



CaMI CCS FIELD RESEARCH STATION ALBERTA, CANADA

**10TH CO₂GEONET OPEN FORUM
11TH – 12TH MAY 2015**

DON LAWTON (CaMI)

RICHARD ADAMSON (CMC)

KIRK OSADETZ (CaMI)

AMIN SAEEDFAR (CaMI)

CMC RESEARCH INSTITUTES AND CaMI

CMC Research Institutes, Inc. is federally incorporated independent not-for-profit corporation dedicated to accelerating innovation associated with addressing the challenge of industrial greenhouse gas emissions.

The Containment and Monitoring Institute (CMC.CaMI) is the first of a series of challenge-focused research institutes developed as operating divisions of CMC.

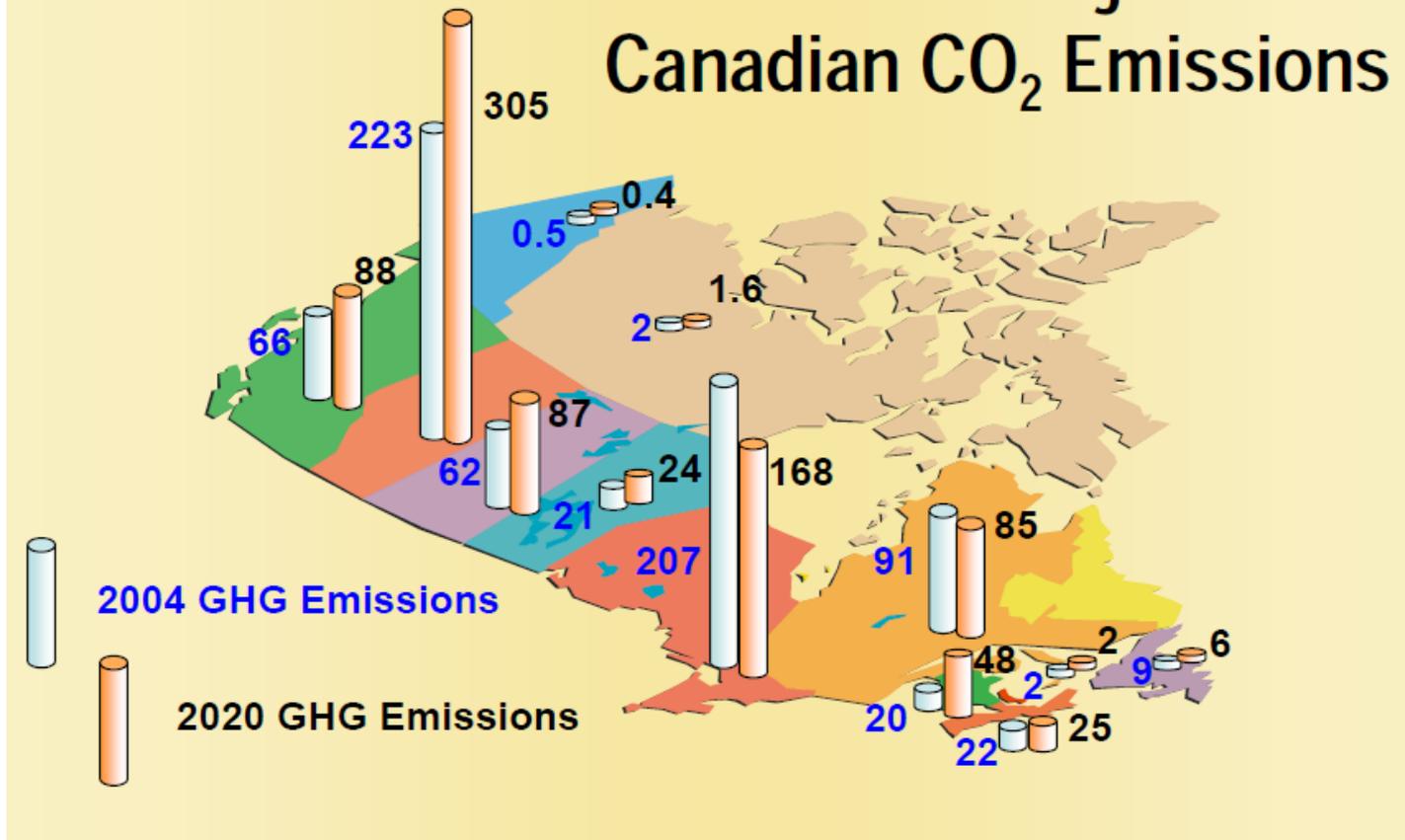
CMC is hosted by the University of Calgary.

CaMI is an affiliate of the University of Calgary, which is actively involved in the Field Research Station at Newell County.



CANADA'S CO₂ EMISSIONS

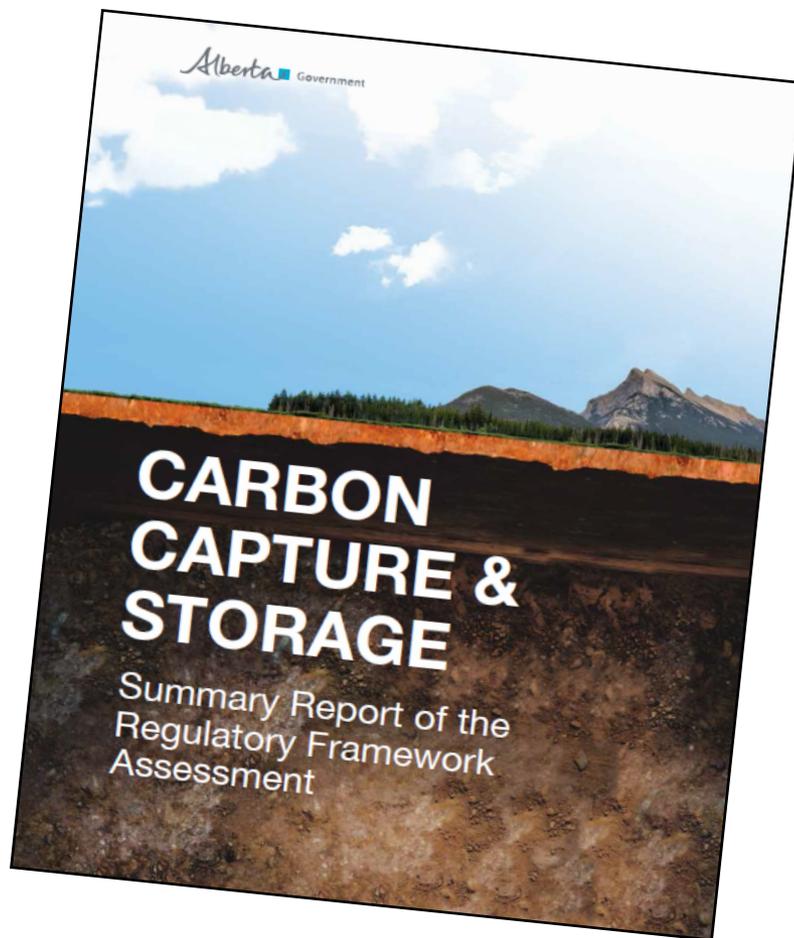
Current and Projected Canadian CO₂ Emissions



GOVERNMENT OF ALBERTA CCS RFA

**Government
of Alberta
Regulatory
Framework Assessment**

(August 2013)



RFA RECOMMENDATION

RISK ASSESSMENT, MONITORING, & TECHNICAL REQUIREMENTS

“Require MMV and closure plans to be based on a project-specific risk assessment, and include the use of best available technologies to monitor the atmosphere, surface, ground and surface water, and subsurface.”



