

# Case study: a field survey in response to claims of CO<sub>2</sub> leakage – Weyburn-Midale oilfield

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George William Sherk



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# Sponsor and Collaborators



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# News of a "Leak" at the Kerr Farm

January 11, 2010

**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

(Troy Fleace/The Canadian Press)

**Carbon injected underground is leaking: Sask. farmers**

Cattle gathered in a pasture near a pumpjack in an oilfield outside of Weyburn, Sask. on Monday, June 8, 2009.

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**CBC News**

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**CO2 leaks worry Sask. farm**

Last Updated: Tuesday, January 11, 2011 | 8:49 PM ET | Comments: 164 | Record

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



**Pffft Goes Promise Of Pumping CO2 Underground**

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

**SCIENCE + TECHNOLOGY**

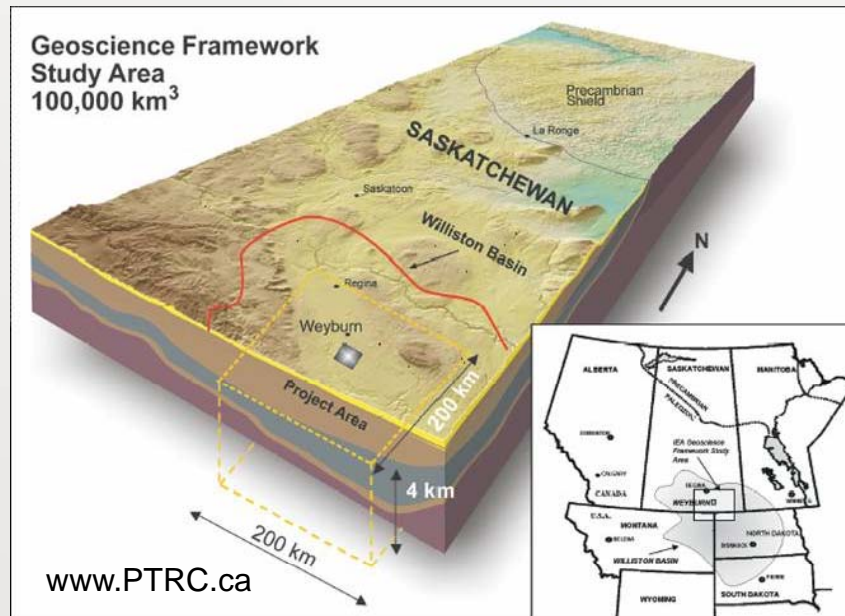
Week in Pic: The News in Review  
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**CO2 Levels at Leaking Canadian Carbon Storage Project Could Asphyxiate You in One Place**  
 by Matthew McDermott, New York, NY on 01.12.11  
 SCIENCE & TECHNOLOGY

