Sproule

C-STORE

Data-Driven CO_2 Sequestration Solutions

C-STORE | Tool to Advance CO_2 Sequestration Opportunities

Sproule

Beyond Screening

- Take early-stage CO_2 sequestration project identification beyond industry-standard suitability checklists.
- Accelerate understanding of future saline aquifer development plans and uncertainties.

Machine Learning

- Machine Learning model predicts critical parameters for project decision-making.
- Bayesian inference method used to build the model on the results of over 200 reservoir simulation runs.
- Applicable to a wide range of saline aquifers and saline aquifer properties.

De-risk Investment

- Identify key uncertainties and data requirements prior to project investment.
- Manage risk through modelling probability distributions and integrate uncertainties into economic scenario modelling.

Integrated Geological Analysis

- Combine with screening and suitability checklist analysis, such as seal presence and continuity, to provide a powerful analysis and foundation to support business decisions.

C-STORE | User Interface

Sproule

INPUTS

Client Selection

- Geographic location

Expert Input

- Porosity
- Permeability
- Thickness
- Depth
- Area Size
- Permeability anisotropy

RESPONSE

Tool Response

- Cumulative CO_2 Injection Potential
- Average, Max, Final CO_2 injection rates
- Injection Wells/Well Spacing
- Estimated CO_2 Plume Length & Diameter

C-STORE | User Interface

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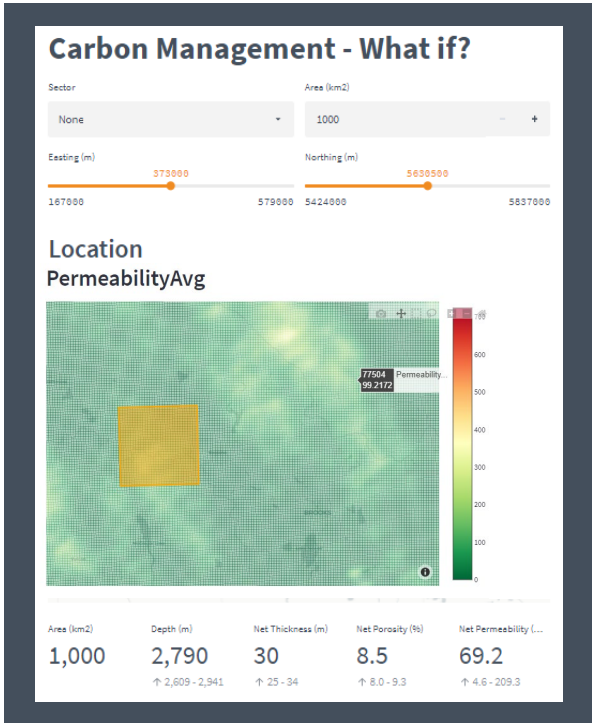
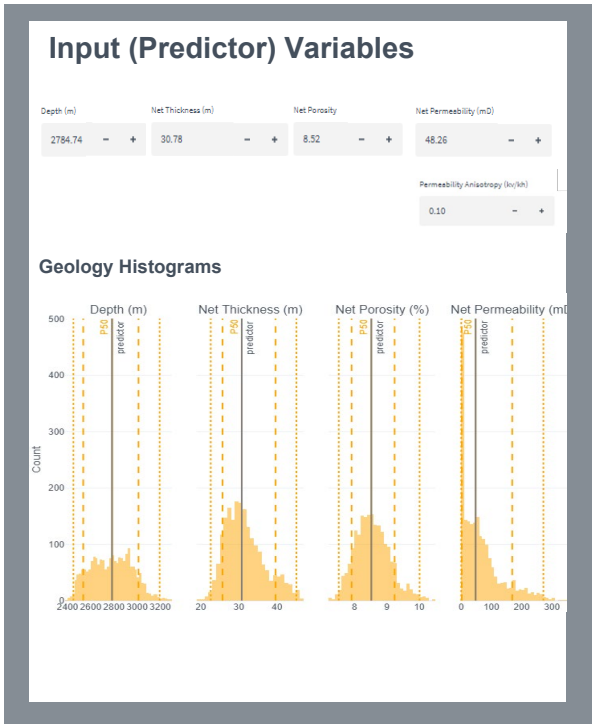
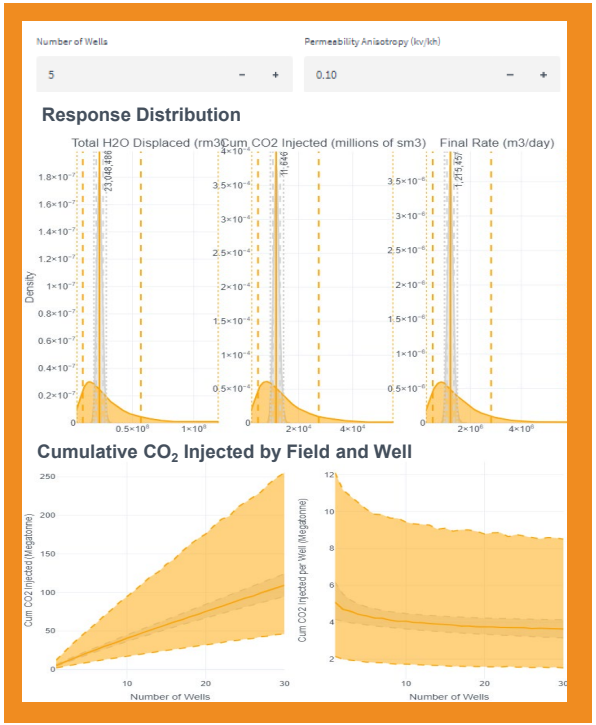
Client Selected Location → **Input Geological Parameters** → **Tool Response**







