Soil Gas Monitoring Techniques and Implications for MMV Plans

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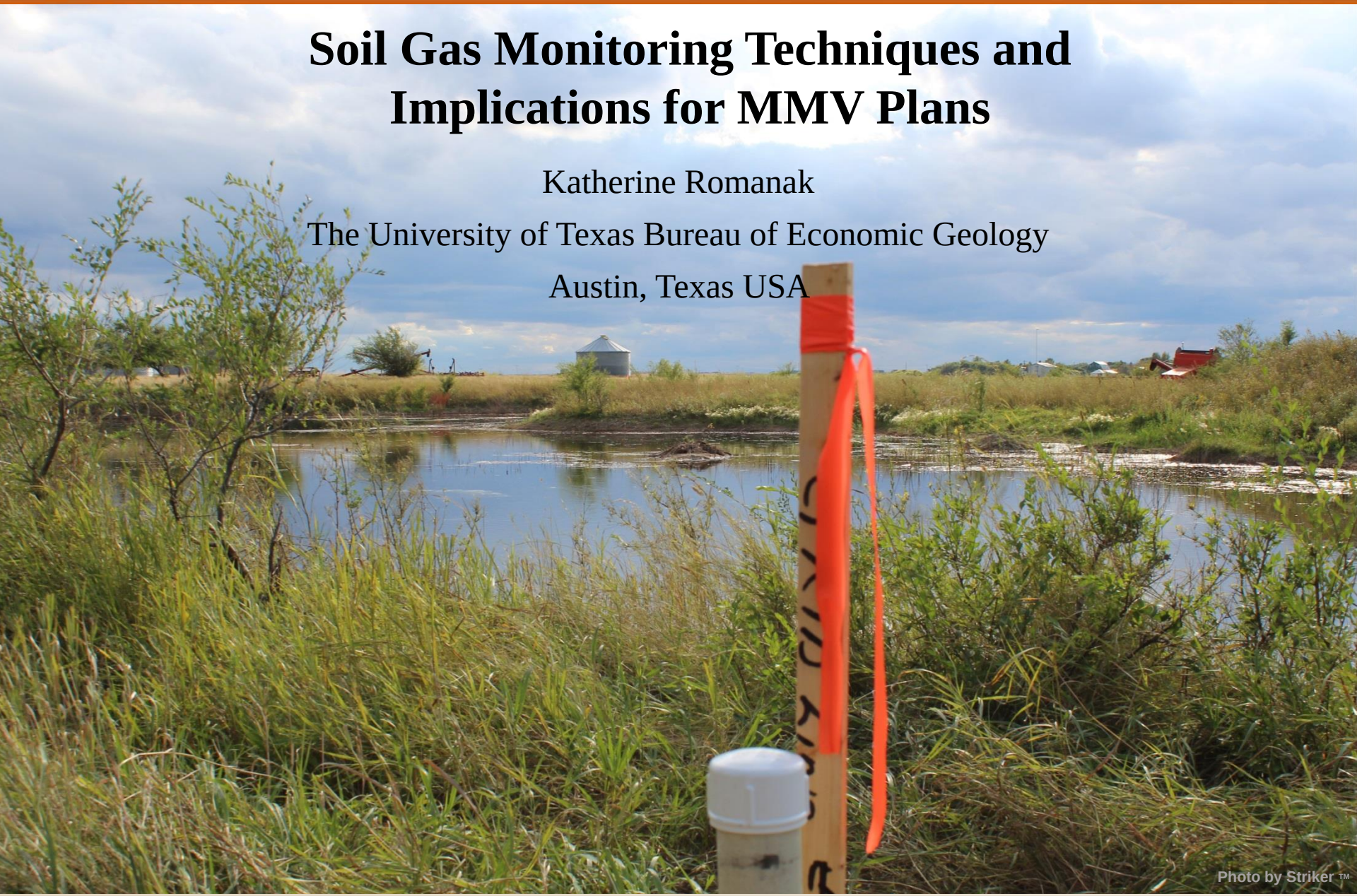
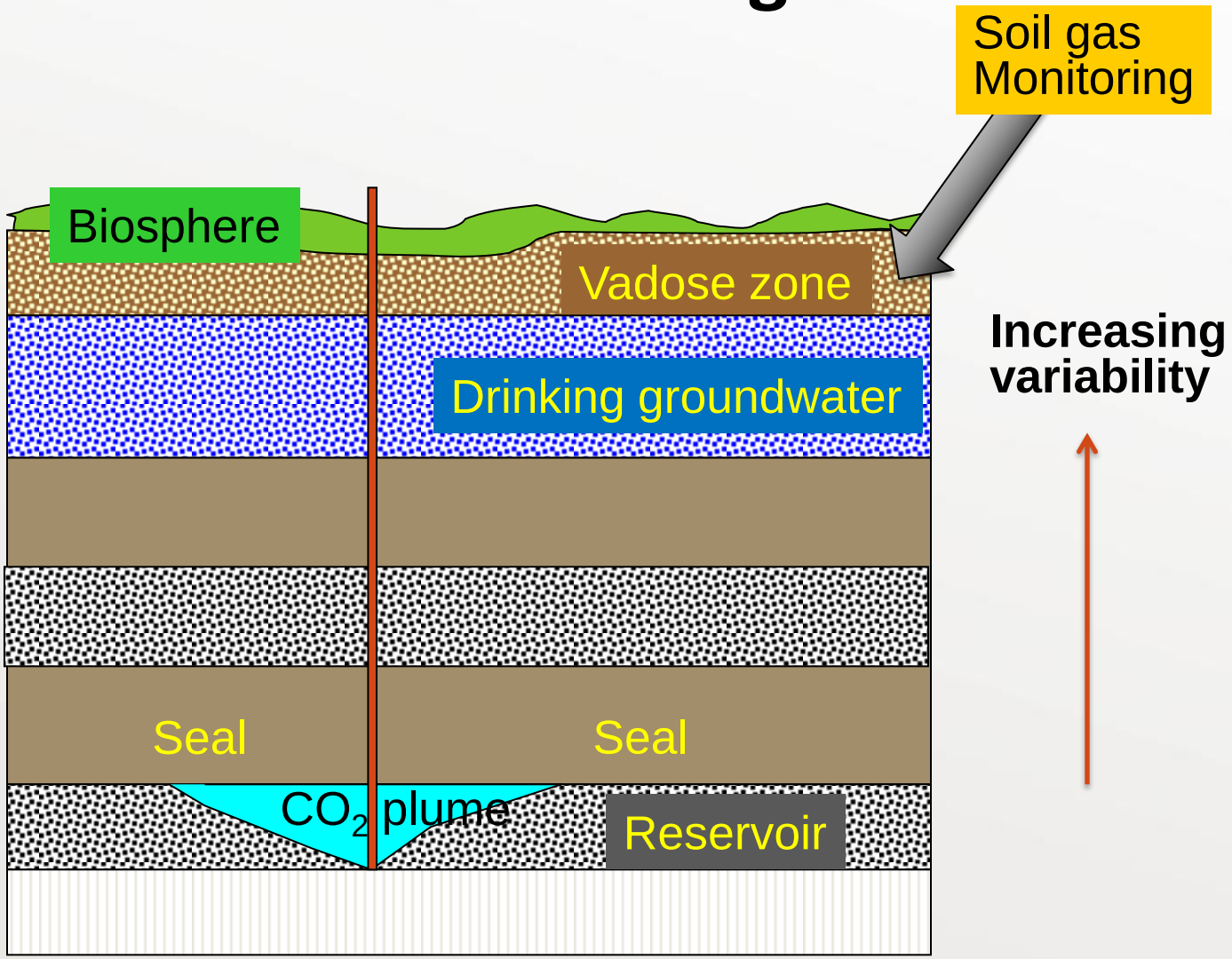


