◆ CCS Technical Workshop 2022 ◆

CO_2地中貯留技術開発と実用化への取組

From Research and Development to Demonstration for Commercial Deployment

二酸化炭素地中貯留技術研究組合・技術部長

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1．温故知新－CO_2-EOR/ CO_2地中貯留

Before looking ahead, let's review the journey so far

(DOE, 2020)

Enhanced Oil Recovery - US

- 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

Commercial Scale： 1Mt /year

Weyburn – Saskatchewan

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

JAPAN： Nagaoka Pilot CO_2 Storage Project USA： Texas Frio Pilot CO_2 Storage Project

Carbon Storage Program

Improving and Optimizing Performance

US/DOE (2020)

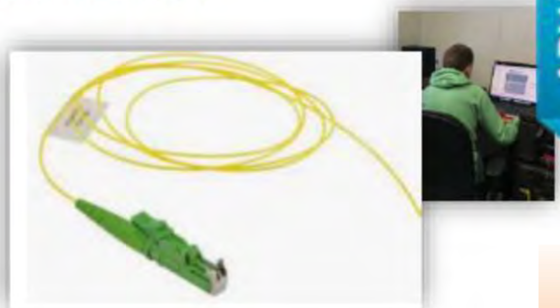
Regional Carbon Sequestration Partnerships (RCSPs)

地域特性を考慮

2011- (new regional initiative)

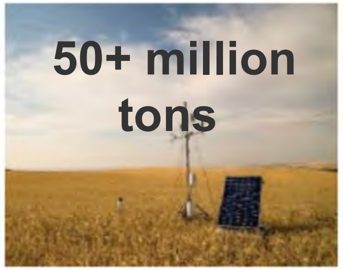
2005-2011
1 million tons

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

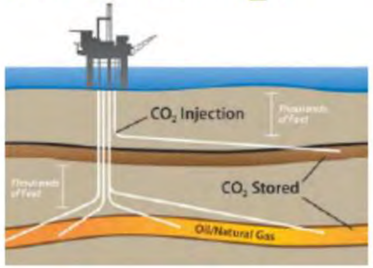


Fiber Optic Distributed Acoustic Sensing (DAS)

CarbonSAFE

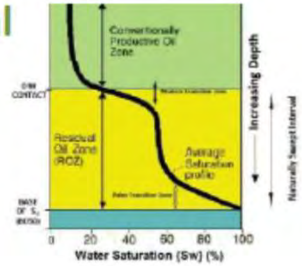


Offshore Storage



Unconventional EOR

Shale Oil EOR



CARBON STORAGE PROGRAM

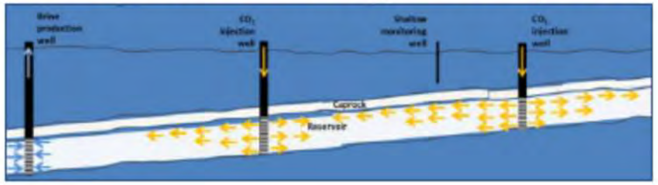
ADVANCED STORAGE R&D

- Plume Detection and Storage Efficiency
- Secure Storage
- Subsurface Stress
- Wellbore Integrity
- Risk Assessment

STORAGE INFRASTRUCTURE

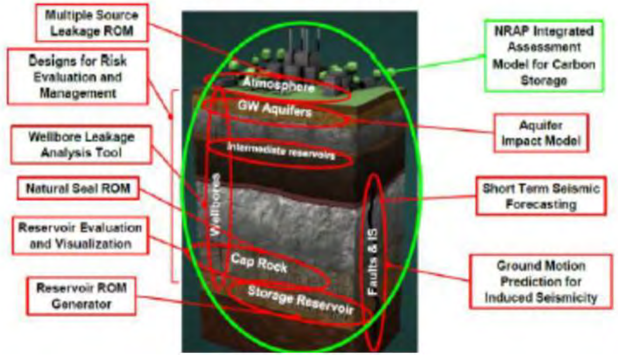
光ファイバーセンシング技術
（分布式音響測定 - DAS）

Brine Extraction Storage Tests (BEST)



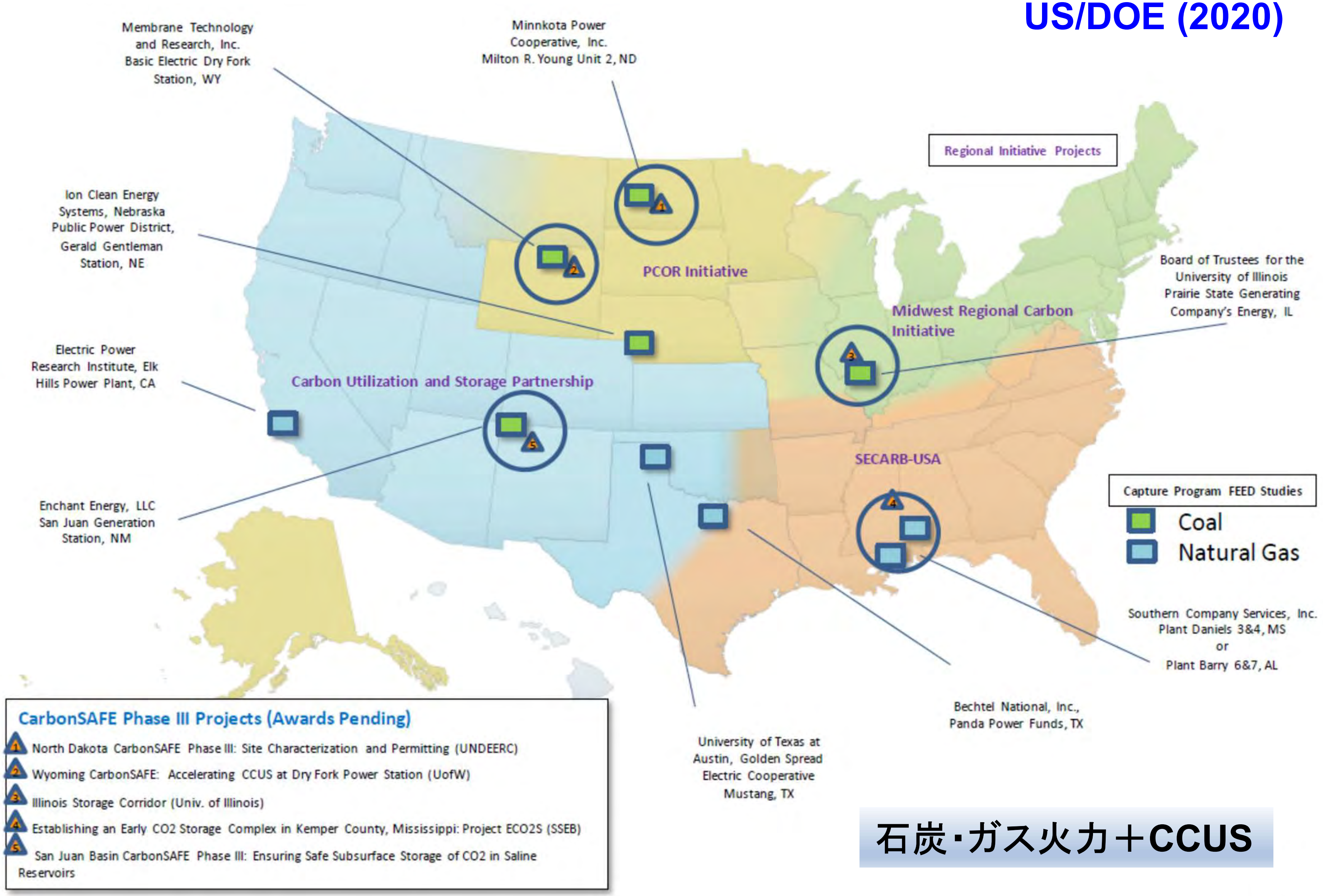
地層水汲み上げによる圧力緩和法

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



Carbon Storage Assurance Facility Enterprise (CarbonSAFE)

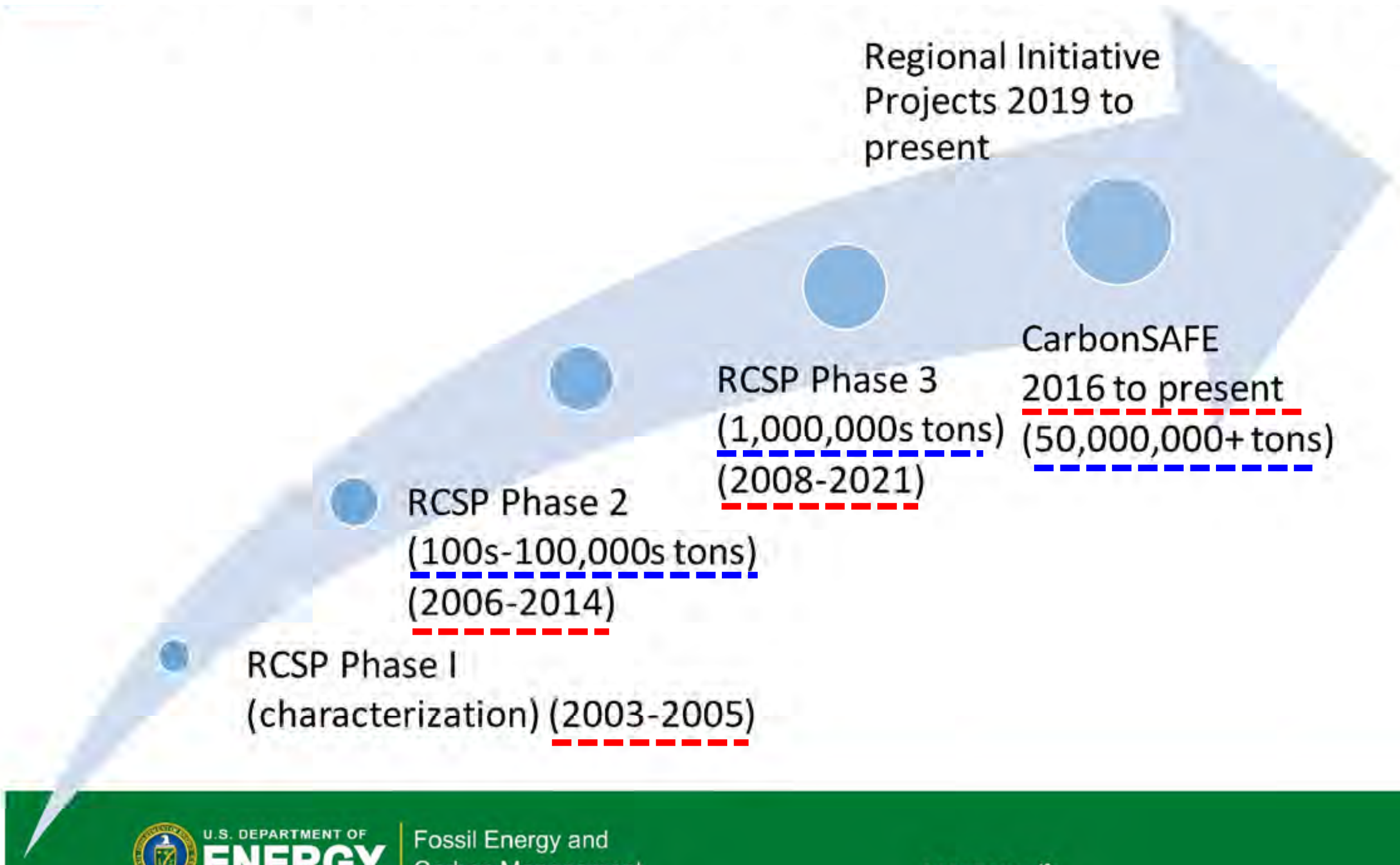
US/DOE (2020)



石炭･ガス火力＋CCUS

Carbon Storage Field Activity Progression

US/DOE (2021)



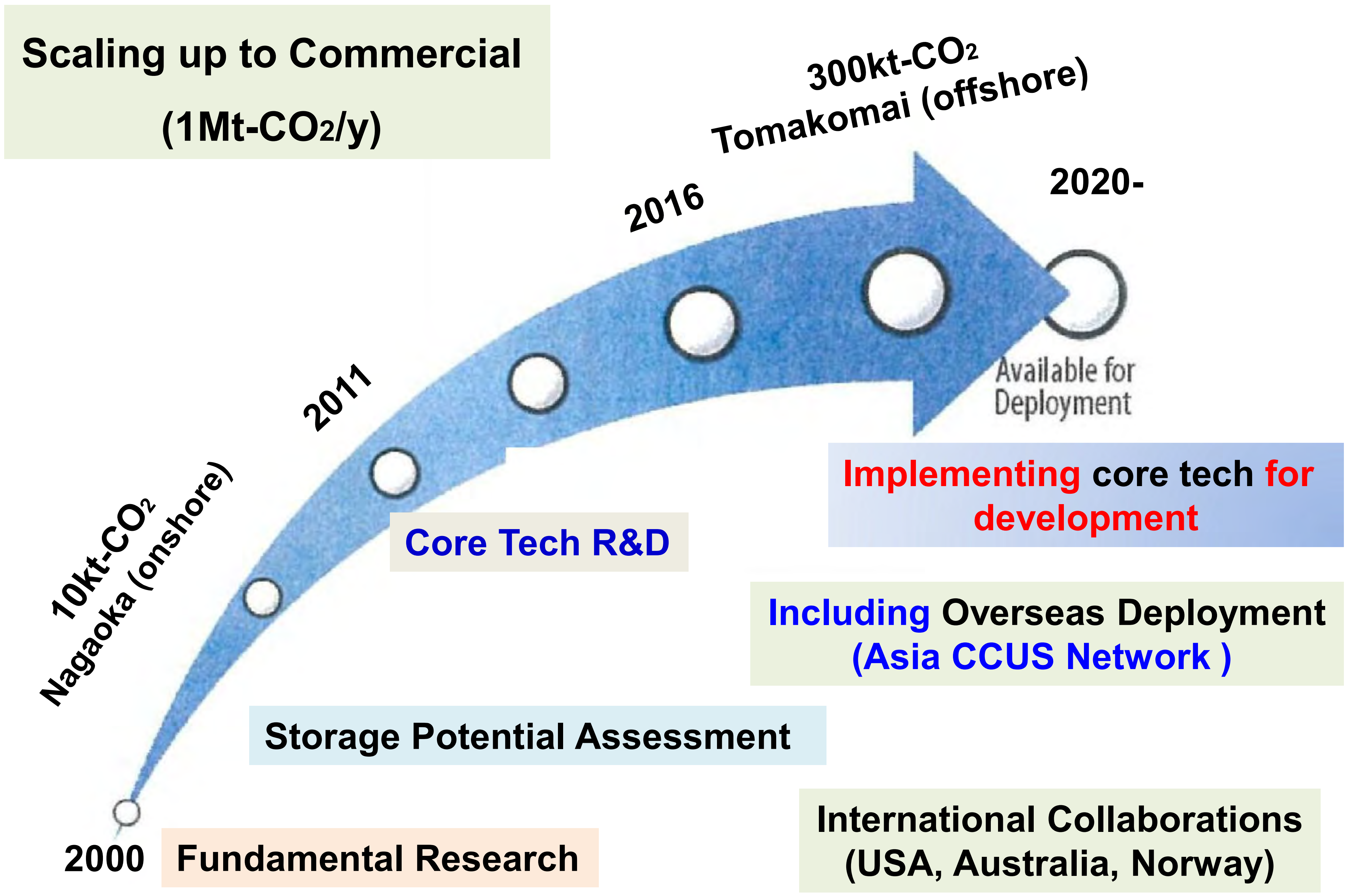
Setting the stage for deployment but many more projects needed to meet emission reduction targets

Supporting field projects

- Pressure and Water Management (BEST)
- CO_2-EOR and associated storage – leveraging existing infrastructure for dedicated storage; net negative oil.
- Offshore Storage

U.S. DEPARTMENT OF ENERGY | Fossil Energy and Carbon Management   energy.gov/fe   5

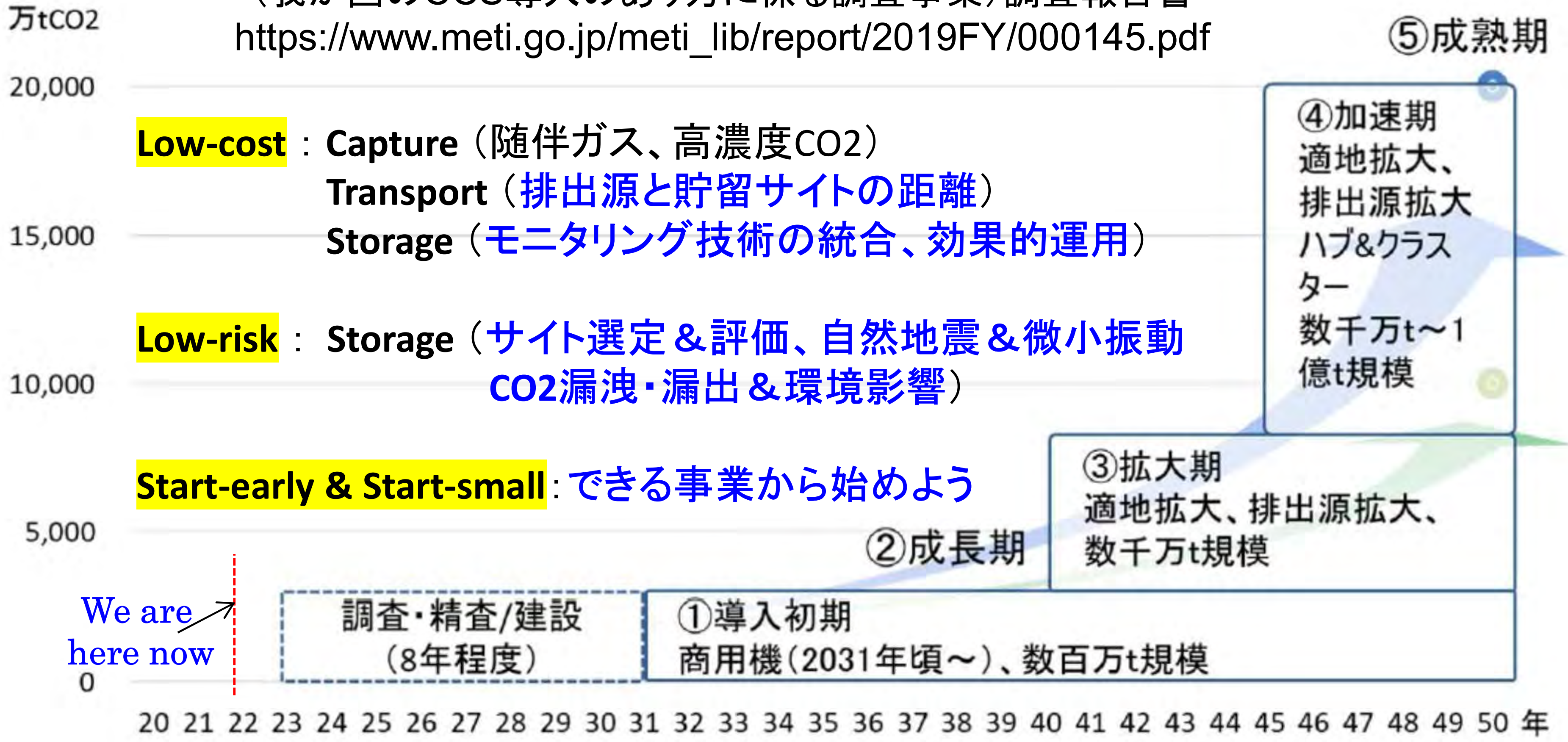
Up-Scaling:　数100～数10万トン　→→　100万トン　→→　5,000万トン


Scaling up to Commercial
(1Mt-CO_2/y)
300kt-CO_2
Tomakomai (offshore)
2016
2020-
Available for
Deployment
2011
10kt-CO_2
Nagaoka (onshore)
Core Tech R&D
Implementing core tech for
development
Including Overseas Deployment
(Asia CCUS Network)
Storage Potential Assessment
2000
Fundamental Research
International Collaborations
(USA, Australia, Norway)

➢ Scaling up to Commercial-scale

2050年に向けて、徐々に拡大するケース

（我が国のCCS導入のあり方に係る調査事業）調査報告書
https://www.meti.go.jp/meti_lib/report/2019FY/000145.pdf



50年にカーボンニュートラル（実質排出ゼロ）を実現するために、今から毎年、同じ削減量で減らしていくと計算すると、30年時点では45.9％の削減が必要になる。この計算で割り出された数字を意識して、新目標が決まったとみられる。

二酸化炭素地中貯留技術研究組合の概要 (2021年6月14日時点)

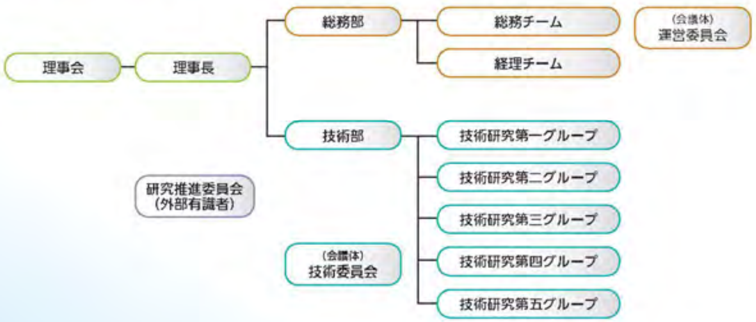
設立年月日

2016年4月1日

組 合 員

- ・応用地質株式会社
- ・株式会社INPEX
- ・石油資源開発株式会社
- ・大成建設株式会社
- ・国立研究開発法人産業技術総合研究所
- ・公益財団法人地球環境産業技術研究機構
- ・JX石油開発株式会社
- ・電源開発株式会社
- ・伊藤忠商事株式会社
- ・伊藤忠石油開発株式会社
- ・三菱ガス化学株式会社