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**Study Region**

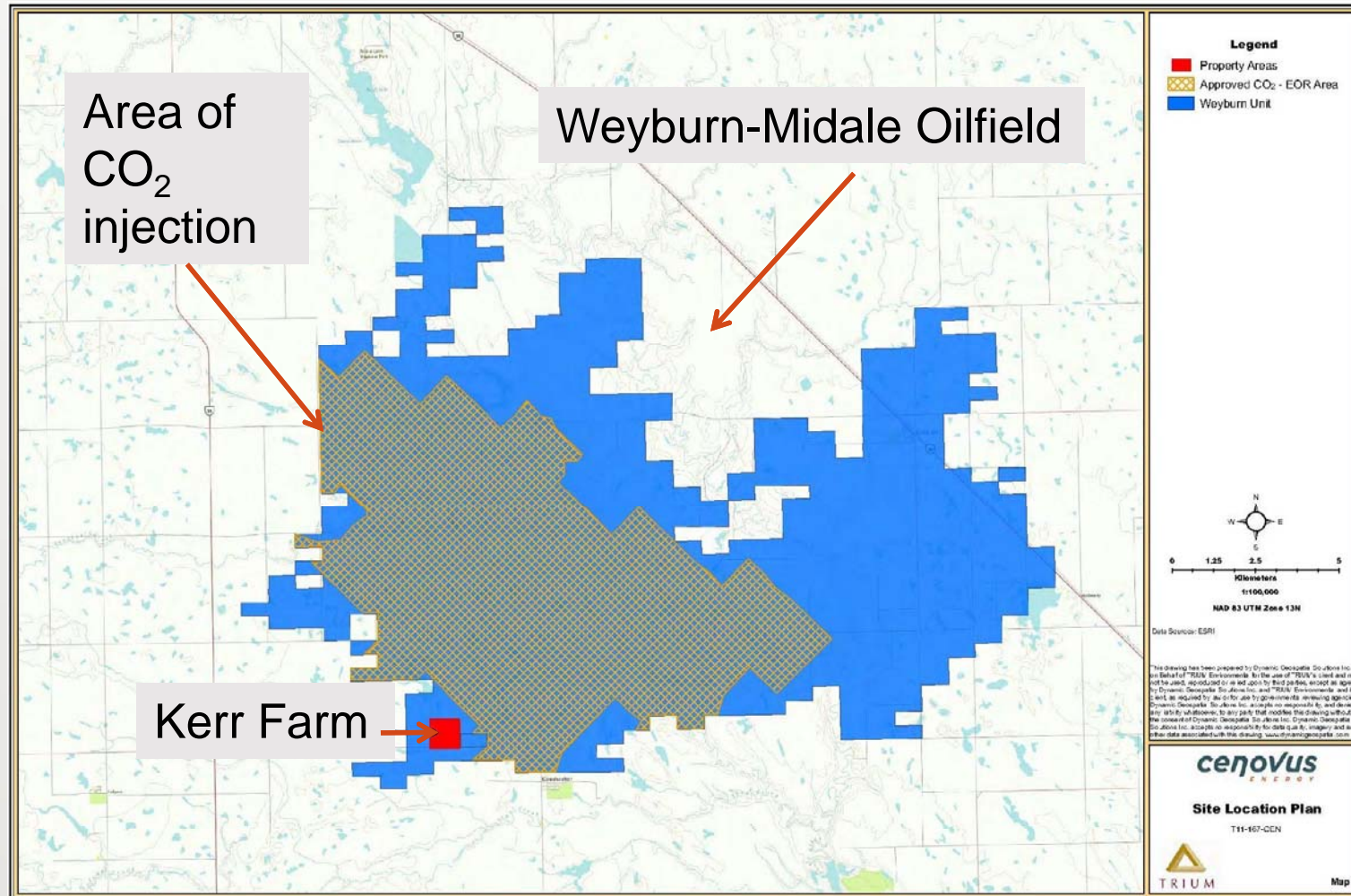
# IEAGHG Weyburn-Midale CO<sub>2</sub> Monitoring and Storage Project



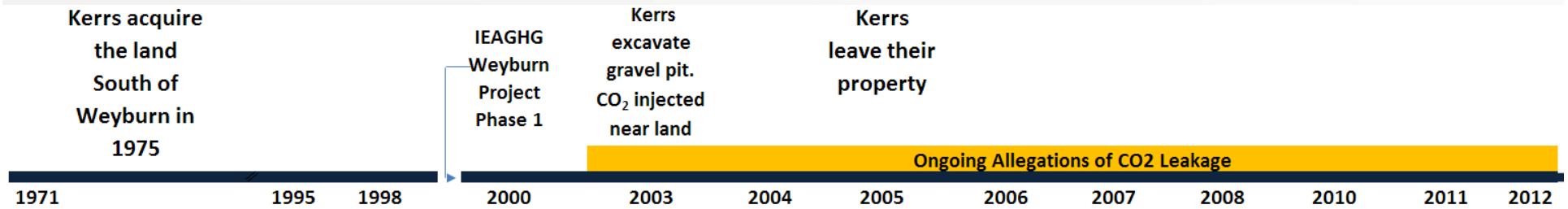
Rostron and Whittaker, Energy Procedia 4 (2011)  
3636–3643