Soil Gas Monitoring



NOT TO SCALE

Figure courtesy of Sue Hovorka

Soil Gas Monitoring

ADVANTAGES

- Inexpensive
- Monitors area near "release to atmosphere"
- Important for quantification/accounting
- Aids in assessing impacts to the environment
- Useful for responding to public concerns

CHALLENGES

- Locating an anomaly
  - Need wide coverage over large areas
- Attributing source of anomaly
  - natural variation
  - leakage

Attribution: Signal over Noise

Leak

Natural CO_2 sources and sinks

- Plant activity
- Organics → CO_2
- Soil carbonate
- Soil moisture
- Weather and seasons

Leak

Leak

Produce CO_2 → Mimic signal

False positives

Consume CO_2 → Dampen signal

False negatives

Popular Methods

Background Measurements

- Measure “background” CO_2 for 1-3 years before project start to understand seasonal variability.
- Monitor CO_2 during project and compare to background.
- Significant increase from background during a project could signal a leak

Isotopes

- Different isotopic signatures can indicate the source of CO_2 whether natural of injected.

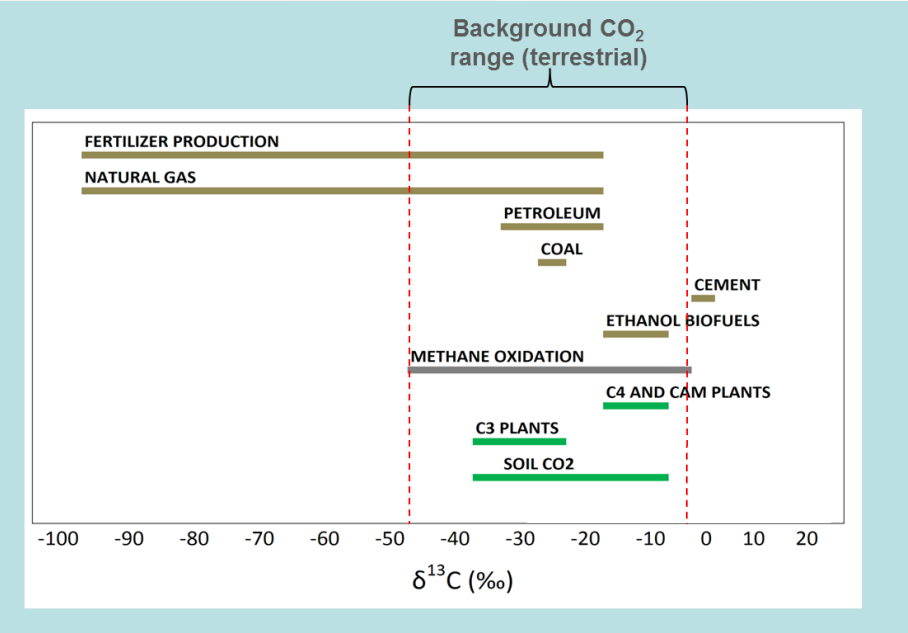
Popular Methods-Challenges

Background Measurements

- Natural CO_2 variability can mask a moderate leakage signal
- Requires long lead time
- "Baseline" will be dynamic
  - climate, land use, and ecosystem variations during a project
- Background CO_2 cannot be measured across all potential leak points

Isotopes

- Not always definitive



News of a "Leak" at the Kerr Farm

January 11, 2011

THE GLOBE AND MAIL

IN PICTURES

Carbon capture leak forces Saskatchewan couple to leave farm

Published Tuesday, Jan. 11, 2011 6:12PM EST

Pair abandon Saskatchewan farm because of blowouts, dead animals and algae

1 of 10

(Troy Fleece/The Canadian Press)

Carbon injected underground is leaking: Sask. farmers

SCIENCE + TECHNOLOGY

Week in Pics: The News In Review

Bacteria: Good, Bad, and Ugly

The Week: In Animal Photos

CO2 Levels at Leaking Canadian Carbon Storage Project Could Asphyxiate You In One Place

by Matthew McDermott, New York, NY on 01.12.11

SCIENCE & TECHNOLOGY

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Study Region

Alberta

Saskatchewan

Manitoba

System Model (10 km beyond EOR)

Montana

Williston Basin

Wyoming

North Dakota

Regional Study (200 x 200 km)