組織構成



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

2021.6

二酸化炭素地中貯留技術研究組合

Geological Carbon dioxide Storage Technology Research Association

設立年月日

2016年4月1日

二酸化炭素地中貯留技術研究組合

組 合 員

Membership: 6 @2016.4 →→ 11 @2022.1

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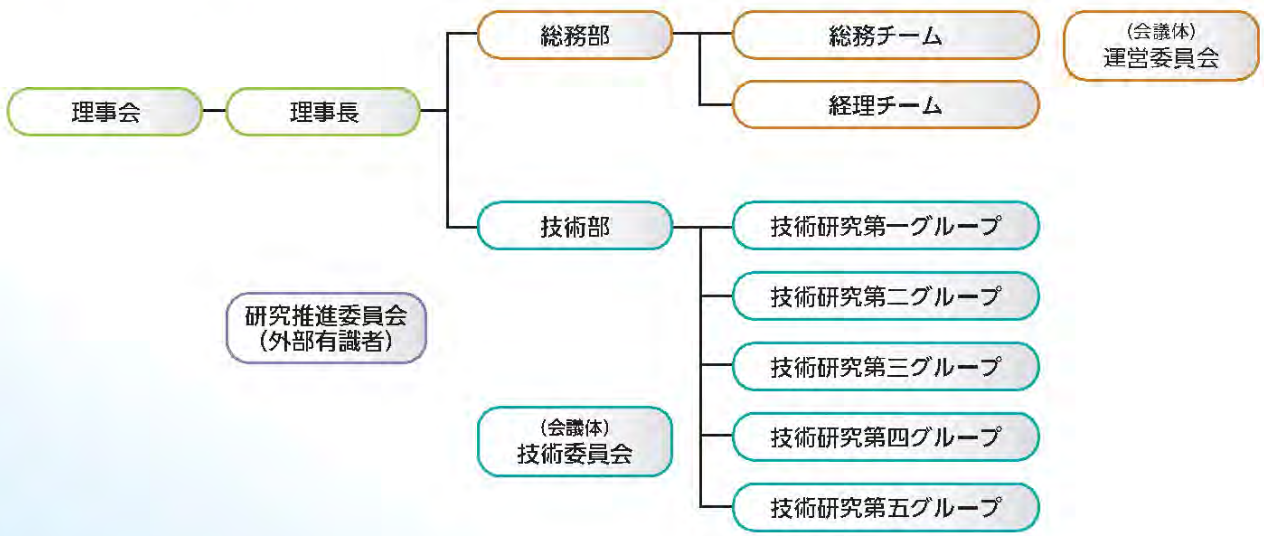


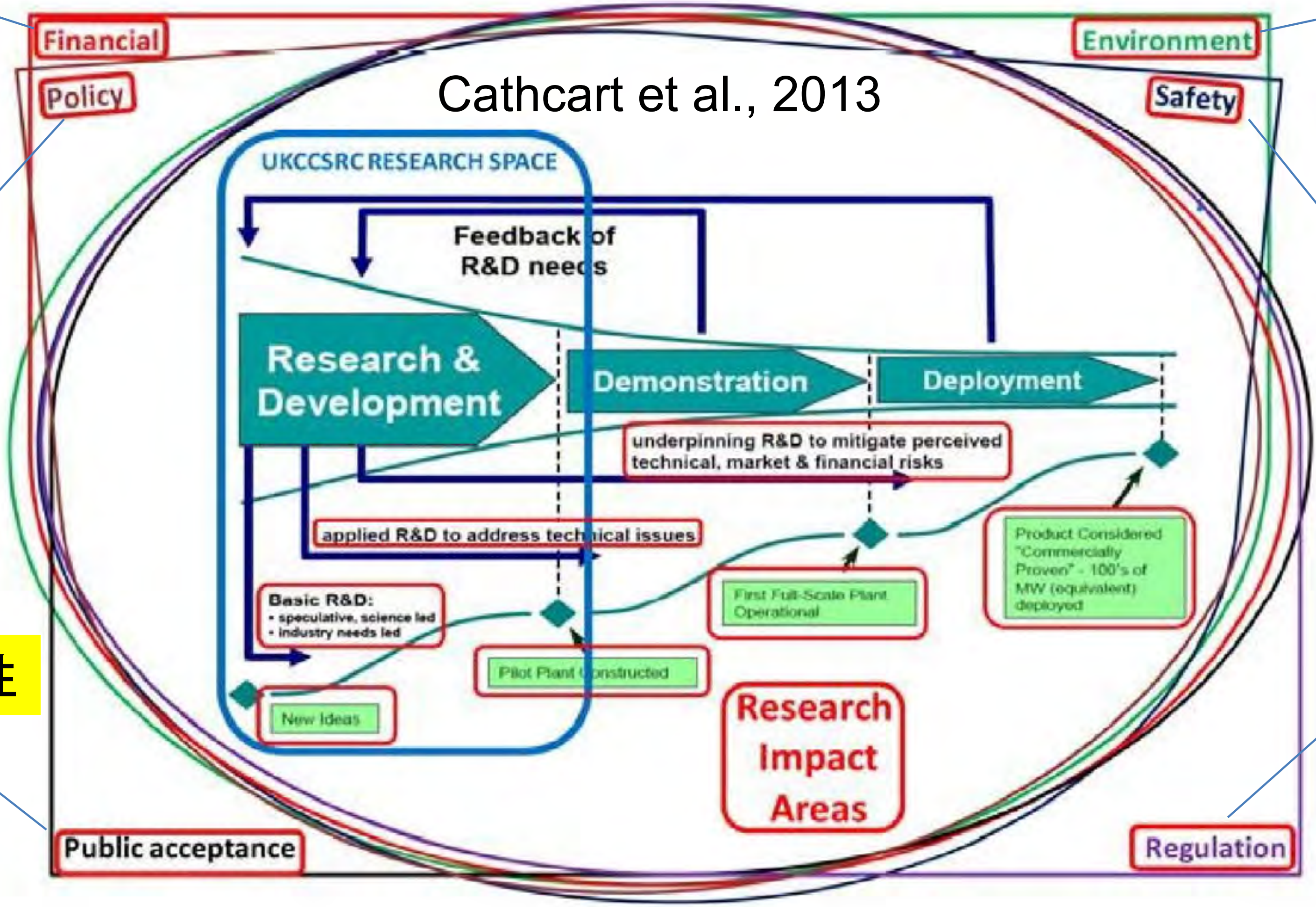
Research & Development → *Demonstration, Deployment*

不確実性の低減・安全性＆経済性の向上

投資

政策

社会的受容性



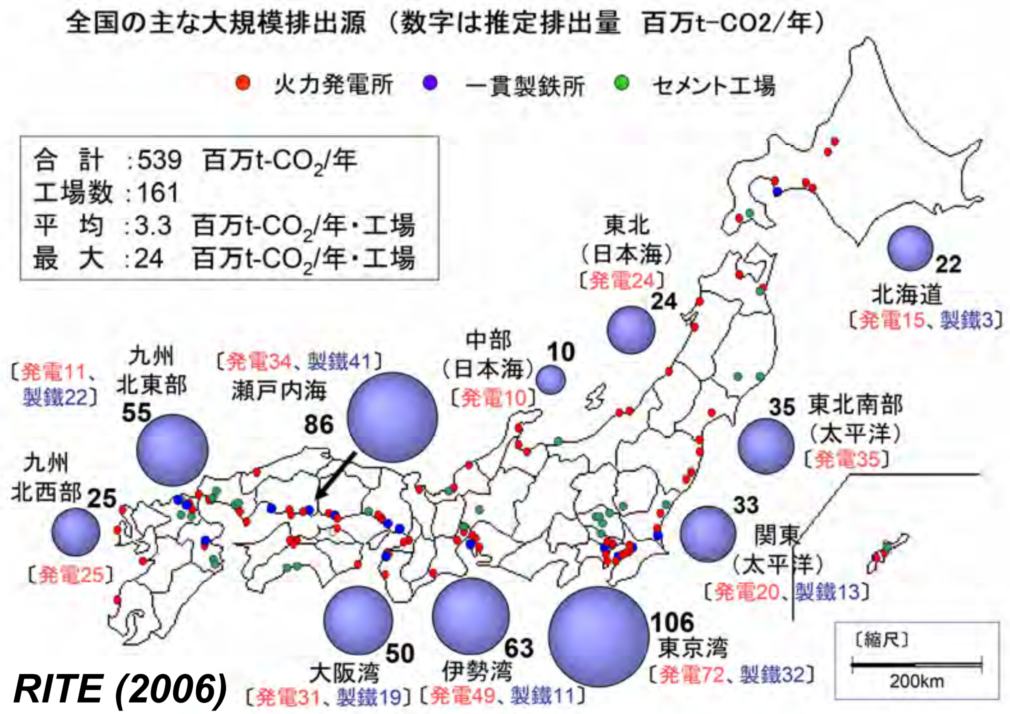
環境

安全性

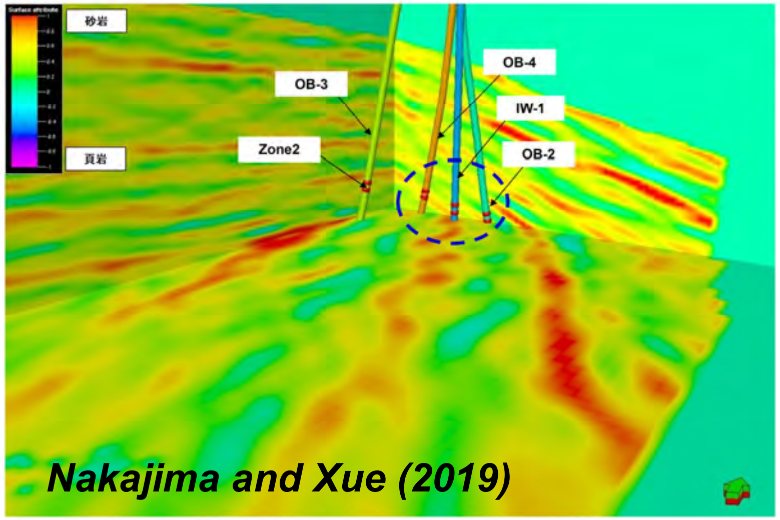
法規

実用化には、技術開発以外の要素（安全性、経済性、社会的受容性、法整備）

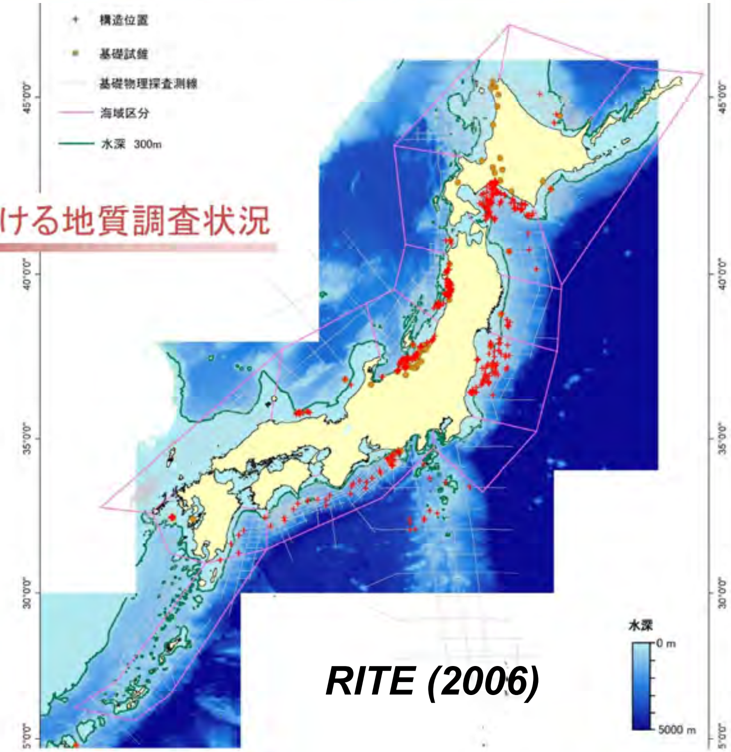
SRM: CO_2 Storage Resources Management（経済性評価込み）



RITE (2006)



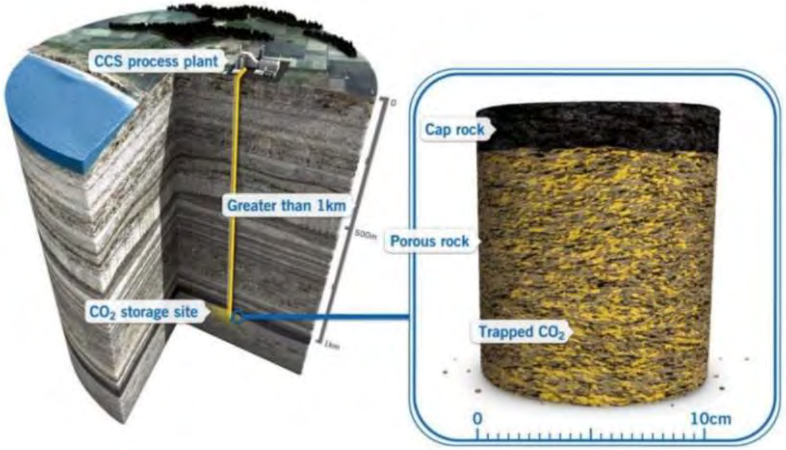
Nakajima and Xue (2019)



国内における地質調査状況

RITE (2006)

1. **Depth:** > 1 km
2. **Location:**
   - reservoir and containment
   - accessible
3. **Capacity:** Space to hold all the planned CO_2

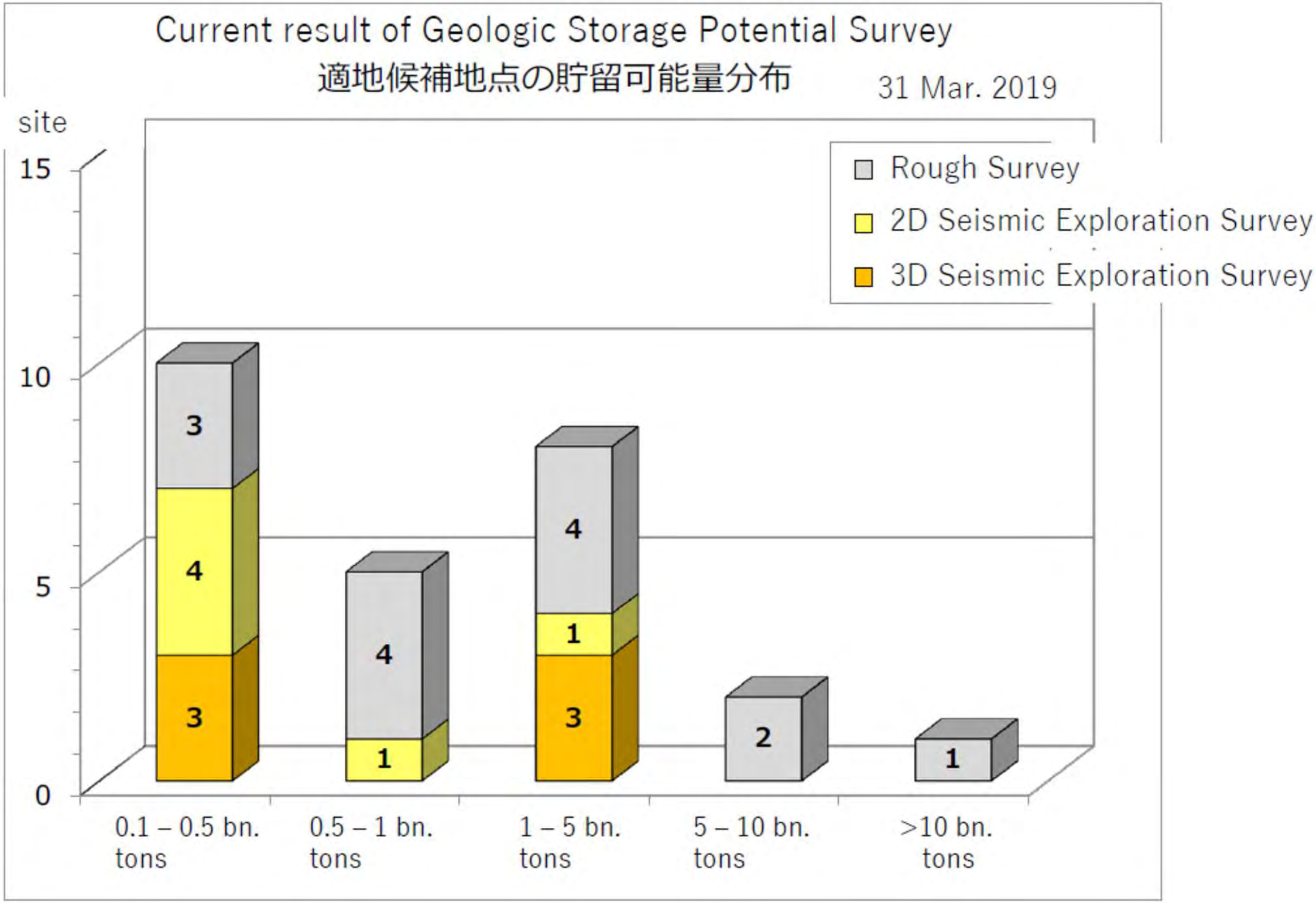


Source: GCCSI

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！

CO2 Storage potential in Japan

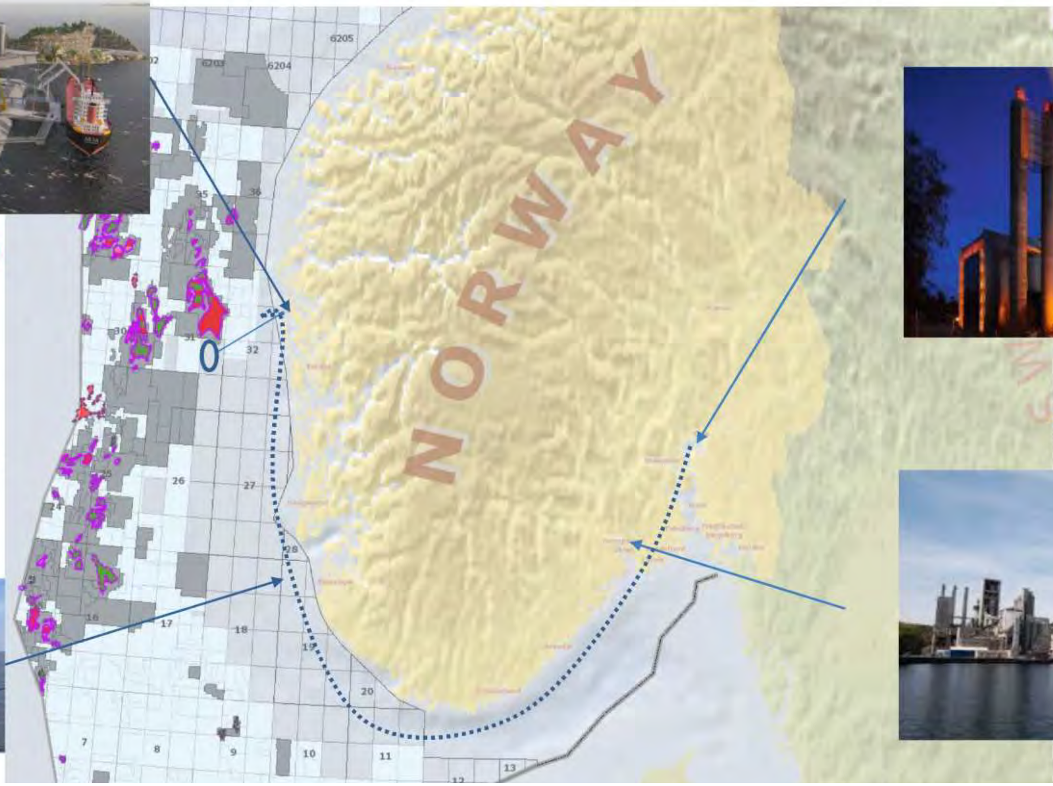
METI(2020)



The Norwegian CCS demonstration project

equinor TOTAL

Ship transport from capture to storage terminal – pipeline to offshore storage complex



Olje- og energidepartementet

fortum

Waste-to-energy 400 000 tonnes CO_2 per annum

NORCEM HEIDELBERGCEMENT Group

Cement production 400 000 tonnes CO_2 per annum

23 years experience with CCS and CO_2 Storage offshore Norway

"...realise a cost-effective solution for full-scale CCS in Norway, provided that this incite technology development in an international perspective".

Iterative Process towards Deployment

Storage Infrastructure

Large-scale field projects to develop best practices for industry and facilitate wide-spread commercialization

Storage Infrastructure Focus

- CarbonSAFE
- Regional Initiatives
- Offshore Storage
- Brine Extraction Strategy Test (BEST)
- Associated Storage (CO_2 EOR)

Advanced Storage Focus

- Well Integrity and mitigation
- Monitoring, verification, and accounting
- Storage complex efficiency and security
- SMART: **S**cience-Informed **M**achine Learning for **A**ccelerating **R**eal **T**ime Decisions
- NRAP: National Risk Assessment Partnership

US/DOE (2021)

Advanced Storage

Harness early-stage storage concepts to technology demonstration

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

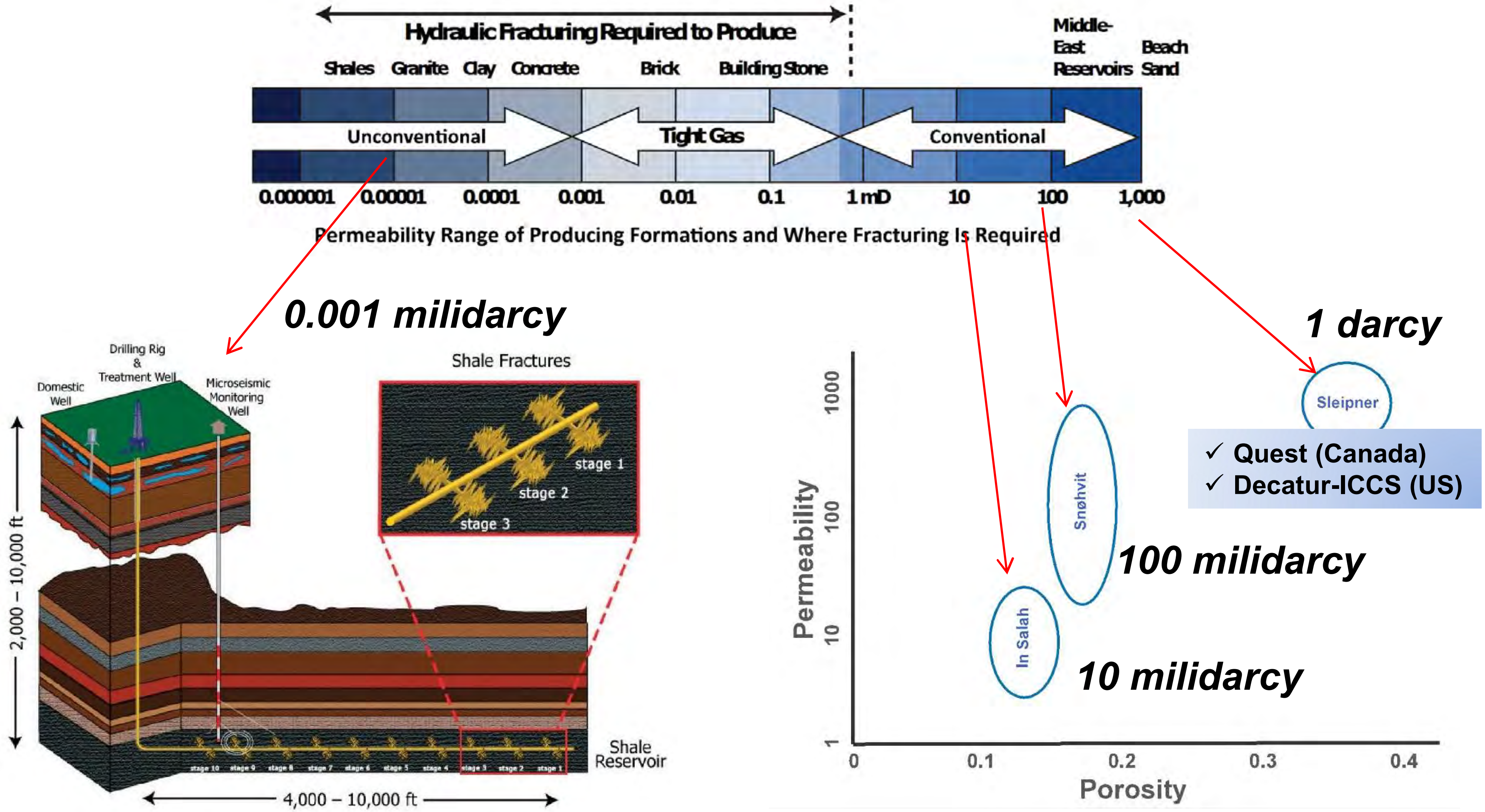
AOI 1: Fault Detection, Characterization, and Hazard Assessment

