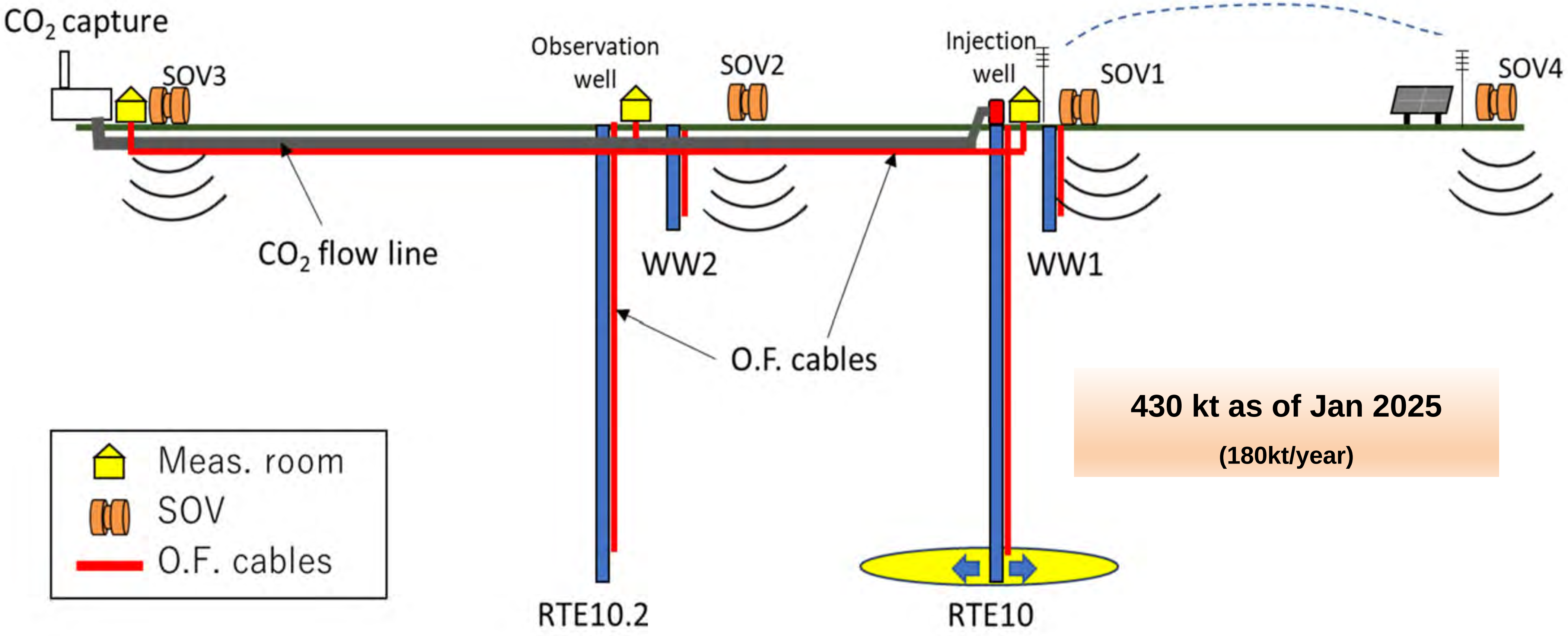
Summary of the Underground Injection Control (UIC) Class VI Permit MVA program

Monitoring Type	RTE Monitoring Program	Structure/Project Area
Analysis of Injected CO_2	Compositional and isotopic analysis of the injected CO_2 stream	Wellhead
CO_2 Flowline	**DTS/DAS and DSS**	Capture facility to the wellsite
Continuous Recording of Injection Pressure, Rate, and Volume	Surface pressure/temperature gauges and a flowmeter installed at the wellhead with shutoff alarms	Surface to reservoir (injection well)
Well Annulus Pressure Between Tubing and Casing	Annular pressure gauge for continuous monitoring	Surface to reservoir (injection well)
Internal and External Mechanical Integrity	Tubing-casing annulus pressure testing (internal) **DTS/DAS fiber-optic cable**, ultrasonic imager tool (USIT) (external)	Well infrastructure
Corrosion Monitoring	Flow-through corrosion coupon test system for periodic corrosion monitoring	Well infrastructure
Near-Surface Monitoring	Groundwater wells in the area of review (AOR) dedicated to Fox Hills monitoring wells and soil gas sampling and analyses	Near-surface environment, USDWs
Direct Reservoir Monitoring	Wireline logging, external downhole pressure and temperature gauges, and **DTS/DAS fiber-optic cable**	Storage reservoir
Indirect Reservoir Monitoring	Time-lapse geophysical surveys, gravity surveys, **InSAR** and passive seismic measurements	Entire storage complex

Richards et al_(2022)

A fully coupled analysis with DSS at ground water wells

Schematic drawing of monitoring system at RTE CCS site



430 kt as of Jan 2025

(180kt/year)

SOV- DAS/VSP for time-lapse CO_2 plume imaging

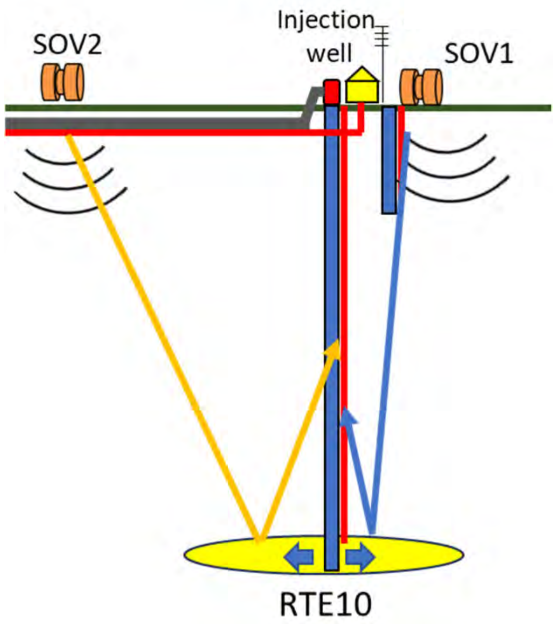
SOVs: Permanent sources

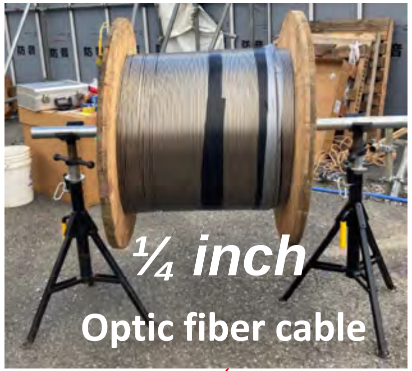
- Remotely controlled
- Programmed operation
- On-demand operation

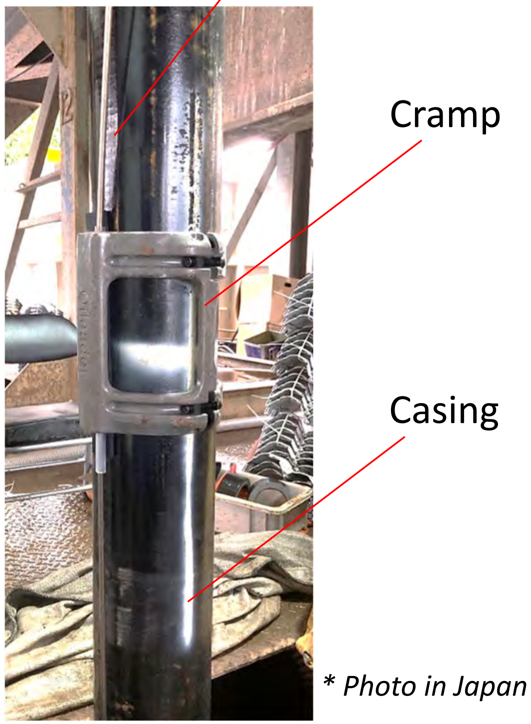
DAS/VSP: Permanent receivers

- Borehole seismic
- Available for continuous recording
- Remotely controlled

Surface Orbital Vibrators (SOVs)

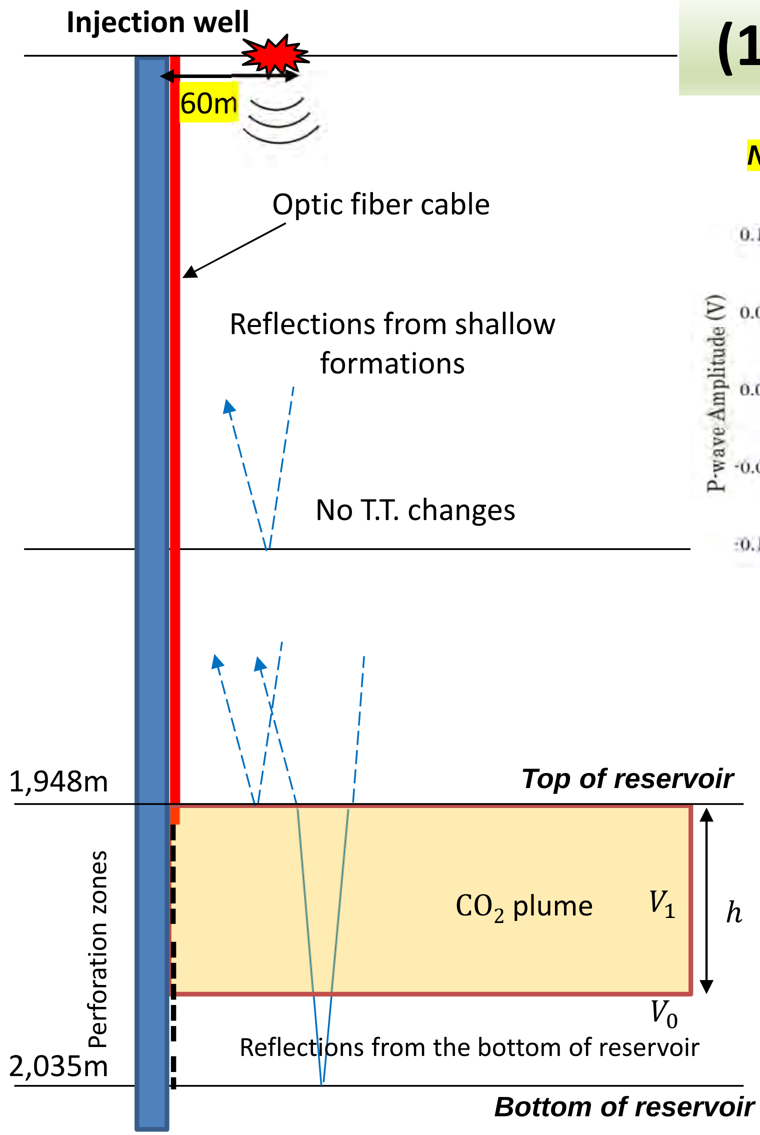




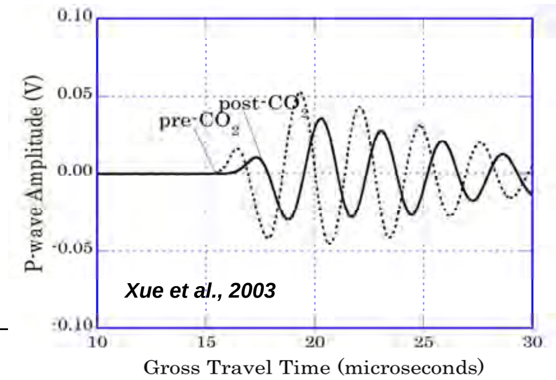


** Photo in Japan*

(1) SOV-DAS/VSP for the injected CO2 detection



Nakajima et al., submitting to IJGGC

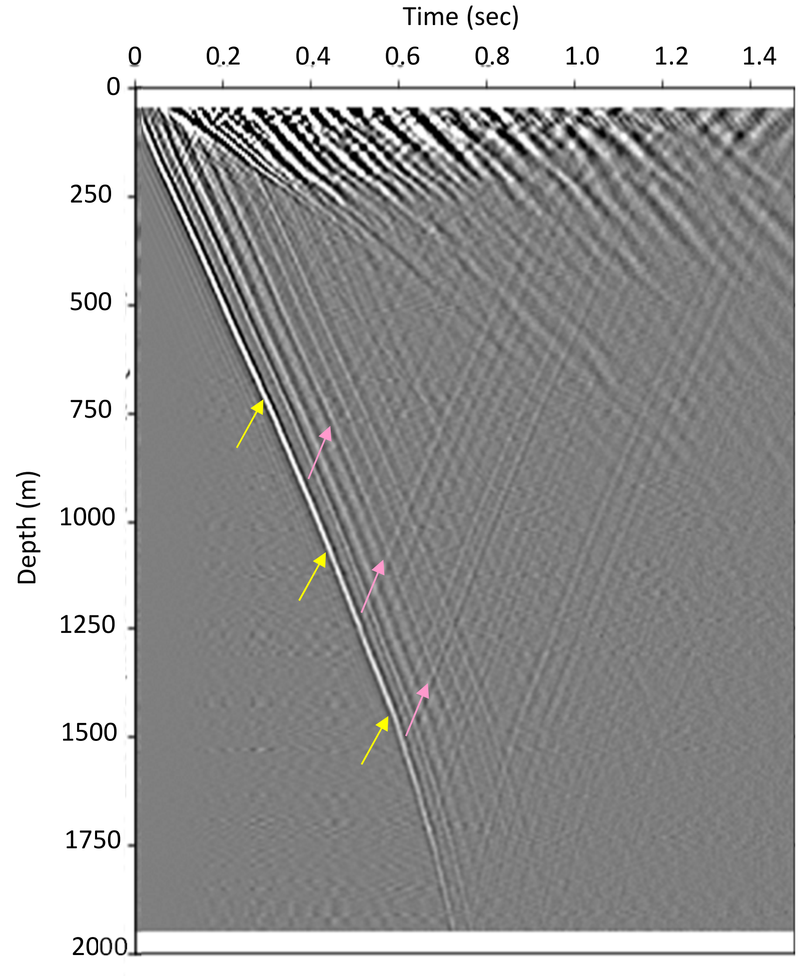


V_0: P-wave velocity (baseline)

V_1: P-wave velocity with CO2 (V_1<V_0)

h : thickness of CO2 plume

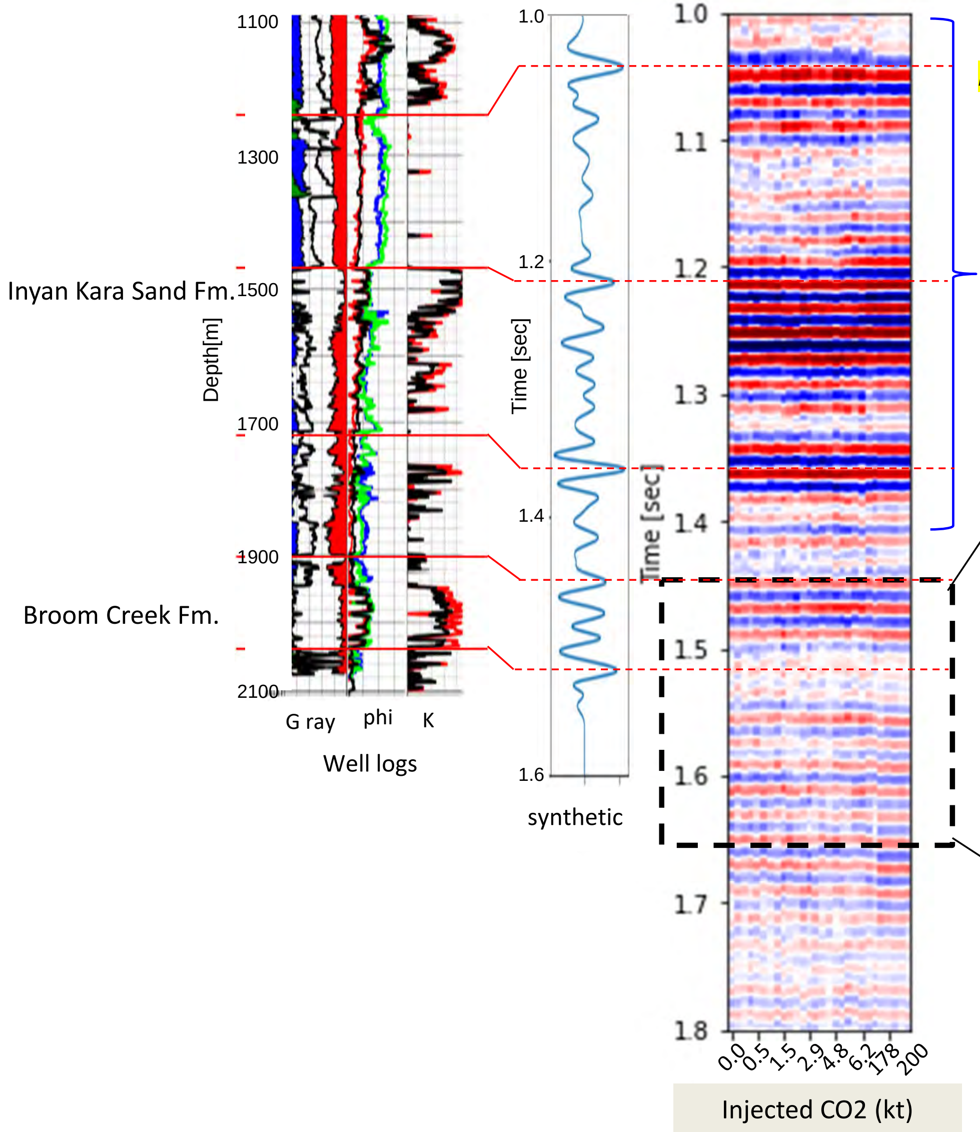
$$\Delta t \approx \frac{2h}{V_1} - \frac{2h}{V_0}$$