RFA CLOSURE MMV

RECOMMENDATIONS FOR CLOSURE REQUIREMENTS

- “a) Sequestered CO₂ and affected fluids are conforming to the objectives and regulatory requirements as described in the project application and approvals.*
- c) Sequestered CO₂ and affected fluids are contained in the sequestration complex.*
- d) Sequestered CO₂ is behaving in a predictable manner.*
- e) Sequestered CO₂ is expected to continue to behave in a predictable manner and is trending towards stability”*



MONITORING CHALLENGES

VERIFICATION OF CONFORMANCE AND CONTAINMENT

- *Thin storage formations (saturation-thickness)*
- *Cap rock integrity*
- *Thief zones, resolution from monitoring methods*
- *High rock matrix K and μ values*
- *Pressure vs CO_2 saturation*
- *Pressure interference with existing hydrocarbon pools*
- *Pressure interference between adjacent CCS projects*
- *Brine/ CO_2 migration through old wells*
- *Out of zone CO_2 migration to another storage formation (pore space encroachment)*

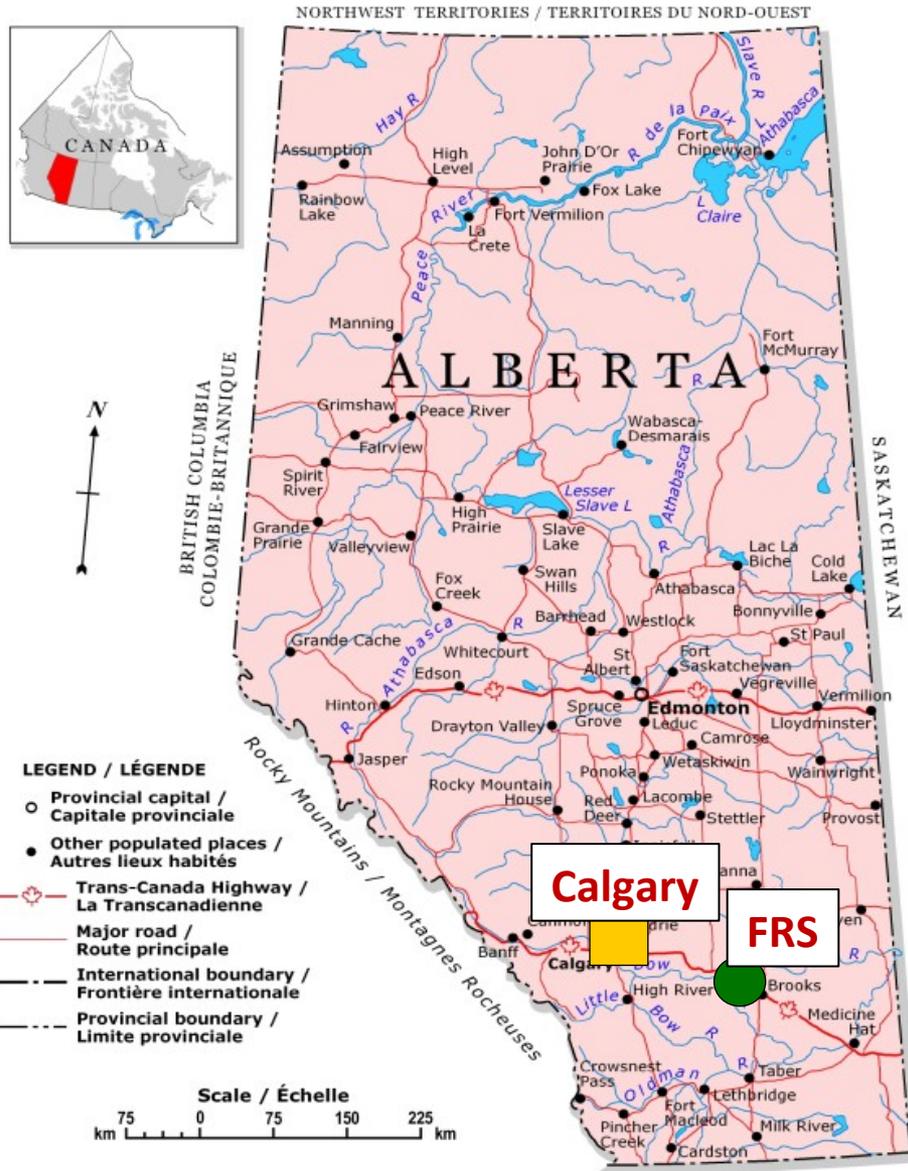


CaMI FIELD RESEARCH STATION (FRS)

- *Undertake controlled CO₂ release at 300 m & 500 m depth; ~1000 t/yr.*
- *Determine CO₂ detection thresholds*
- *Develop improved monitoring technologies.*
- *Monitor gas migration at shallow to intermediate depths.*
- *University & industry field training & research, integrating engineering and geoscience*
- *Provide quantitative monitoring knowledge to the regulator (AER)*
- *Accelerate public outreach & education.*
- *Provide on-site fuel cell for CO₂ source and natural gas utilization; energy storage; energy efficiency*



LOCATION OF THE FRS



© 2004. Her Majesty the Queen in Right of Canada, Natural Resources Canada.
 Sa Majesté la Reine du chef du Canada, Ressources naturelles Canada.