South Dakota

CBC News

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CO2 leaks worry Sask. far

Last Updated: Tuesday, January 11, 2011 | 8:49 PM ET Comments 184 Reco

The Canadian Press

Land fizzing like soda pop: farmer says CO2 injected underground is leaking

By: Bob Weber and Jennifer Graham, The Canadian Press

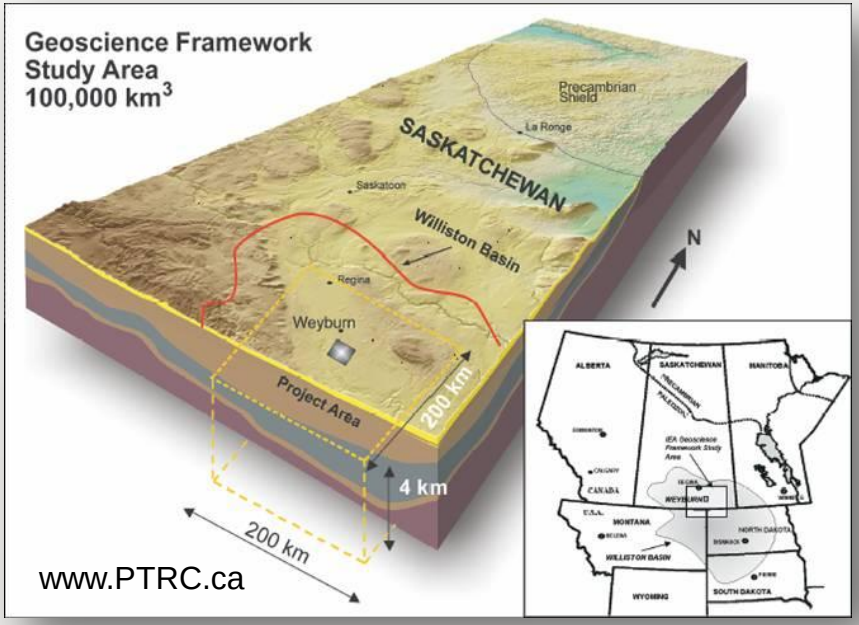
Posted: 01/11/2011 10:22 AM | Comments: 9

Jane Kerr took this picture of what they say is bubbling from water on their property.

Cameron and above the Weyburn oilfi Saskatchewan, have released a consultant's report that claims to link high concentrations of carbon dioxide in their soil to gas injected underground

Pffft Goes Promise Of Pumping Co2 Underground

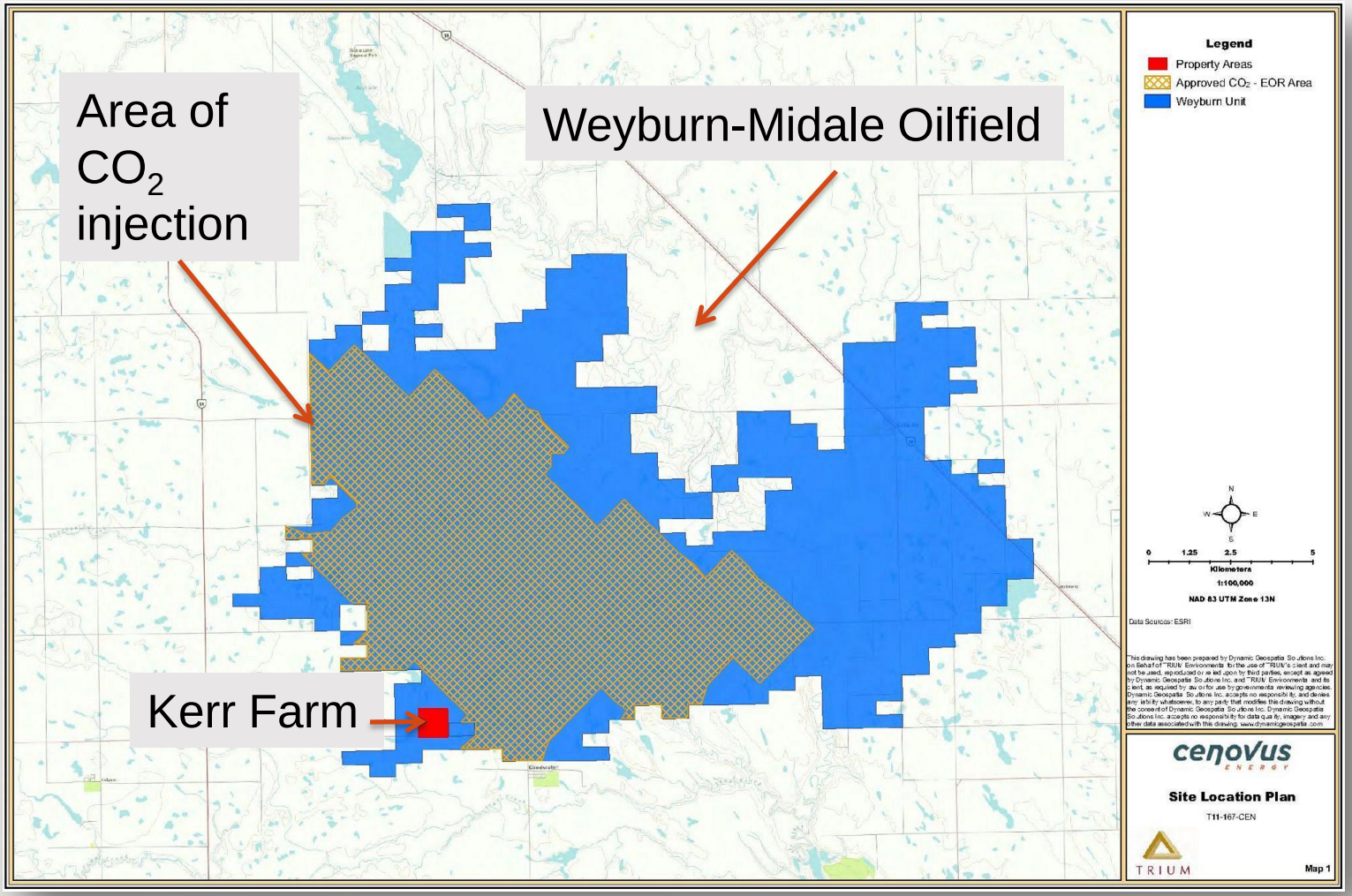
IEAGHG Weyburn-Midale CO_2 Monitoring and Storage Project