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

CO_2貯留層特性の違い：日本 vs 海外

（reservoir porosity, permeability, heterogeneity, thickness）

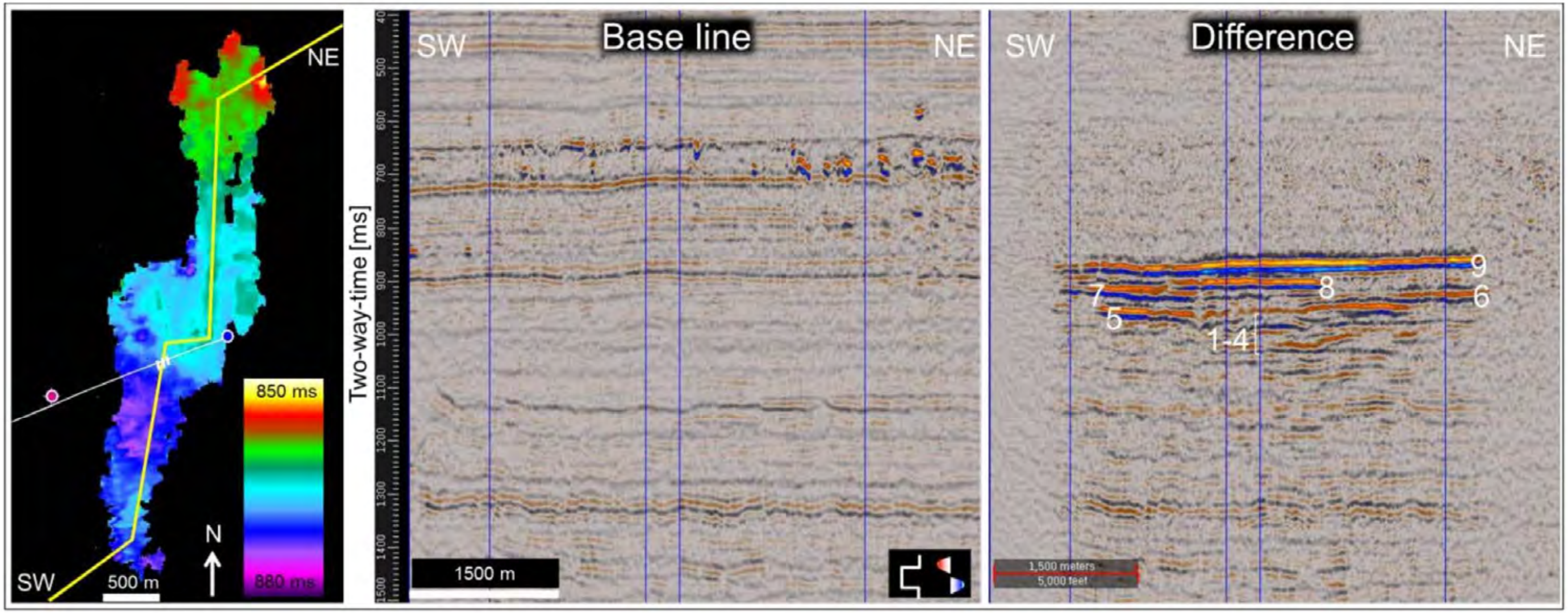
Storage Capacity, Injectivity



CO_2 high buoyancy in high permeability and thick formation (1/2)

Low storage factor at Sleipner, North Sea

Furre et al., 2017



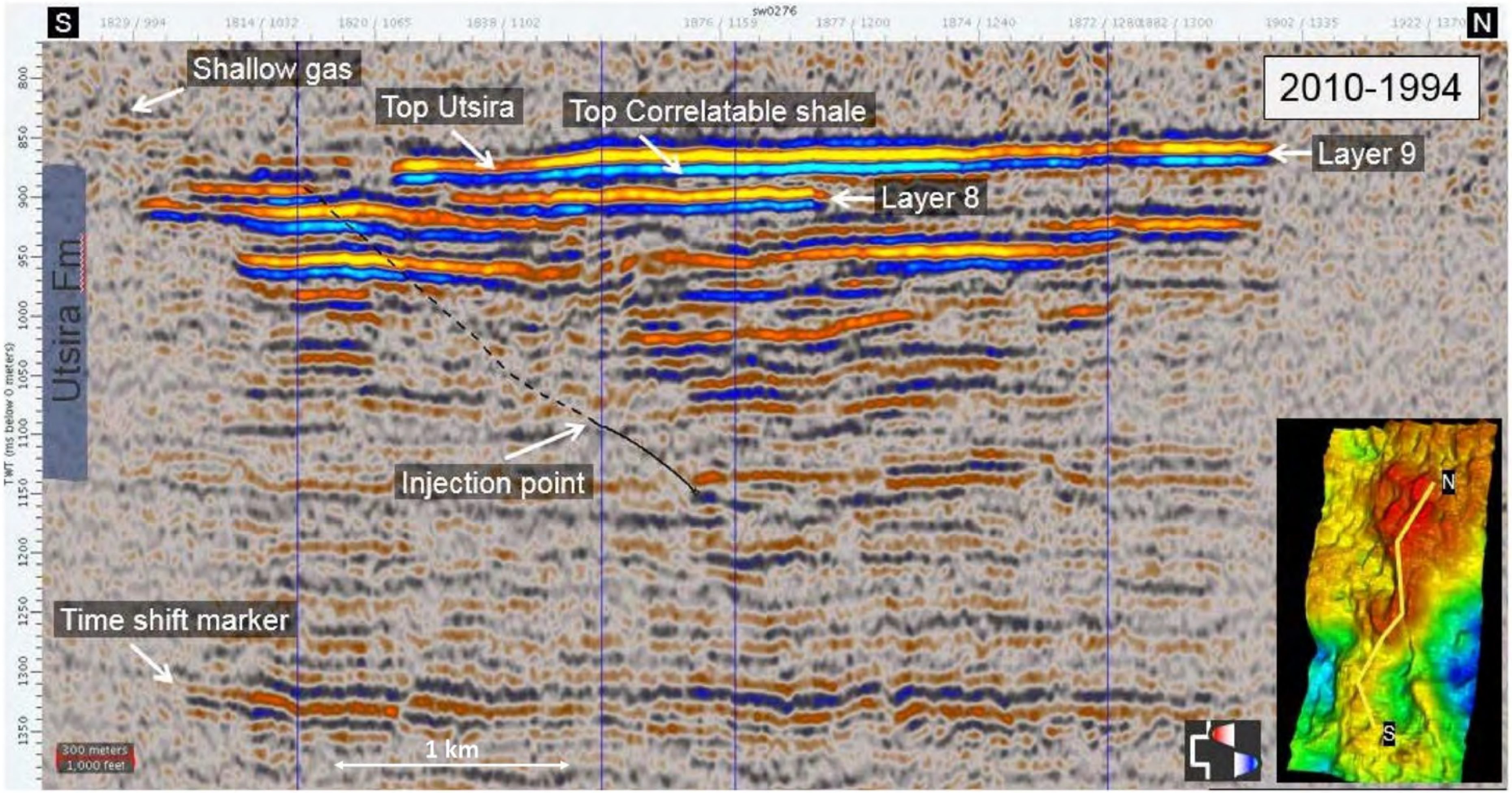
Map of the two-way time interpretation of the CO_2 plume in Utsira sand

(Utsira sand: a giant sand body with high permeability and large thickness)

In the early years the CO_2 signatures in the shallower layers (6-9) were spatially small, and in more recent data, imaging is better for layers 5-9, whereas layers 1-4 are challenging to interpret.

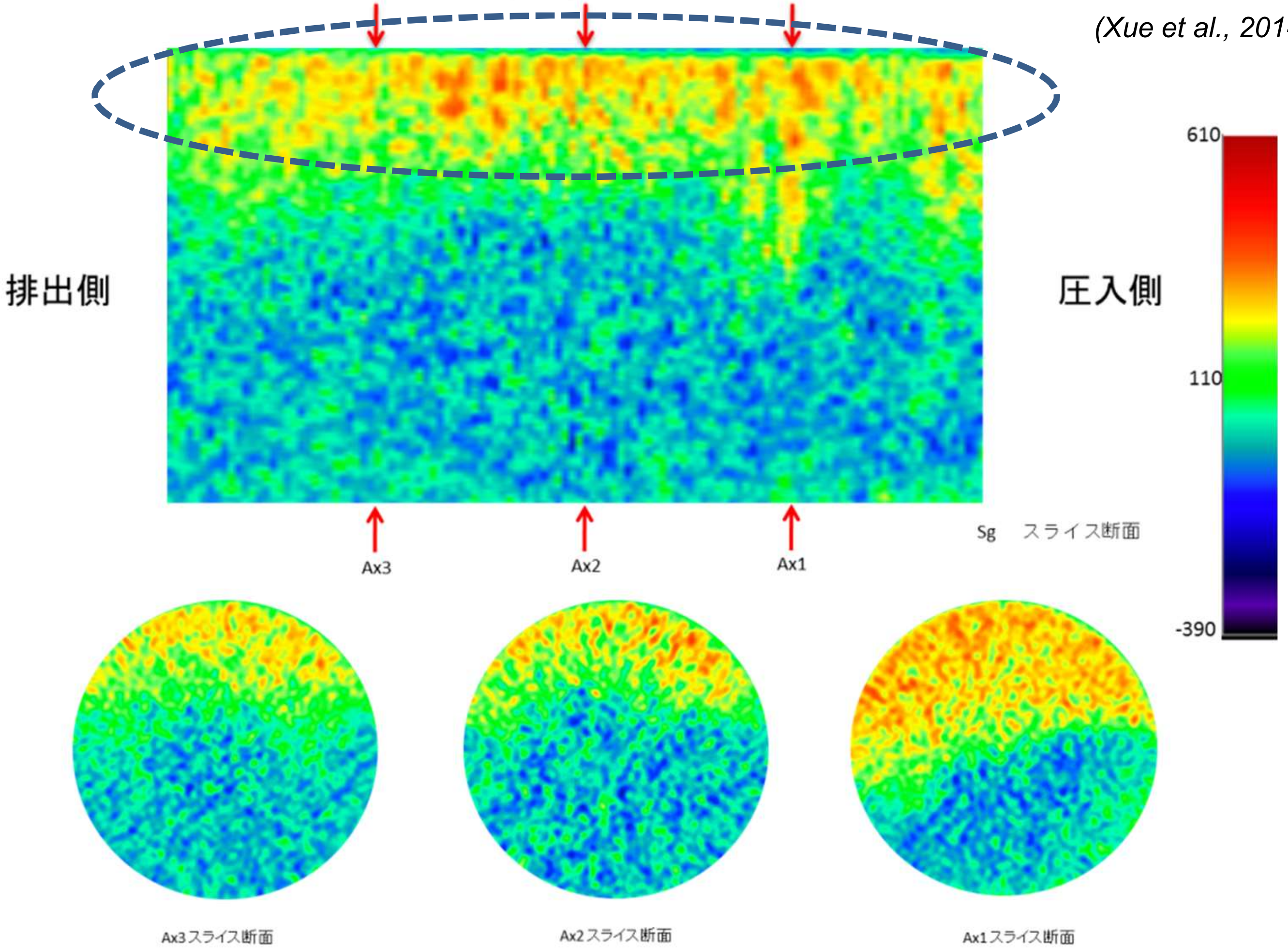
CO_2 high buoyancy in high permeability and thick formation (2/2) at the Sleipner site

Furre et al., 2017



Gravity Override of the Injected CO_2 In high permeability reservoir

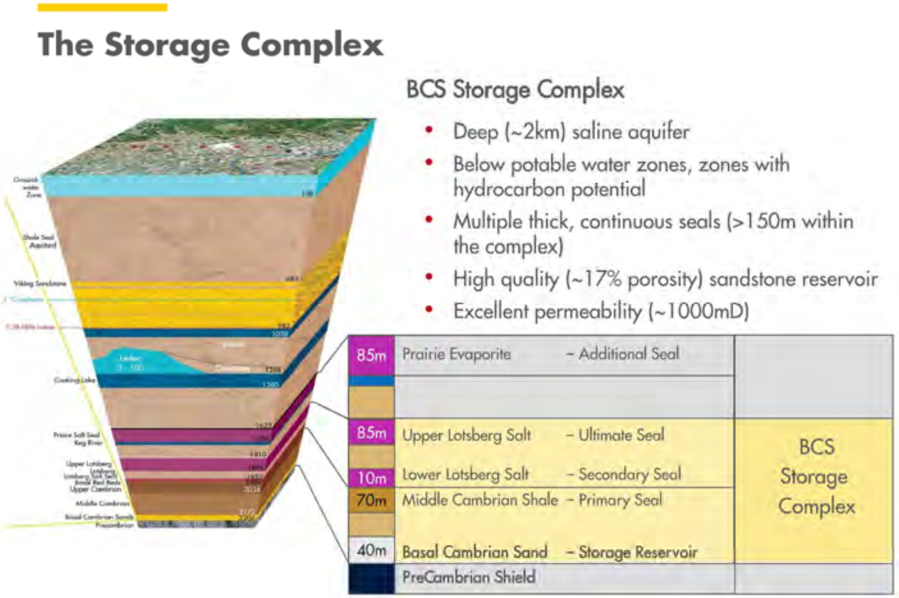
(Xue et al., 2014)

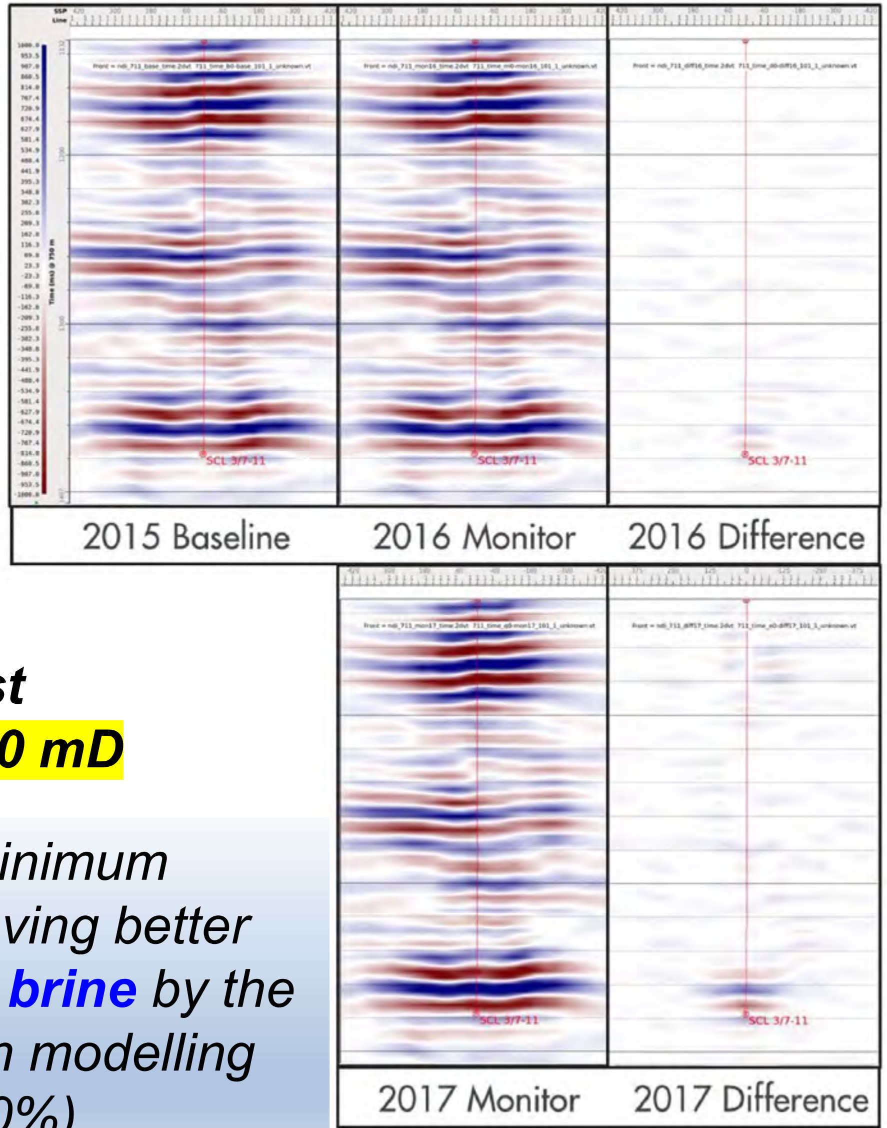


the high storage factor at Quest (high CO_2 saturation)

1 Mt/year, started in 2015

Shell Report, 2017



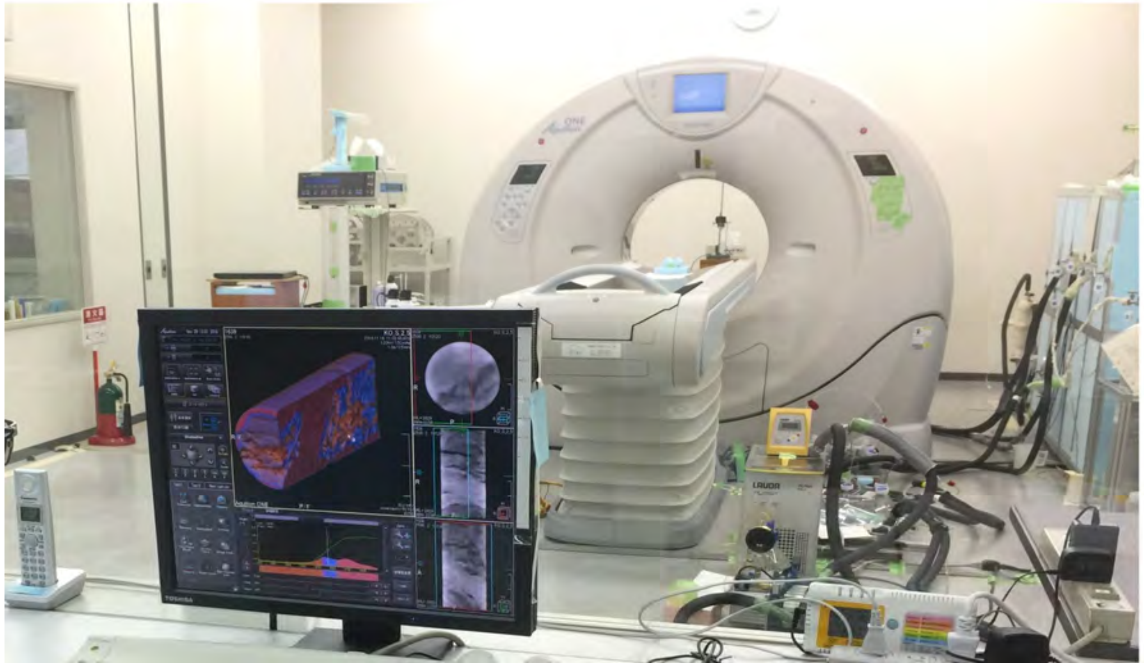


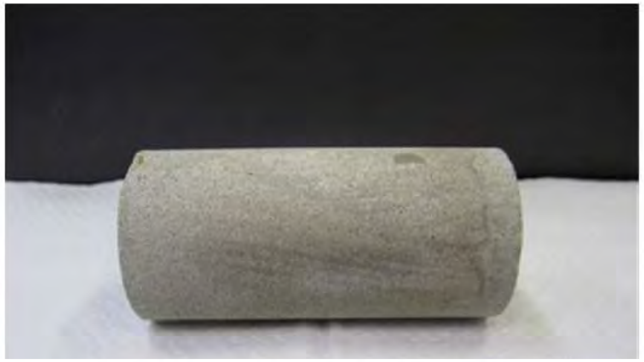
Sandstone reservoir property Quest

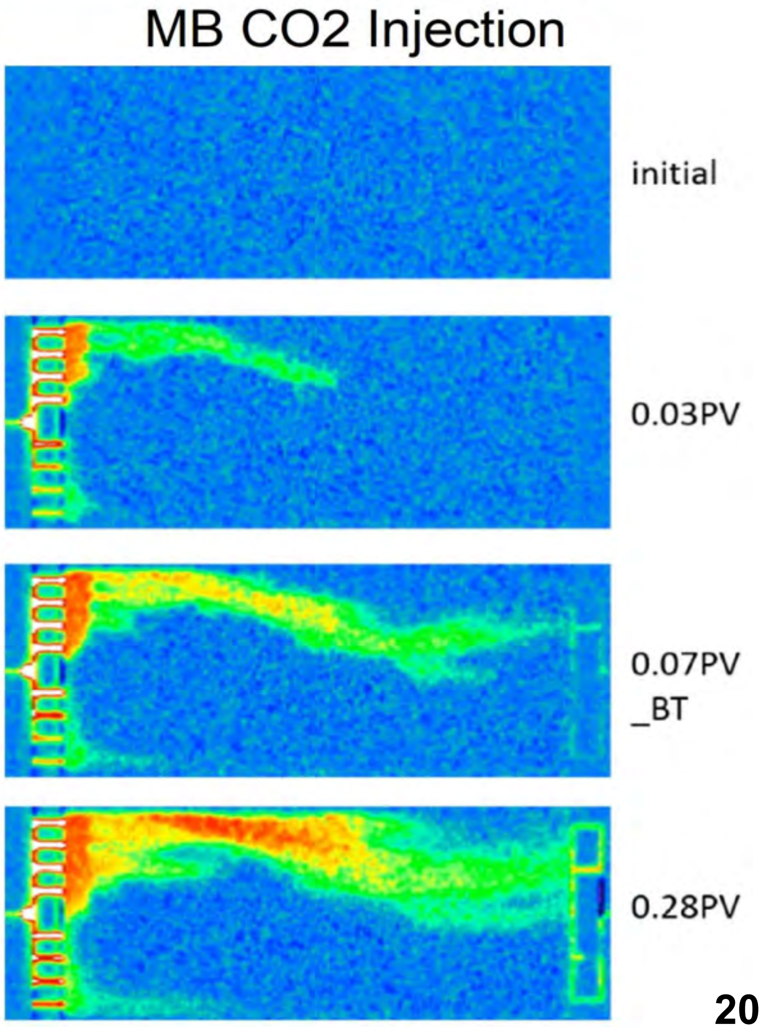
thickness: 40m; permeability: ～1,000 mD

the plume extent is closer to the theoretical minimum is another indication that the reservoir is behaving better than expected, and that the ***displacement of brine*** *by the CO_2 may be* ***more effective*** *than pre-injection modelling predicted. (CO_2 saturation assumed up to 100%)*