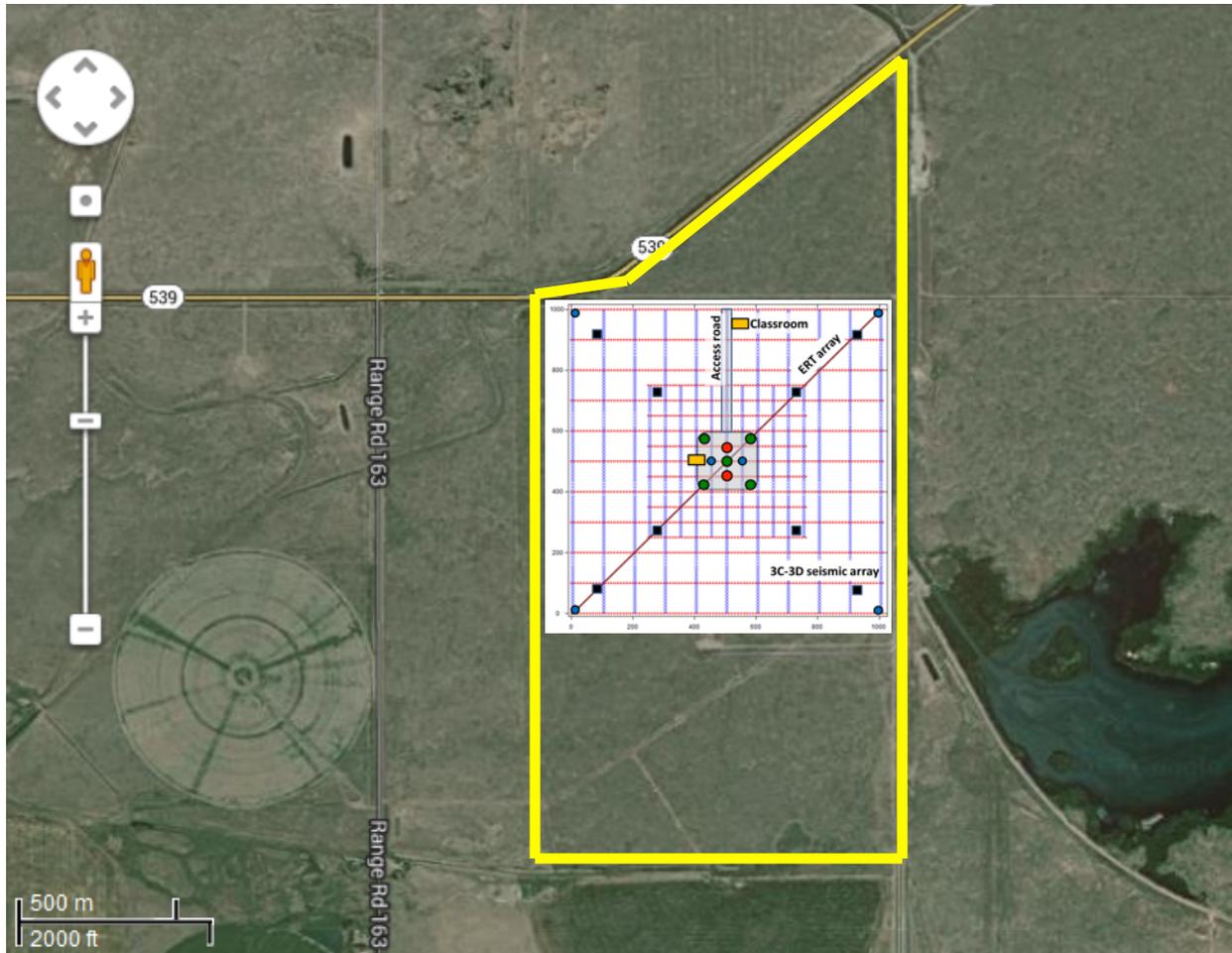
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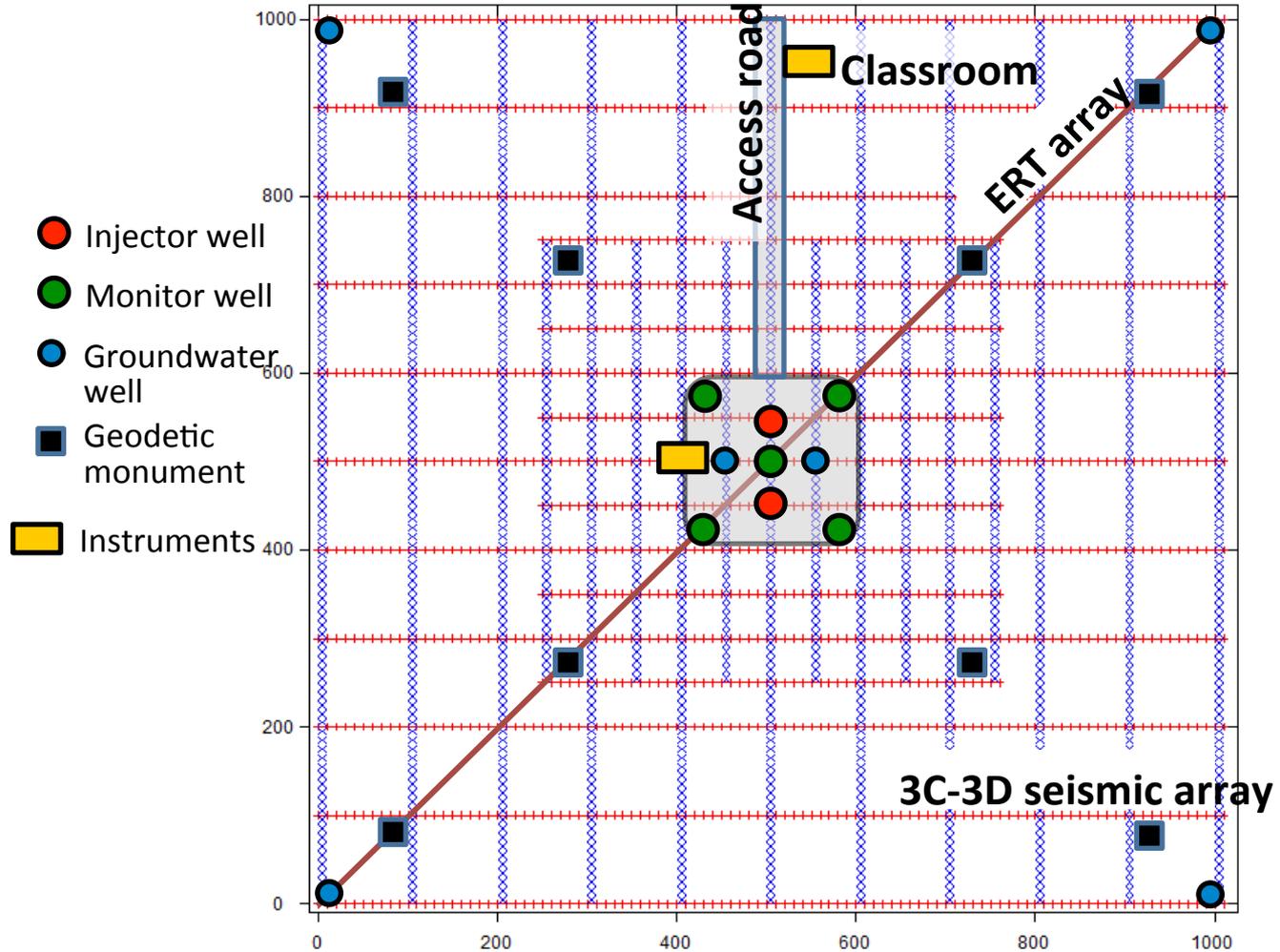
FRS SITE – COURTESY OF CENOVUS