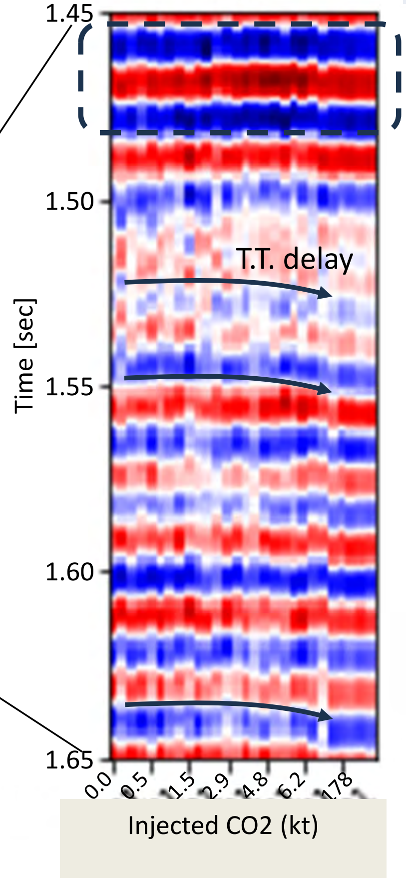


(2) Time lapse Zero-offset DAS/VSP for CO_2 monitoring

Nakajima et al., submitting to IJGGC

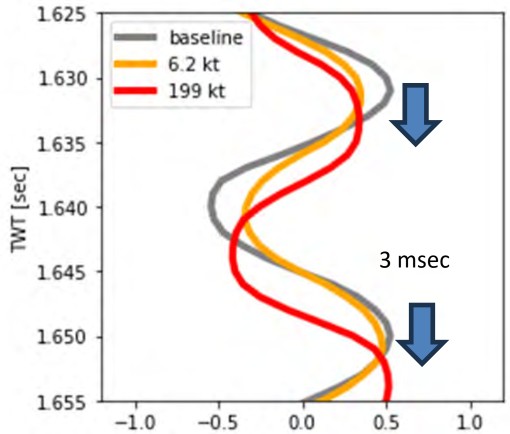
Period	Injected CO_2
2022/6/13--7/6	0 ~ 6.2 kt
2023/08/18--10/01	180 ~200 kt





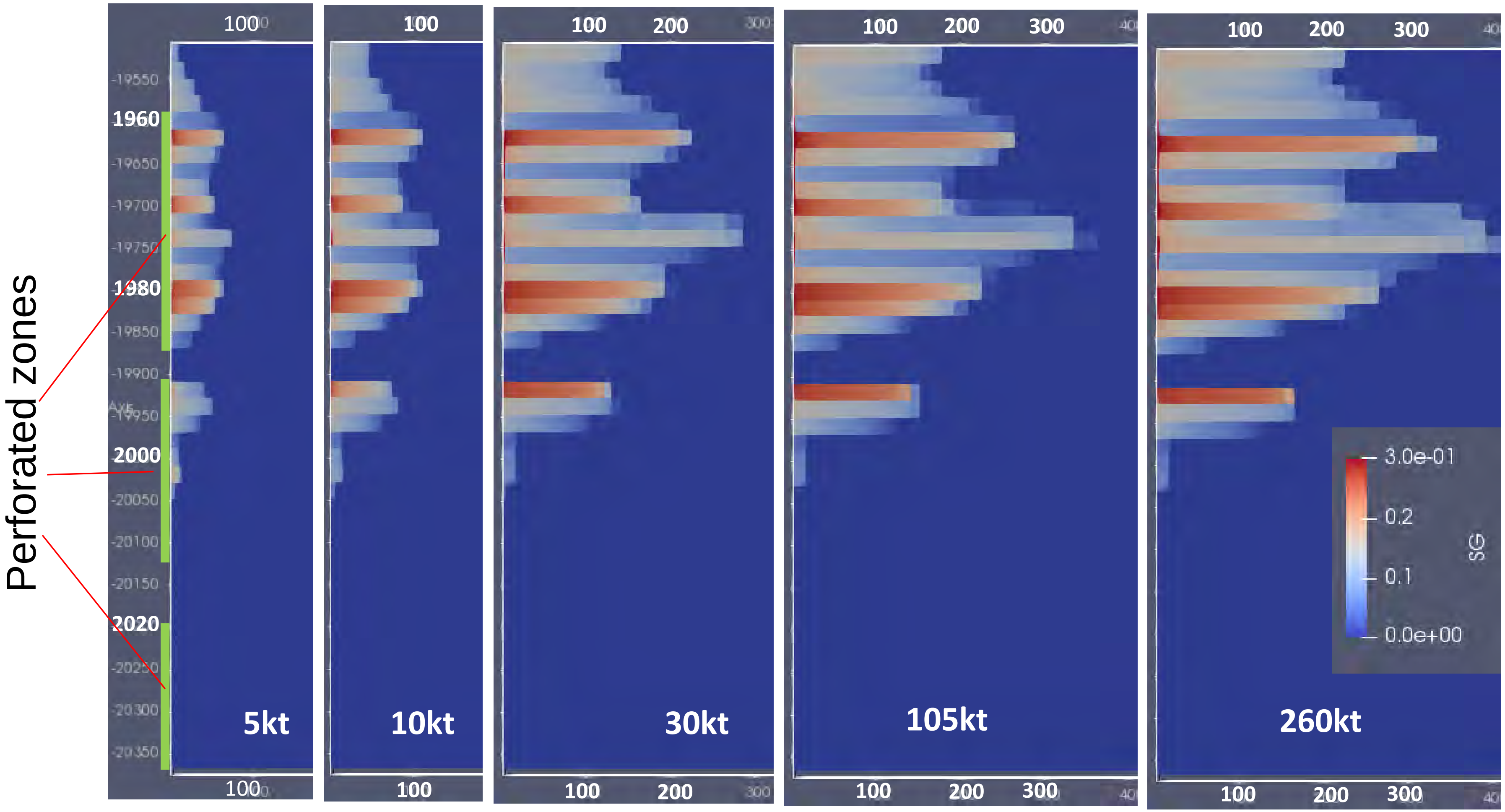
Travel time delay observed below the reservoir top

Estimate TT delays based on cross-correlation method



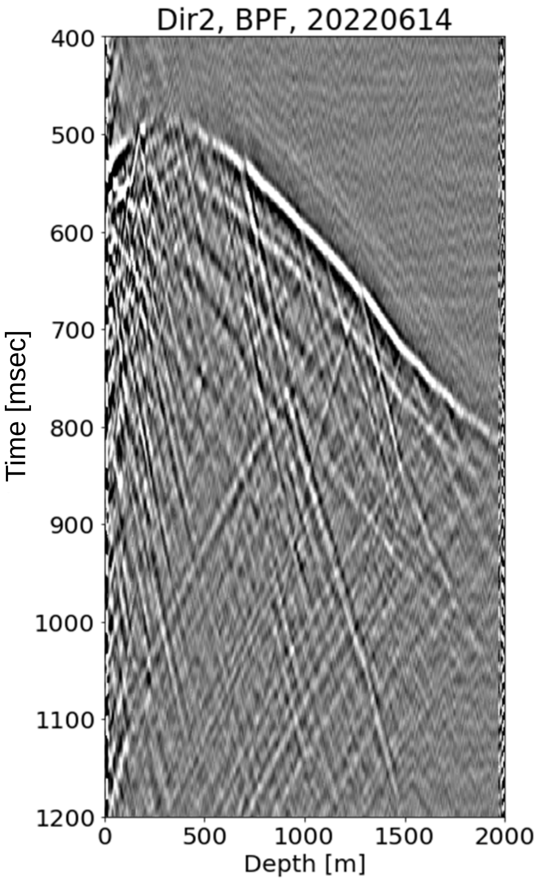
(3) Simulated results (HM with PNL) of CO_2 Saturation in the reservoir

Nakajima et al., submitting to IJGGC

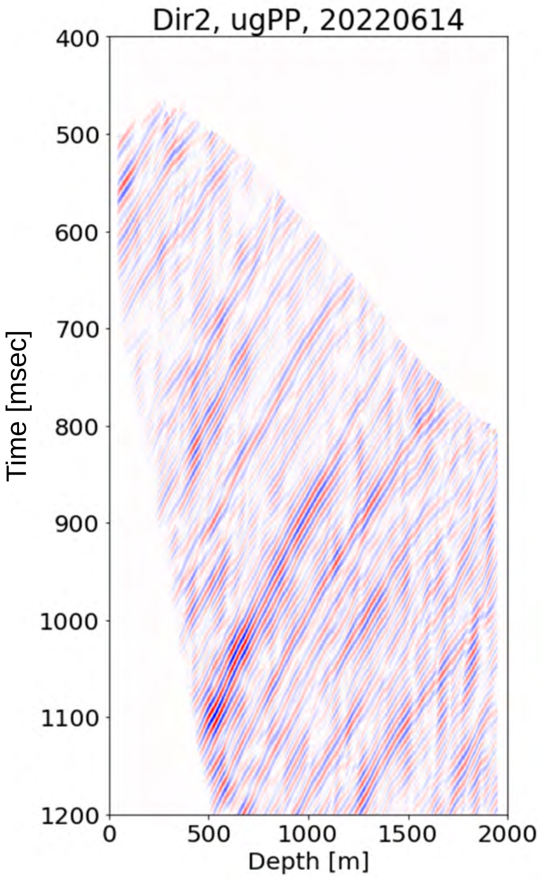


SOV2 - RTE10 (offset 1,077m) DAS/VSP Baseline

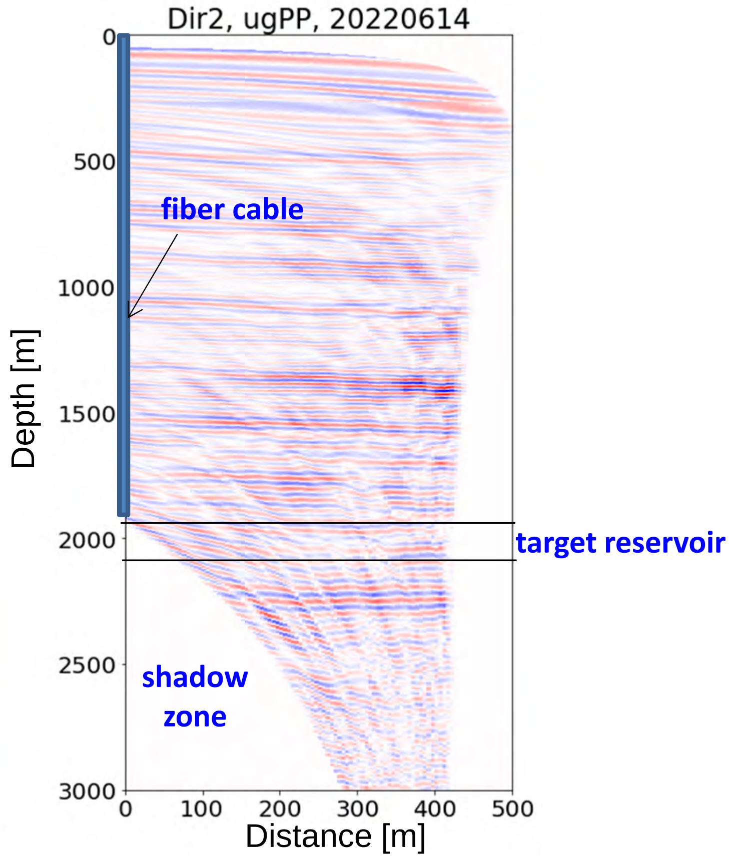
Baseline data



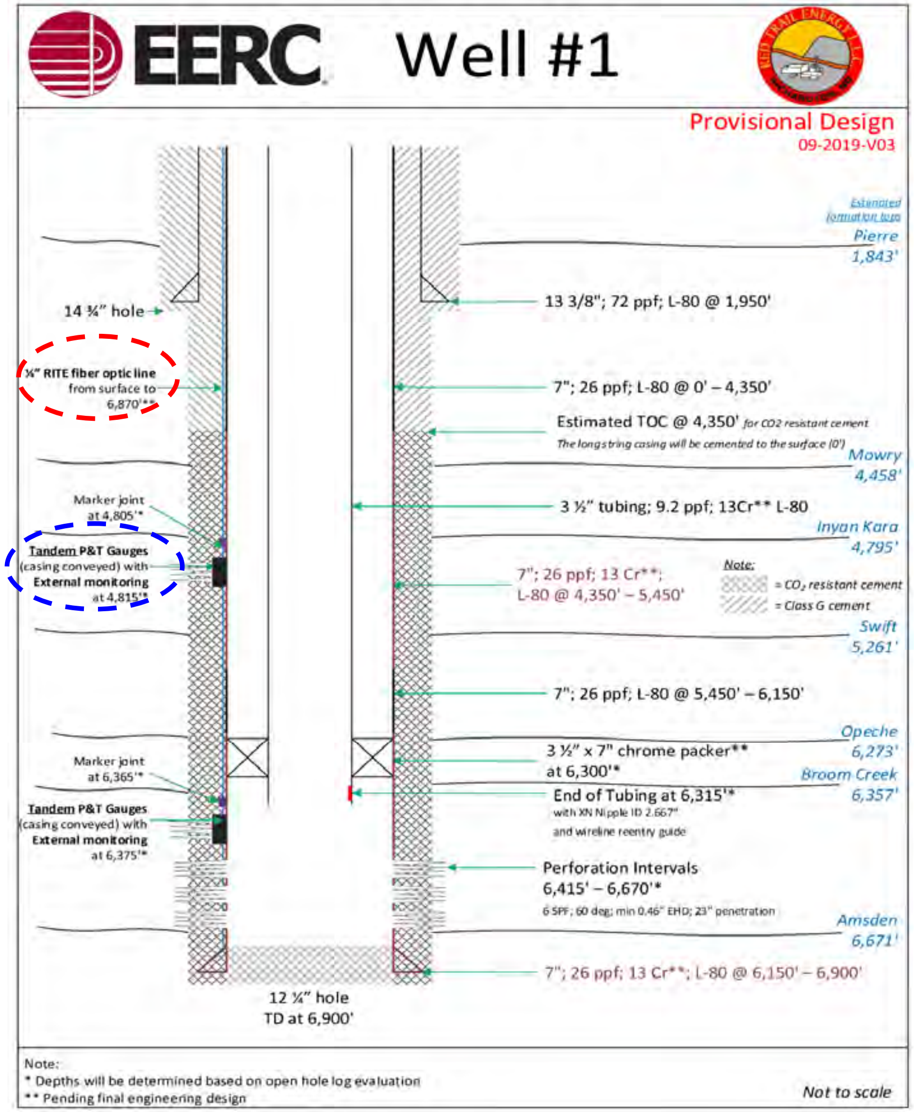
Up-going P-wave



CMP transformed



Optic Fiber Cable Installation and Oriented Perforation (1/3)