- Largest geologic CO<sub>2</sub> monitoring and storage project
- Since 2000 > 17 M tonnes of CO<sub>2</sub> injected
- CO<sub>2</sub>-EOR operated by Cenovus Energy
- Studied by an international team of CO<sub>2</sub> storage experts
- Managed by Petroleum Technology Research Centre (PTRC)

# Site Location



# Kerr Farm History



# Alleged Land Disturbances

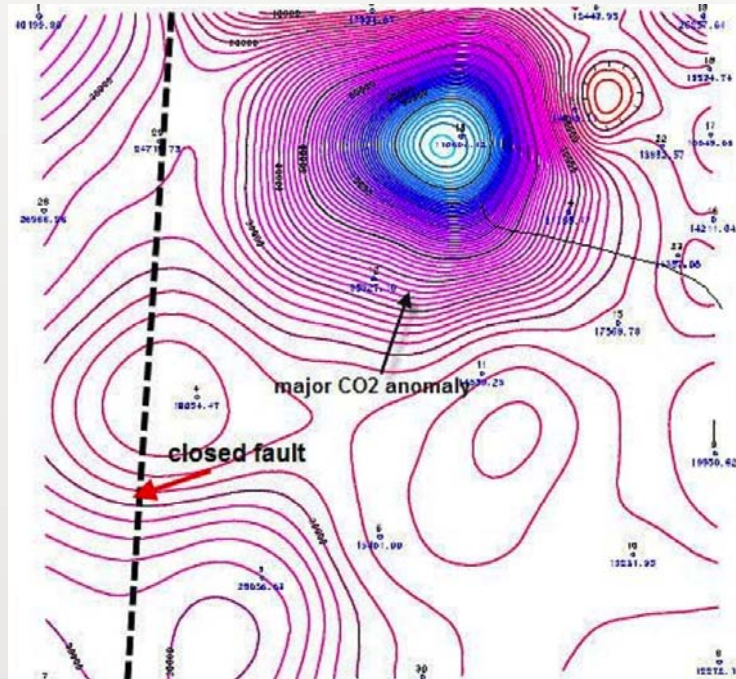


# Industry and Government Response

- **1998:** (Operator) Weyburn Pump and Water Conditioning, groundwater test report
- **2002 – 2005:** (Operator) Farmwell 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<sub>2</sub> in soils of the Kerr property is clearly the anthropogenic CO<sub>2</sub> 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.)

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

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# 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*

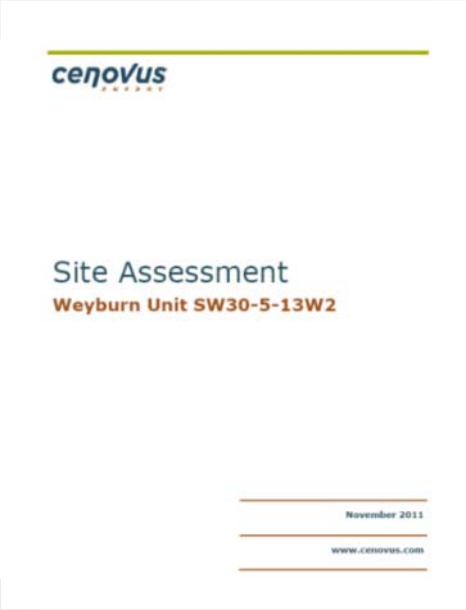
*www.ptrc.ca*



# Investigations in Response to Allegation



European Research Team



The Operator



Independent study

# Incident Response Protocol

*Response to report of an unintentional release of a gas or gases associated with a specific CCS project.*

1. Validate the allegation
2. Correspondence and document review
  - The operator of the CCS project
  - The provincial and federal governments
  - Other participants in the CCS project



Tested at  
Kerr site

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If a release has occurred

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



Not tested  
at Kerr site

# Protocol Step 1- Validating the Allegation

## Review of Allegations

- Site History, SW30-5-13-W2M Near Weyburn, Saskatchewan, Cameron and Jane Kerr. Calgary, Alberta: 2010, Ecojustice.
- Geochemical Soil Gas Survey: A Site Investigation of SW30-5-13-W2M Weyburn Field, Saskatchewan. Saskatoon, SK: 2010, Petro-Find Geochem Ltd.
- Geochemical Soil Gas Survey: A Site Investigation of SW30-5-13-W2M, Weyburn Field, Saskatchewan, Monitoring Project Number 2. Saskatoon, SK: 2011, Petro-Find Geochem Ltd.
- Site-specific documentation