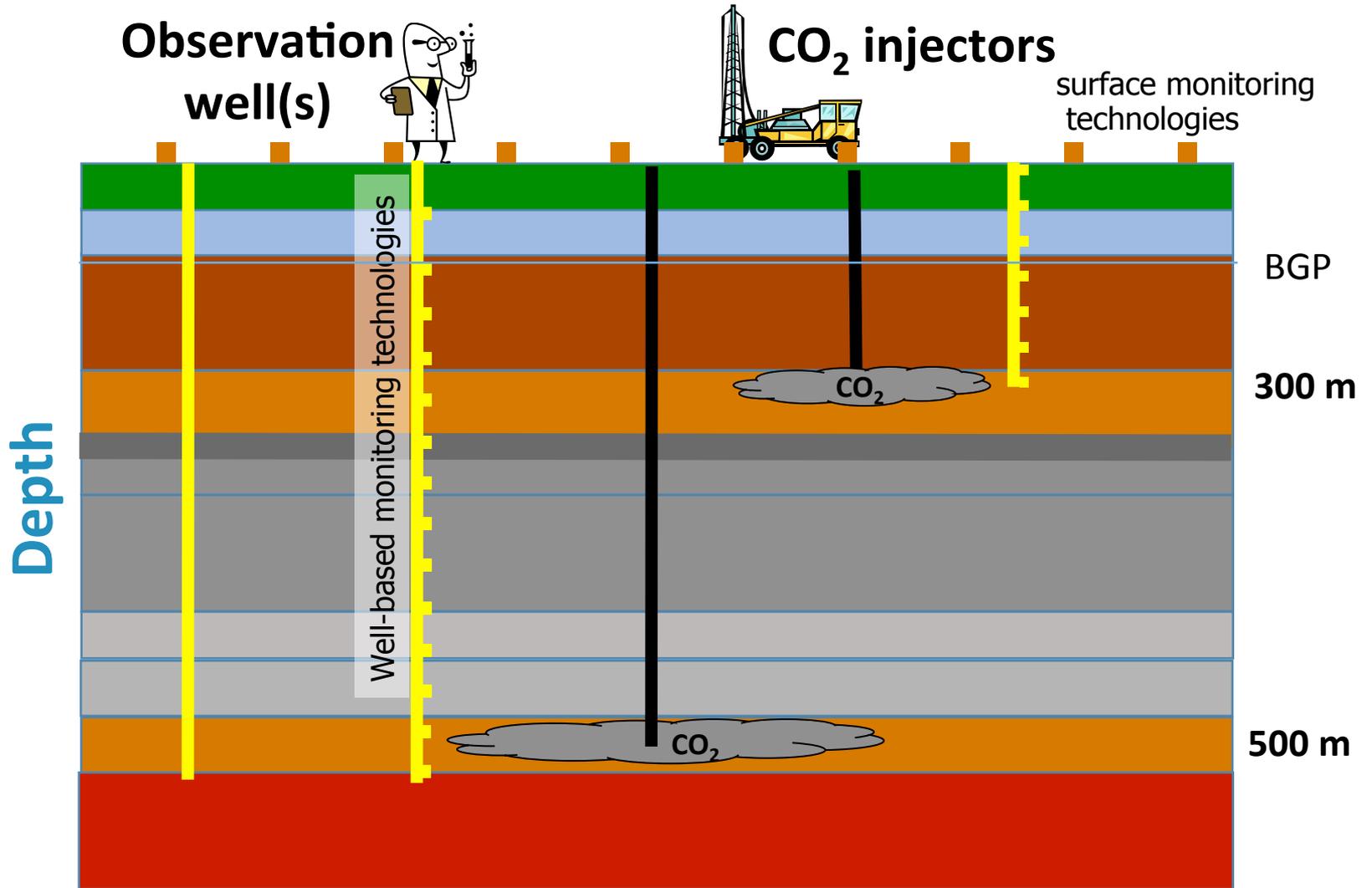
CAMI | UOFC | FRS



FRS MONITORING LAYOUT



FRS SCHEMATIC



FRS monitoring technologies

- 3D-3C surface seismic surveys
- 3D vertical seismic profiles
- Cross-well seismic surveys
- Microseismic surveys
- Full logging suites & core analysis
- Fibre-optic monitoring technologies (DAS, DTS)
- Fibre-optic accelerometers vs geophones
- Geomechanics analysis
- Geochemical sampling/tracers (isotopes)
- Groundwater monitoring surveys
- Electrical and electromagnetic geophysical surveys
- Casing gas, soil & atmospheric surveys
- Tiltmeters & DGPS surveys
- InSAR imaging and interpretation
- Fuel cell h/p CO₂ supply