C-STORE | Workflow

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Geomodelling & Petrophysics

Reservoir Simulation Modelling

Bayesian Machine Learning Model

1 Geomodelling & Petrophysics

- Large (32.5 million acre), comprehensive geomodel (Petrel) constructed for a deep sandstone saline aquifer.
- Performed geostatistical workflow tailored for uncertainty studies utilizing well databases and magnetic field mapping.
- 3D geologic framework built on over 240 wells with properties characterized by distributions rather than single values.

2 Reservoir Simulation Modelling

- Underpinned by sector simulation models to evaluate full range of saline aquifer properties.
- Over 200 reservoir simulation sensitivity runs applying CMG CMOST (Intelligent Optimization & Analysis Tool) to support subsurface uncertainty analysis.
- Models apply analytical aquifers to simulate open boundary conditions and fixed Flowing Bottom Hole Pressure (FBHP) so as not to exceed fracture pressure.

3 Bayesian Machine Learning Model

- Applies a Bayesian Regression Machine Learning algorithm to model and predict probability distributions of response variables.
- Model returns P_{10}, P_{50}, P_{90} range in Cumulative CO_2 Injection Potential, Number of Injection Wells, Maximum, Average and Final Injection Rates, and CO_2 Plume Diameter response variables.

Input Variable Range	Min	Max
Depth (m)	1900	3650
# of wells	1	25
Porosity (%)	2	18
Permeability (mD)	1	10000
Kv/kh	0.01	0.5

Illustrative Case Study | Assess Storage Suitability and Potential

Sproule

Client Overview

- Company is looking to understand **the Basal Cambrian Sandstone CO_2 storage suitability and potential** in a specific area in Western Canada.
- Limited budget for initial scoping study.

2,000 km²
Western Canada

2.0 Mt CO_2 / year
Total Required Storage

Sproule Solution

Client provides area of interest. Model determines Basal Cambrian Sandstone reservoir properties and range in uncertainty within the area of interest:

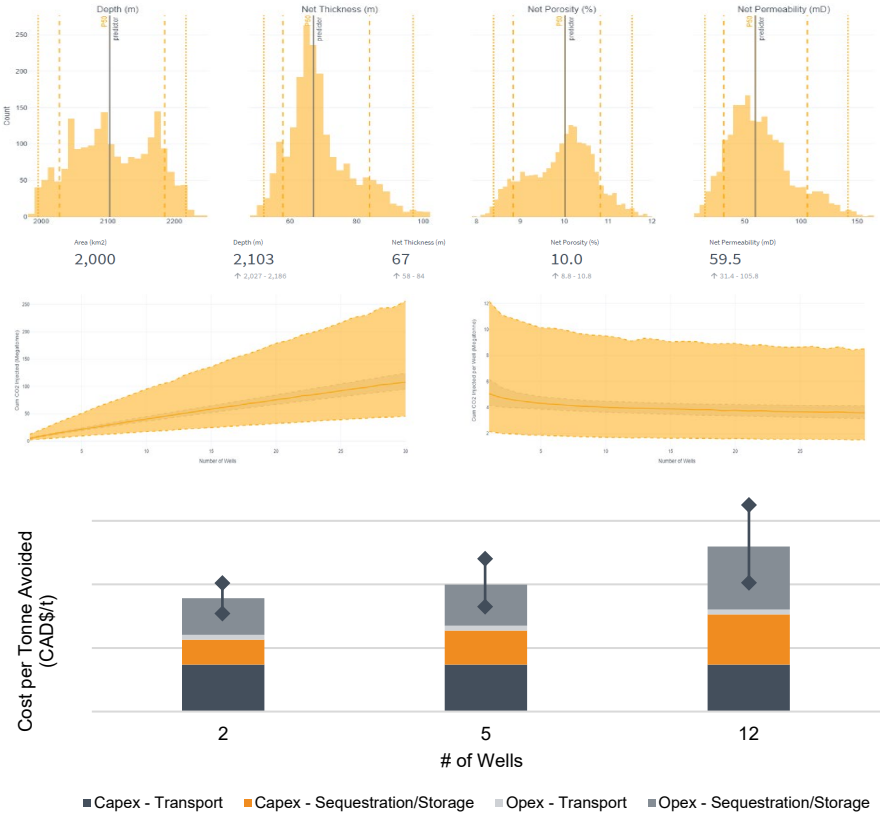
- **Net Thickness** - 67m (P_{90} - 58m, P_{10} - 84m)
- **Net Porosity** – 10% (P_{90} - 8.8%, P_{10} - 10.8%)
- **Net Permeability** - 59 mD (P_{90} - 31 mD, P_{10} - 106mD)