深さが6,900 feet（約2.1km）の圧入井（RTE-10）、観測井（RTE10.2）に、Tandem P&T Gauges（事業者Red Trail Energy提供）と光ファイバー（技術組合提供）を設置

指向性パーフォレーションが断念

⇩

光ファイバーが貯留層上部まで

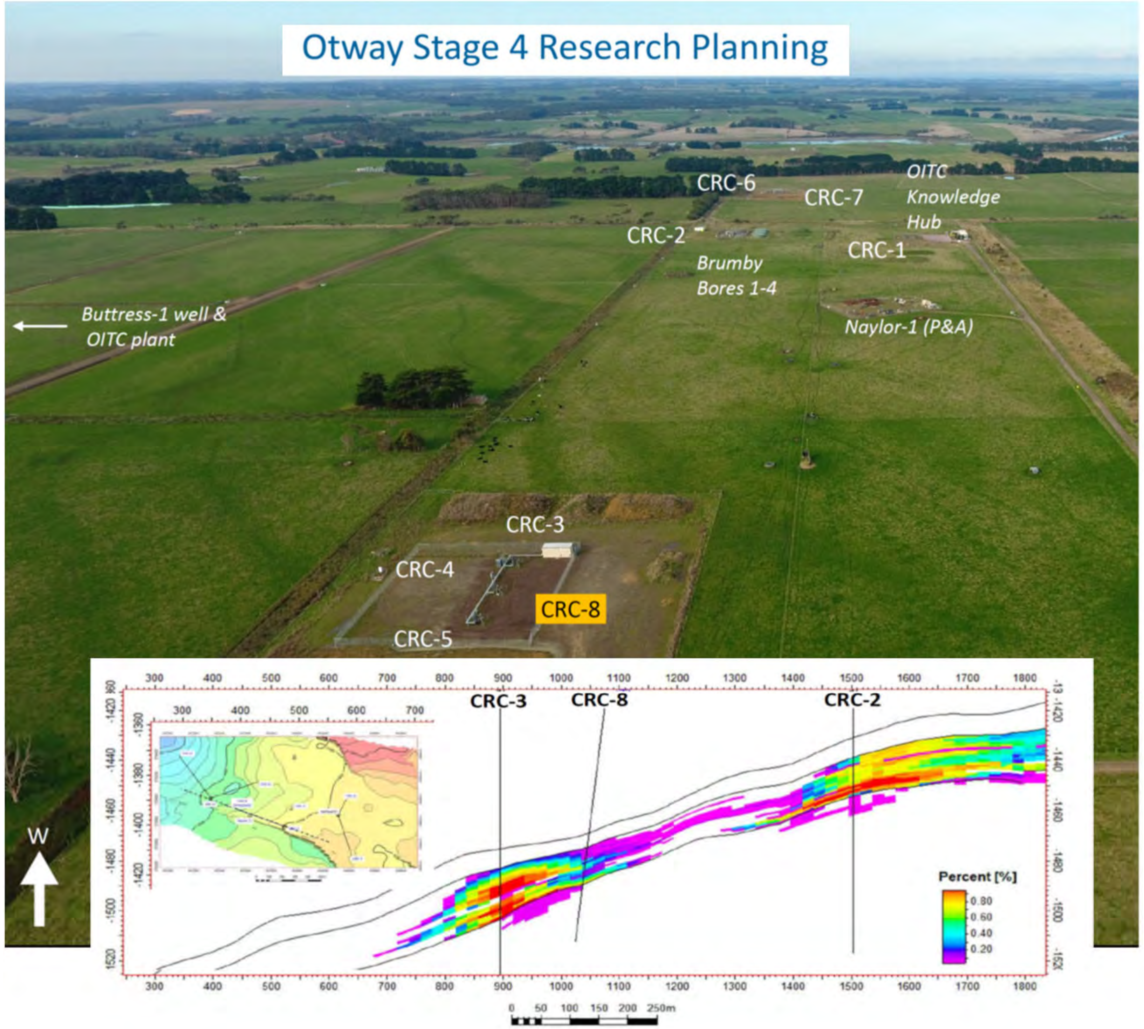
⇩

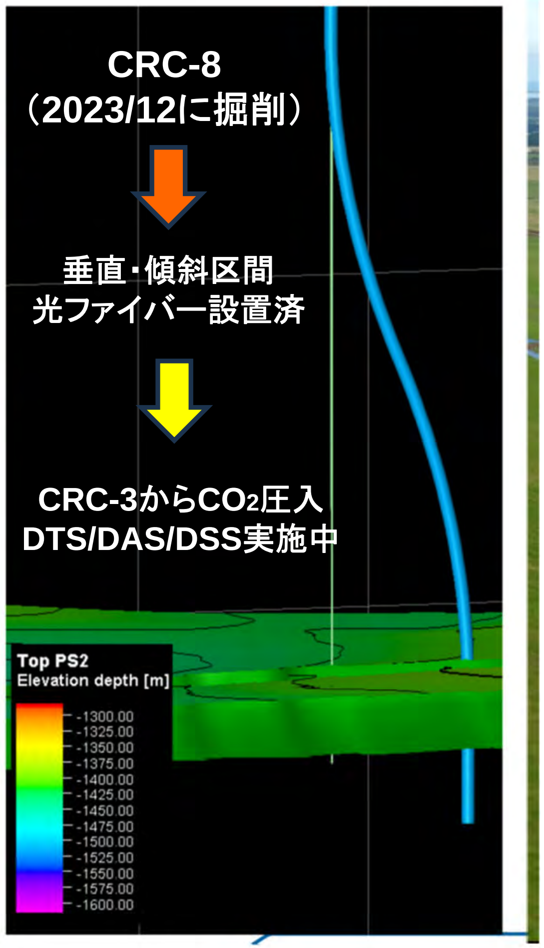
DAS/VSP観測で光ファイバー終端直下に空白域

光ファイバー設置に伴う作業時間の増加は10%程度

Optic Fiber Cable Installation and Oriented Perforation (2/3)

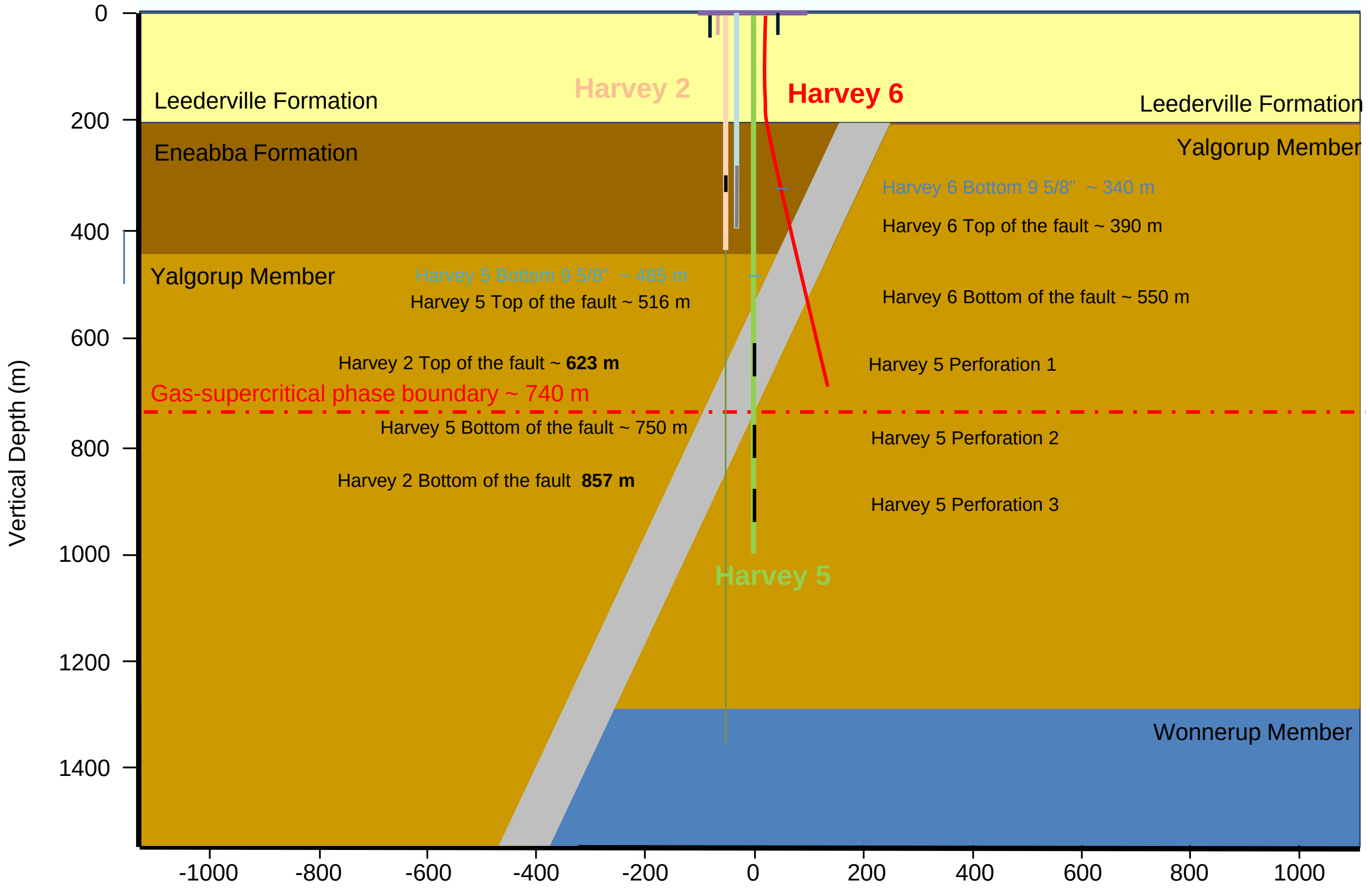
RITE-CO2CRC Collaboration @Otway site, Victoria, Australia

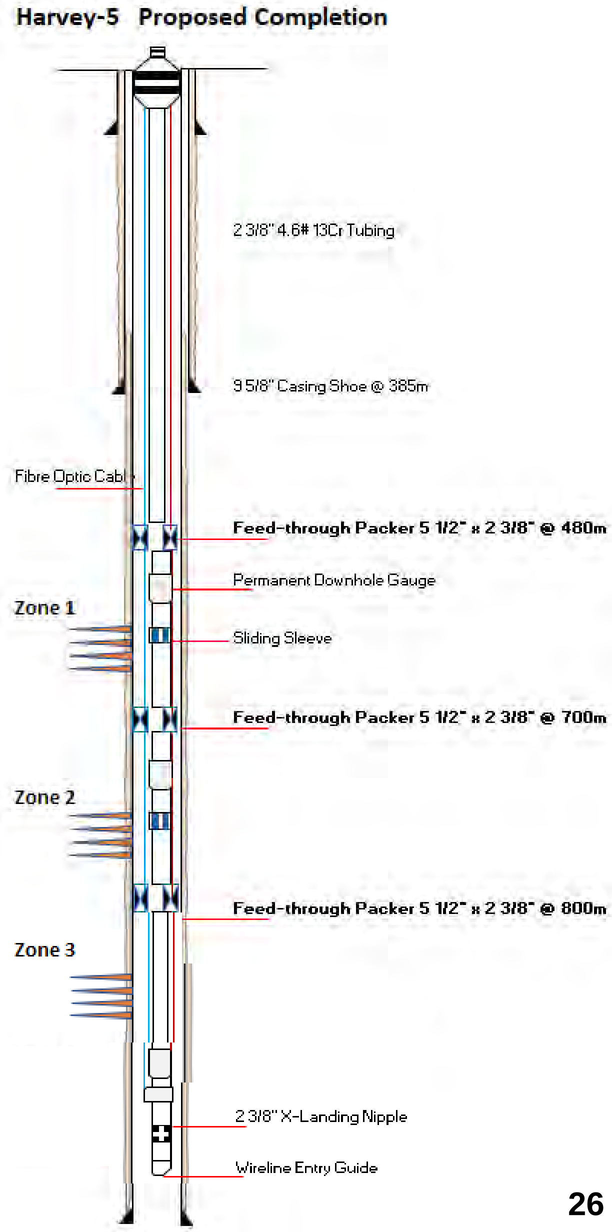




Optic Fiber Cable Installation and Oriented Perforation (3/3)

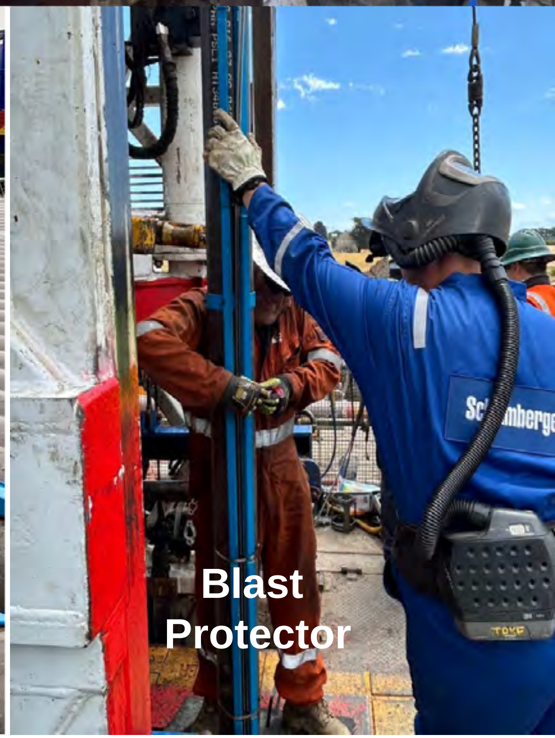
RITE-CSIRO Collaboration at In-Situ Lab, South Perth (Harvey), WA





Optic Fiber Cable Installation

- ✓ Mid-joint Clamp (fixing cable on casing)
- ✓ Blast Protector for oriented perforation
- ✓ BOP (blowout preventer)

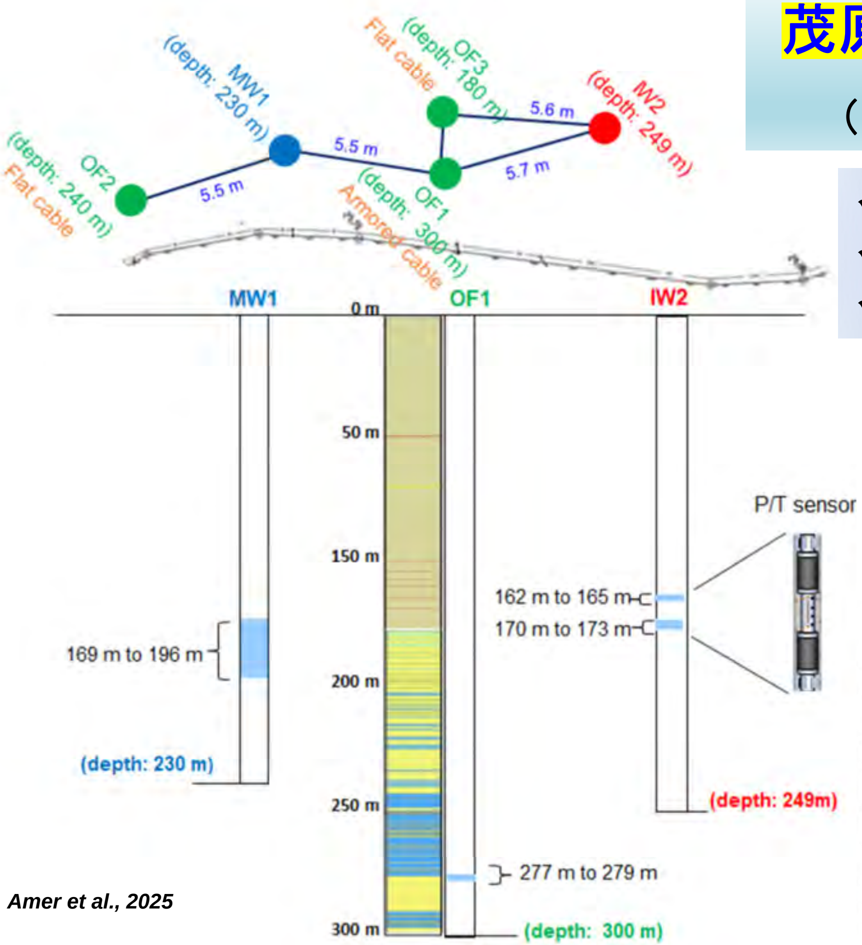


Distributed Strain Sensing (DSS) for Geomechanical Monitoring & Modeling Applications for Caprock and Well Integrity Monitoring