PUBLIC ENGAGEMENT AND OUTREACH

March 13 & May 8, 2014: County of Newell

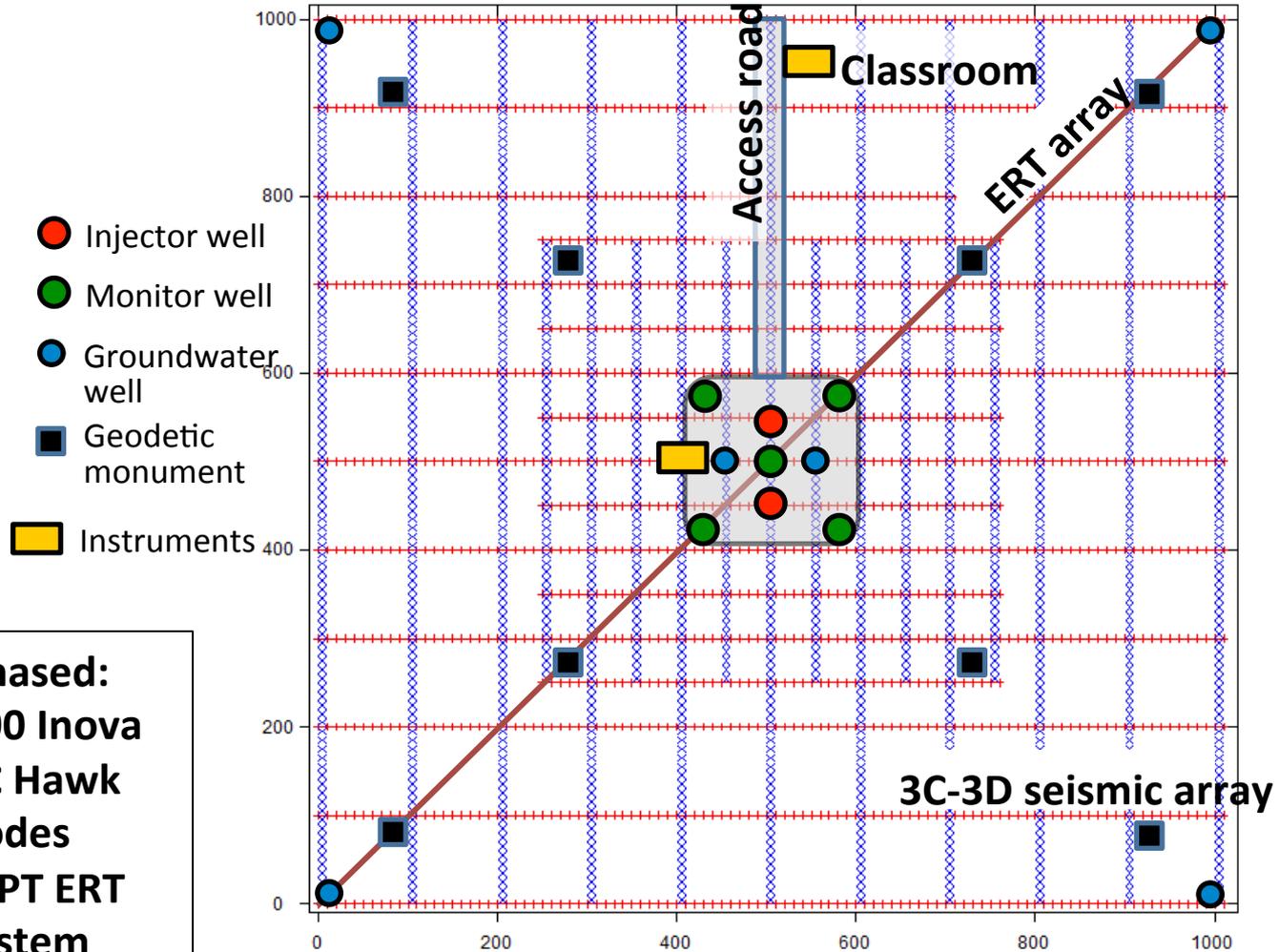
- *Manager – Planning and Development*
- *Director of Information Technology*
- *Manager of Fire and Emergency Services*
- *Chief Administrative Officer*
- *Director of Corporate Services*
- *Director of Agricultural Services*



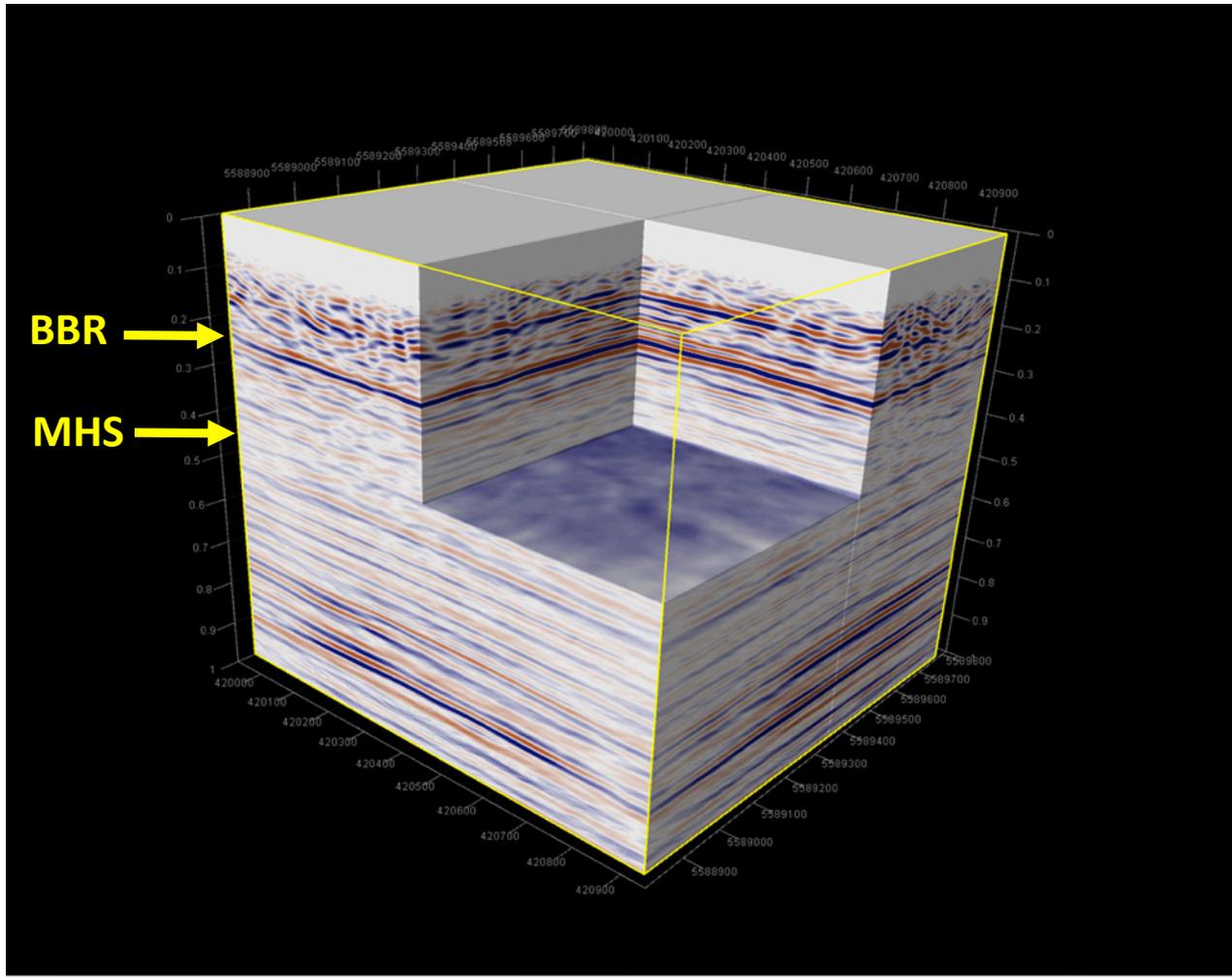
The latest in greenhouse gas containment technology: Don Lawton, PhD, PGeoph is proposing a carbon capture containment and monitoring research station near Scandia that will attract international attention when up and running in early 2015. Lawton, centre, made a pitch for County of Newell support last week with part of his team, Ruth Klinkhammer, right, and Kirk Osadetz, left. Mickey Dumont | Chronicle photo