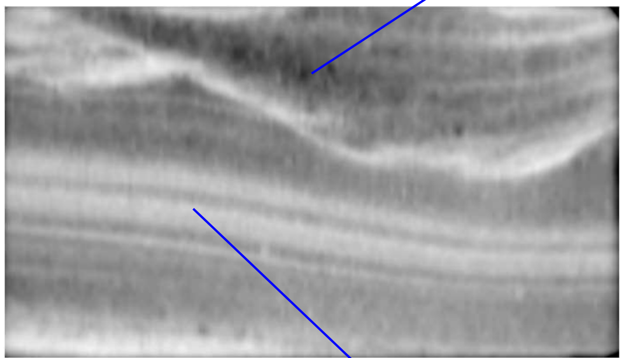
医療用X-CTによる砂岩中のCO_2 挙動の可視化





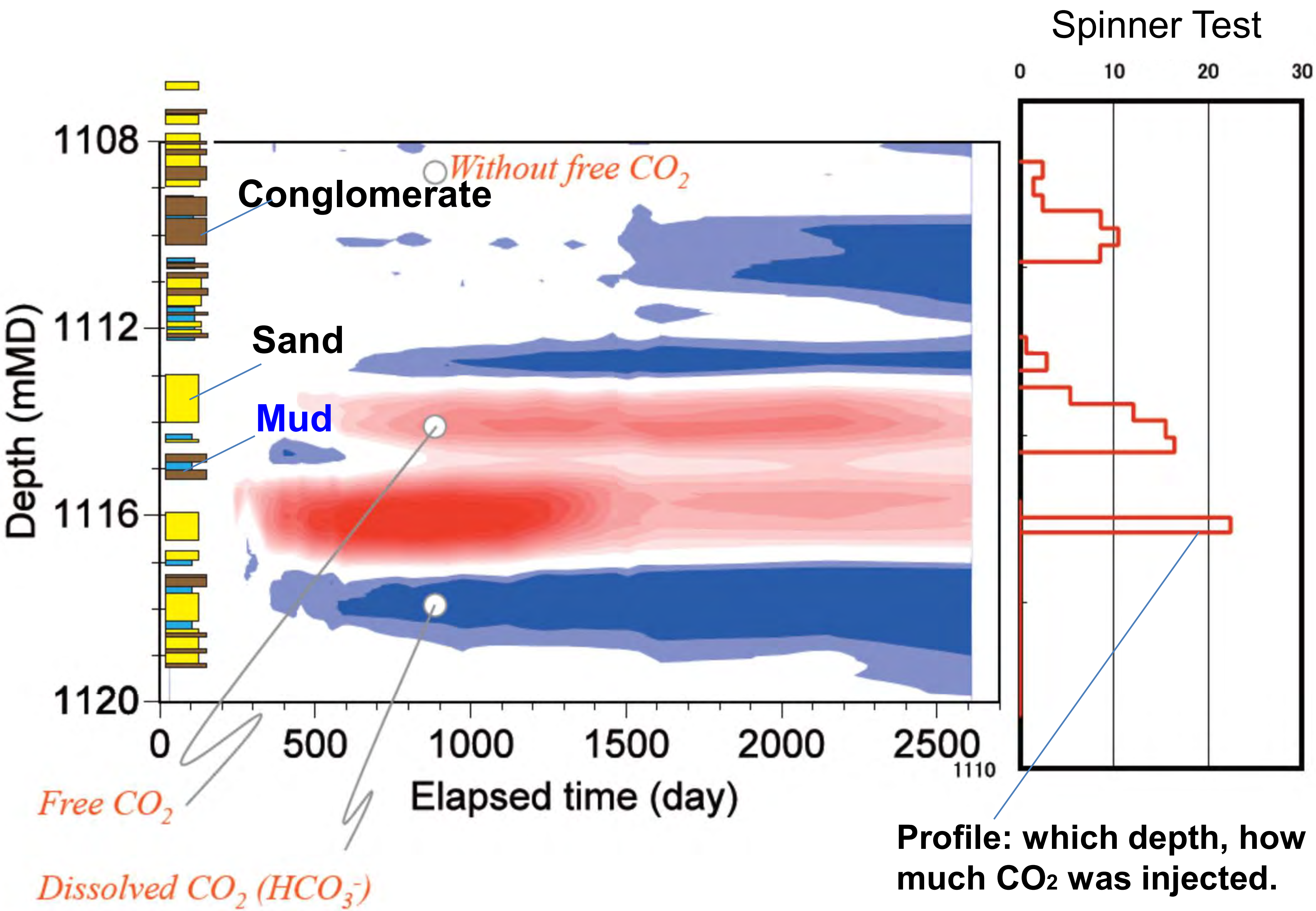


灰色-黒色域：密度が低い（隙間が多い）



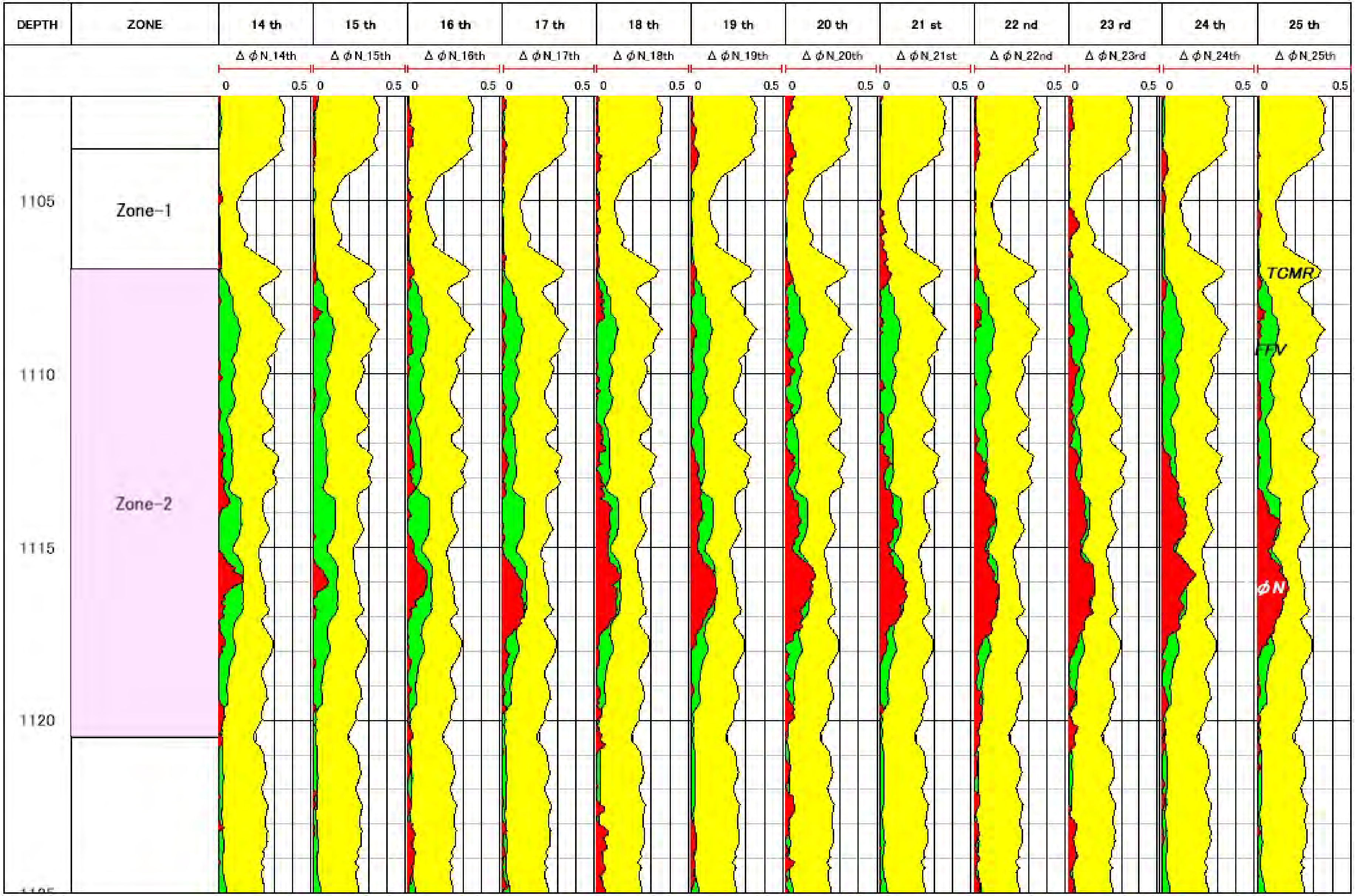
白色域：密度が高い（隙間が少ない）

CO_2 Distribution @Nagaoka, Japan



Profile: which depth, how much CO_2 was injected.

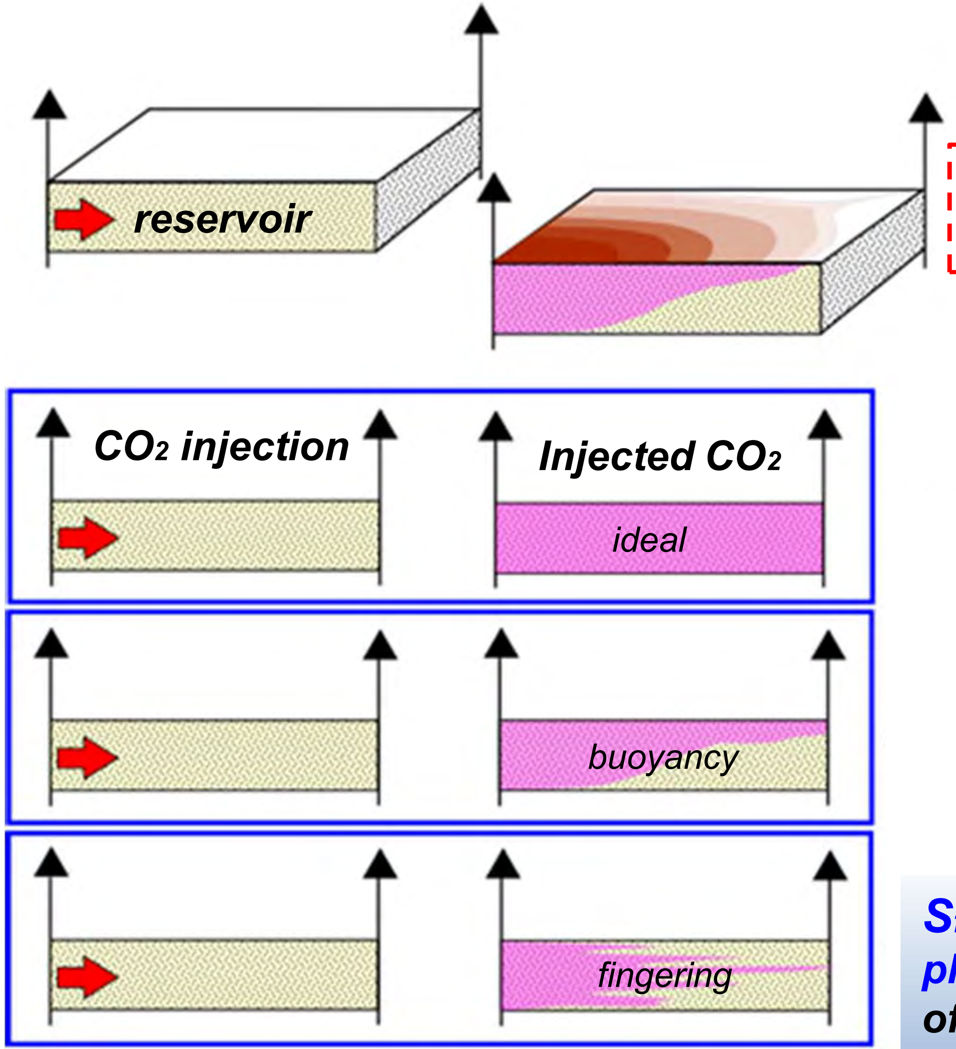
中性子孔隙率(CO2含有率)変化図 (OB-2)



Estimating Volumetric Storage Capacity

Sf: Storage efficiency

(RITE, 2006; Ogawa et al., 2011)



To calculate the CO_2 storage capacity of a deep saline aquifer, the following equation may be used:

$$CO_2\ \text{storage capacity (mass)} = \frac{S_f \times A \times h \times \phi \times S_g \times \rho}{B_g CO_2}$$

where A, h and ϕ are aquifer area, effective aquifer thickness and porosity respectively, so that the product $(A \times h \times \phi)$ represents the total pore volume within the aquifer volume under consideration. S_g is the supercritical CO_2 gas-phase volume fraction in the injected CO_2 plume. ρ is CO_2 density at standard conditions (=1.976 kg/m^3), and $B_g CO_2$ is the CO_2 volume factor, which depends on local pressure and aquifer temperature. Therefore, the term $(\rho/B_g CO_2)$ represents the in situ density of pure CO_2 at the local pressure and temperature. S_f represents a "storage factor", the ratio of immiscible CO_2 plume volume to total pore volume, which incorporates the combined effects of trap heterogeneity, CO_2 buoyancy and displacement efficiency and so on. In the calculation, the entire aquifer below a depth of 800 m is considered.

S_f : a "storage factor", the ratio of immiscible CO_2 plume volume to total pore volume, the combined effects of trap heterogeneity, CO_2 buoyancy and displacement efficiency.

Storage Factors in Different Regions

Comparisons of storage efficiency factors. (Ogawa et al., 2011)

	Efficiency*	Comments*
Australia	19 %	Geodisc, Bradshaw et al., 2004
Japan	*12.5 %*	S_f x S_g ≃ E (DOE) or Cc (CSLF) [S_f = 0.25, S_g = 0.5]
Alberta	≃ 9 %	Bachu & Adams, 2003 (Dissolution)
USA	1 — 4 %	DOE Atlas, 2008 (Monte Carlo Simulation)
Norway offshore	≃ 4.4 %	Joule II, 1996

*Note: After Thibeau and Mucha (2007).

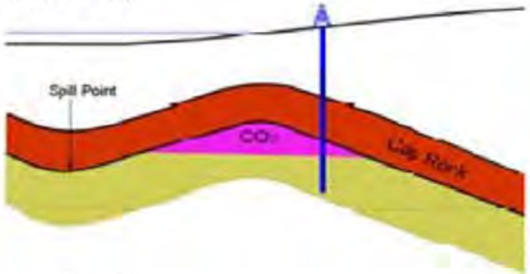
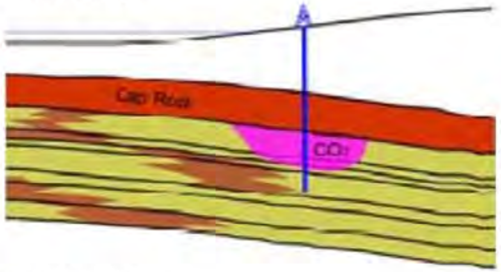
Storage potential

$$= A \times h \times Sf \times \phi \times Sg / BgCO_2 \times \rho$$

- A : aquifer area
- h : effective thickness
- Sf : storage efficiency factor
- φ : porosity
- Sg : CO_2 saturation
- $BgCO_2$: CO_2 volume factor 0.003m³/m³, depth: 2000m, 70°C
- ρ : CO_2 density 0.001976 (t/m³)

Table 1
Classification of deep saline aquifers for CO_2 storage.

(Ogawa et al., 2011)

Geological data		Category A (storage in an anticlinal structure)	Category B (storage in a geological structure with a stratigraphic trapping etc.)
Existing oil/gas field	Well and seismic exploration data abundant	A1 3.5Gt-CO_2	B1 27.5Gt-CO_2
Exploratory well and seismic survey	Well and seismic exploration data available	A2 5.2Gt-CO	
Basic seismic exploration	Seismic exploration data available, but no well data	A3 21.4Gt-CO_2	B2 88.5Gt-CO_2
Concept of storage			
Sub totals		30.1Gt-CO_2	116.0Gt-CO_2
Totals		146.1 Gt-CO_2	

After RITE (2006).

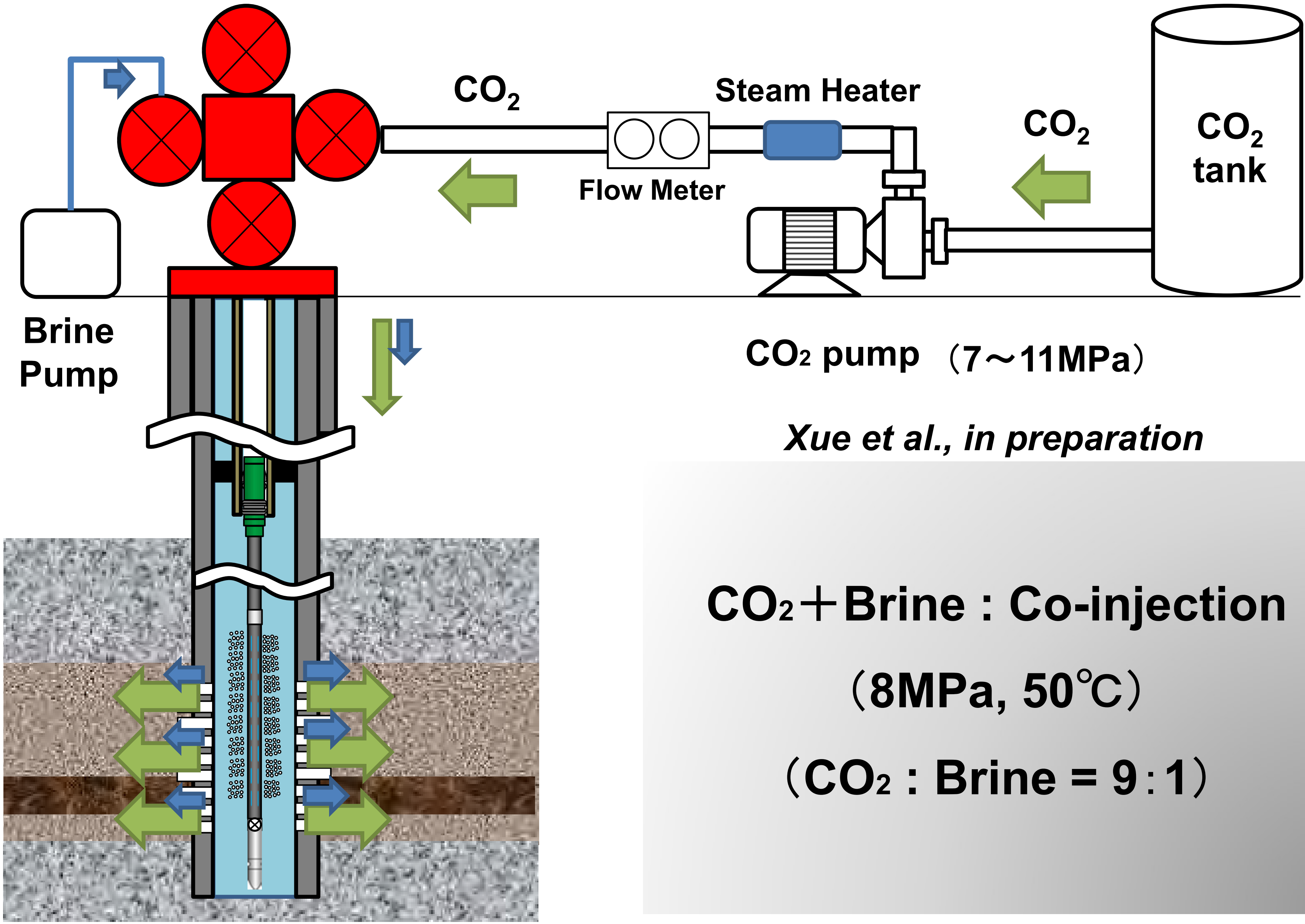
全国貯留ポテンシャル：約1,460 億t-CO_2

The definition for each storage category in Table 1 is summarized, as follows: Category A: Aquifers in the structural traps including depleted oil and gas reservoirs. This storage category is sub-divided into three subcategories:

A1: Petroleum reservoirs and their neighbouring aquifers in oil and gas fields.
A2: Aquifers in the drilled structural traps where exploratory wells were drilled by the government.
A3: Aquifers in the undrilled structural traps where seismic data for petroleum exploration were acquired by the government.

Category B: Aquifers in the offshore sedimentary basins where the water depth is less than 200 m, and are onshore dissolved gas fields.

B1: Aquifers in monoclinal structures and/or heterogeneous aquifers without trapping structures comprising three onshore natural gas fields with gas dissolved in formation water, Minami-Kanto, Niigata and Miyazaki.
B2: Aquifers in monoclinal structures and/or heterogeneous aquifer without trapping structures in the continental shelf where regional seismic data were acquired by the government.