# Protocol Step 1- Validating the Allegation

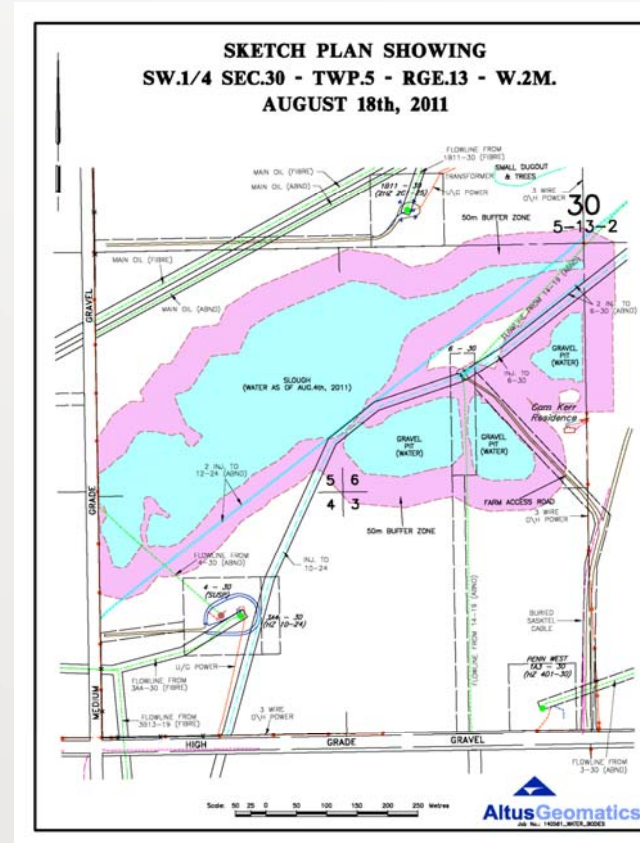
## Vicinity history:

- Chronology of events
- Results of previous testing
- Injection history (substances, depth, formations)
- Land use history
- Incidents in vicinity (e.g., hydrocarbon spills)
- Release history (if any)

# Protocol Step 1- Validating the Allegation

Vicinity inspection to identify potential areas of release and monitoring sites:

- Overview
- Existing wells
- Pipelines
- Injection sites
- Endangered Species
- Monitoring sites
- Study sites





# Protocol Step 1- Validating the Allegation

Reconnaissance environmental survey  
to choose appropriate technical  
method

- Direct methods (e.g., analysis of ground water, surface water, soil, soil-gas, vegetation, mineralogy)
- Indirect methods (e.g., geophysical modeling, seismic imaging, microseismic monitoring, electromagnetic surveys, land/surface deformation)



# Protocol Step 1- Validating the Allegation

## Detailed fingerprinting of anomalies:

- Vertical and horizontal soil-gas gradients
  - Gas transport
  - Refinement of reconnaissance surveys as needed
- Outcome of Step 1: Was there an unintentional release of gas associated with a specific CCS project?