Rostron and Whittaker, Energy Procedia 4 (2011) 3636–3643

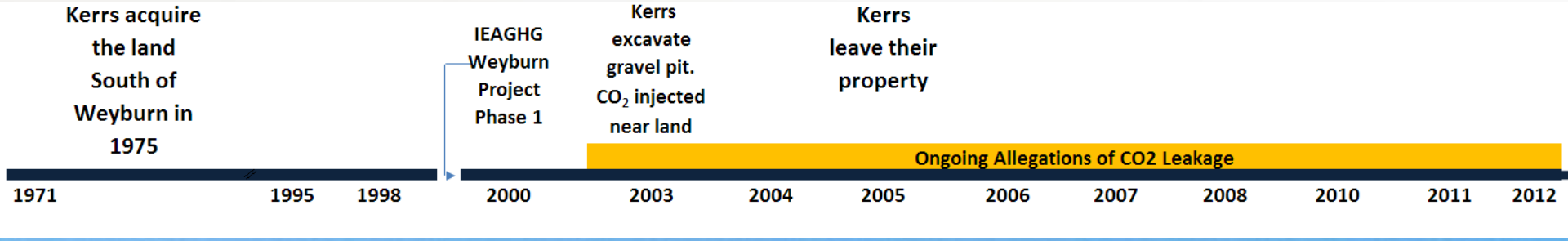
- Largest geologic CO_2 monitoring and storage project
- Since 2000 > 24 M tonnes of CO_2 injected
- CO_2-EOR operated by Cenovus Energy
- Studied by an international team of CO_2 storage experts
- Managed by Petroleum Technology Research Centre (PTRC)