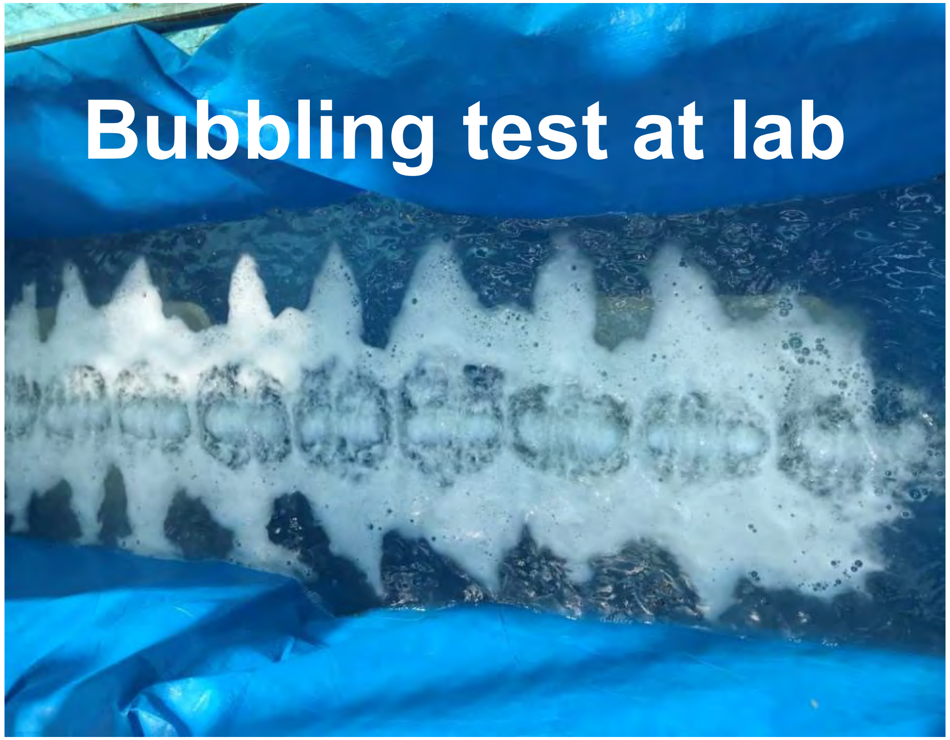
Xue et al., in preparation

CO_2＋Brine : Co-injection

（8MPa, 50℃）

（CO_2 : Brine = 9：1）

上田ほか、2020; Xue et al., 2021



Xue et al., in preparation

Downhole Tool for Microbubble CO_2 Generation

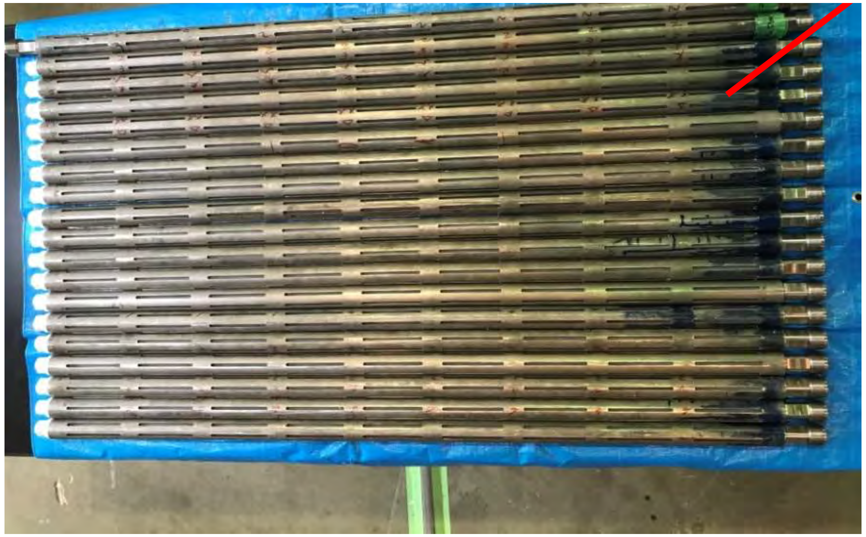
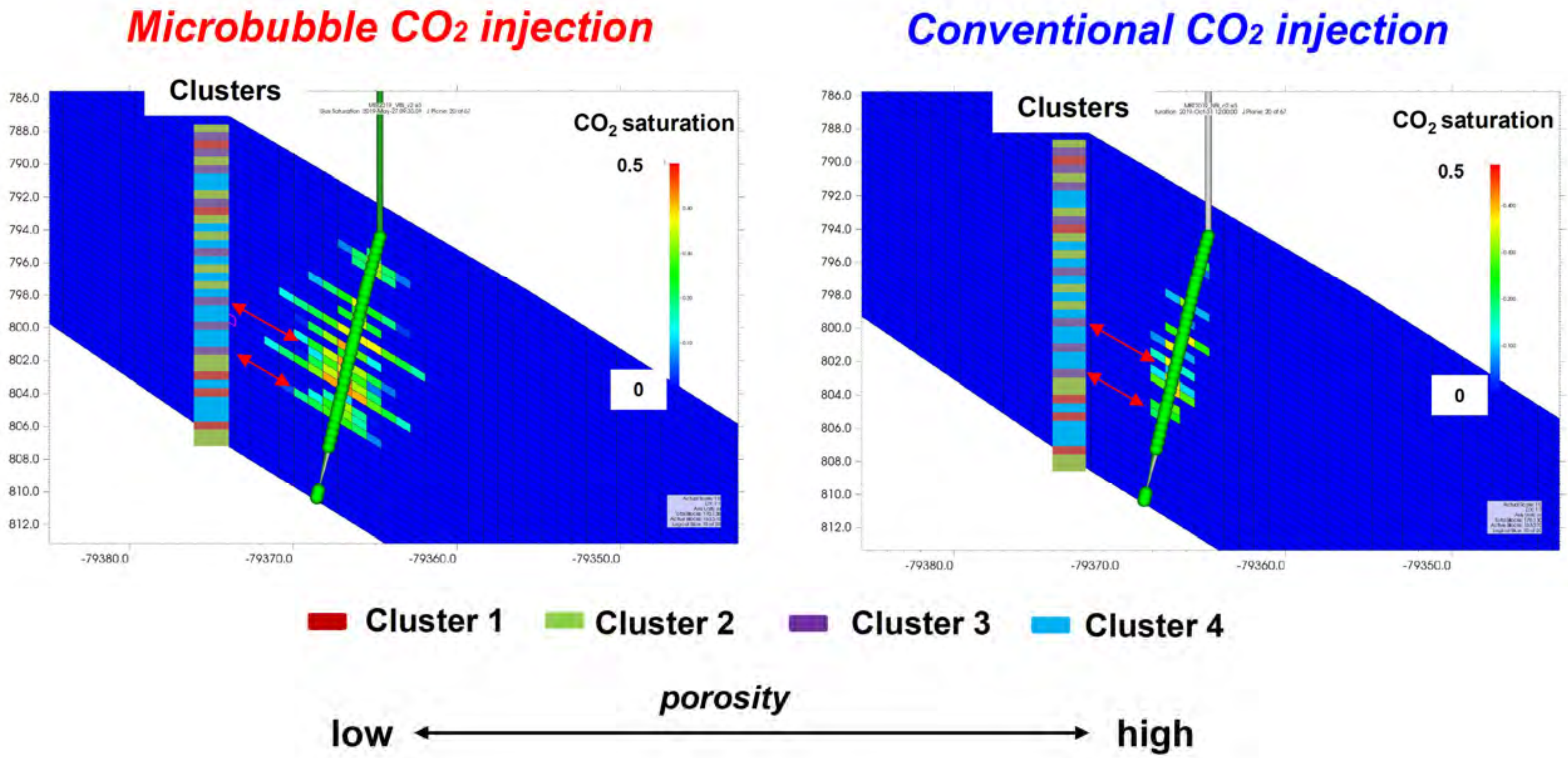


Table 1 Results of the injection and production tests

	Injection		Production			CO_2 stored	Injection index
	tonne	KL	tonne	KL	KL		
Microbubble injection	CO_2	brine	CO_2	brine	oil	80%	0.39 tonne/D/MPa
	20	4	3.9	1.2	0.6		
Conventional injection	CO_2	brine	CO_2	brine	oil	63%	0.09 tonne/D/MPa
	5.8	1.2	2.1	0.35	0		



Xue et al., in preparation for Int. J. Greenhouse Gas Control

「二酸化炭素を地下に埋める」注目の技術“CCS”が抱える期待と課題【脱炭素とはなにか#5】

https://www.businessinsider.jp/post-234099

三ツ村 崇志 ［編集部］
Apr. 30, 2021, 03:00 PM | TECH INSIDER 9,929

2020年12月に発表された、日本の脱炭素に向けたロードマップであるグリーン成長戦略でも、電力部門で排出している**二酸化炭素の30〜40%分の削減**を、原子力発電と火力発電にCCUS（CCS含む）を組み合わせた技術で達成するとしている。

仮に40%すべてをCCSで達成するには、年間1.8億トンもの二酸化炭素を処理しなければならない計算となる。

埋める場所はあるか

日本近海で二酸化炭素1400億トン分の容量

日本CCS調査では、貯留層と遮蔽層を兼ね備えた1億トン以上の二酸化炭素を貯留できる立地を3カ所程度選定することを目指し、日本近海の調査を進めている。

本当に安全か

コストの壁をどうクリアするのか？

海外では、二酸化炭素を単純に地中に埋め戻すCCSではなく、二酸化炭素を油田に送り込むことで石油の生産を増やす「**原油増進回収法（EOR）**」という手法を用いている企業が多い。

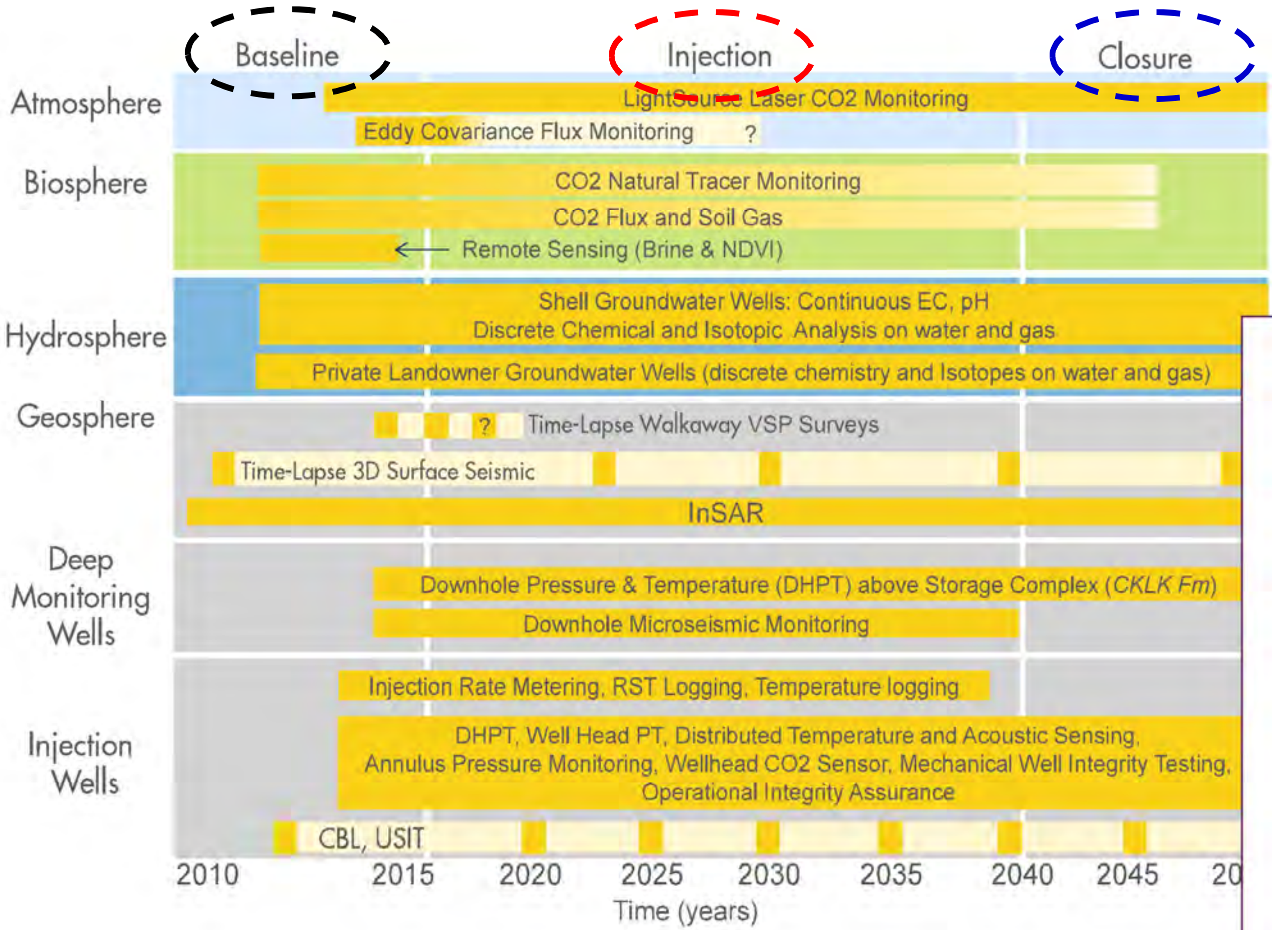
長期安全性（貯留メカニズム）、地域社会の理解（地震や漏洩への懸念解消）

２．CO_2地中貯留技術開発から、実用化（運用・検証・普及）へ

Research, Development and Deployment of CO_2 Storage

Up-Scaling Injection and Down-Sizing Costs

MMV plan throughout the project life @QUEST



(based on ISO standard)

- First o f a kind – conservative approach
- Comprehensive: from atmosphere to geosphere
- Risk-based
- Site-specific
- Independently reviewed
- Combination of new and traditional technologies
- Baseline data collected before start-up

MMV: Measurement, Monitoring and Verification

➢ Advanced Monitoring by US/DOE

- Monitoring at a carbon storage site is necessary to **track the movement** of CO_2 and **assure permanence** for geologic storage.

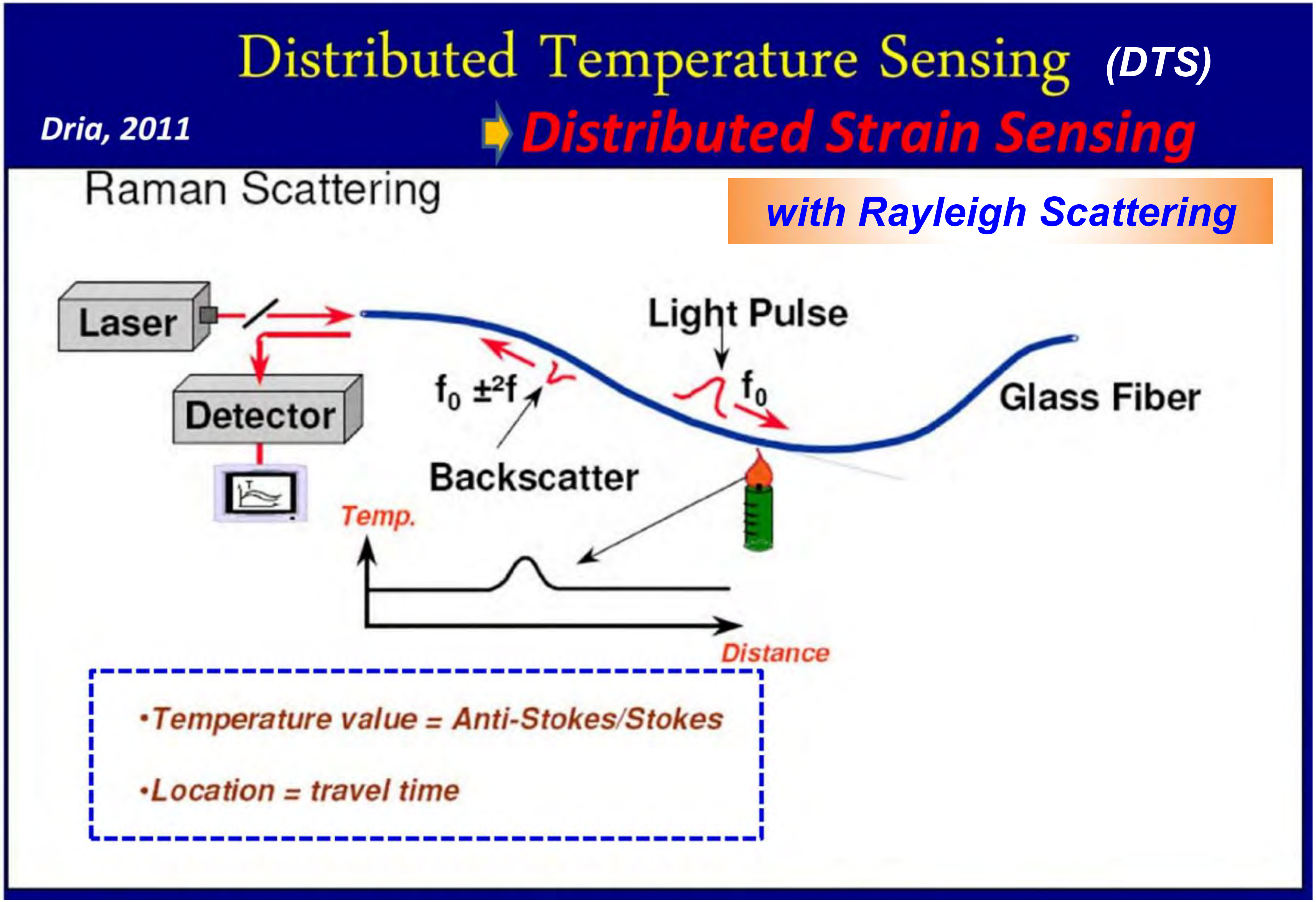
- **Advanced monitoring** technologies are needed to **decrease the cost and uncertainty** in measurements and satisfy regulations.

- Giving site operators the ability to: (1) measure **critical subsurface parameters** associated with the injected CO_2, (2) provide measurements of **down-hole** and reservoir conditions for **real-time decision making** and **process optimization**, and (3) provide **long-term** post-injection monitoring of the fate of injected CO_2.

- **Transformational sensor** to support demonstration and deployment of advanced coal power with CCS **beginning in 2025**.

Fiber Optic Sensing: temperature, pressure, strain, acoustic, fluid chemistry

Distributed Fiber Optic Strain Sensing (DFOSS)

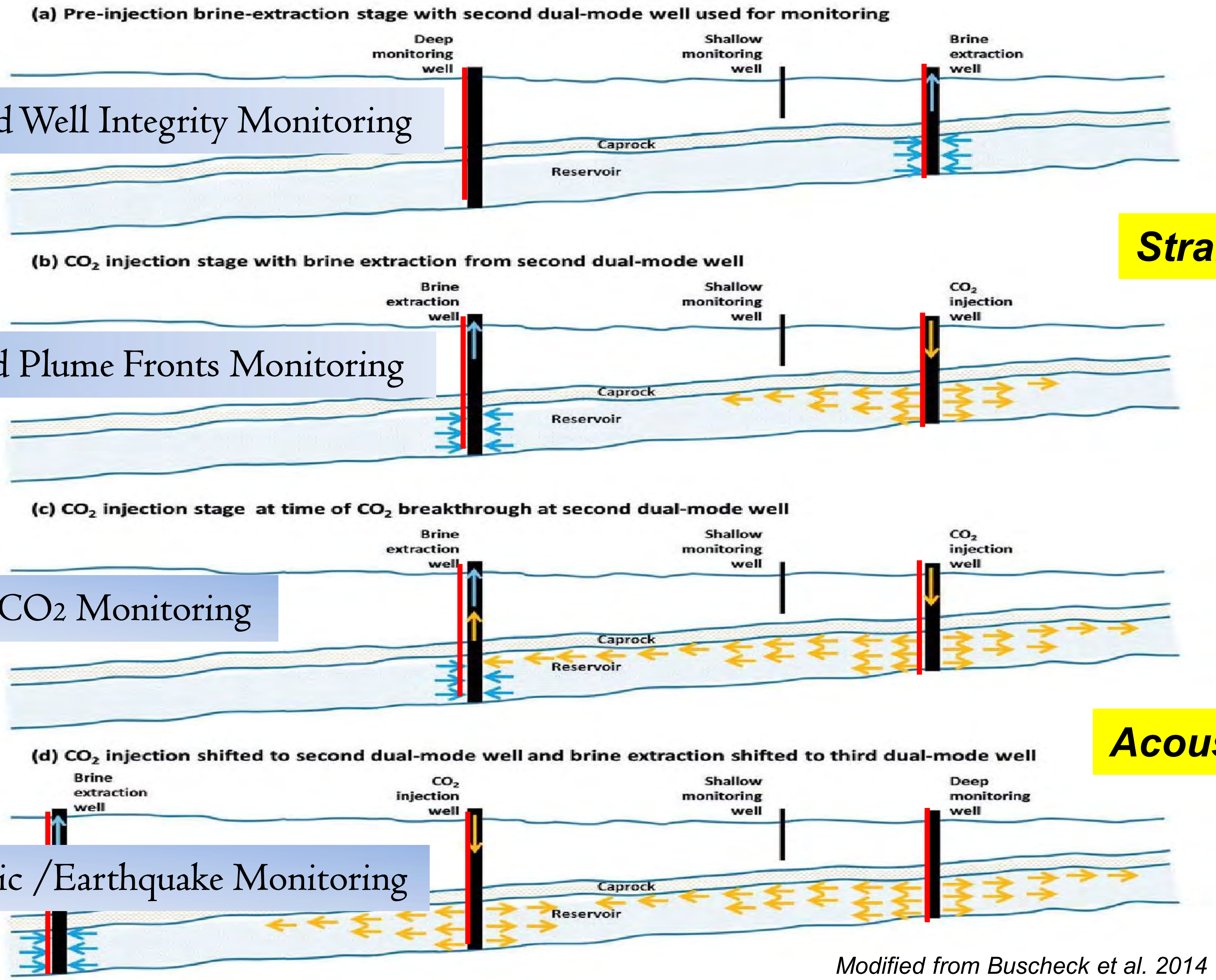


Applications of Optic Fiber Sensing in CO_2 Storage

- Caprock and Well Integrity Monitoring
- Pressure and Plume Fronts Monitoring
- DAS/VSP CO_2 Monitoring
- Microseismic /Earthquake Monitoring

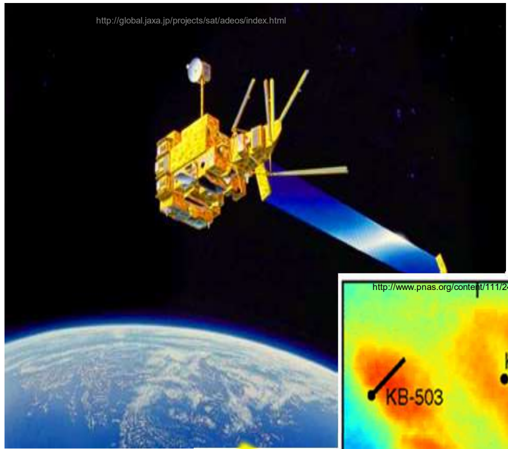
Strain

Acoustic

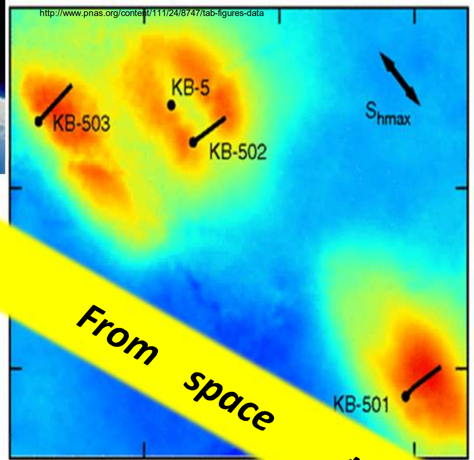


Modified from Buscheck et al. 2014

Field Applications: Collaborations with Univ. North Dakota/EERC and Red Trail Energy in North Dakota (onshore)



Satellite measurements+ GPS and geodesy for onshore sites

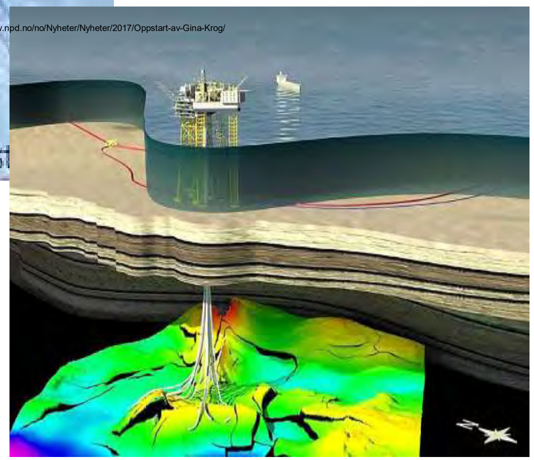


Demonstration of concept and methods: onshore surface heave (e.g. In Salah)

Onshore: North Dakota

From space to the subsurface

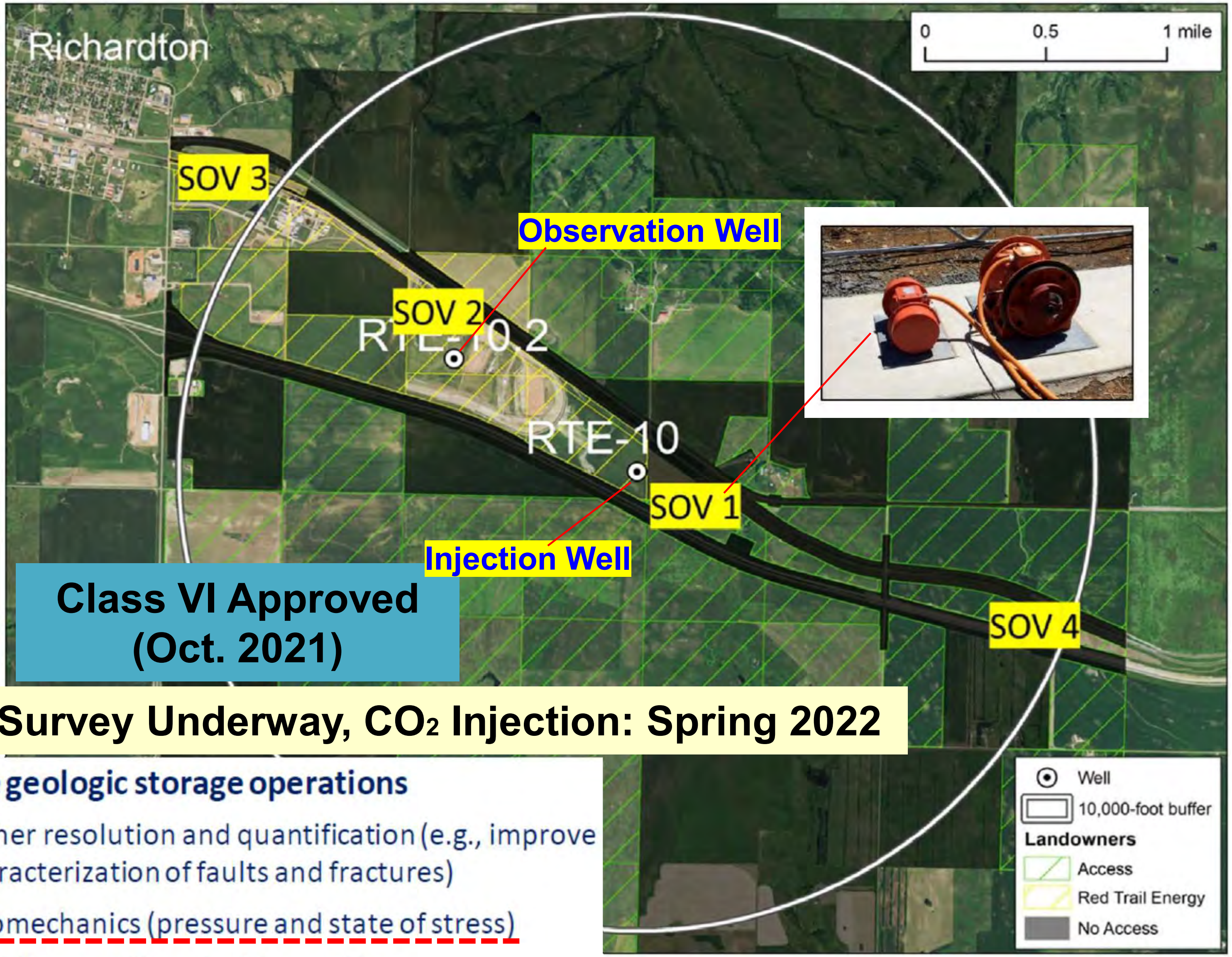
Offshore: North Sea/Norway



The World First Field-scale Demonstration!