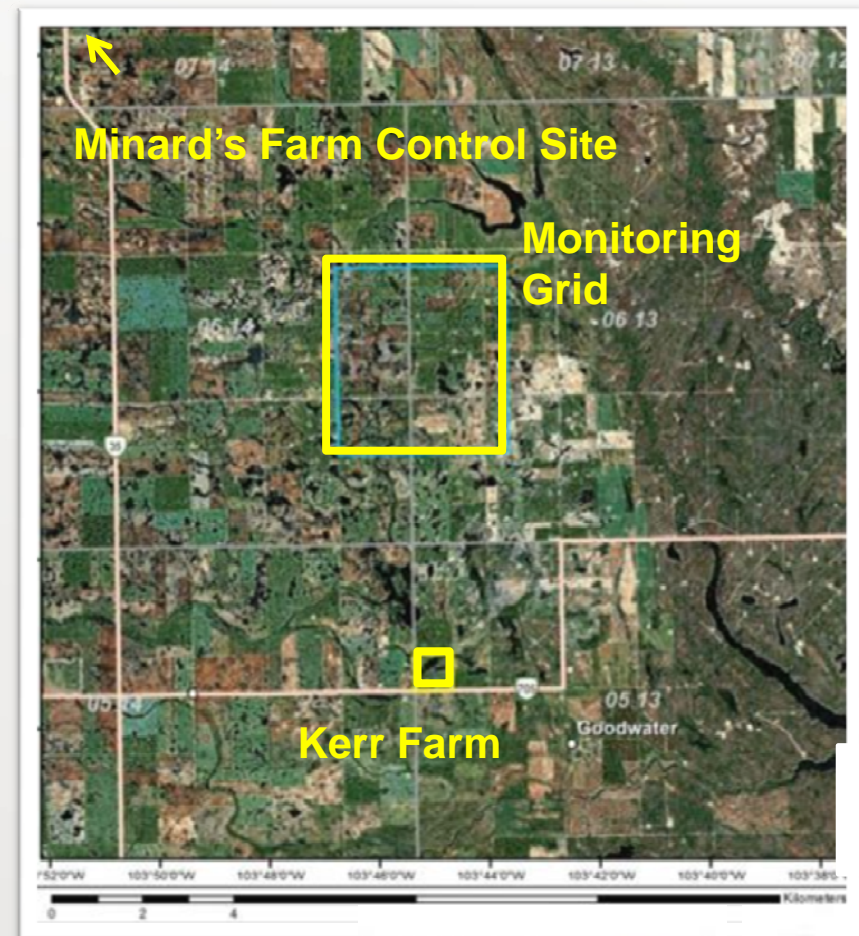
# Fingerprinting Gas Anomalies

- Identify a leakage signal from background noise
  - Soil CO<sub>2</sub> is naturally variable in space and time
  - Injected (anthropogenic) CO<sub>2</sub> is chemically indistinguishable from natural CO<sub>2</sub>



# Current Leakage Detection Approach

- Measure natural “background” CO<sub>2</sub> concentrations over years.
- Compare anomaly values with background ranges.
- Statistical difference could signal a release.
- Kerr Farm not in 2000-2005 monitoring areas

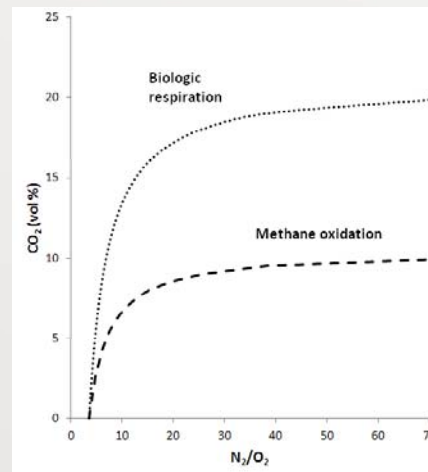
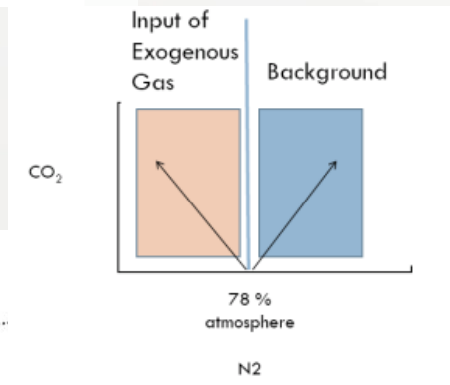
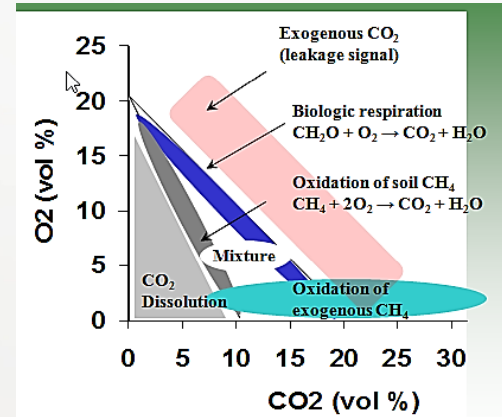


# Challenges of Concentration-Based

- 1-3 years cannot capture the full variation in natural CO<sub>2</sub>.
- Background measurements time, cost, and labor intensive.
- Leakage signals smaller than natural variability may be overlooked
- Background concentrations cannot be measured everywhere within the area of review.
- An incident can occur in an area with no background monitoring.