Site Location



Cenovus, Site Assessment Weyburn Unit SW30-5-13W2, November 2011

Kerr Farm History



Alleged Land Disturbances

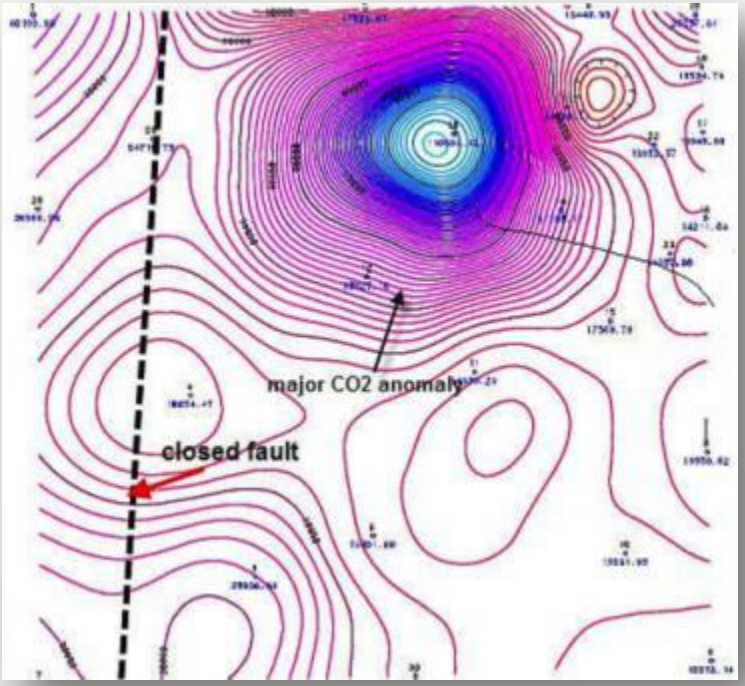





Industry and Government Response

- **1998**: (Operator) Weyburn Pump and Water Conditioning, groundwater test report
- **2002 – 2005**: (Operator) Farm well Inventory Project, regional groundwater analysis
- **2004**: (Operator) KBL Land Use Consulting Ltd., gravel pit water and soil samples
- **2005**: (Operator) Enviro-Test Analytical soil sample
- **2005**: (Government) Saskatchewan Health Provincial Laboratory, gravel pit and domestic well water
- **2006**: (Operator) Aqua Terre Solutions Inc., well and gravel pit water test
- **2006**: (Landowner) MR2 McDonald & Associates, water quality investigation
- **2007**: (Landowner) Consultation with Dr. Malcolm Wilson, Office of Energy & Environment, University of Regina
- **2008**: (Government) Ministry of Environment – Review of studies
- **2008**: (Government) SRC Analytical Laboratories, soil, water and air quality monitoring
- **2008**: (Government) Droycon Bioconcepts Inc., Bacteriological content of water
- **2010-2011** (Landowner) Petro-Find Geochem Ltd. Soil gas surveys.

Petro-Find Conclusion



"The...source of the high concentrations of CO_2 in soils of the Kerr property is clearly the anthropogenic CO_2 injected into the Weyburn reservoir."

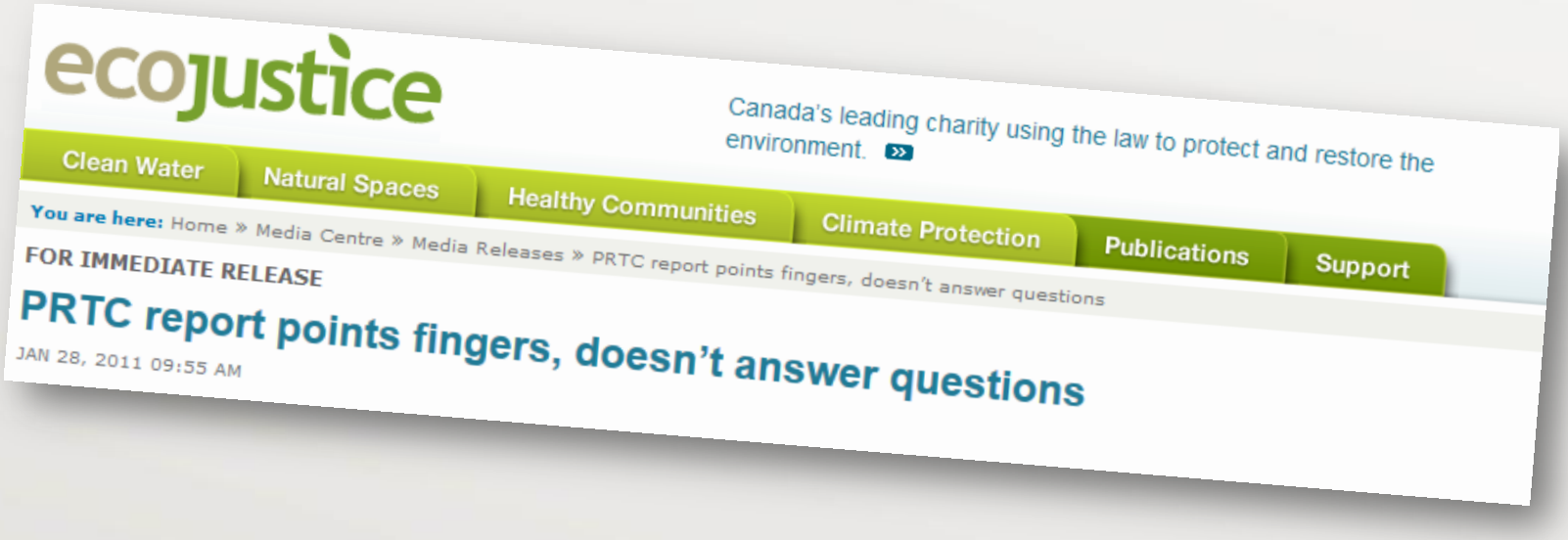
Source: Lafleur, P. 2010. *Geochemical Soil Gas Survey: A Site Investigation of SW30-5-13-W2M Weyburn Field, Saskatchewan. Saskatoon, SK: Petro-Find Geochem Ltd.)*