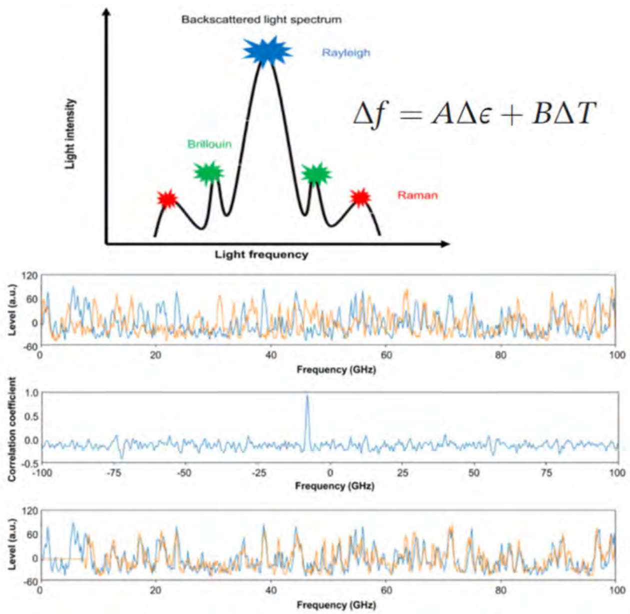
茂原（pilot field tests）から世界へ

（large field demonstrations）

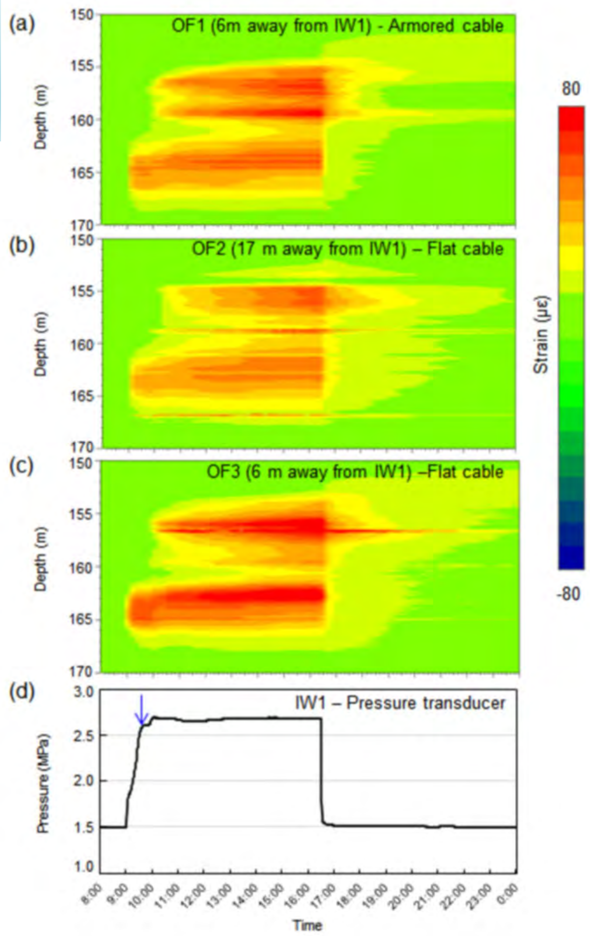
- ✓ Fiber optic cable design
- ✓ Cable installation
- ✓ Strain data analysis



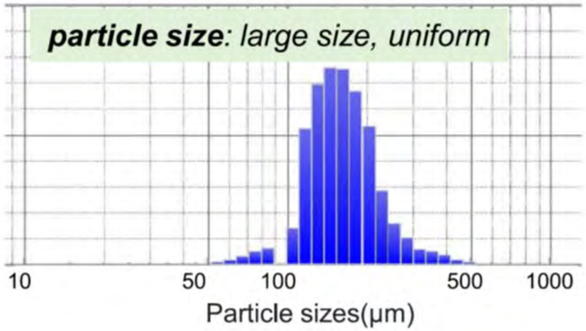
Amer et al., 2025

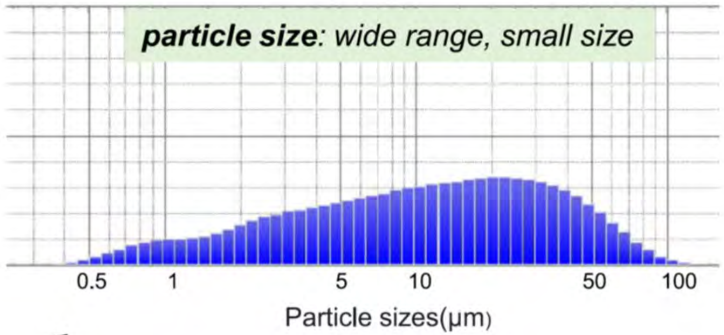


Amer et al., 2025

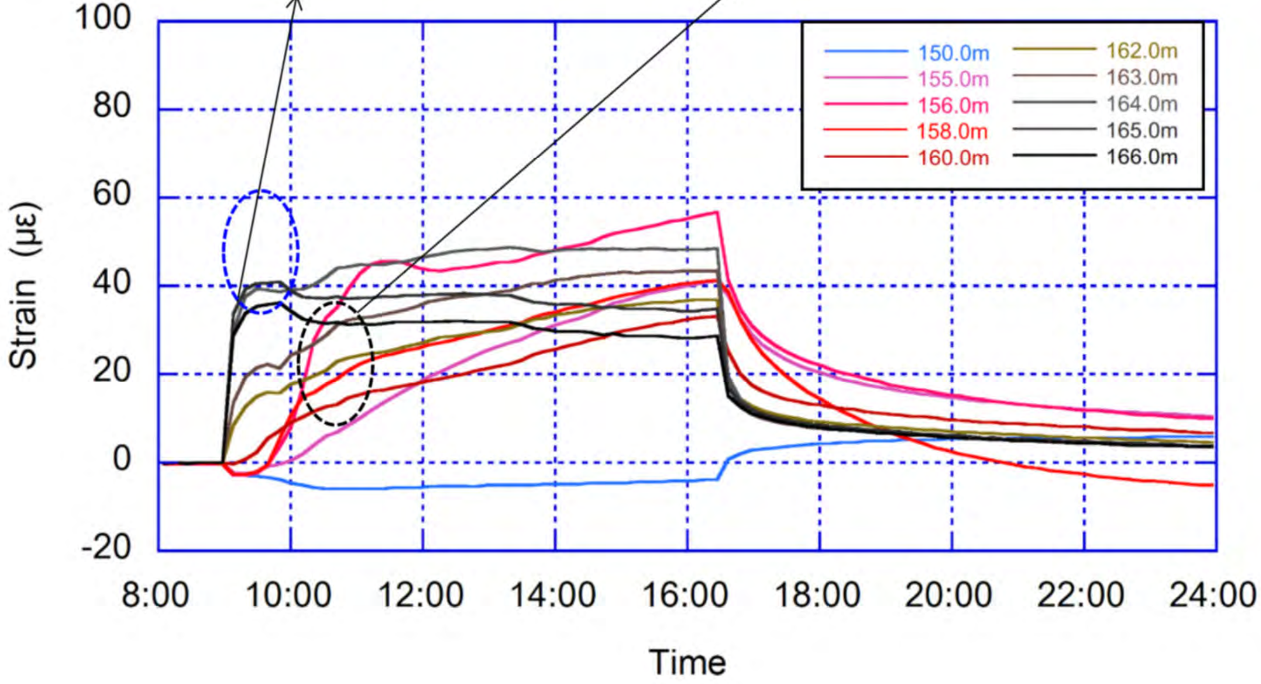


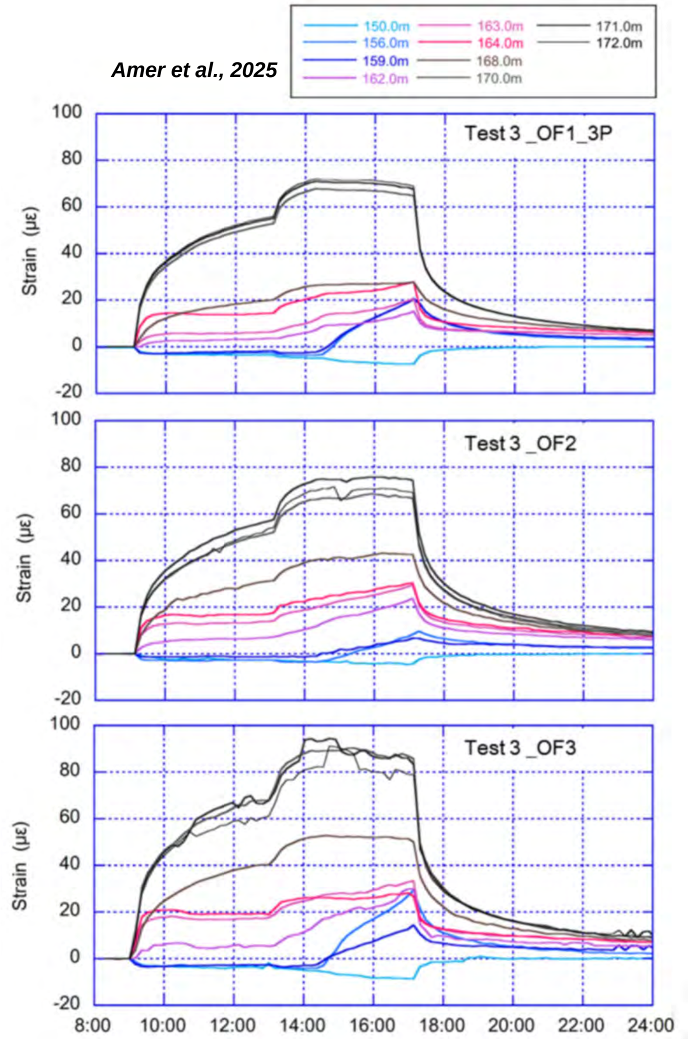
Estimating Hydraulic & Mechanical Properties from Strain Sensing