Using the **CO_2 Sequestration Screening Tool**, Sproule estimates in the P_{50} case Company requires:

- ✓ 5 injection wells to sequester 50Mt of CO_2 over 25 years.

(P_{10} – 12 wells, P_{90} – 2 wells)

- ✓ P_{50} Prospective CO_2 Storage Resource of 432 Mt.
- ✓ Estimated P_{50} Maximum Plume Length after 25 years of injection – 2.1 km.
- ✓ Scoping Economics and Sensitivity Analysis e.g. Transportation and Sequestration cost per tonne CO_2 avoided.



Deepen Client's understanding and advance CO_2 sequestration opportunities through our data-driven analysis and solutions.

Illustrative Case Study | Storage Site Comparison

Sproule

Client Overview

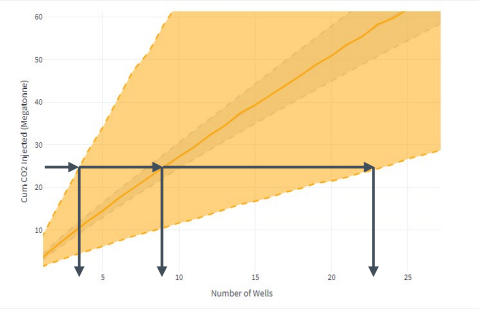
- Company is looking to evaluate, **high-grade and rank CO_2 storage opportunities within 560 km² area surrounding three natural gas processing plants**.
- Company has identified a target formation and average reservoir properties surrounding each site. Each site will produce 0.5 Mt CO_2 per year over 25 yrs.

Site 1	Site 2	Site 3
Depth – 2000m	**Depth – 3000m**	**Depth – 2500m**
Thickness - 60m, ϕ - 8%, k - 10 mD	**Thickness - 40m, ϕ - 7%, k - 40 mD**	**Thickness - 20m, ϕ - 5%, k - 100 mD**

Sproule Solution

Site 1

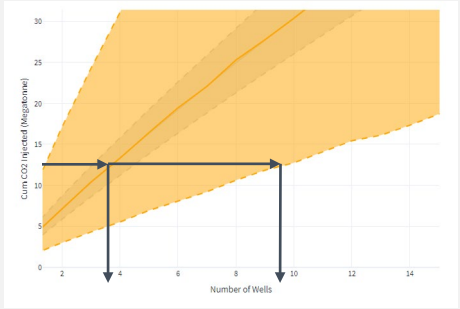
- ✓ Using the Sproule **CO_2 Sequestration Screening Tool**, Sproule estimates in the P_{50} case Company requires:
- ✓ 5 injection wells to sequester 12.5Mt of CO_2 over 25 years (P_{10} – 2 wells, P_{90} – 11 wells).



- ✓ P_{50} Prospective CO_2 Storage Resource of 60.7 Mt.

Site 2

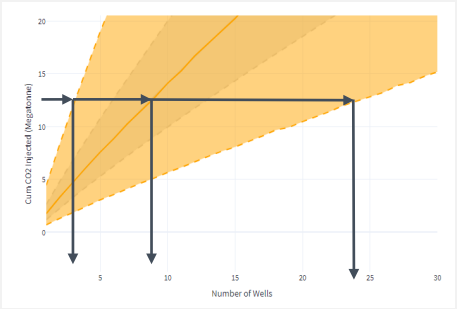
- ✓ Using the Sproule **CO_2 Sequestration Screening Tool**, Sproule estimates in the P_{50} case Company requires:
- ✓ 4 injection wells to sequester 12.5Mt of CO_2 over 25 years (P_{10} – 1 wells, P_{90} – 10 wells).



- ✓ P_{50} Prospective CO_2 Storage Resource of 16.8 Mt.

Site 3

- ✓ Using the Sproule **CO_2 Sequestration Screening Tool**, Sproule estimates in the P_{50} case Company requires:
- ✓ 9 injection wells to sequester 12.5Mt of CO_2 over 25 years (P_{10} – 3 wells, P_{90} – 24 wells).



- ✓ P_{50} Prospective CO_2 Storage Resource of 12.9 Mt.

Site 2 requires the fewest CO_2 injection wells due to large permeability thickness and contains sufficient storage potential