Petroleum Technology Research Centre Response

"Researchers, engineers, geologists and geophysicists involved in the IEAGHG project have reviewed the Petro-Find report and concluded that it does not support its claim."

PTRC Response to Petro-Find report

www.ptrc.ca



How To Avoid This?

Industry and Government Response

- **1998**: (Operator) Weyburn Pump and Water Conditioning, groundwater test report
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Claim Response Protocol

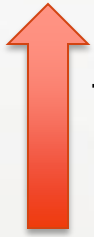
Response to allegation of an unintentional release of a gas associated with a specific CCS project.

Site Assessment

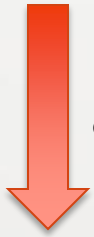
Validate the allegation

Risk Communication

Correspondence and document review



Tested at Kerr site



Not tested at Kerr site

If a release has occurred

1. Substances released and scope of the release
2. Release mechanisms
3. Time release was detected
4. Response to the release
5. Consequences of the release
6. Compliance with applicable industry performance standards/best practices
7. Conclusions and recommendations

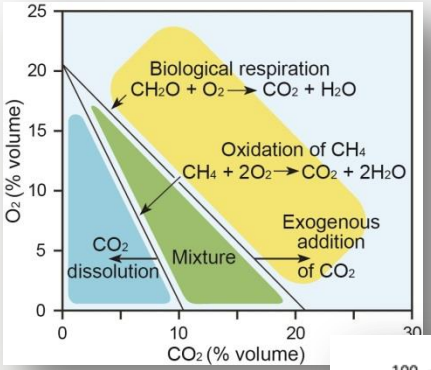
Step 1- Validating the Allegation

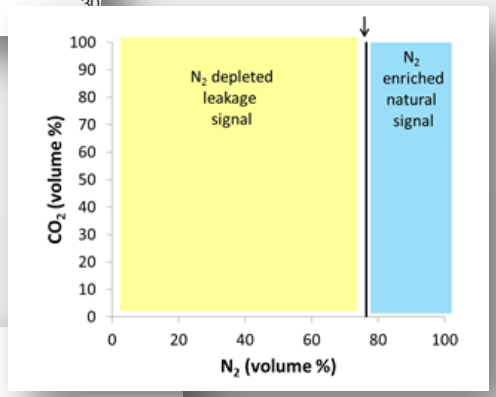
Outcome of Step 1: Was there an unintentional release of gas associated with a specific CCS project?