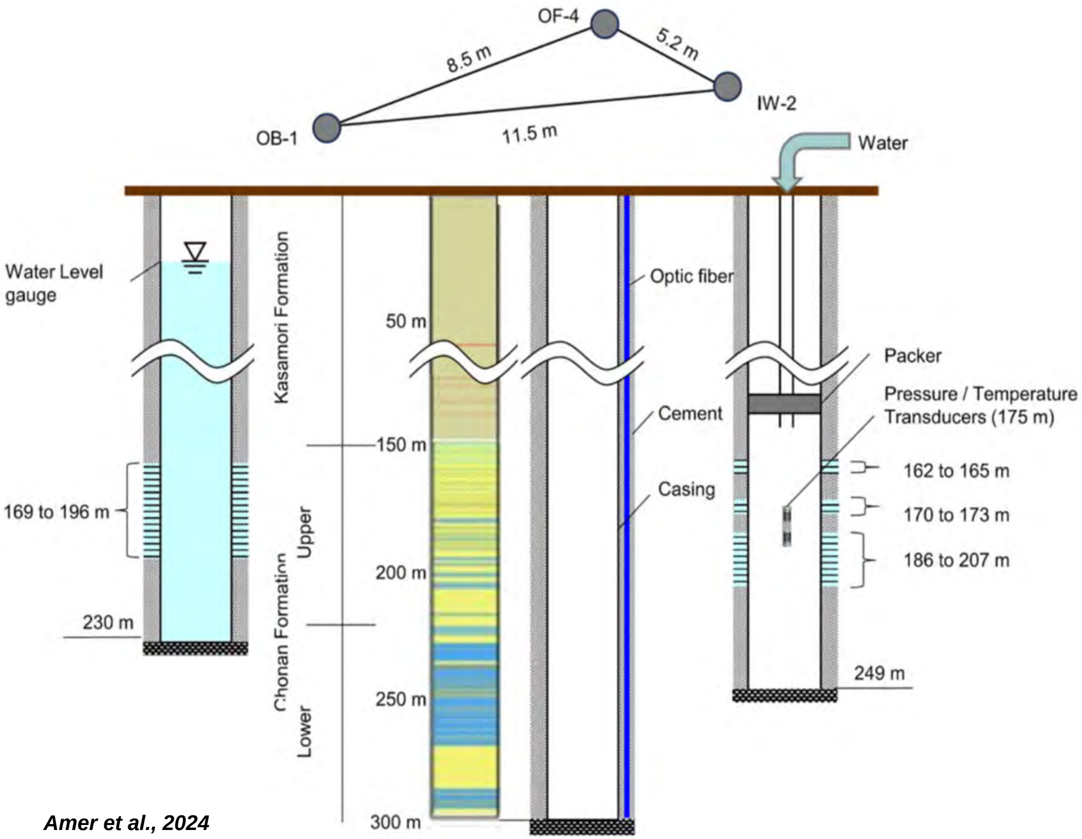


Amer et al., 2025

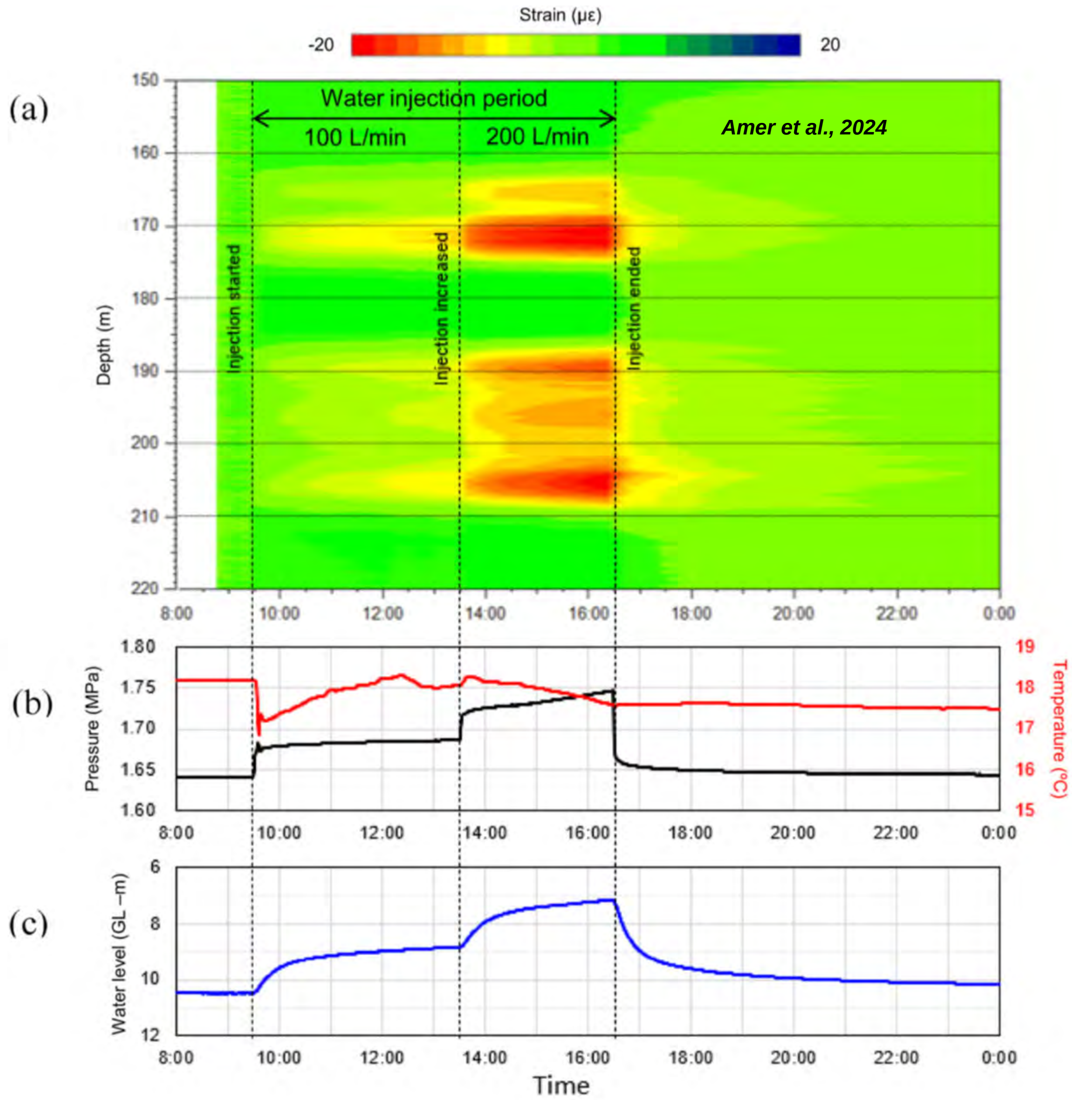




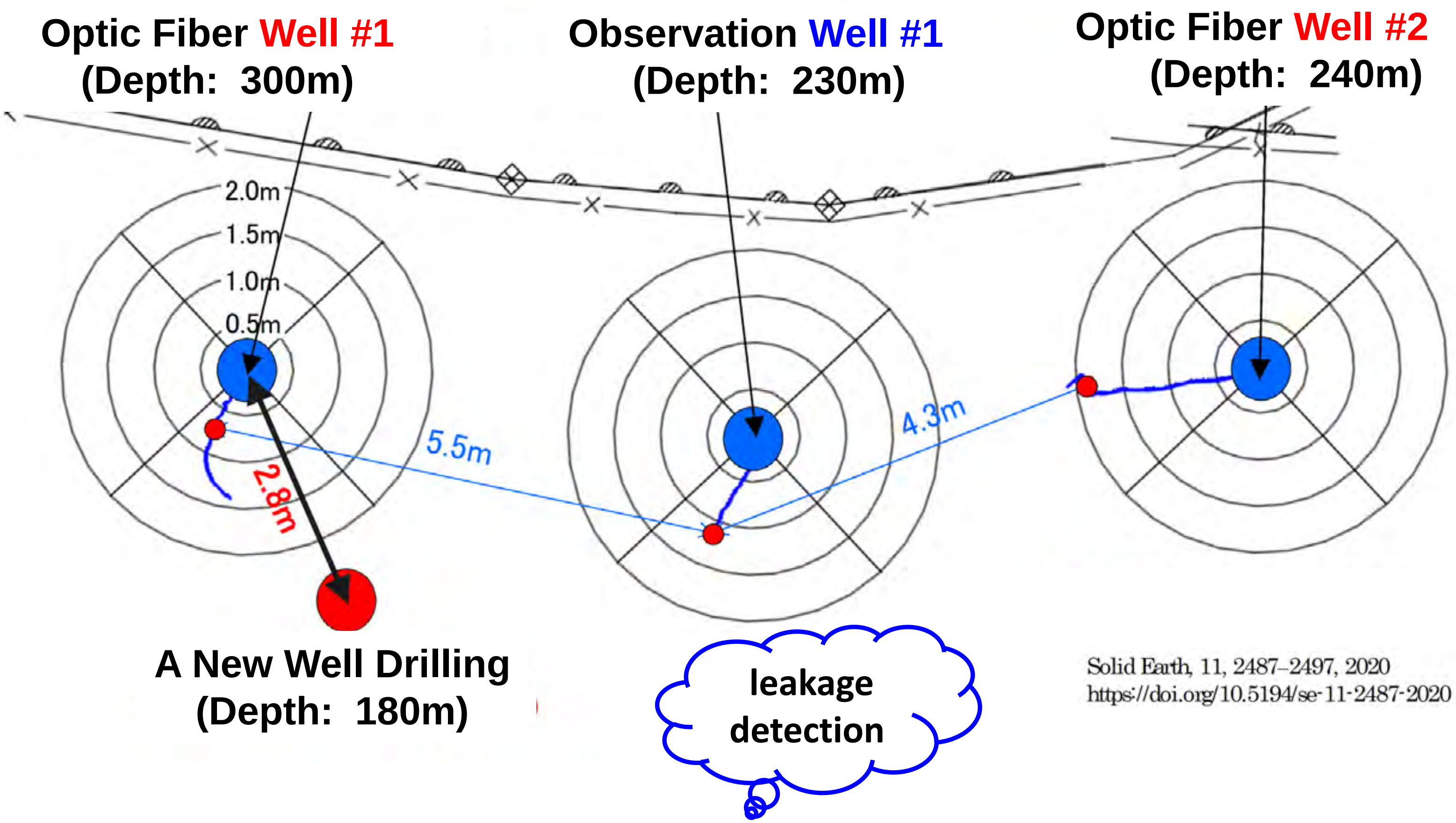
Strain vs Pressure in water injection (strain sensitivity)



Amer et al., 2024



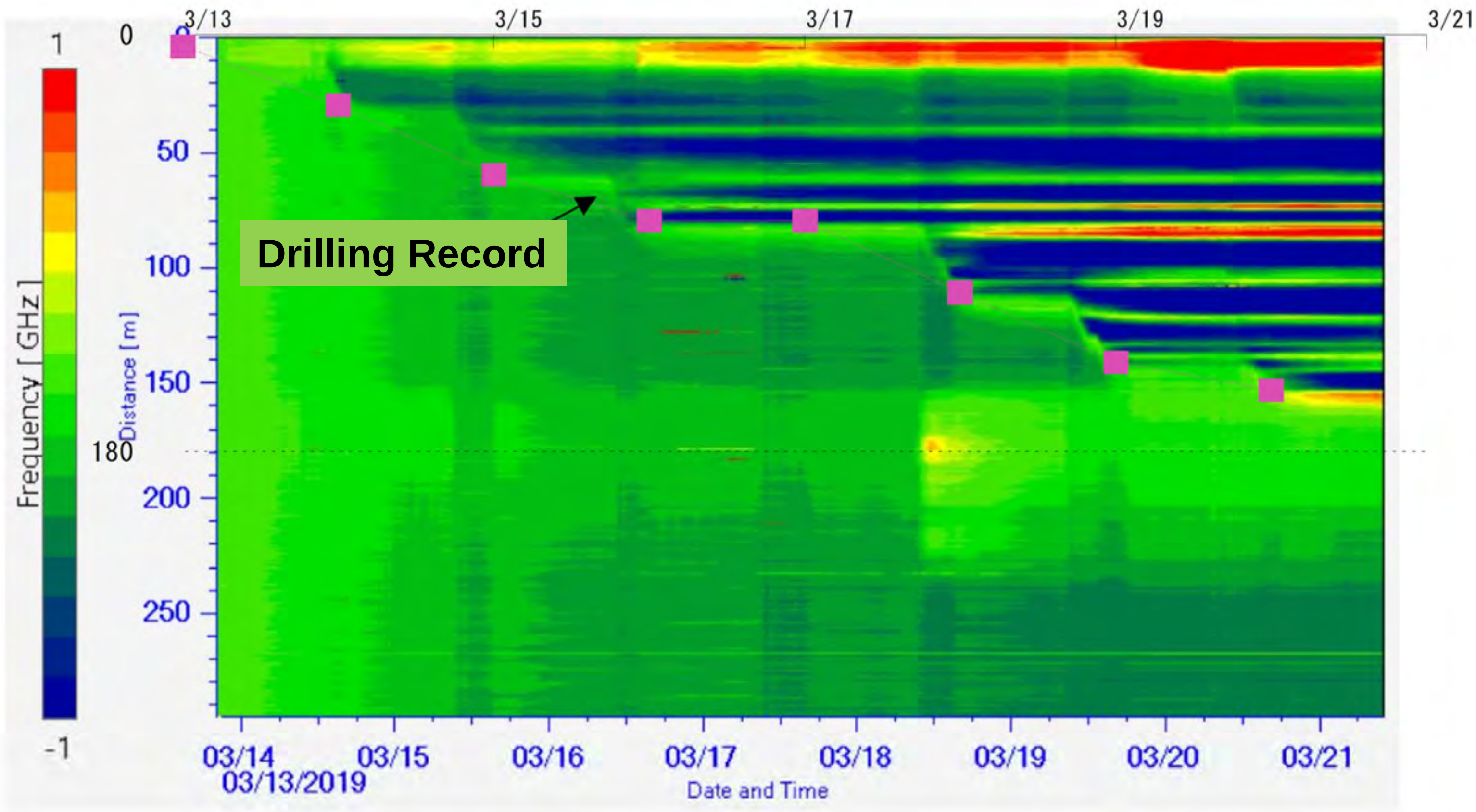
Field Experiments on Well Integrity/leakage Monitoring with Distributed Fiber Optic Strain Sensing at our pilot site, Chiba Japan



Solid Earth, 11, 2487–2497, 2020
https://doi.org/10.5194/se-11-2487-2020

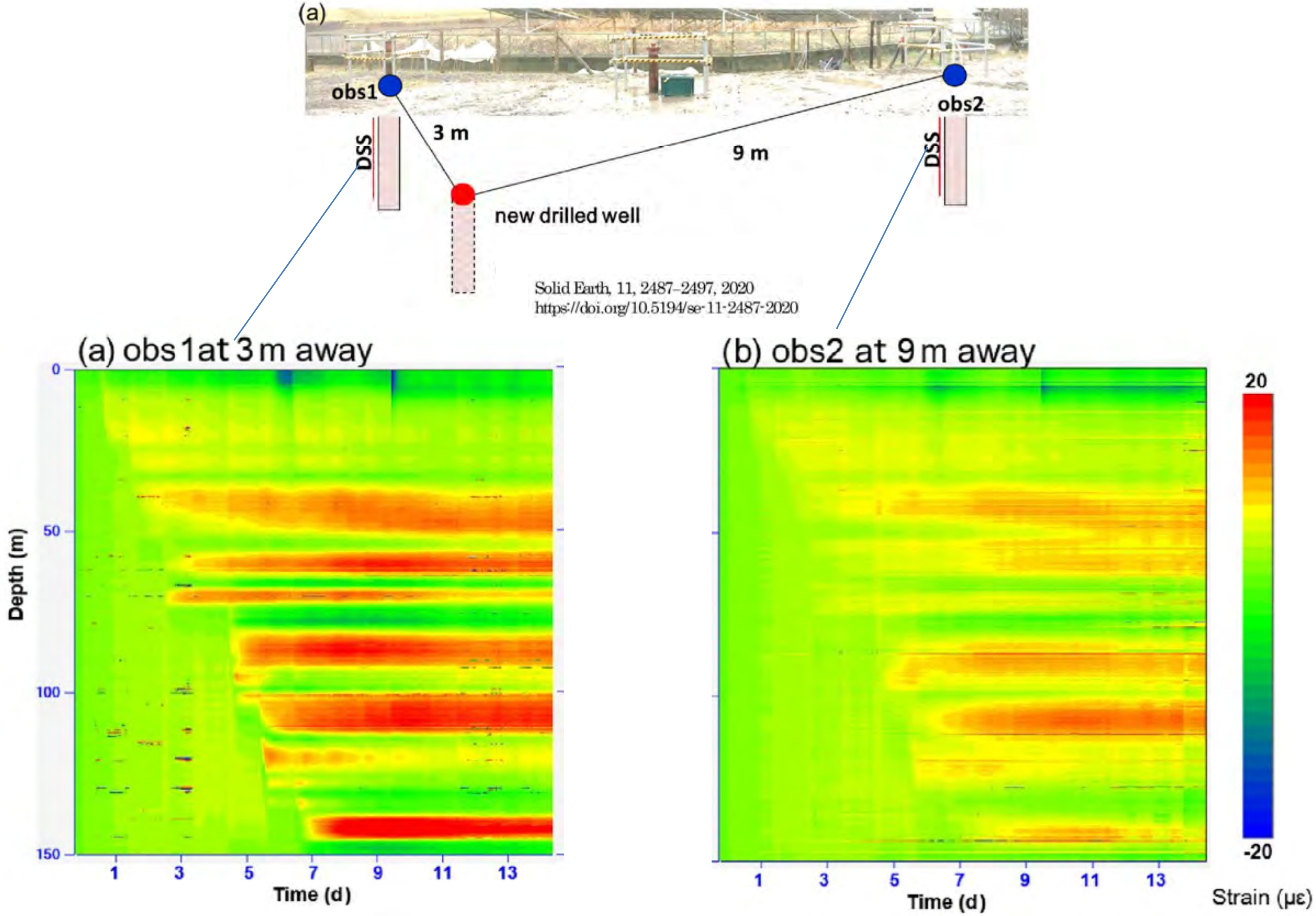
How optic fiber responses to the well drilling in various distances?

Results of Fiber Optic Response during the Well Drilling



It's useful for <u>small leakage detection</u> to secure caprock and well integrity

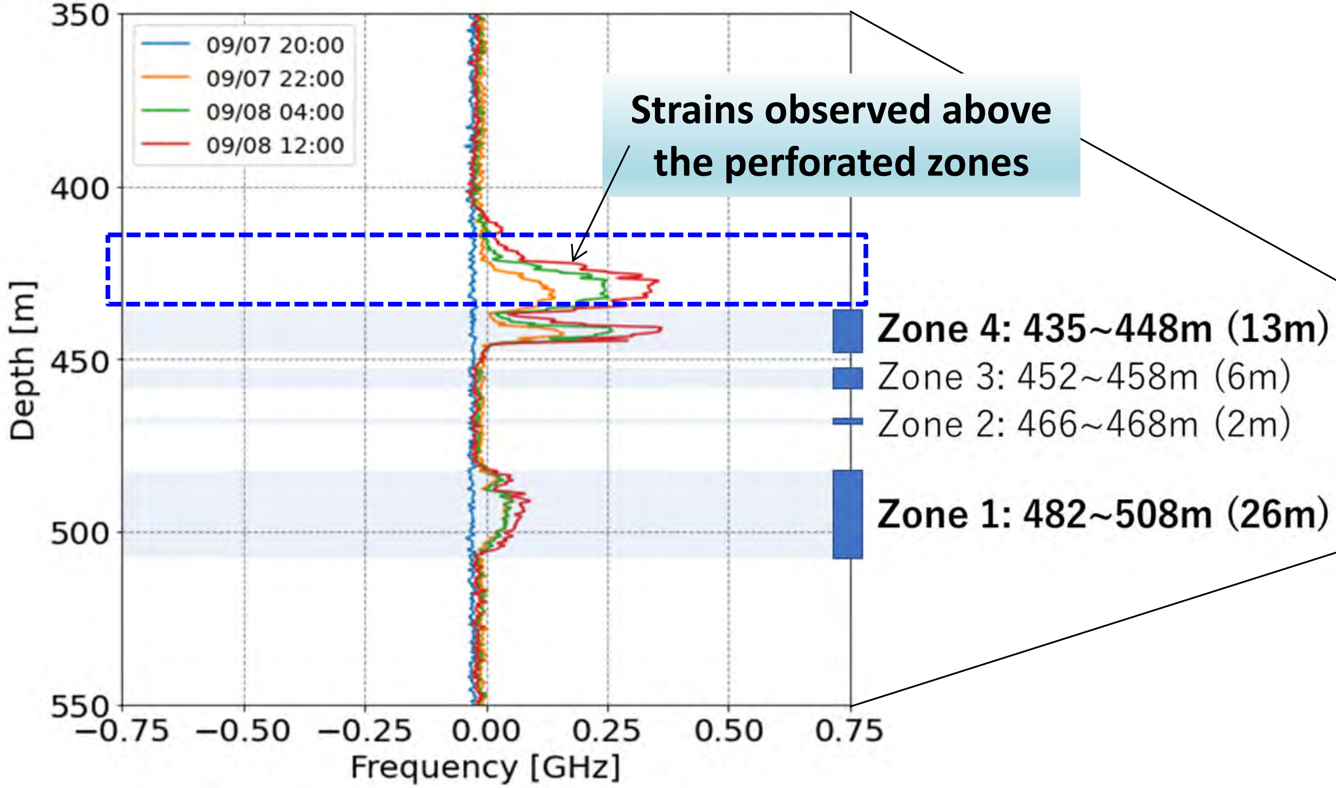
Fiber optic strain response detected at 9m away from the drilling well