# Process-Based Soil Gas Method

- Does not rely on background  $\text{CO}_2$  measurements
- Uses ratios among major gases ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2$ ,  $\text{O}_2$ )
- Discerns process
  - In-situ from exogenous gas
  - Mixing with air
  - $\text{CO}_2$  dissolution
  - Oxidation of  $\text{CH}_4$  into  $\text{CO}_2$ 
    - **Important for CCUS monitoring**
- Being developed for groundwater and marine environments



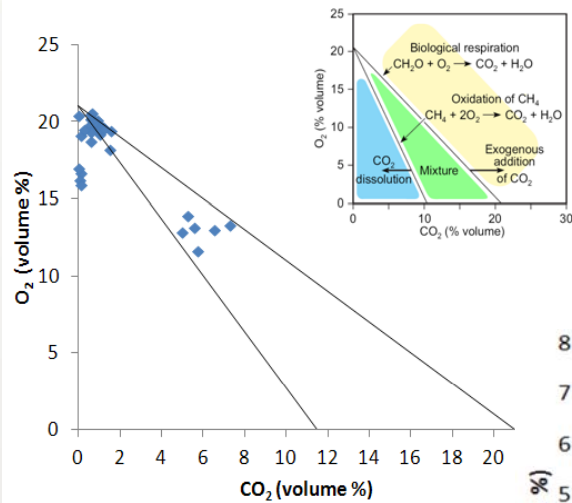
# Validating the Allegation

**IPAC**  
**CO<sub>2</sub>**

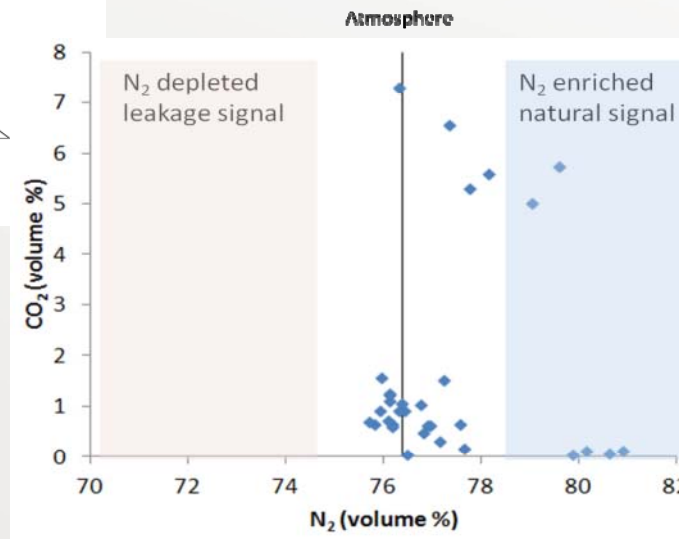


- Targeted approach based on Petrofind anomaly
- 10 sampling locations
- Minimal number of analytes
- Process-based method with no need for complex data sets or statistical analyses

# Results

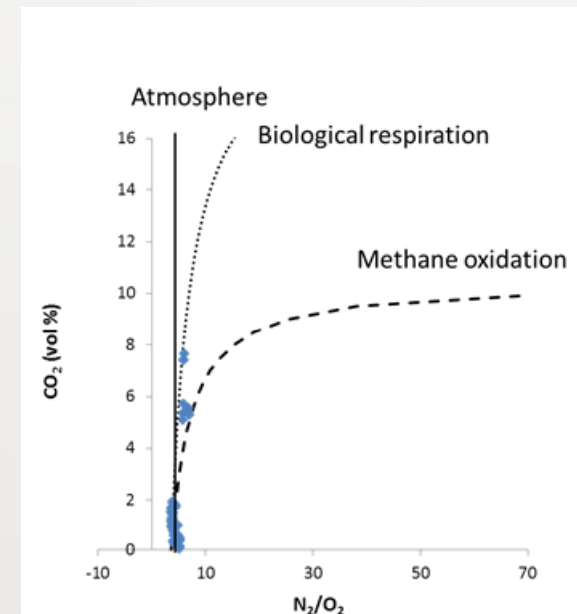


CO<sub>2</sub> is from biologic respiration with some dissolution of CO<sub>2</sub> into groundwater.