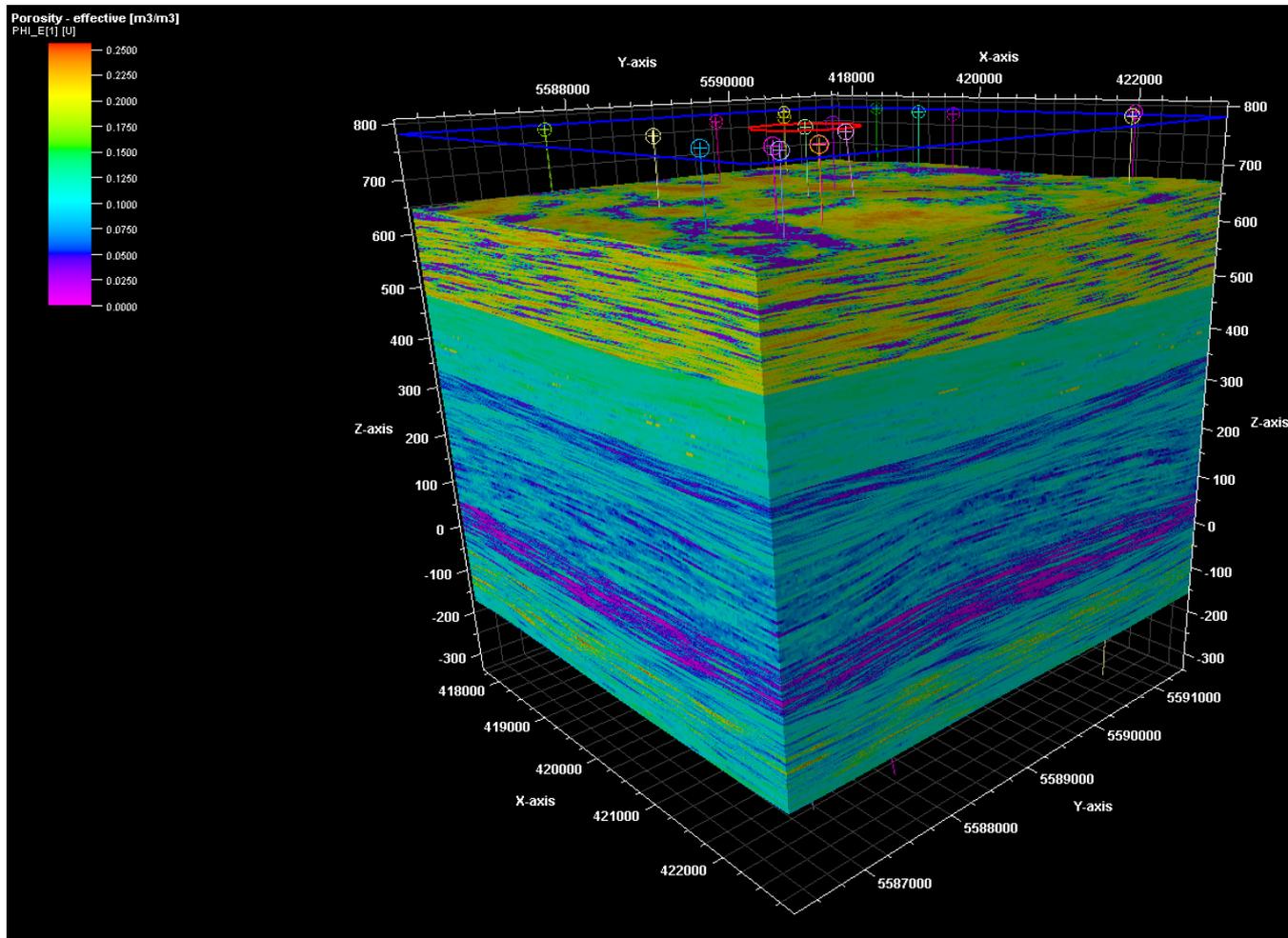
FRS MONITORING LAYOUT



FRS SEISMIC VOLUME



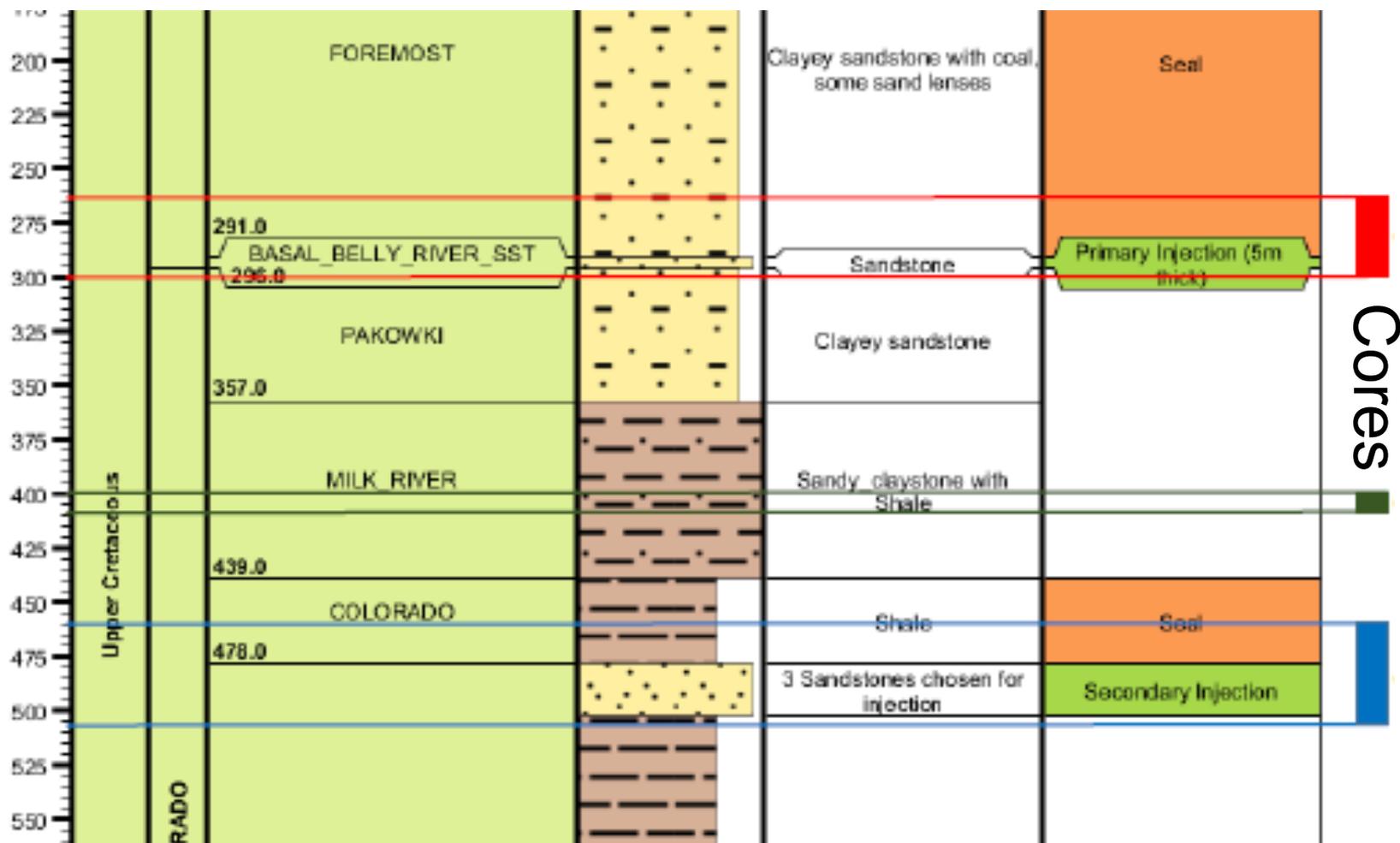
FRS GEOSTATIC MODEL



FRS #1 WELL (FEB 2015)