A *fully-coupled Surface-Subsurface* (InSAR – Fiber Optic) Geomechanical Monitoring at the Red Trail Energy CO_2 Storage Site, North Dakota, USA !

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



Class VI Approved (Oct. 2021)

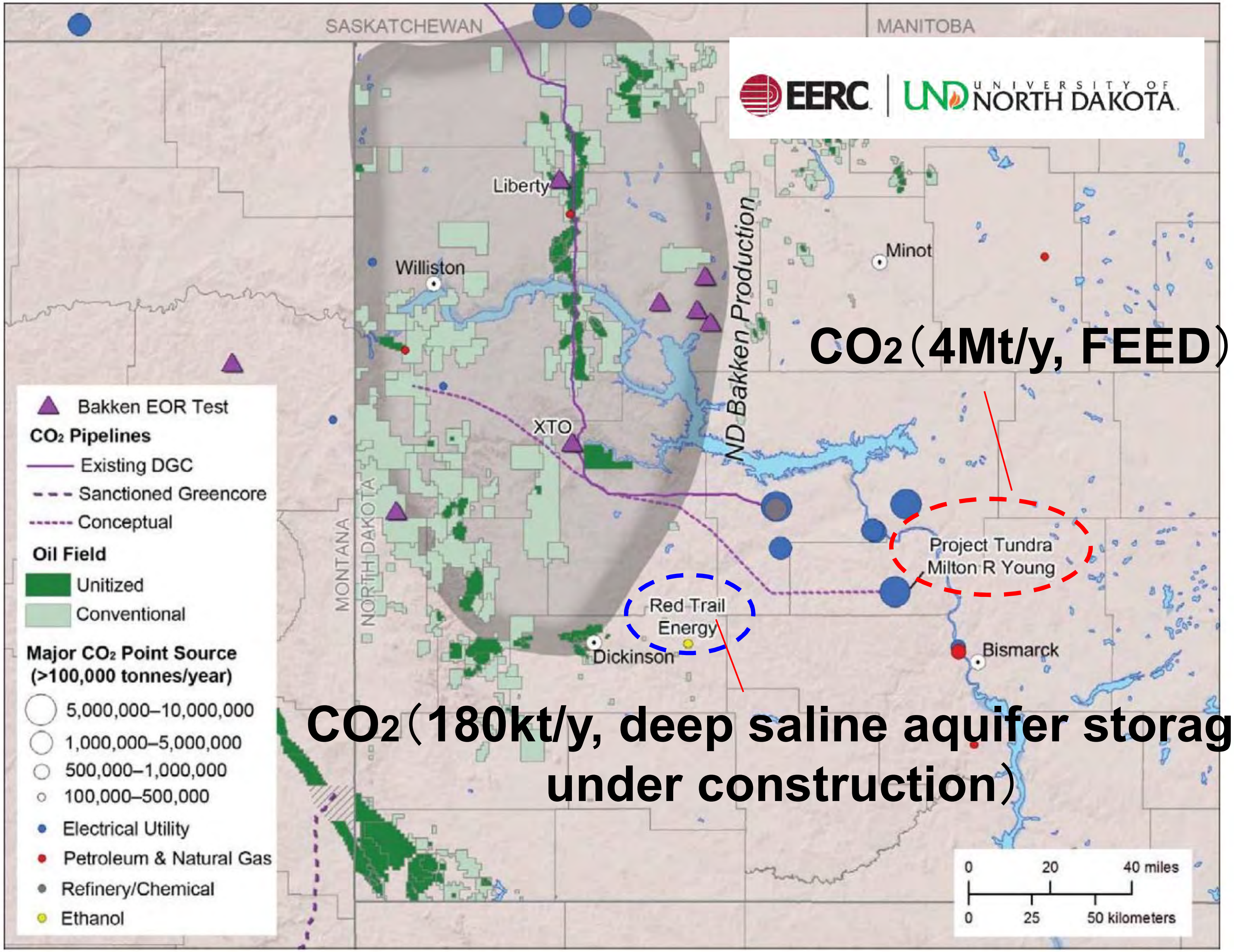
Baseline Survey Underway, CO_2 Injection: Spring 2022

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

US-Japan CCUS Collaboration at North Dakota

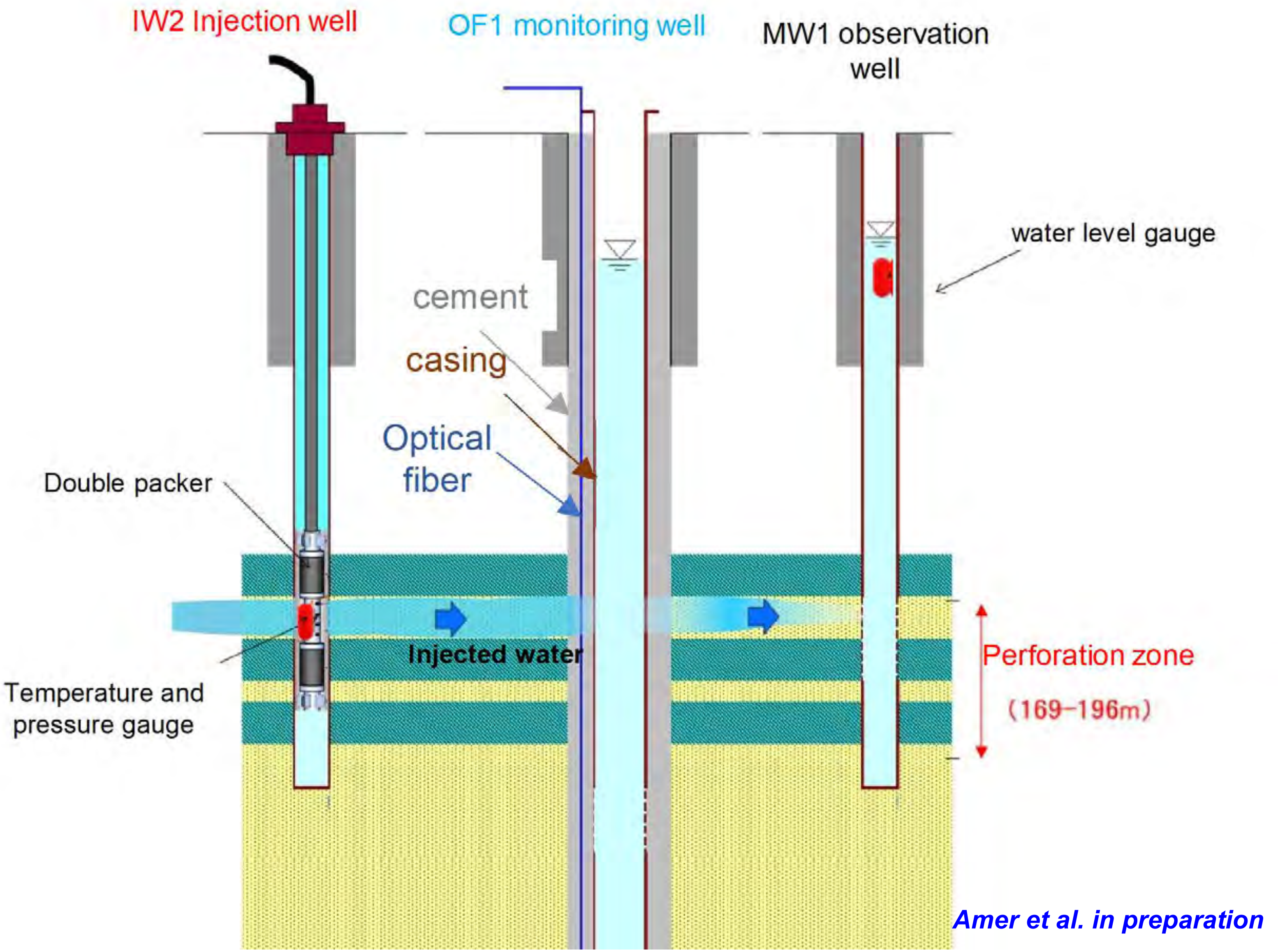


CO_2（4Mt/y, FEED）

CO_2（180kt/y, deep saline aquifer storage under construction）

DFOSS for Geomechanical Monitoring

Water Injection Test (1/2)

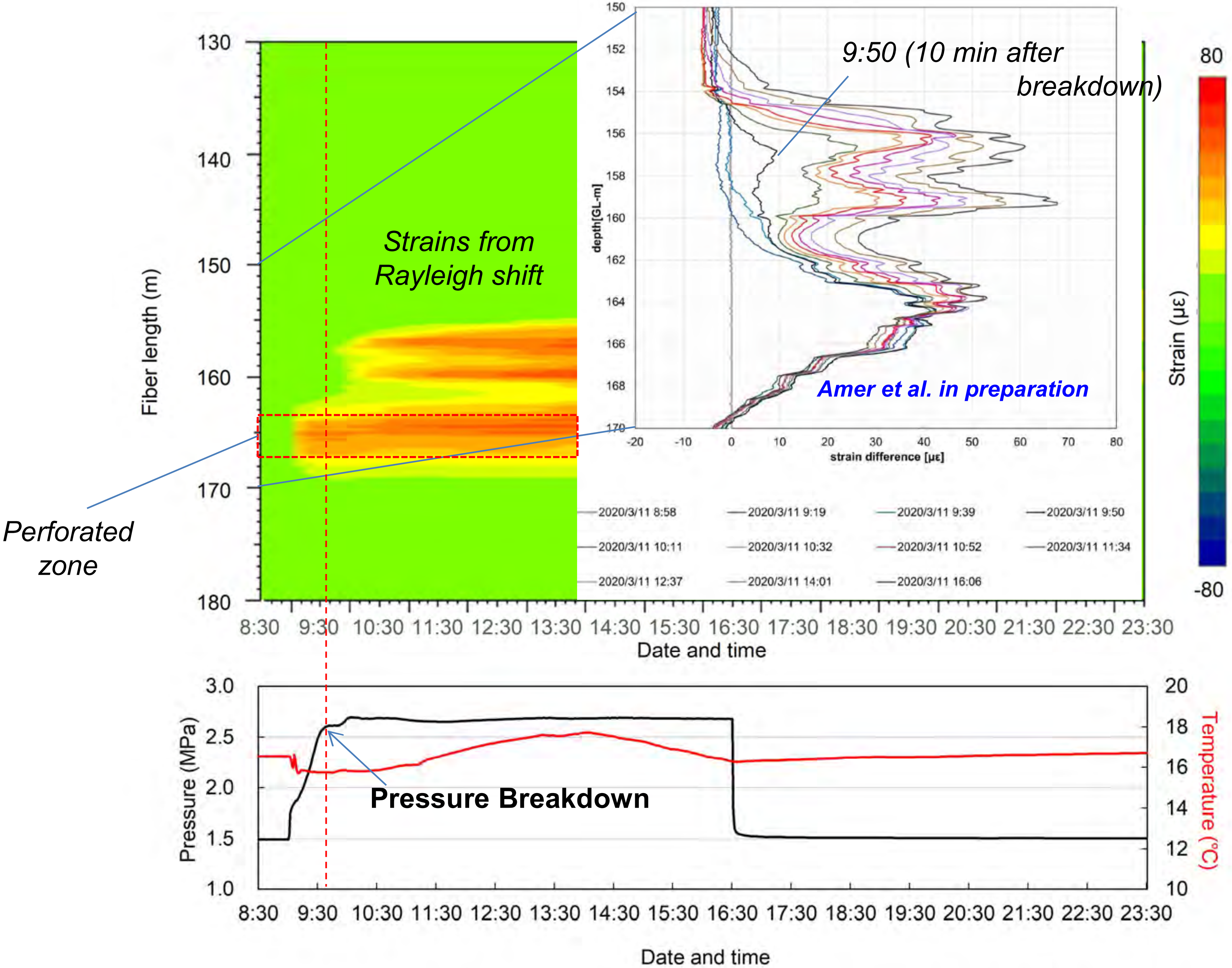


Amer et al. in preparation

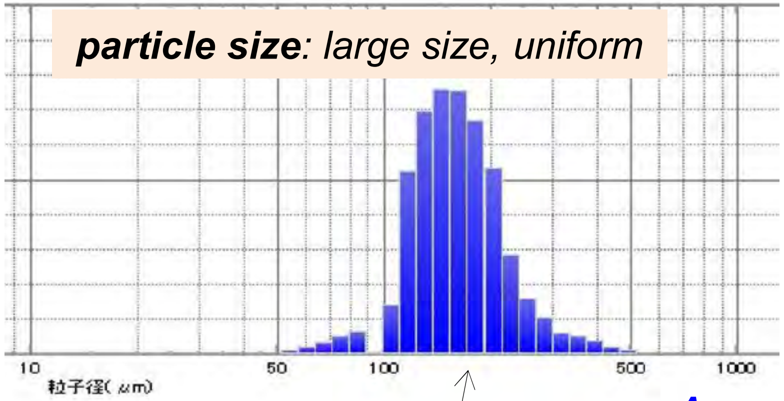
Strain profile suggests injection profile, revealing reservoir heterogeneity

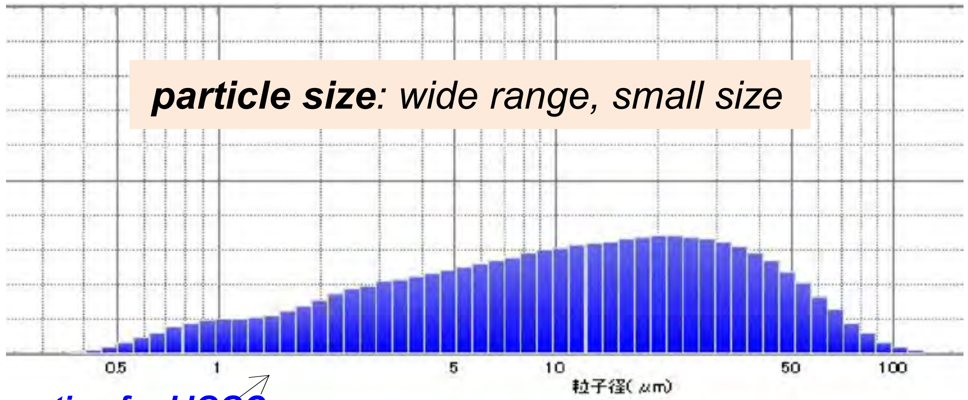
DFOSS for Geomechanical Monitoring

Water Injection Test (2/2)

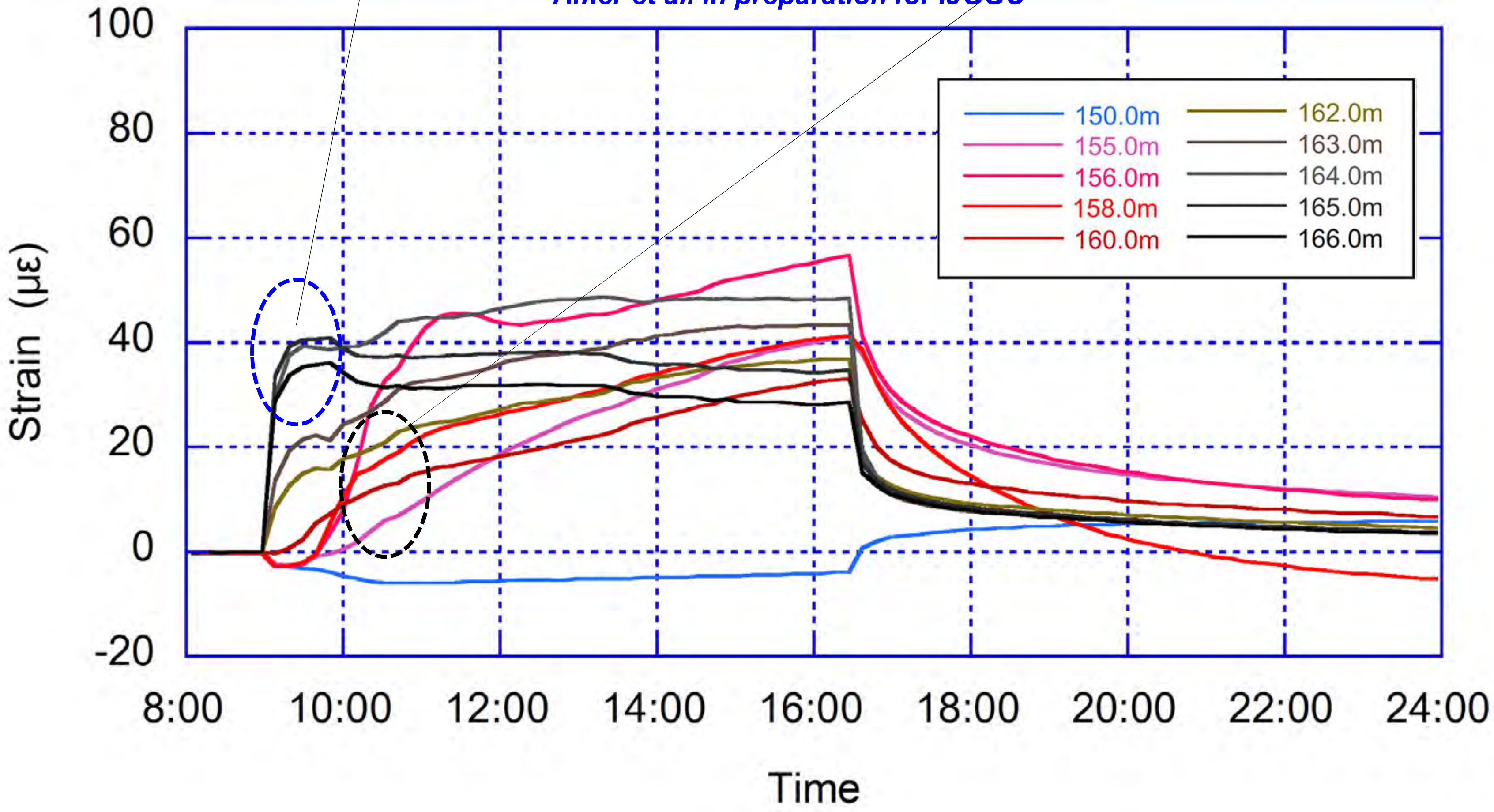


Strong correlation between strain and particle size (lithology)