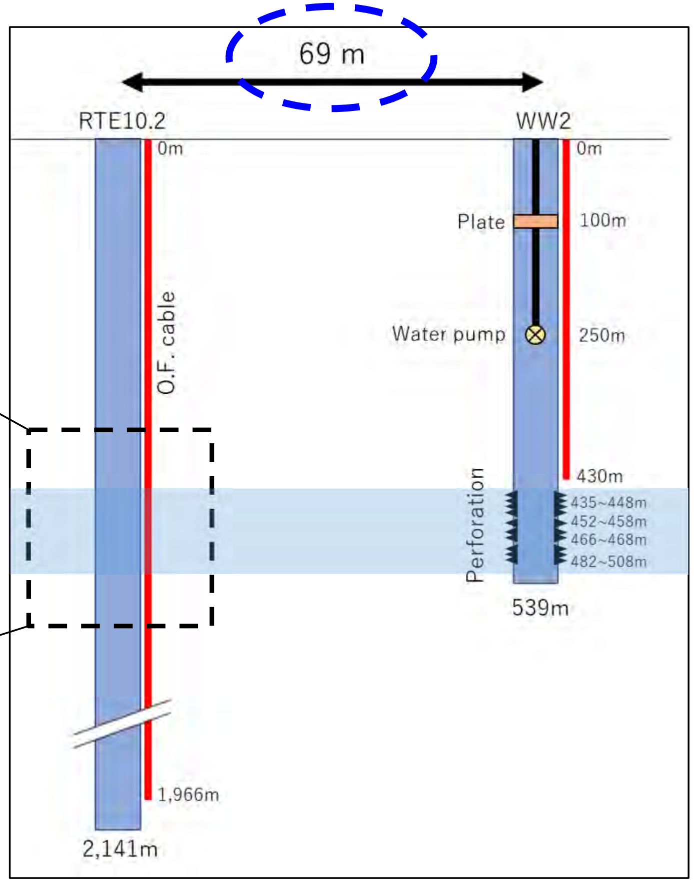


DSS results from water pumping (sampling), North Dakota

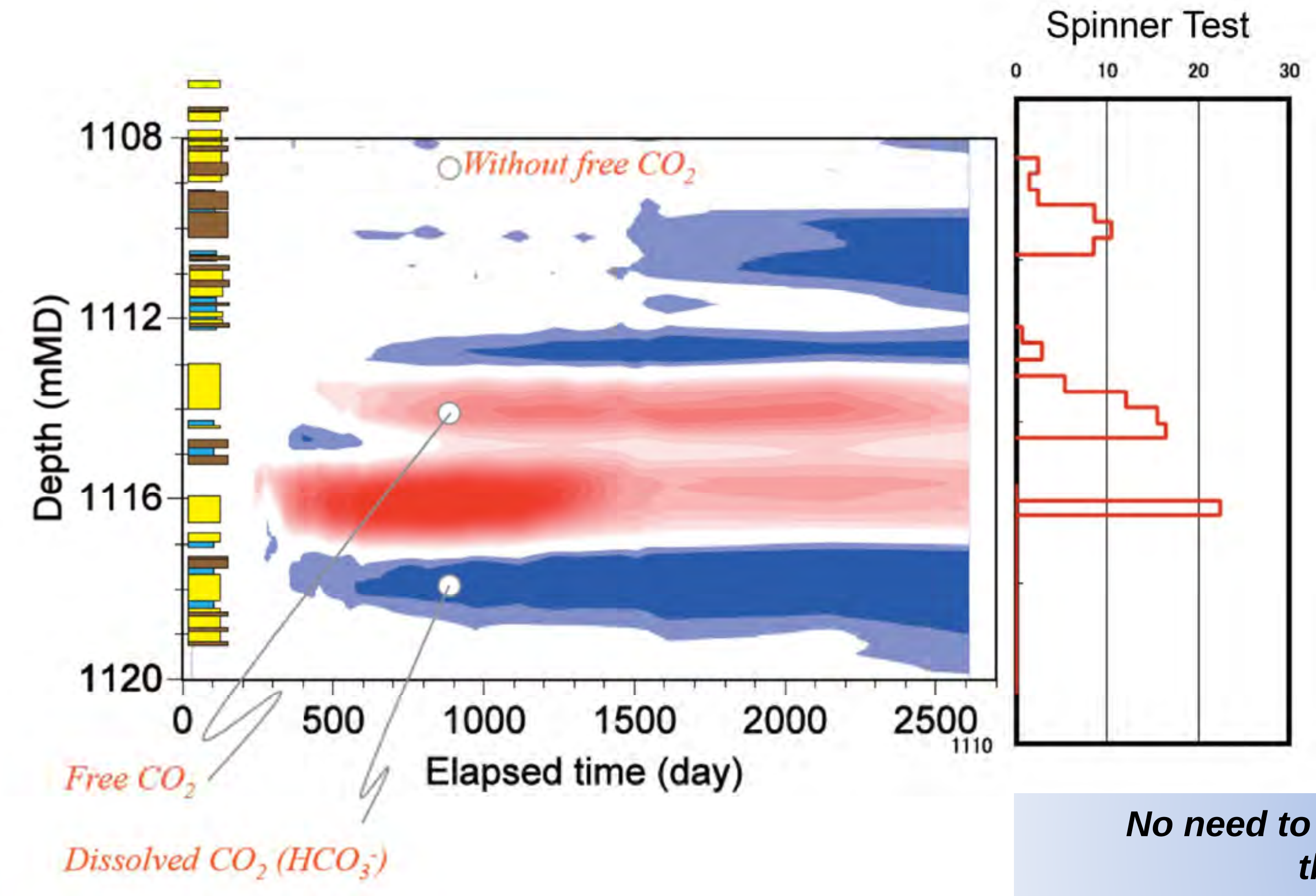
Xue et al., submitting to IJGGC

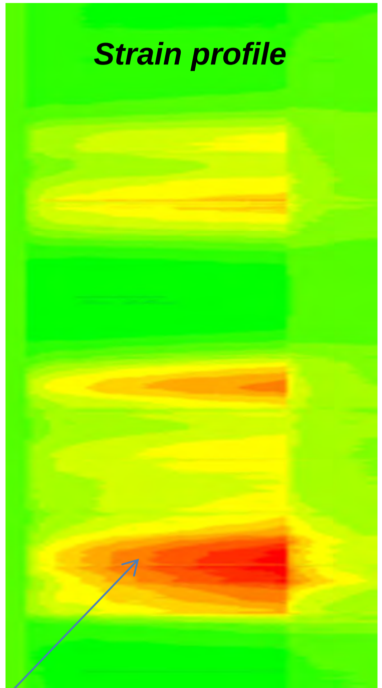
Small strain (< 5 $\mu\varepsilon$), production profile





Application #1 Strength profile from injection well or observation well as injection profile (as an input for CO_2 flow simulation)



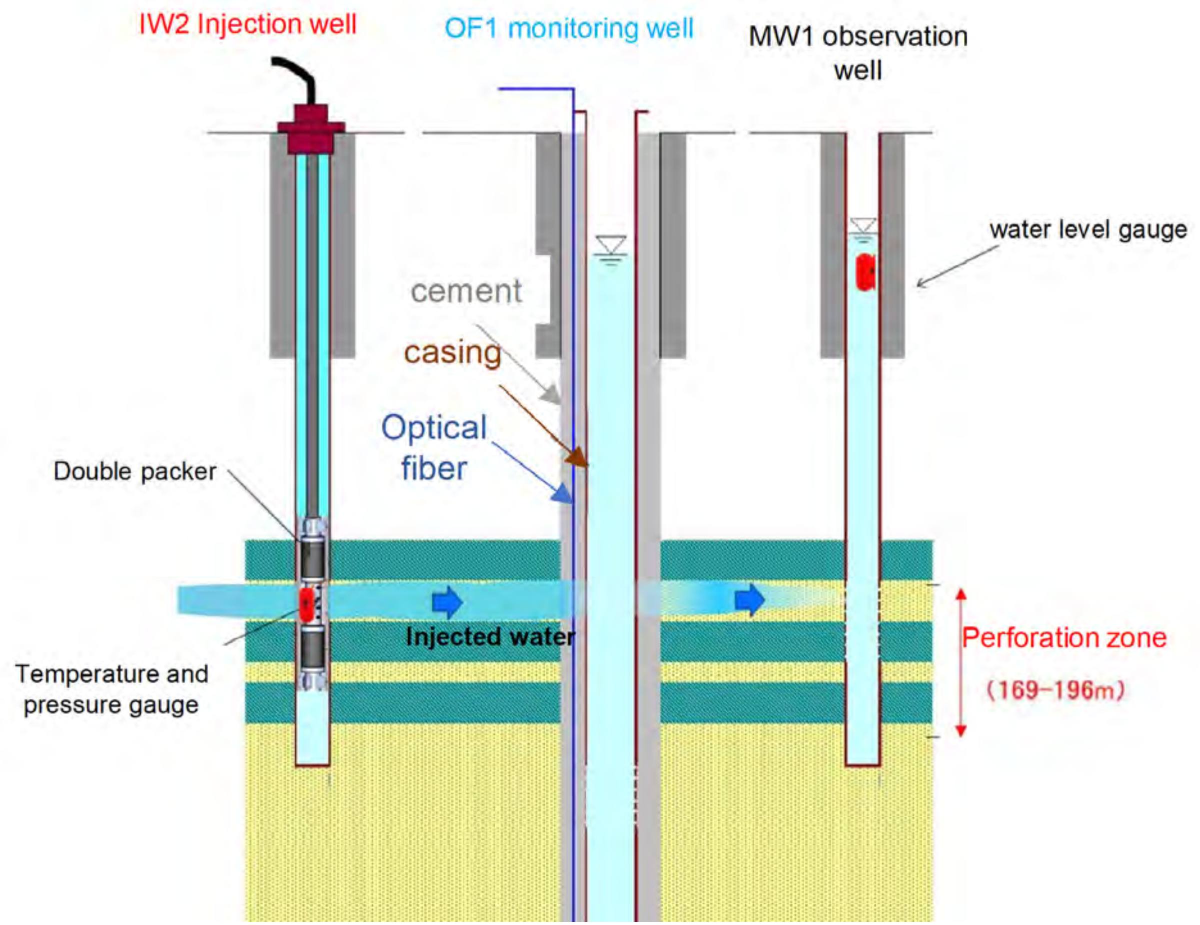


No need to run the spinner test to collect the injection profile !

DFOSS for Geomechanical Monitoring

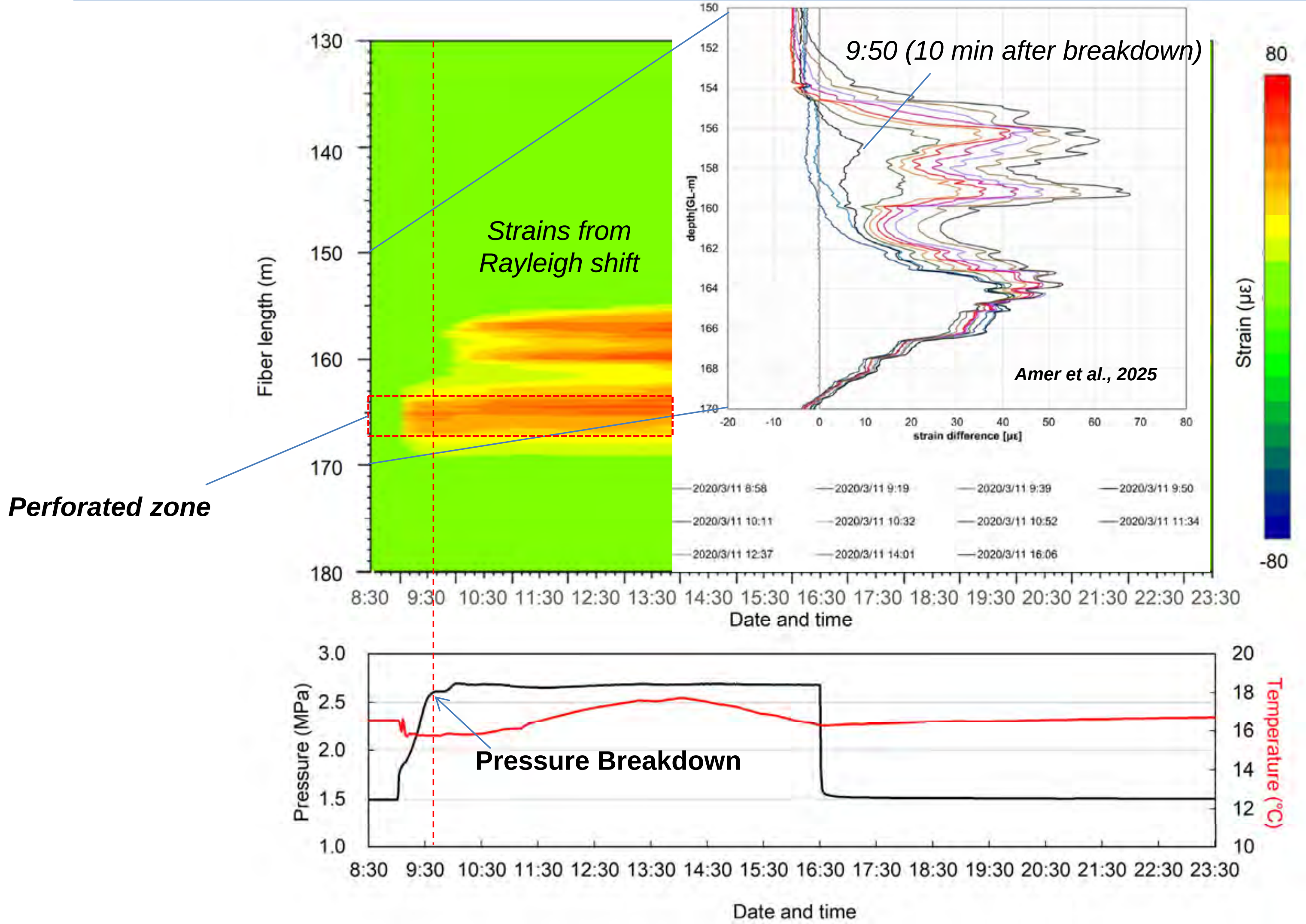
Water Injection Test (1/2)

Amer et al., 2025

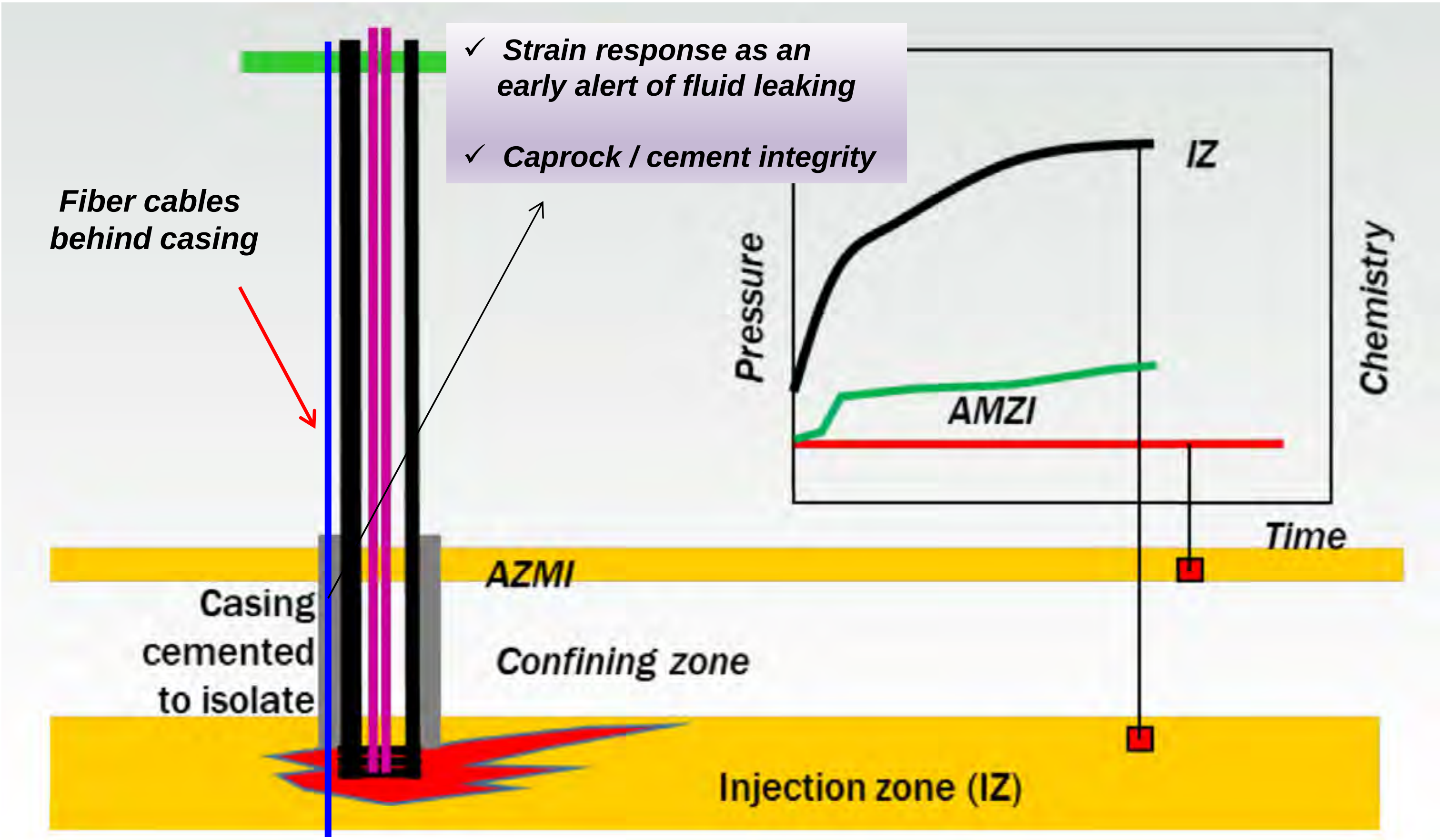


Strain profile suggests injection profile, revealing reservoir heterogeneity

DFOSS for Geomechanical Monitoring
Water Injection Test (2/2)