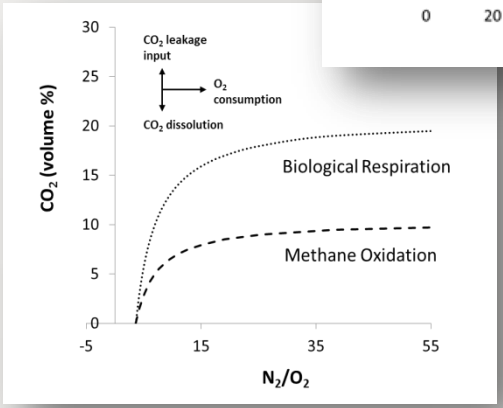
- Anomaly was located by PetroFind and wrongly attributed to leakage using isotopes.
- We used an new optimized approach to attribute CO_2 source
  - 10 sampling locations
  - Minimal number of analytes
- ***Process-based*** soil gas method

Process-Based Soil Gas Method

- Does not rely on background CO_2 measurements
- Uses ratios among simple gases (CO_2, CH_4, N_2, O_2)
- Discerns process
  - In-situ from exogenous gas
  - Mixing with air
  - CO_2 dissolution
  - Oxidation of CH_4 into CO_2
    - **Important for CCUS monitoring**







Process-Based Soil Gas Method

- Developed at a natural CO_2-rich perched playa wetland, West Texas
- Tested at a CCUS field
  - plugged and abandoned well site
  - near-surface soil gas anomaly
- Confirmed at the ZERT controlled release site, Montana, USA

Used at Otway (Australia) and considered for use at QUEST (Canada) and Gorgon (Australia)

Leakage Allegation Discounted

"In a media release, Ecojustice lawyer Barry Robinson, who represented the Kerrs, accepted the IPAC-CO_2 study's findings while emphasizing its necessity, saying that "without a full scale investigation, it has been impossible until now to rule out CO_2 contamination."

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FOR IMMEDIATE RELEASE

Long-awaited investigation into CO2 impacts a 'win for all Canadians'

DEC 12, 2011 09:37 AM

ACCN Canadian Chemical News L'Actualité chimique canadienne

Weyburn CO_2 leak a false alarm

By Tyler Irving
Posted February 2012

In January 2011, Cameron and Jane Kerr alleged that CO_2 from a nearby experimental carbon storage project was leaking onto their farm near Weyburn, Sask. A year later, two independent investigations have concluded that this is not the case.

The project consists of piping CO_2 from a coal gasification plant in North Dakota into an oil field operated by Canadian oil company Cenovus. Last summer, Cenovus contracted TRIUM Environmental to undertake extensive soil and surface water sampling operations on the property. The results, delivered last November, show CO2 concentrations consistent with what is commonly found in prairie soil gas in summer. Moreover, carbon levels were inversely correlated with oxygen levels, a sign that the CO_2 was produced by biological respiration. Finally, the presence of unstable

^{14}C indicated a young carbon source. Since ^{14}C has a half-life of about 5,730 years, it would have been absent in CO_2 from the several million-year-old coal deposits.

Improving the Monitoring Protocols for CO_2 Geological Storage with "CO_2 Attribution Monitoring"

IPCC Guidelines • London Convention and Protocol • EU CCS Directive and the EU Emissions Trading Scheme • US EPA Rules

Combined Summary of Monitoring Activities:

- Acquire background measurements
- Assess CO_2 storage performance in the reservoir
- Detect ~~leakage~~ anomalies that may signal leakage
  - *and, if leakage is ~~detected~~, suspected or alleged, then…*
- Attribute the source of CO_2
- Quantify leakage and

And only if CO_2 attributed to injected CO_2, then…

- Assess impacts of leakage

Dixon and Romanak, in review, Improving the monitoring protocols for CO_2 geological storage with CO_2 attribution monitoring, International Journal of Greenhouse Gas Control

Summary

- The Kerr investigation is a case study in response to leakage claims.
- Adopting a protocol to leakage claims in advance of a CCS project is beneficial for avoiding :
  - Long-running allegations,
  - Unqualified sources reaching incorrect conclusions
  - Inaccurate information affecting public perception of CCS.
- Relatively simple tools for responding to claims are now available
  - A process-based approach to asssessing anomalies is cost effective, accurate, relatively simple and can be used in areas lacking background data.
- Recommend updating current protocols to reflect CO_2 source attribution

More Information

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Sponsor and Collaborators

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