FRS #1 SAMPLING

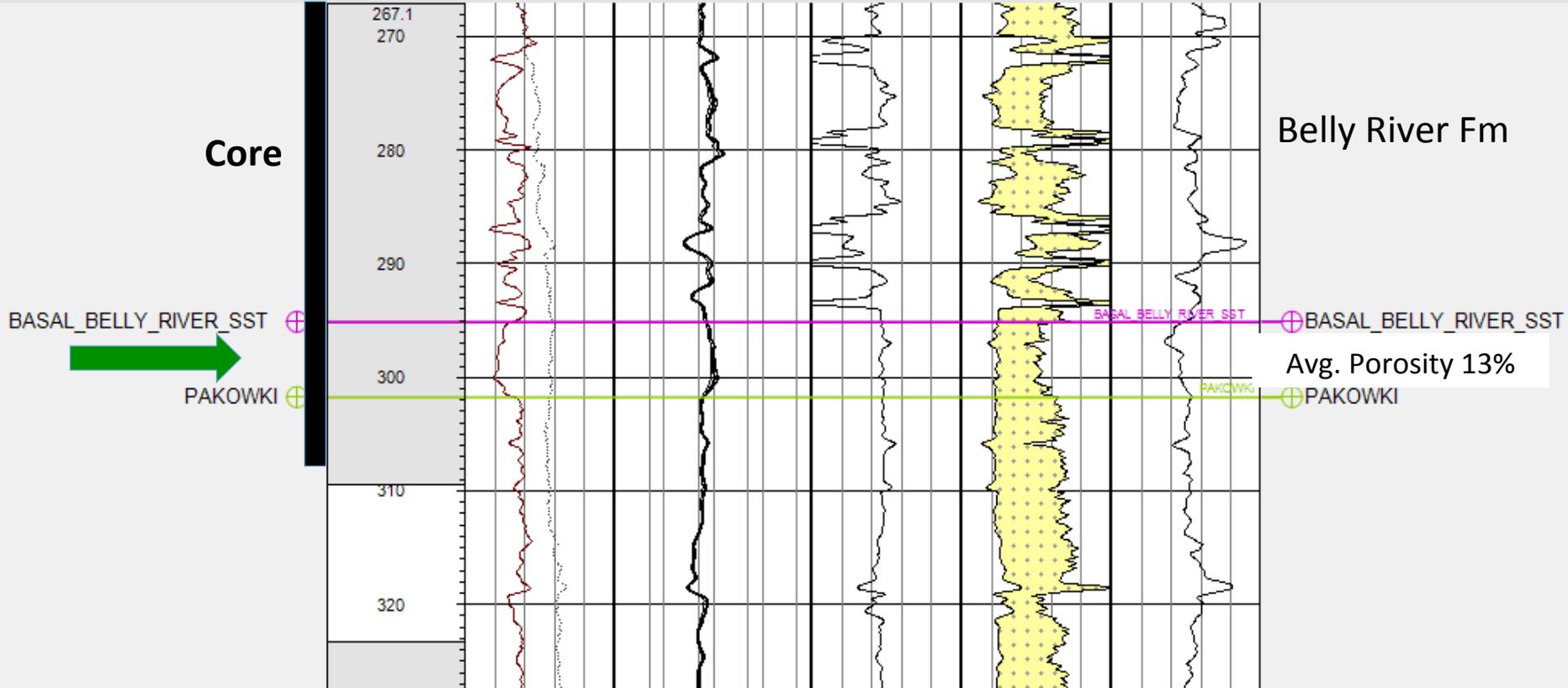


Mud-gas sampling every 5 m



BASAL BELLY RIVER FM (300m)

CMCRI COUNTSS [TVD]											
MD	SP		AF90			RHOZ		NPOR_SAN		TCMR	
	-69.38	mV 18.37	0.1	ohm.m	1,000.0	1.95	g/cm3 2.95	0.00	m 0.60	0.00	m3/m3 0.30
	GR		AF60					DPHI_SAN			
	10	gAPI 180	0.1	ohm.m	1,000.0			0.00	m 0.60		
			AF30					Color fill			
			0.1	ohm.m	1,000.0						
			AF20								
			0.1	ohm.m	1,000.0						
			AF10								
			0.1	ohm.m	1,000.0						