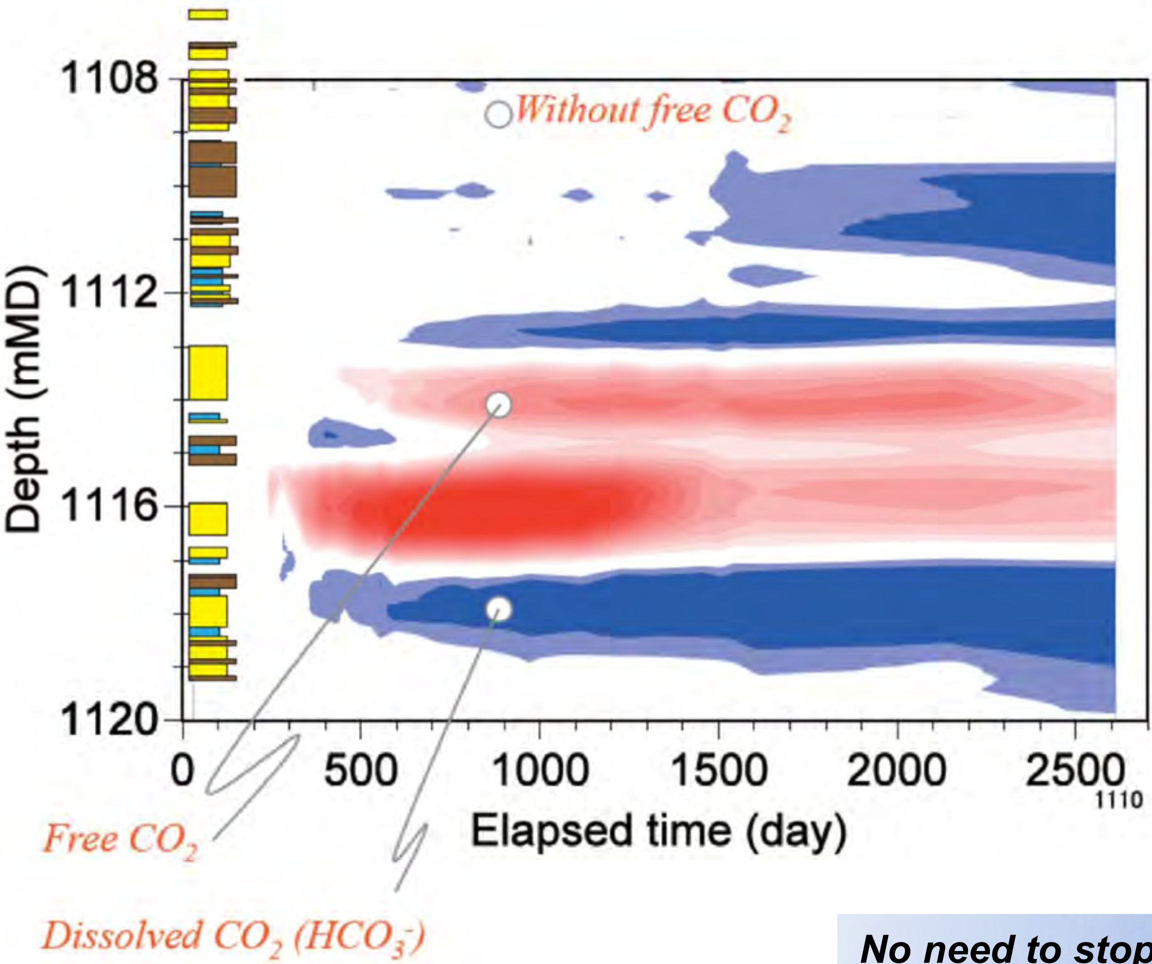


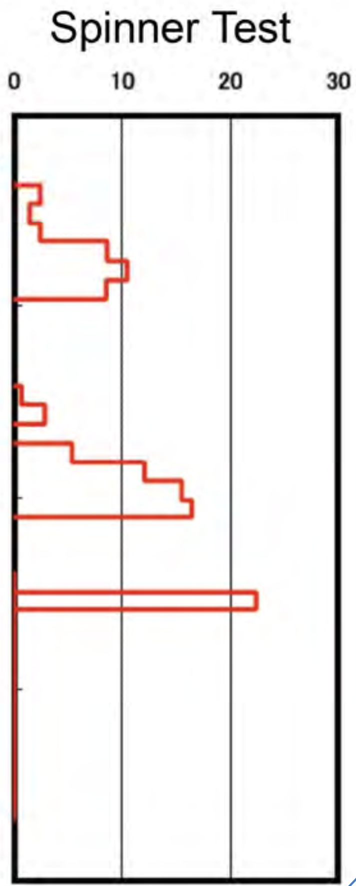


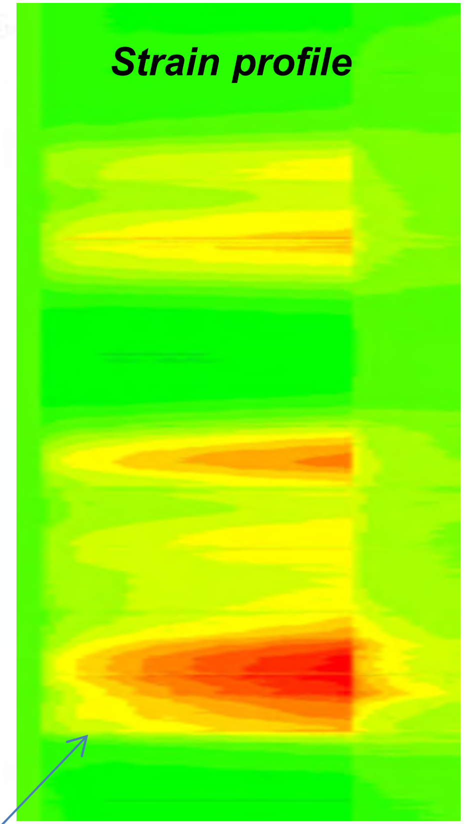
Amer et al. in preparation for IJGGC



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

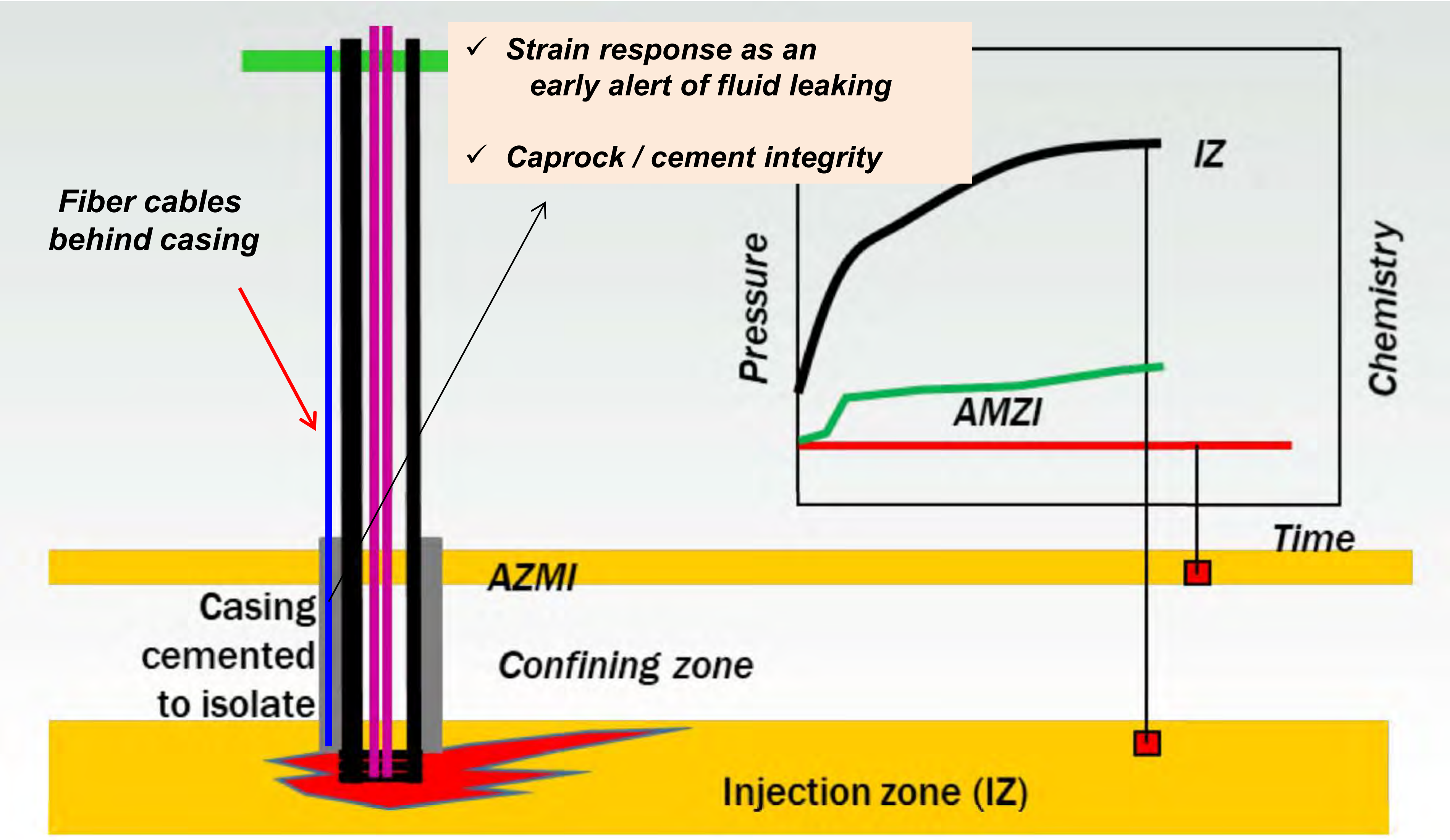






No need to stop injection for running spinner test to collect injection profile !

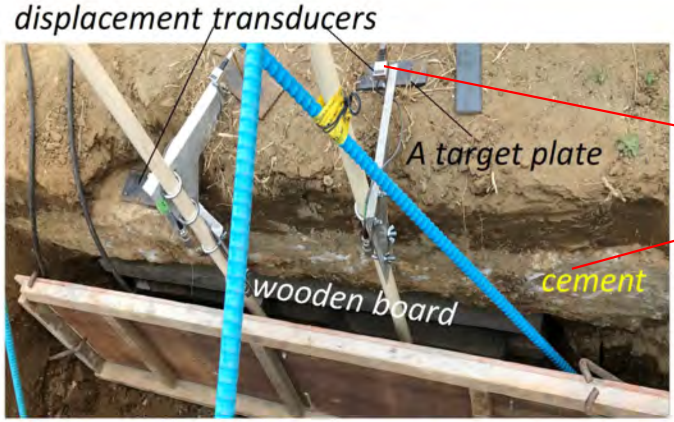
Application #2 for well integrity monitoring, combined with AZMI (Above-Zone Monitoring Interval) pressure monitoring

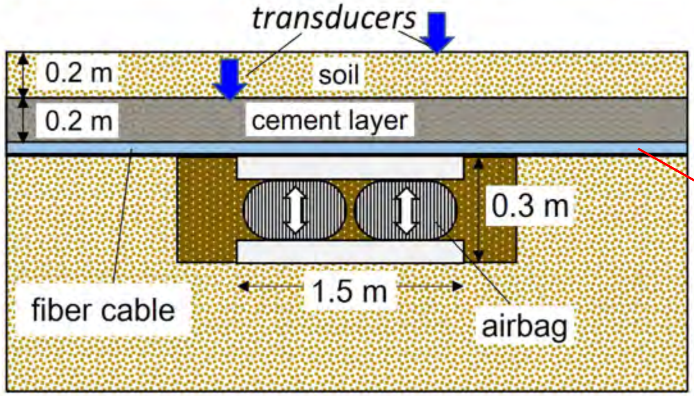


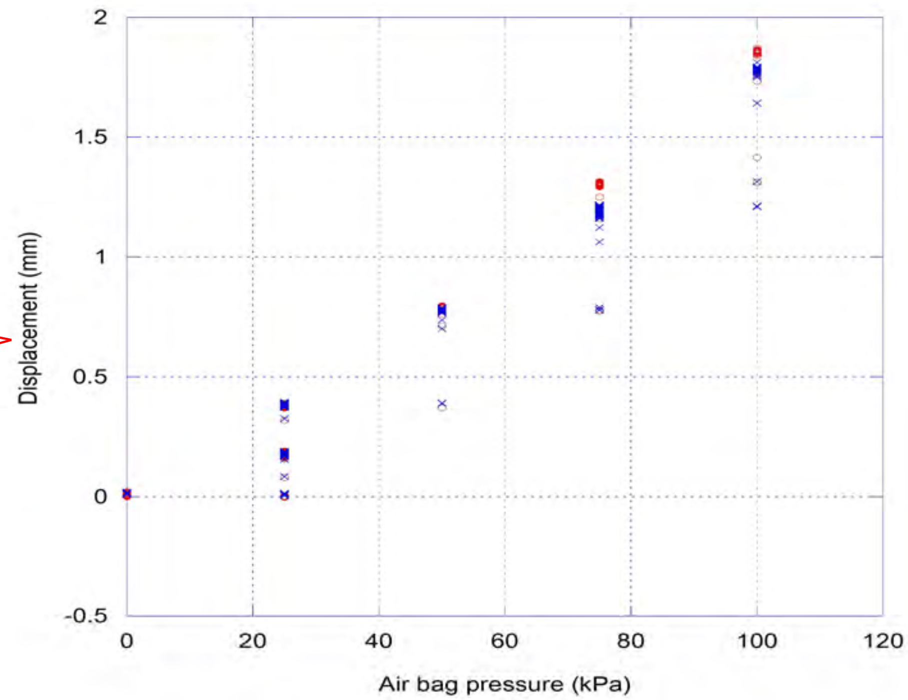
Hovorka et al, 2018

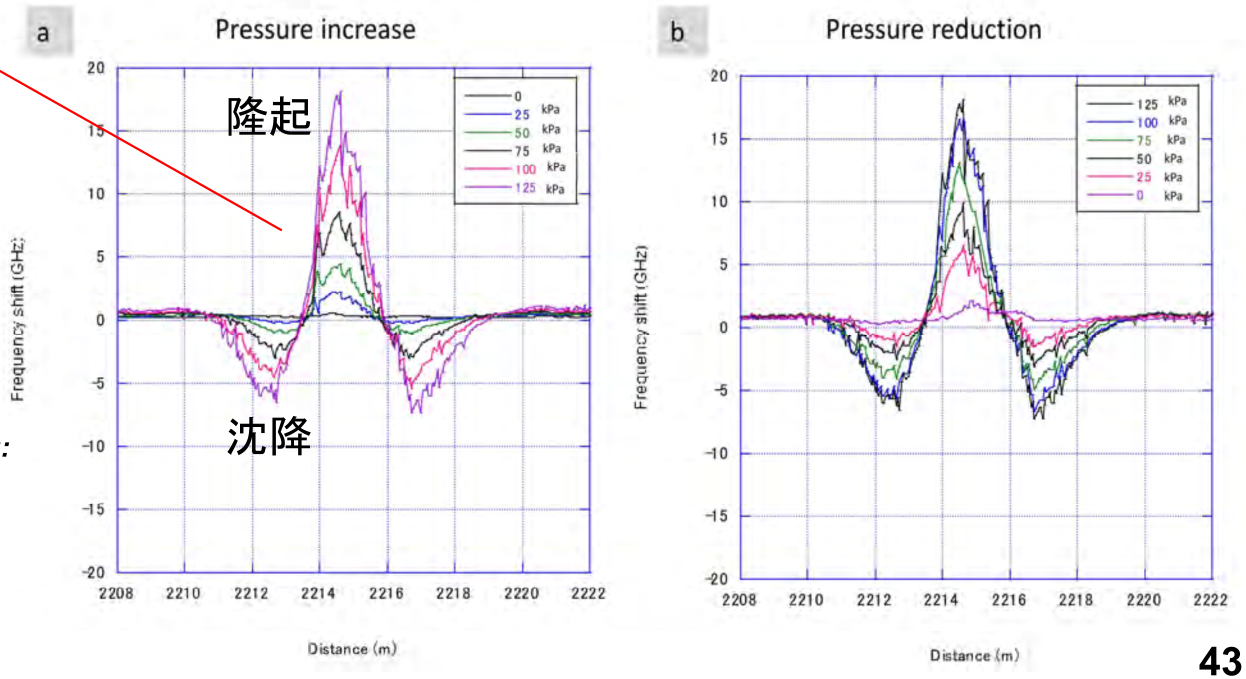
市原サイトの地表変状測定

光ファイバー vs 変位計



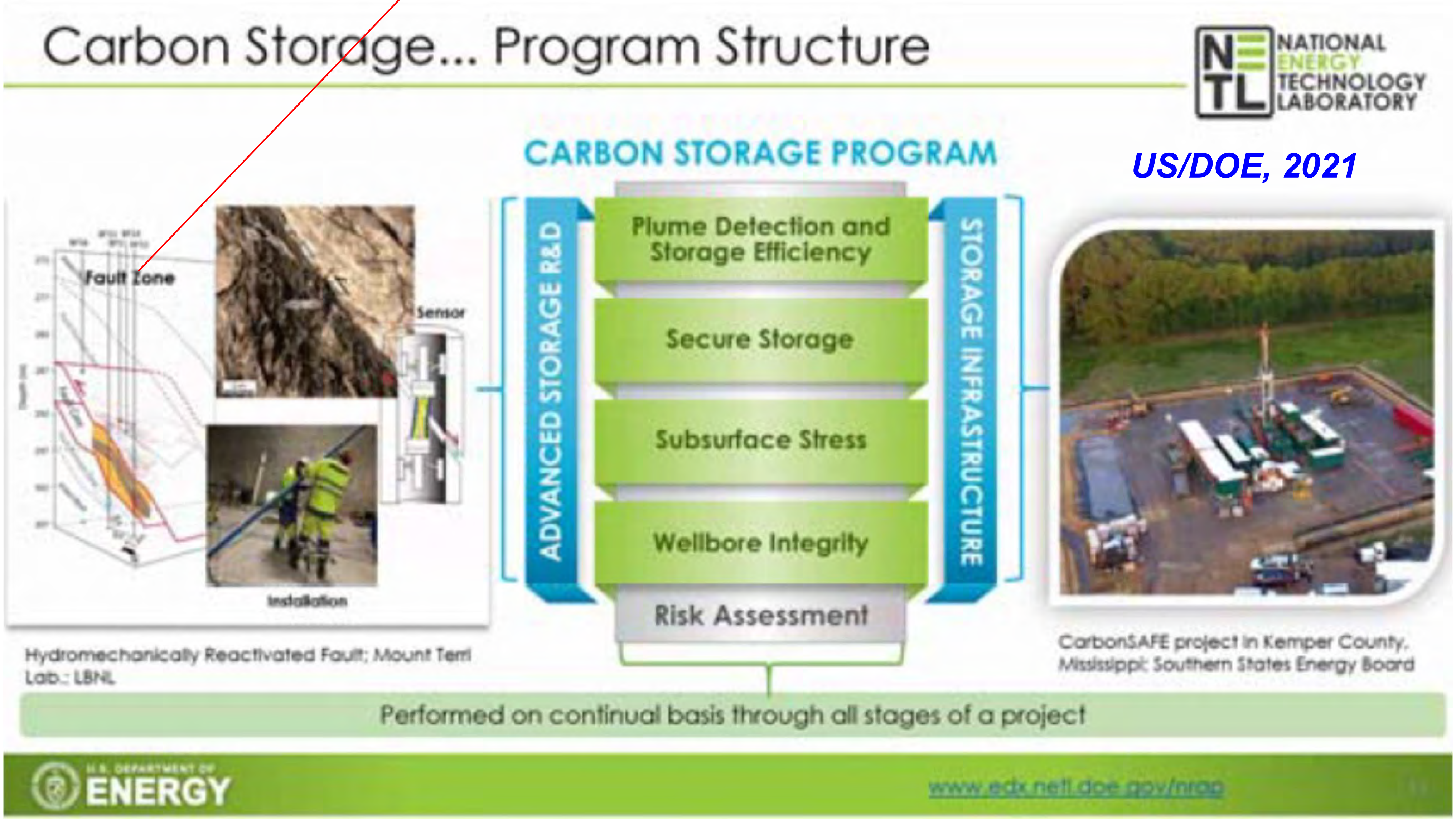






Amer, R.; Xue, Z.; Hashimoto, T.; Nagata, T., Distributed Fiber Optic Strain Sensing for Geomechanical Monitoring: Insights from Field Measurements of Ground Surface Deformation. Geosciences 2021, 11, 285. https://doi.org/10.3390/geosciences11070285

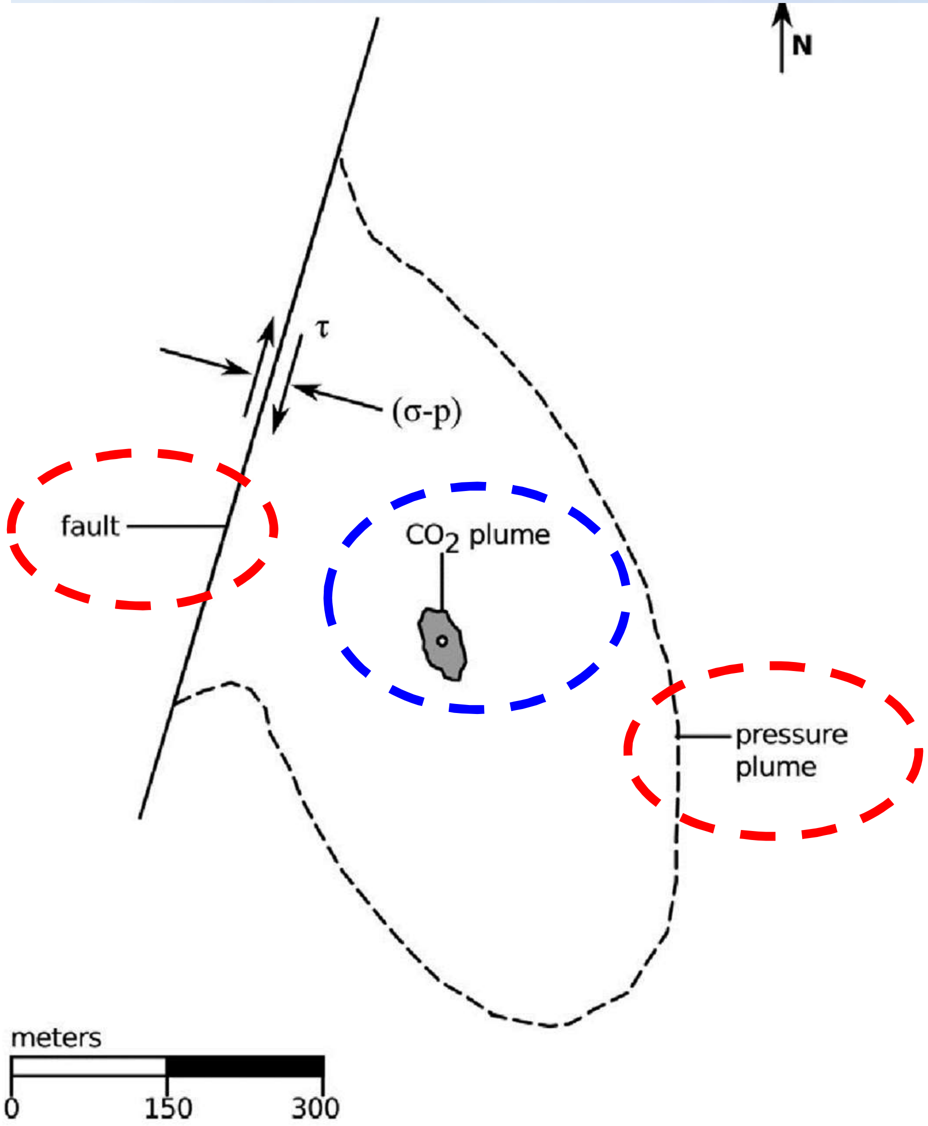
Fiber Optic Sensing Application at Mount Terri