No input of exogenous gas from depth

Methane oxidation is negligible





# Leakage Allegation Discounted

“In a media release, Ecojustice lawyer Barry Robinson, who represented the Kerrs, accepted the IPAC-CO<sub>2</sub> study’s findings while emphasizing its necessity, saying that “without a full scale investigation, it has been impossible until now to rule out CO<sub>2</sub> contamination.”

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FOR IMMEDIATE RELEASE

**Long-awaited investigation into CO<sub>2</sub> impacts a 'win for all Canadians'**

DEC 12, 2011 09:37 AM

**ACCN** Canadian Chemical News  
L'Actualité chimique canadienne

## Weyburn CO<sub>2</sub> leak a false alarm



By Tyler Irving  
Posted February 2012

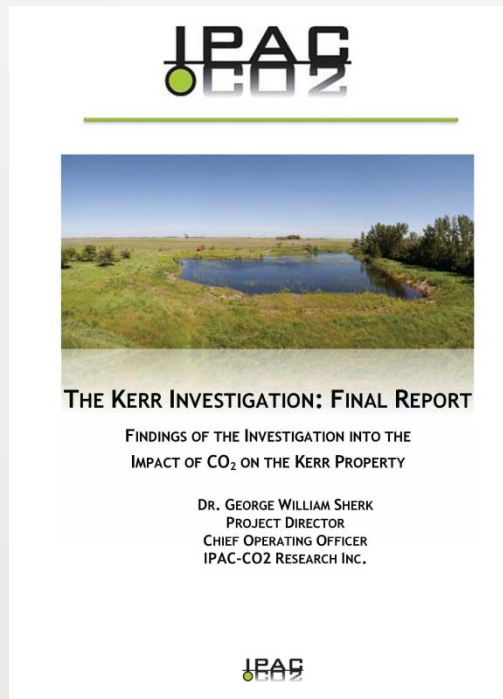
In January 2011, Cameron and Jane Kerr alleged that CO<sub>2</sub> from a nearby experimental carbon storage project was leaking onto their farm near Weyburn, Sask. A year later, two independent investigations have concluded that this is not the case.

The project consists of piping CO<sub>2</sub> 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 CO<sub>2</sub> 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<sub>2</sub> was produced by biological respiration. Finally, the presence of unstable <sup>14</sup>C indicated a young carbon source. Since <sup>14</sup>C has a half-life of about 5,730 years, it would have been absent in CO<sub>2</sub> from the several million-year-old coal deposits.

# Summary

- The IPAC-CO<sub>2</sub> Kerr investigation is a case study in incident response.
- Adopting an incident response plan 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 incident response are available
  - A process based approach to fingerprinting anomalies is cost effective, accurate, relatively simple and can be used in areas lacking background data.

# More Information



<http://www.ipac-co2.com/projects/investigations>

## [IPAC-CO2: The Kerr Investigation - YouTube](#)



[www.youtube.com/watch?v=wcxIXpl21IQ](http://www.youtube.com/watch?v=wcxIXpl21IQ)

Dec 7, 2011 - 28 min - Uploaded by ipacco2

A video documenting IPAC-CO2's independent investigation into the source of carbon dioxide on ...

Romanak, K. D., Bennett, P. C., Yang, C., and Hovorka, S. D., 2012, Process-based approach to CO<sub>2</sub> leakage detection by vadose zone gas monitoring at geologic CO<sub>2</sub> storage sites: Geophysical Research Letters, v. 39, L15405, doi:10.1029/2012GL052426.

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