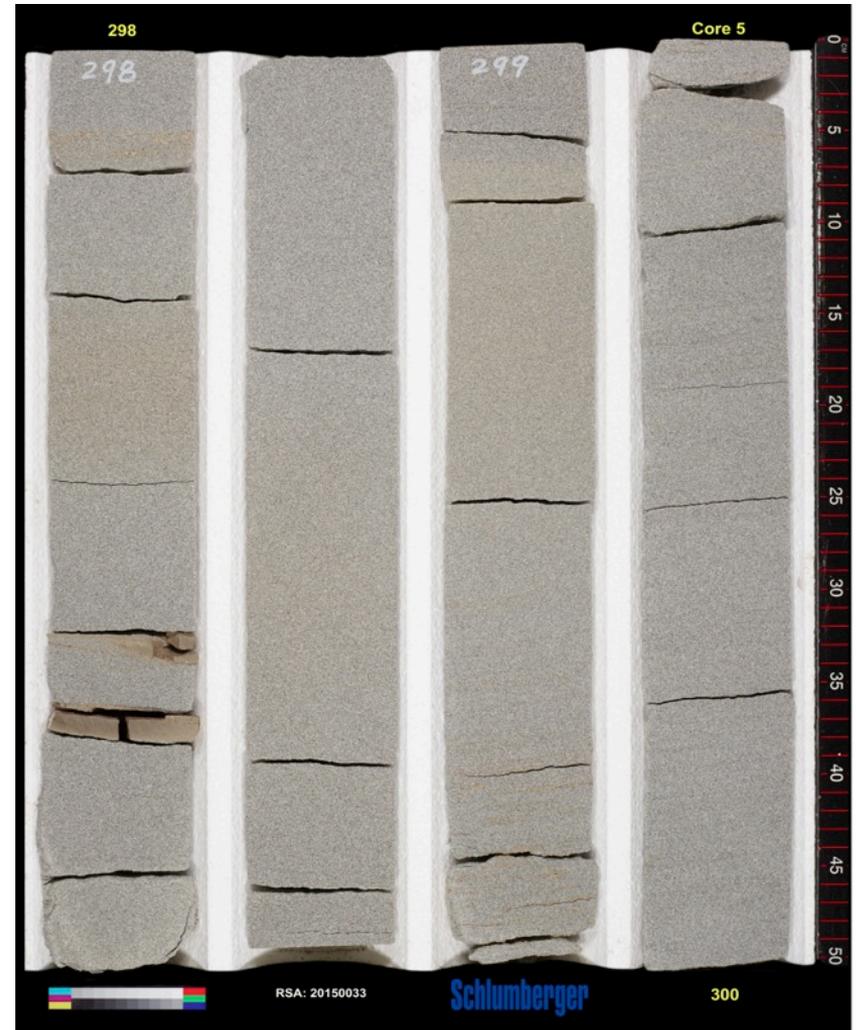


BASAL BELLY RIVER FM (300m)

Cap rock



Reservoir



MOBILE GEOCHEM LABORATORY

- *Sondes for field measurements (pH, EC, T, DO, Eh)*
- *Soil gas flux chambers and soil gas collection probes*
- *Gas chromatographs for hydrocarbon and soil gas analyses*
- *Ion chromatograph (Dionex) for anion and cation concentration analyses on water samples*
- *Titration for alkalinity and H₂S in water samples*
- *Portable H₂S gas analyzer*
- *Carbon isotope laser analyzer for methane*
- *Carbon and oxygen isotope laser*



Dr. Bernhard Mayer



NEAR-SURFACE CHARACTERIZATION

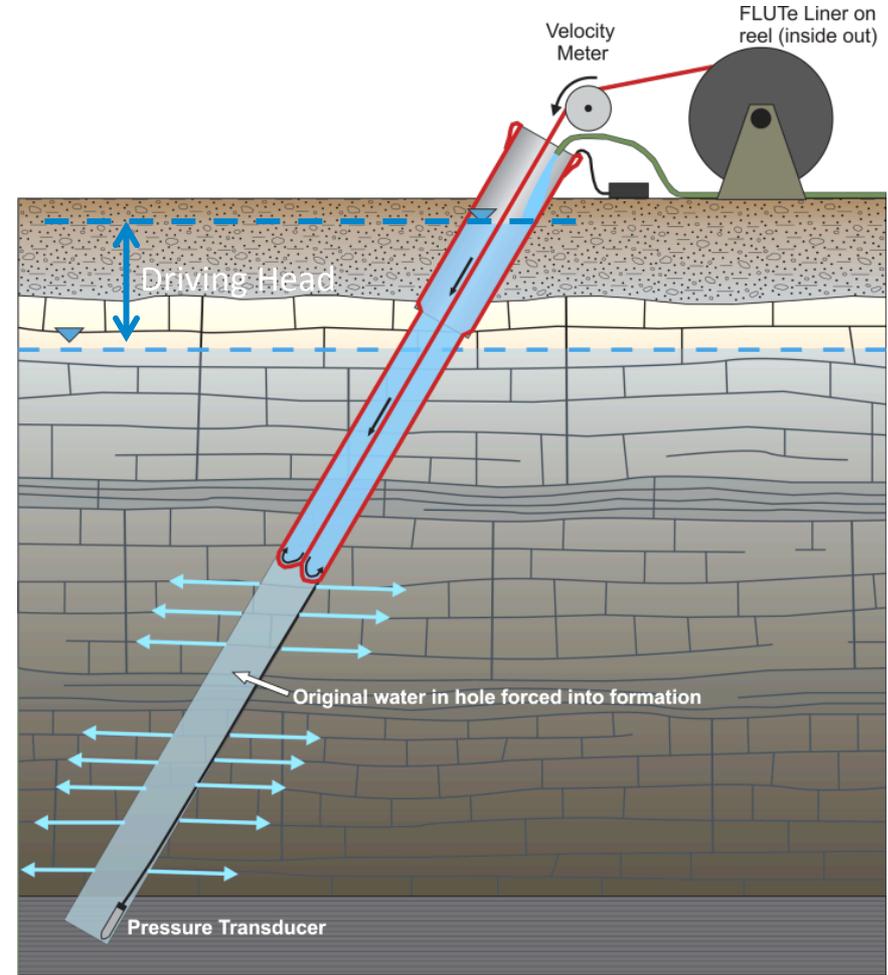
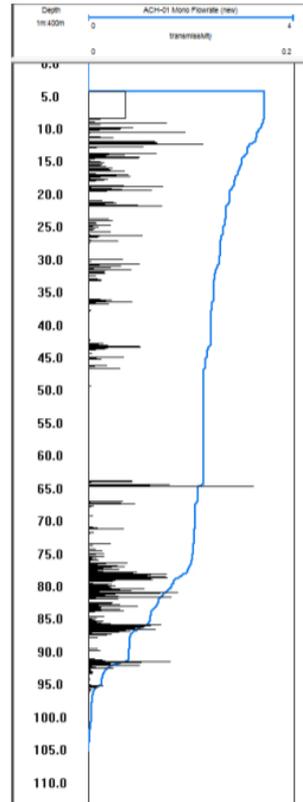
PROPOSED G360 CONTRIBUTION, UNIVERSITY OF GUELPH
(DR. JOHN CHERRY, DR. BETH PARKER, DR. AARON CAHILL)

- *Characterize geology to 300 m depth in high detail using Discrete Fracture Network (DFN) Methodology.*
- *Using results from characterization design a highly accurate and relevant multi-level Westbay groundwater sampling system.*
- *Use data from characterization and custom built Westbay to observe and understand impacts of injected CO₂*



FLUTE TRANSMISSIVITY PROFILING

Provides depth-discrete transmissivity distribution



RESOURCING AND COLLABORATIONS

- *\$4.40 M CMC (capital & operating)*
- *\$4.92 M from Western Economic Diversification (Federal - capital)*
- **Implementation through Schlumberger Carbon Services**
- **NRCan**
- **AITF**
- **US Department of Energy**
- **UK Carbon Capture and Storage Research Centre**
- **Scottish Carbon Capture and Storage**
- **South Korea**
- *Industry subscriptions (programs)*



SUMMARY

- *There is a need to better characterize containment risks for injection or production of fluids into/from reservoirs*
- *FRS is a unique benchmarking and evaluation program for monitoring subsurface fluids*
- *FRS is unique internationally*
- *FRS is being developed by CaMI in collaboration with the University of Calgary for training and education*
- *Technologies transferable to other monitoring challenges (EOR, HF, AGD, CSS, SAGD)*
- *Evaluation of shallow CO₂ storage potential for oil sands*



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