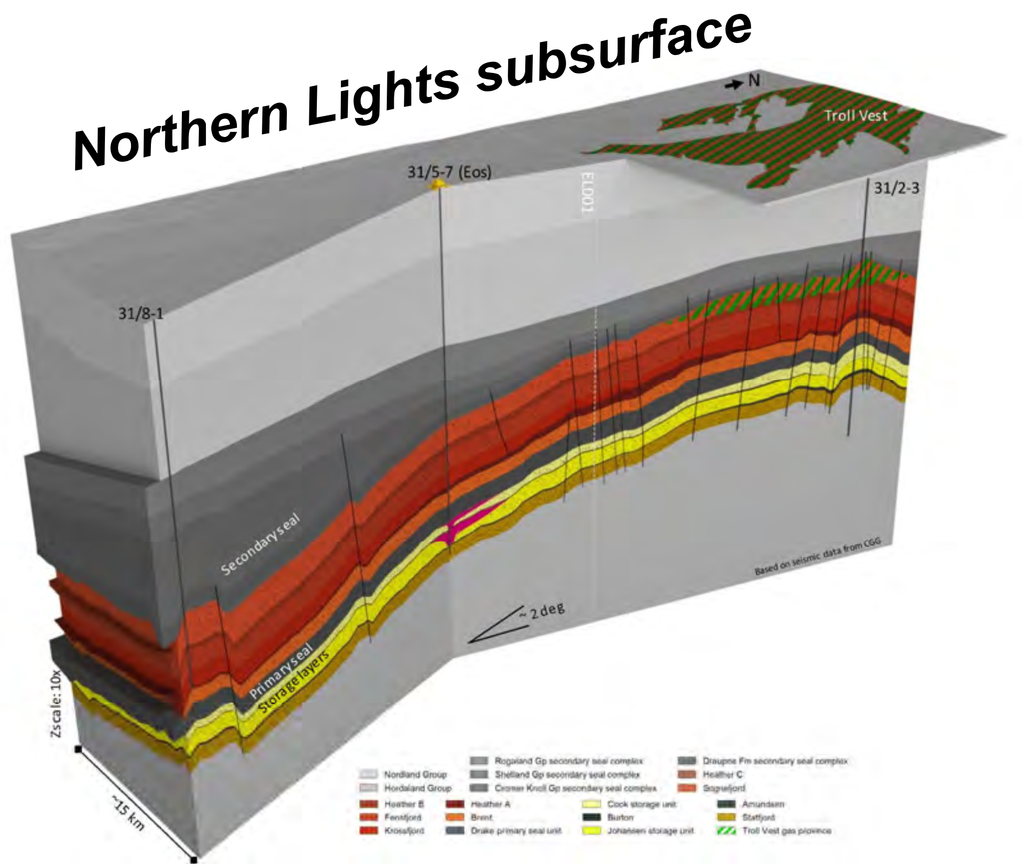


Hydromechanically Reactivated Fault : Integrity Monitoring

CO_2 plume front *vs* pressure front

(Geomechanical Modeling)



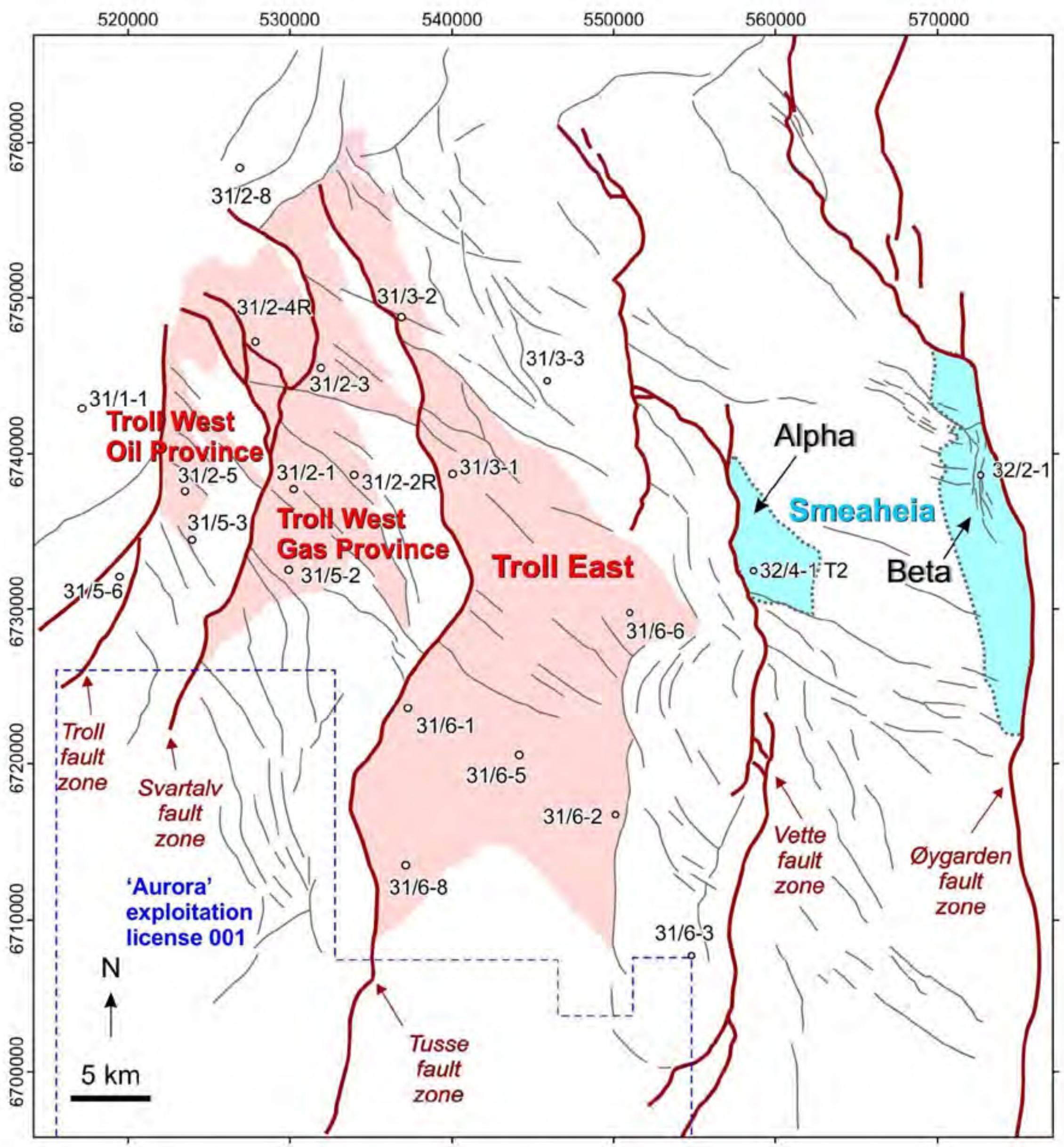


Schematic of the subsurface going from south to north through the 31/5-7 (Eos) CO_2 confirmation well. The CO_2 plume extent after 37.5 Mt injection is illustrated in magenta.

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

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

Quantifying storage risks @Northern-Lights Project



Long Wu et al (2019), EAGE Fault & Top Seal Conference

- Fault mapping from seismic
- Fault Seal and fault permeability
- Pressure communication
- 3D geological modelling
- Geomechanics and strain
- Micro-seismic monitoring
- Flow simulation

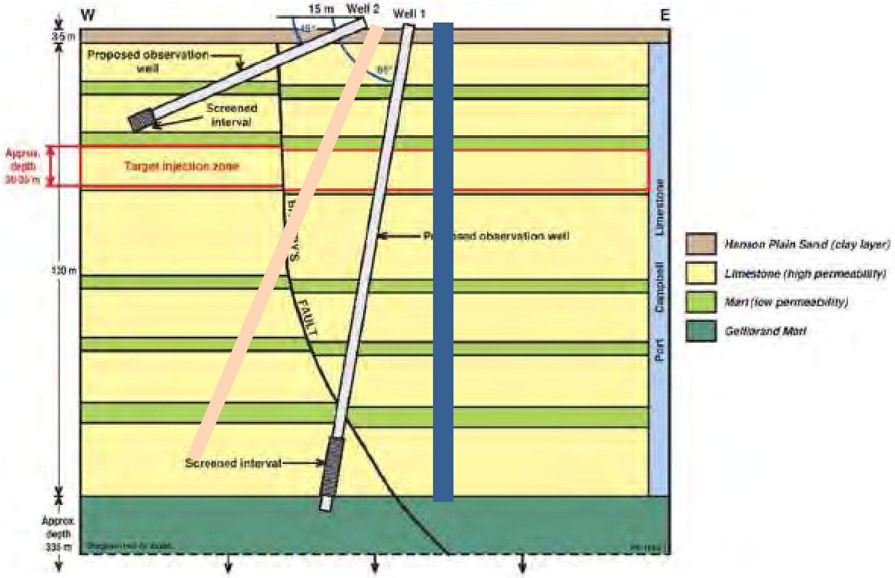
Collaborations Between RITE-CSIRO & RITE-CO2CRC Fiber Optic Sensing for Fault Integrity Monitoring

DAS (Acoustic), DSS (Strain), DTS (Temperature)

浅部地層の断層漏洩検知現場試験

Drilled and cored wells through fault

New wells?

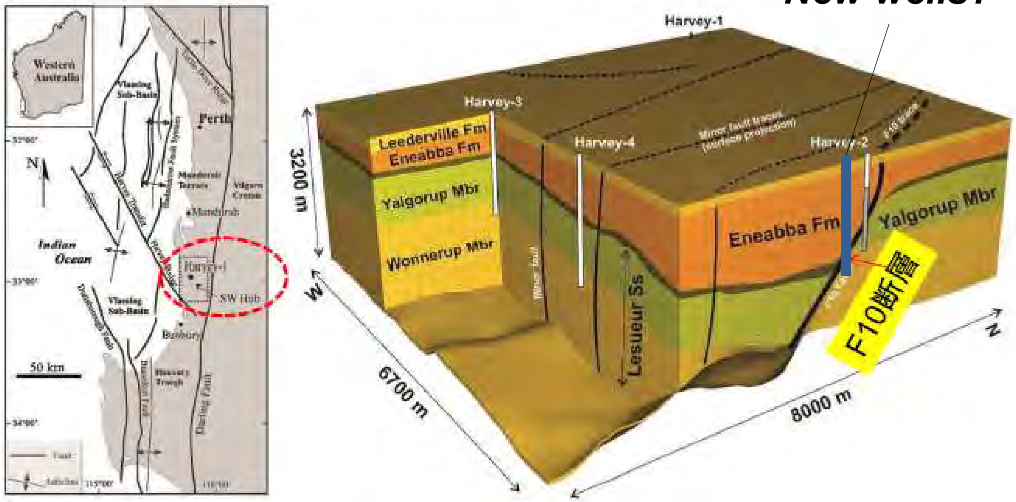


RITE-CO2CRC @Otway

深部地層の断層安定性評価の現場試験

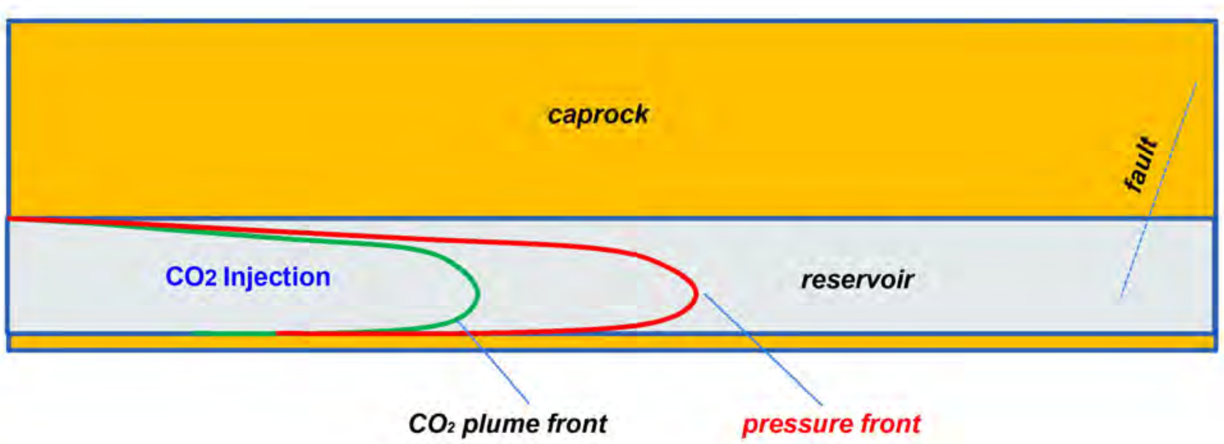
The South West Hub In-Situ Laboratory – A Facility for CO_2 Injection Testing and Monitoring in a Fault Zone

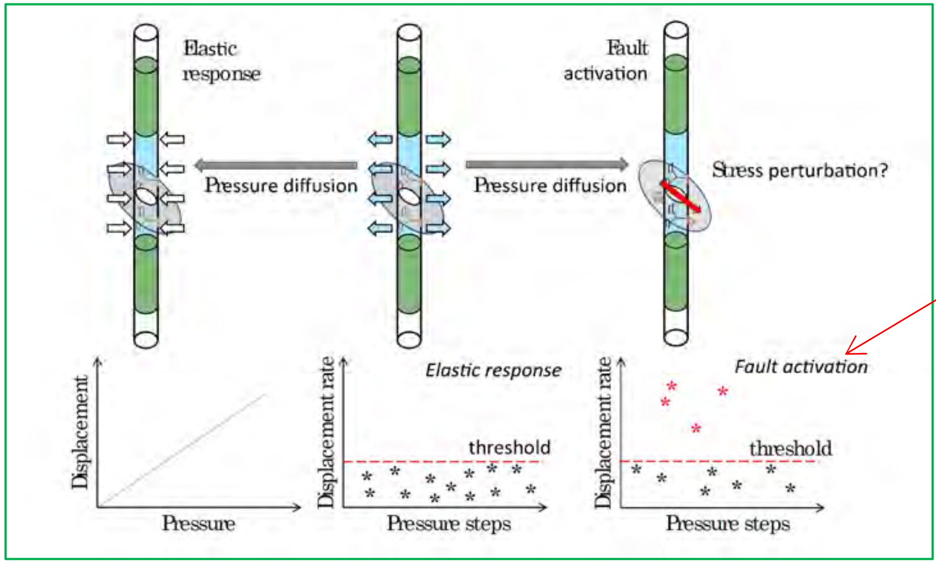
New wells?



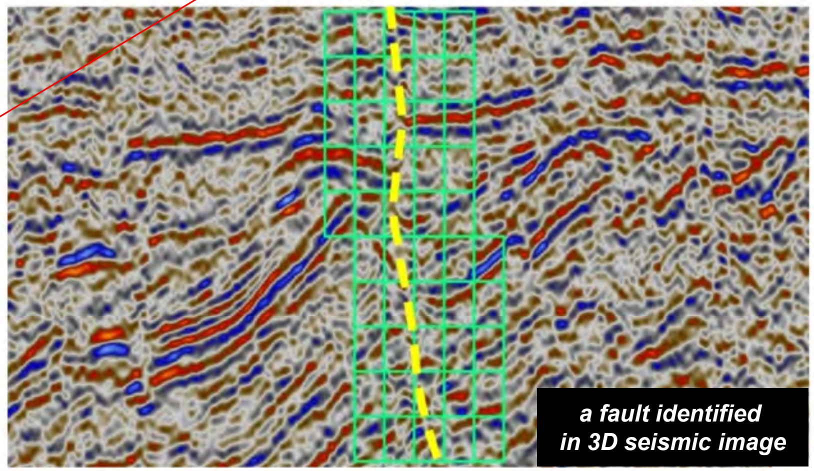
RITE-CSIRO @SW Hub In-Situ Lab

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





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



Kakurina et al, 2020

3. Social License to Operate (SLO) for CO_2 Storage in Japan

Social license (SLO)
社会からの免許

Actuarial license (ALO)
法規制の免許（許認可）

Political license (PLO)
政策的な免許

Risk Communication Approaches

SLO手法開発 ： 開発目標

地元や社会全体にCCSが受け入れられる条件整備

（単に規則を遵守し、営業許可を得るのはOperating License）

我が国のCCS実現に特化した手法を開発

1)情報ニーズ分析
・過去の要求事例の分析
・CCS実用化を想定した情報ニーズ予測
2)ODIインターフェース構築
・1)に基づいた情報整理
・2)要求情報提供を支援するインターフェース構築

【On Demand Information】

【コミュニケーション構築手法開発】
1) 実践的アプローチ
・地元対応業務の経験・ノウハウをSLOへ展開（リスク説明、トラブル対応重視）
2) 社会科学的アプローチ
・社会インフラ導入時のコミュニケーションに係る国内外先行事例調査・分析
・リスクに関する適格な説明と理解獲得手法策定
3) CCS導入効果（地元）
・CCS建設、運用時の地元経済波及効果分析
4) 科学的根拠に基づいたQA集
・CCS事業のリスク・メリット説明の基盤となるQA集拡充

【CCS導入メリット分析】
1) CO_2削減、経済性（社会全般）
・CCSコスト分析、ビジネスモデル検討
・CCS普及によるCO_2削減効果分析、他手法とのCO_2削減
・リスクファイナンス（CCS事業の財務保証や保険の調査）
2)排出源データベースの構築と活用
・排出源と貯留候補地を面的に俯瞰
・コスト比較（輸送コスト分析、CO_2削減効果等の分析）

【法制度整備・インセンティブデザイン支援】
1) インセンティブデザイン（ID）
・CO_2削減に係る海外のIDの調査（45Q等）、我が国に適したID分析
2) 法制度整備
・CCSに係る海外の法制度の調査・分析
・我が国の実情に合わせた法制度要件検討・支援

Tools for project cost estimation & business models

技術開発（technology development）から話術（art of conversation）への変身（transforming）

PASSIVE SEISMIC SERIES

Geophysics Role of Non-technical Issues Integral to Full-scale CCUS Deployment

Dr. Carpenter

Full-scale deployment of CCUS in the United States today is not dependent on the advancement of technical issues alone. There are a host of integrated issues that are necessary for the full-scale industry-wide deployment of CCUS that include, but are not limited to regulatory considerations (e.g., permitting, Class VI, etc.), economic considerations (e.g., financial lending, 45Q tax credits, etc.), risk evaluation, stakeholder engagement, Environmental Social Governance (ESG), Environmental Justice (EJ), and political/policy needs.

In many cases, technologists such as reservoir engineers, chemical engineers, geologists, geoscientists, etc., either overlook or are not exposed to these non-technical considerations. This presentation will discuss and illuminate the integrated nature of these issues and provide some insights for technologists to become more literate and therefore more valuable and engaging to their teams advancing CCUS projects.

Risk Communications Approaches

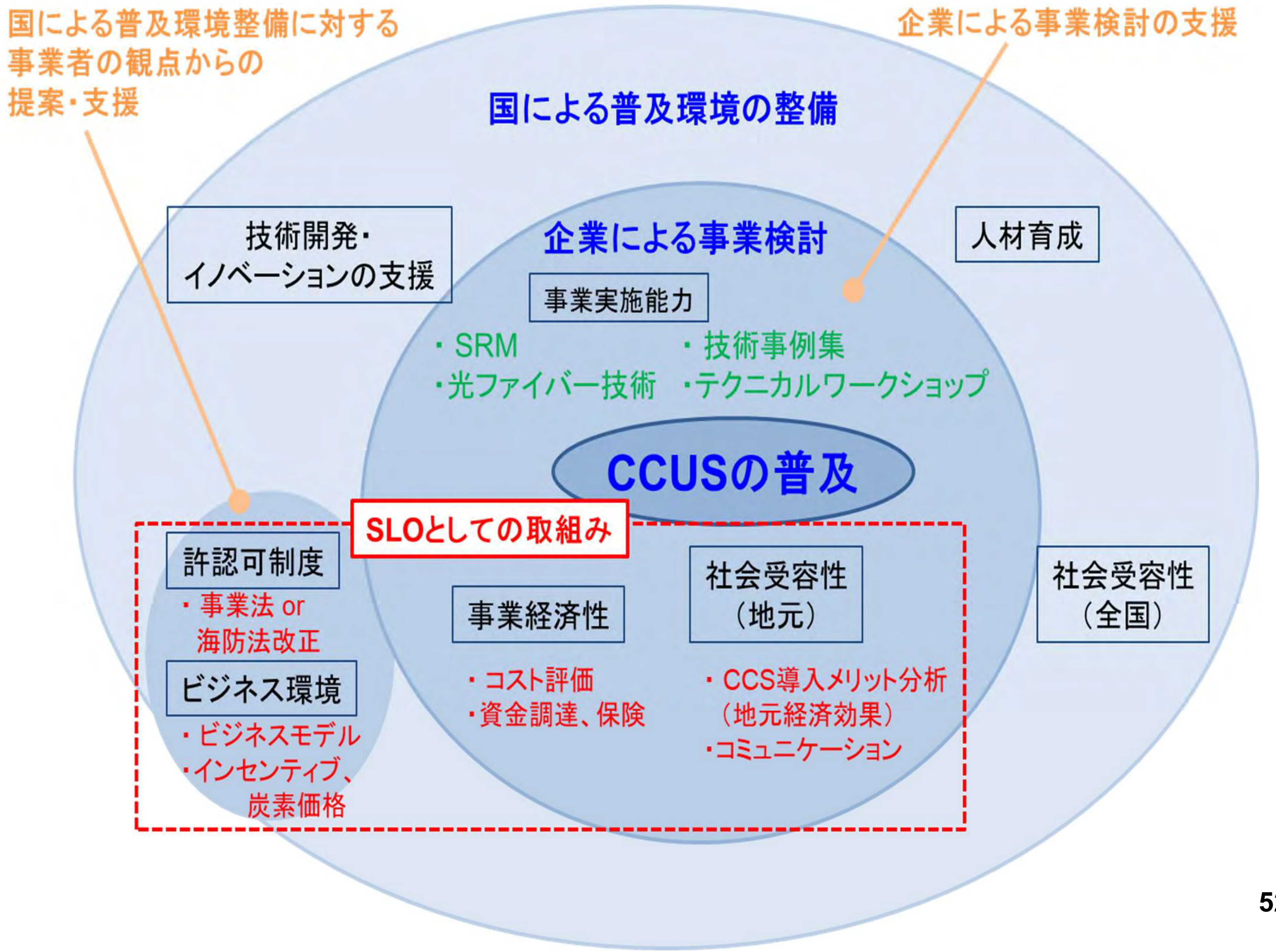
Uncertainties in Subsurface Characterization (Geology, Science and Technology), Policy and Regulation

→→ Public Concerns over Potential Risks →→ Sending Experts into the Community & Building Relationships and Trust !

謝 辞

この成果は、国立研究開発法人新エネルギー・産業技術総合開発機構（NEDO）の委託業務の結果得られたものです。ご協力いただいた関東天然瓦斯（株）、（株）物理計測コンサルタント、サンコーコンサルタント（株）、東京ガス（株）、ニューブレクス（株）にも感謝申し上げます。

This talk is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO) and the Ministry of Economy, Trade and Industry (METI) of Japan.


国による普及環境整備に対する
事業者の観点からの
提案・支援
企業による事業検討の支援
国による普及環境の整備
技術開発・
イノベーションの支援
企業による事業検討
人材育成
事業実施能力
・SRM
・光ファイバー技術
・技術事例集
・テクニカルワークショップ
CCUSの普及
SLOとしての取組み
許認可制度
・事業法 or
海防法改正
ビジネス環境
・ビジネスモデル
・インセンティブ、
炭素価格
事業経済性
・コスト評価
・資金調達、保険
社会受容性
（地元）
・CCS導入メリット分析
（地元経済効果）
・コミュニケーション
社会受容性
（全国）