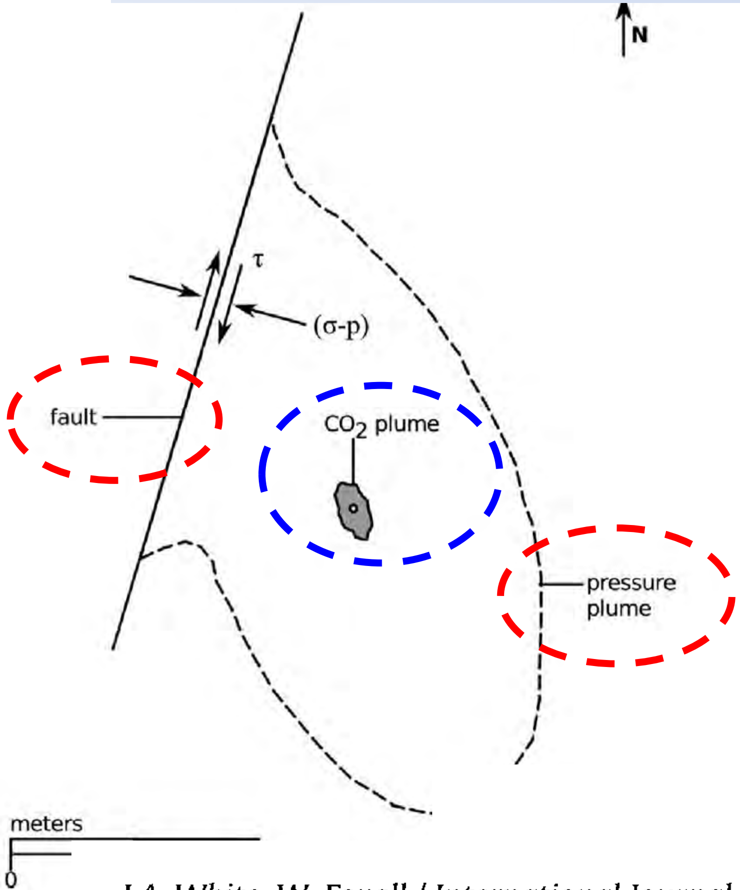
Application #2 for well integrity monitoring, combined with AZMI (Above-Zone Monitoring Interval) pressure monitoring



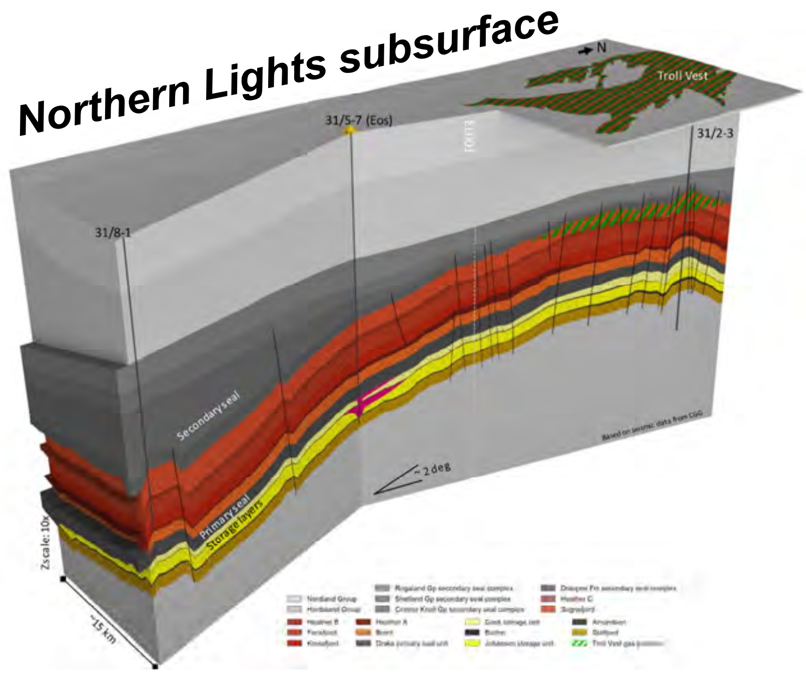
Hovorka et al, 2018

CO_2 plume front *vs* pressure front

(Geomechanical Modeling)



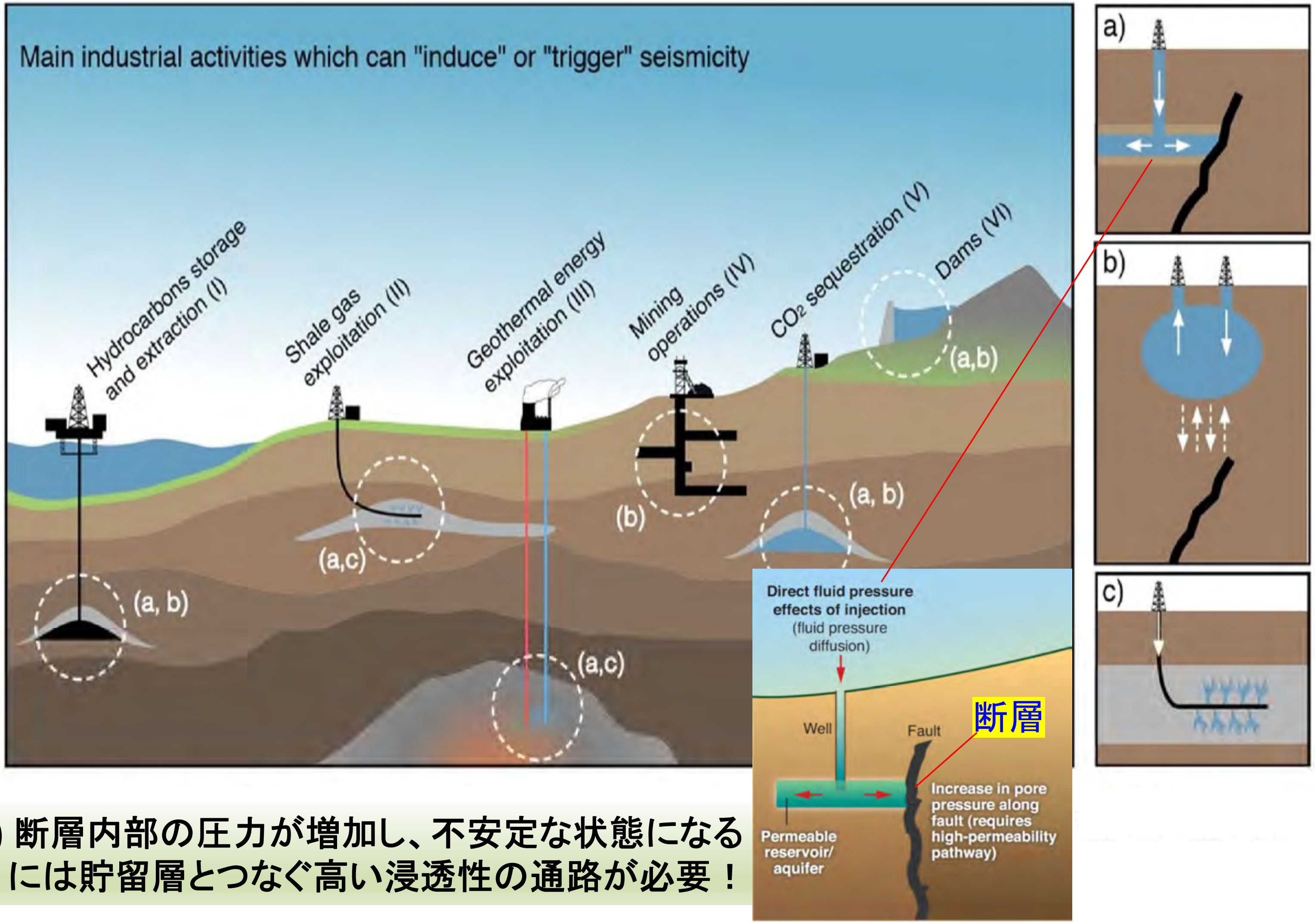
J.A. White, W. Foxall / International Journal of Greenhouse Gas Control 49 (2016) 413–424



Schematic of the subsurface going from south to north through the 31/5-7 (Eos) CO_2 confirmation well. The CO_2 plume extent after 37.5 Mt injection is illustrated in magenta.

https://www.equinor.com/en/news/20201019-sharing-data-northern-lights.html

人間活動と誘発地震について



(a) 断層内部の圧力が増加し、不安定な状態になるには貯留層とつなぐ高い浸透性の通路が必要！

Accounting for Offbeat Earthquakes Could Improve Forecasts

A new model considers the full history of earthquakes on a fault, improving forecasts of when the next will strike.

By Erin Martin-Jones

It's one of the toughest questions seismologists face: When will the next big earthquake occur? Although seismologists are **not able to predict earthquakes**, they can make forecasts showing the probability of one happening in a given area.

> ***"Earthquakes are almost like an unreliable bus, sometimes turning up sooner or later than expected."***

Taking the Strain

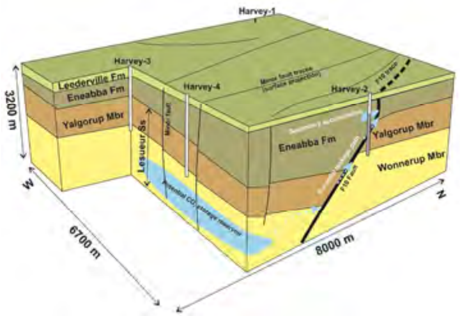
allows researchers to estimate how much the surrounding rocks have deformed along a fault over time. This buildup of what is known as strain influences whether earthquakes arrive ahead of schedule.

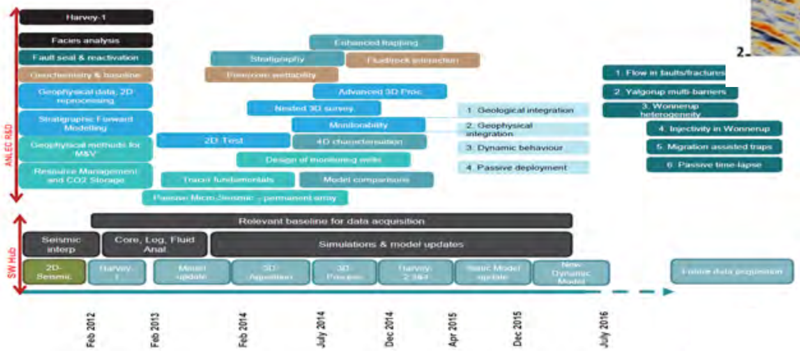
Since the devastating **1906 San Francisco earthquake**, seismologists have supposed that slow movements along a fault cause strain to build up, all of which is released in a big earthquake.

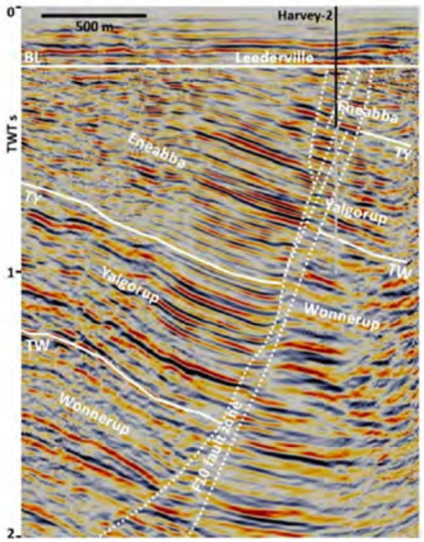
Collaborations: RITE-CSIRO
Fiber Optic Sensing for Fault Zone Mapping and Stability Monitoring

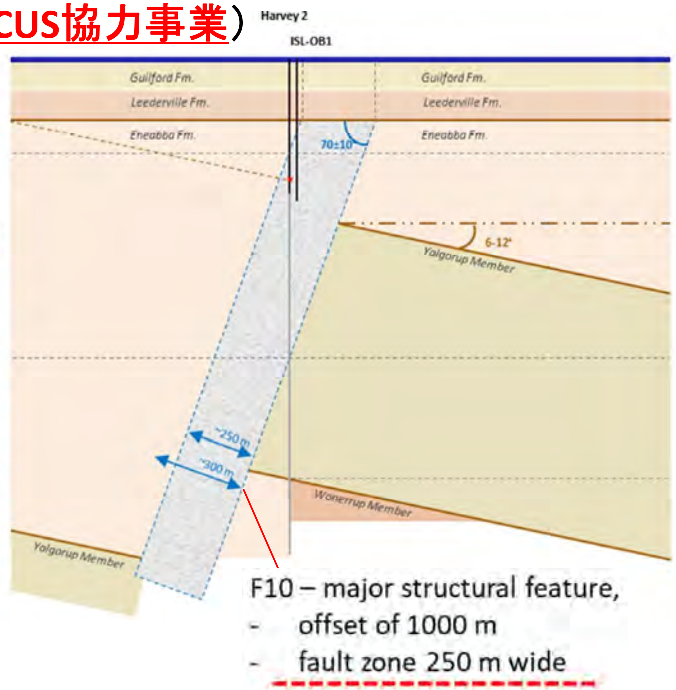
（日豪CCUS協力事業）

In Situ Lab / SW-Hub: South Perth



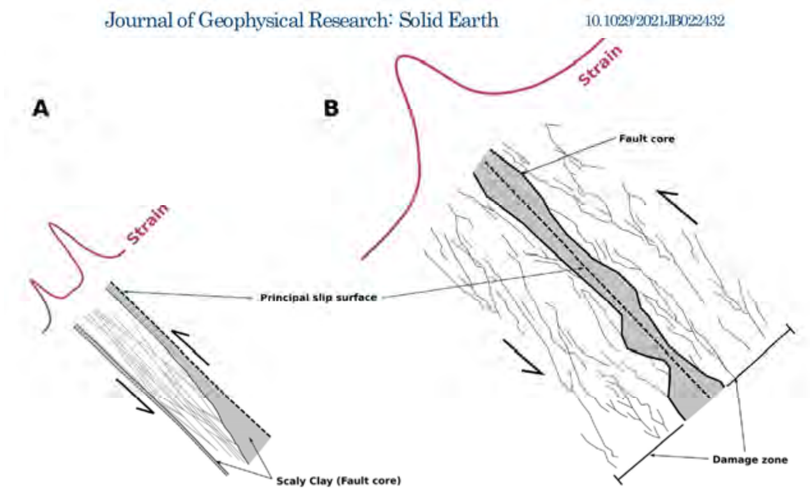


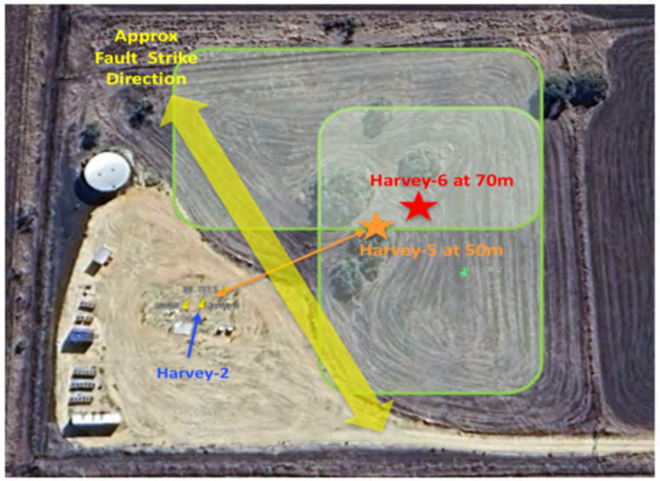




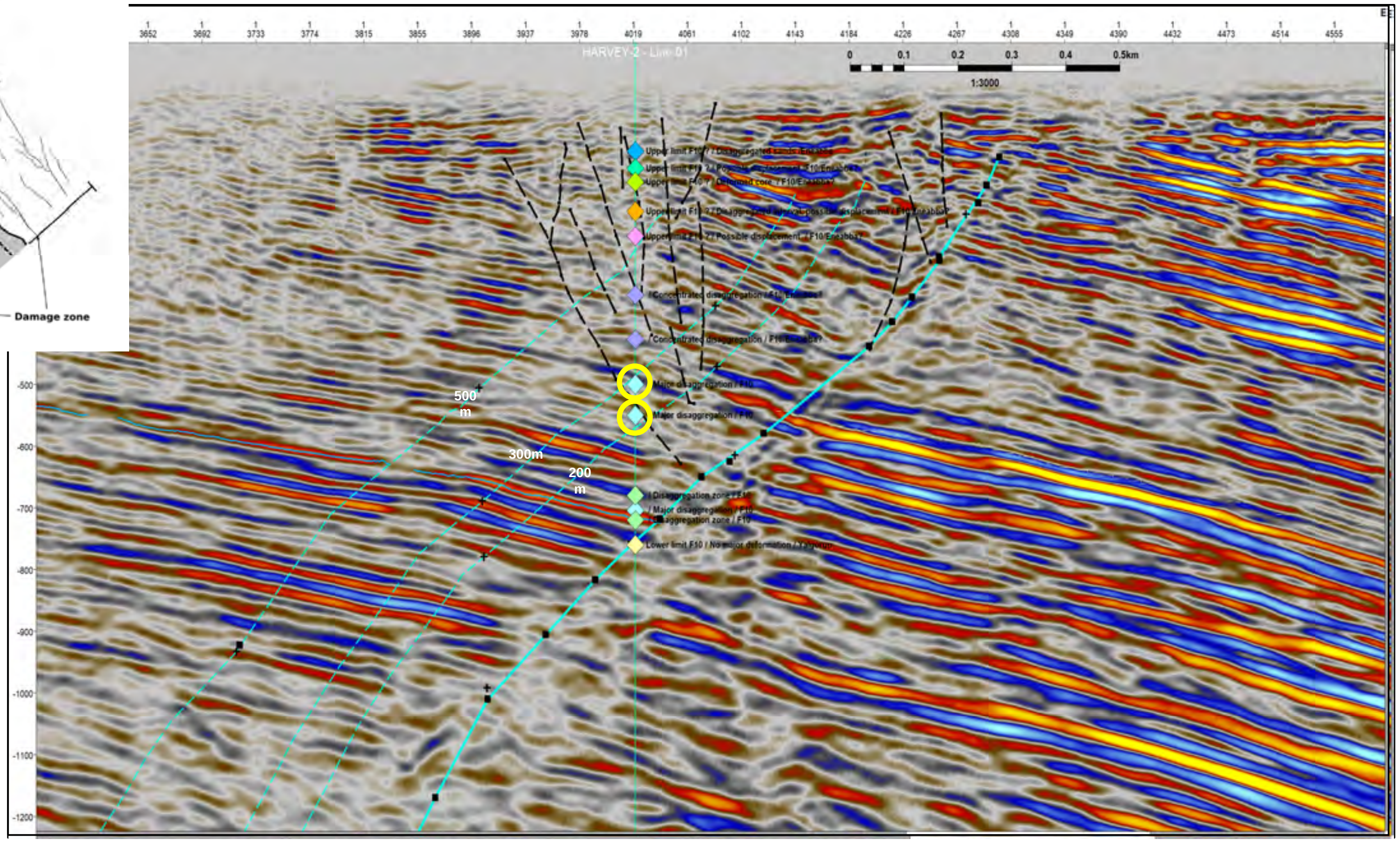
- Fault zone mapping and monitoring with Strain Sensing (RITE) coupled with temperature and acoustic sensing (CSIRO)

Fault Characterization (fault zone, hydraulic-mechanical property)
Drilling two new wells and applying Fiber Optic Strain Sensing





the relationship between fault core/gouge, principal slip surfaces, and the 'fault damage zone'



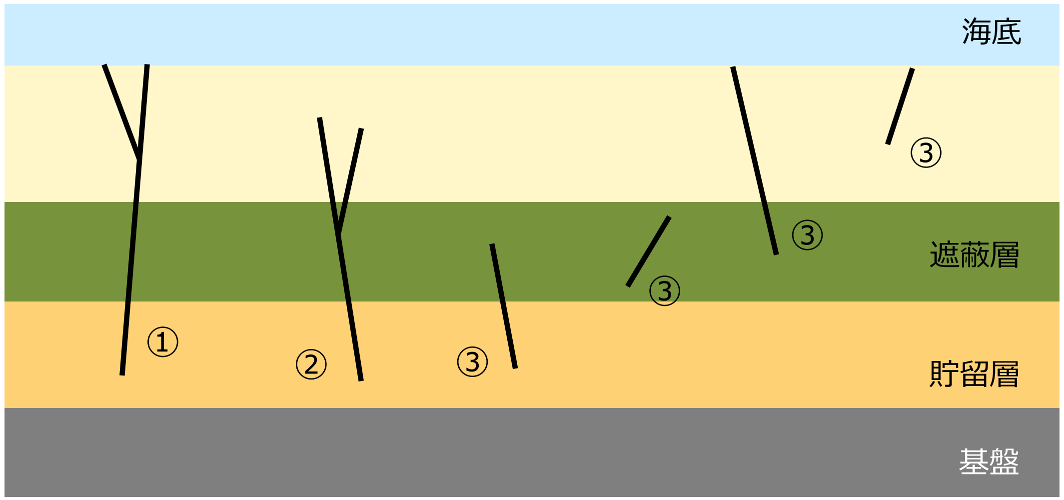
■断層区分（カテゴリー）

カテゴリー①：貯留層から連続し、海底面まで変位を与える断層
⇒　断層活動として確実度が高い断層と見做し、離隔対象とするべきか？

カテゴリー②：貯留層から連続し、遮蔽層の上部まで変位を与える断層

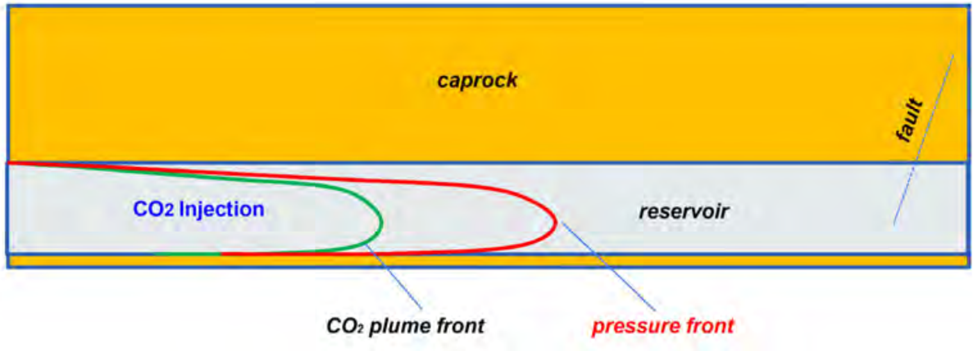
カテゴリー③：その他（貯留層を切るが遮蔽層内で止まる断層、遮蔽層内の断層など）

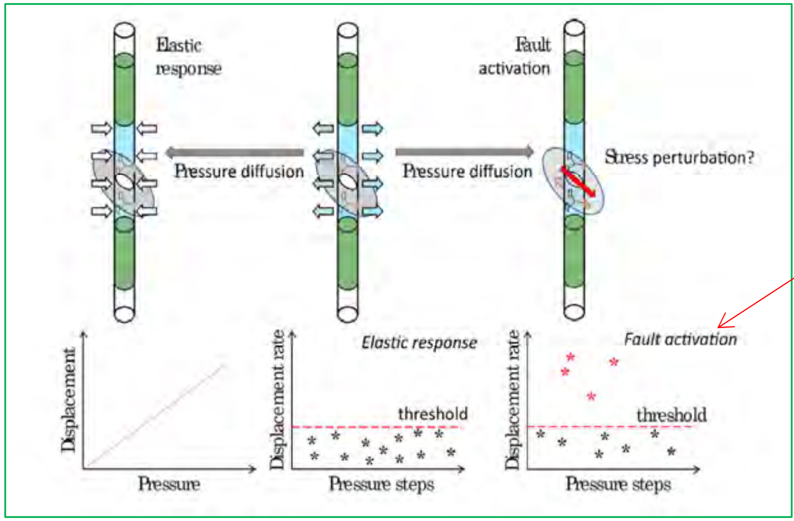
■断層タイプ　正断層・逆断層・横ずれ断層、断層長、断層上下端深度



✓ サイト選定では、どの断層を離隔すべきか。妥当な離隔距離は？

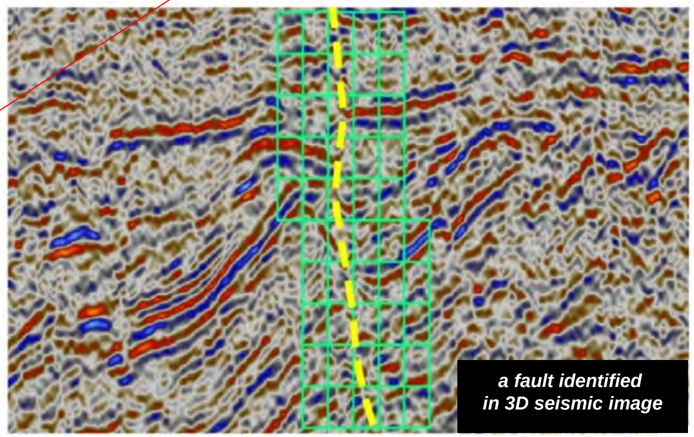
Fault Integrity Monitoring (reactivation, leakage) with Fiber Optic Sensing





Kakurina et al, 2020

Installing fiber optic cables behind casing of monitoring wells for Distributed Strain, Temperature and Acoustic sensing



EXPRO

Superior ENERGY SERVICES

TASMAN

SILIXA A LUNA company

ASCO

slb

Cactus

NMG NEIL MANSELL GROUP

KENNARDS HIRE

AZTECH WELL CONSTRUCTION

CCI CLEAR CUT INTERVENTIONS

PHOENIX PETROLEUM

NEWPARK

LEISTON ENGINEERING PTY LTD

SKIPPERS TRANSPORT

OILFIELD TRADERS AUSTRALIA

P &T Curulli and Son

CARBONE

WAROONA HARVEY BUS SERVICES

West Coast Waste

SANDGROPER CONTRACTING

HUCKLEBERRYS Tank and Water Service

ROBERT'S TILT TRAY & HIAB

TONY'S Mechanical Services and Lubricants

OLD COAST RD BREWERY

Amana Inn

Brugan

Harvey Homestead

Chalbury Park B&B

IGA

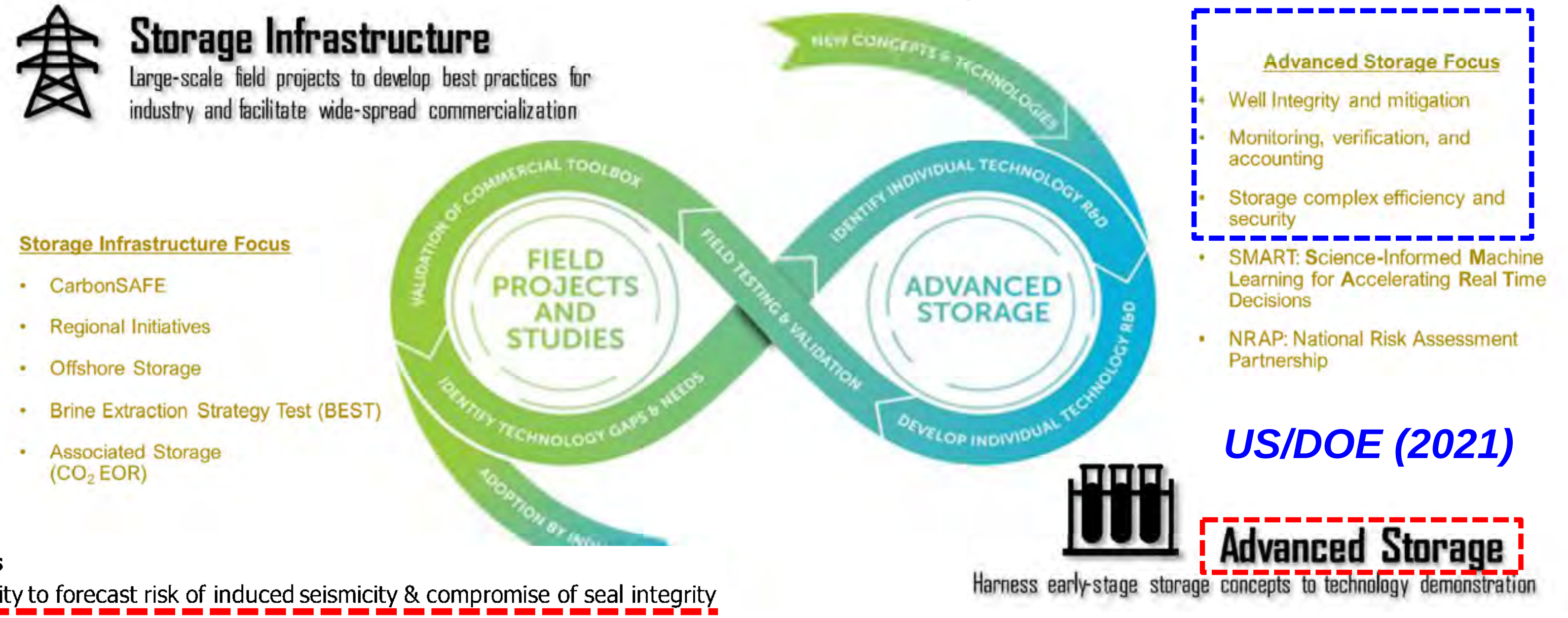
CSIRO In-situ Laboratory

CSIRO

RITE Research Institute of Innovative Technology for the Earth

これからの研究開発(advanced storage)：事業(field projects)との密接な連携

Iterative Process towards Deployment



US/DOE (2021)

Subsurface stress
- improved capability to forecast risk of induced seismicity & compromise of seal integrity

Wellbore integrity
- Find & assess legacy wells and novel materials/techniques for remediation

Secure storage
- Improve AZMI tools

Plume detection and storage efficiency
- Locate plume margins & pressure increase; improve use of pore space)

Site characterization
- Map reservoir & seal heterogeneities and deep faults

Regional resource estimates
- filling the data gaps & realistic basin-scale storage estimates)

Transformational sensing
- Micro/nano and optical fiber sensing capabilities; wireless power/telemetry systems; edge computing to enable intelligent monitoring systems

➢ **With JCCS**

➢ **Collaborating with North Dakota University in USA**

➢ **Collaborating with CSIRO in Aus.**

AOI 1: Fault Detection, Characterization, and Hazard Assessment
Focused on developing new characterization methods for providing high-fidelity data on faults, fault slip or potential fault slip, assessment of faults during active injection, criteria for cost-effective methods for assessing and choosing a site, and other related research

謝 辞

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