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# **Report from the Methodology Working Group – Capacity Estimations**

## **North American Carbon Atlas Partnership Meeting**

**July 22, 2009**

**Pittsburgh, Pennsylvania**

**Ed Steadman and Charlie Gorecki**

**Energy & Environmental Research Center**



# Presentation Outline

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- Overview of NACAP Methodology Working Group activities
- Brief summary of capacity/mapping issues
- Summary of the CO<sub>2</sub> Storage Coefficients project
- Path forward
- Open discussion





## PCOR Partnership Region

- Initiated in fall 2003
- Nine states and four provinces
- Over 1.4 million square miles
- 29.7 million people\*

The Plains CO<sub>2</sub> Reduction (PCOR) Partnership is assessing the technical and economic feasibility of capturing and storing (sequestering) carbon dioxide (CO<sub>2</sub>) emissions from stationary sources in the central interior of North America.

\* Based on 2007 estimates by the U.S. Census and Statistics Canada.

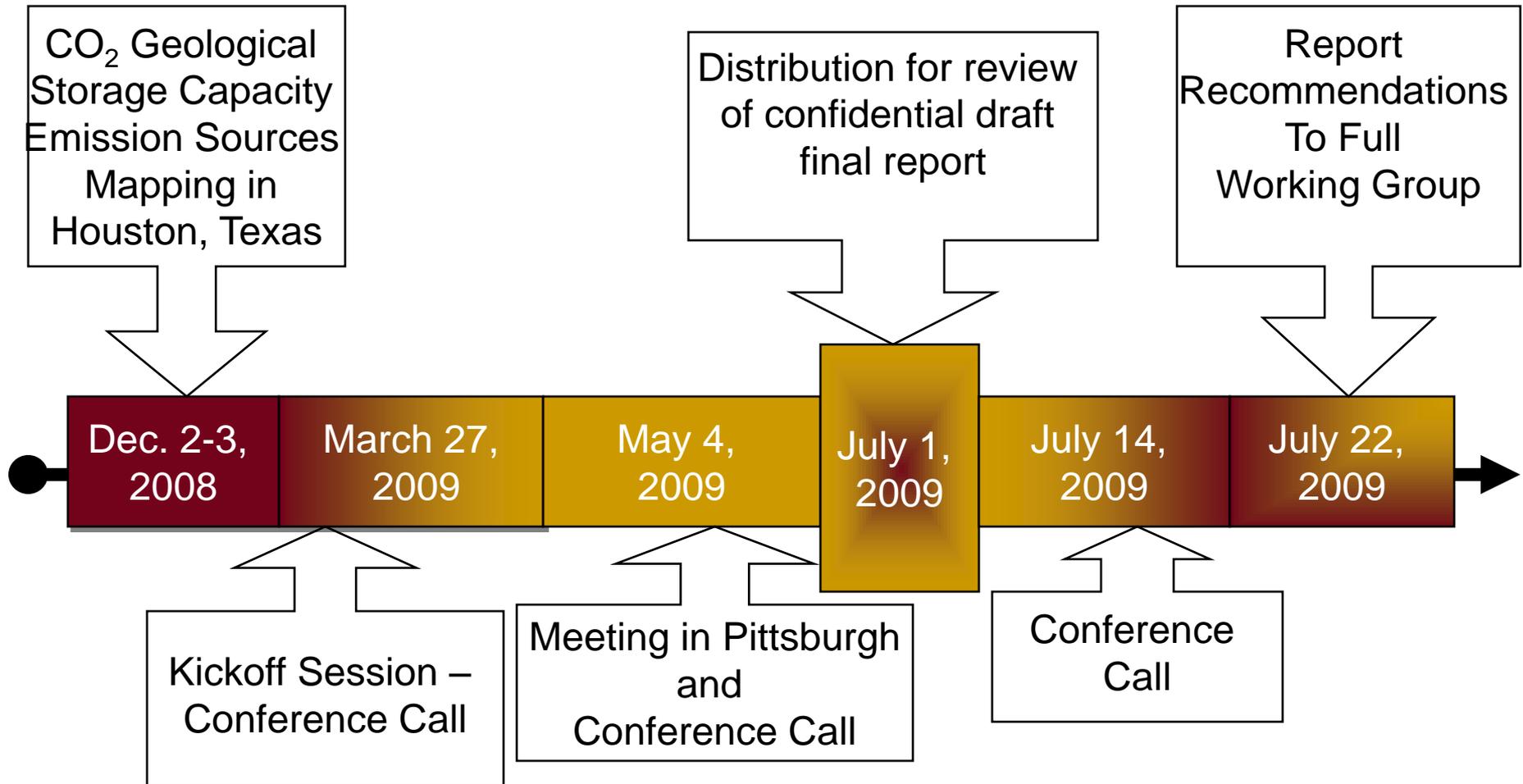


# NAEWG CO<sub>2</sub> Storage Capacity Estimation Subcommittee Goal

To agree on a standard methodology to be employed to develop a carbon sequestration atlas for Canada, the United States, and Mexico.



# Subcommittee Timeline



# July 14 Conference call

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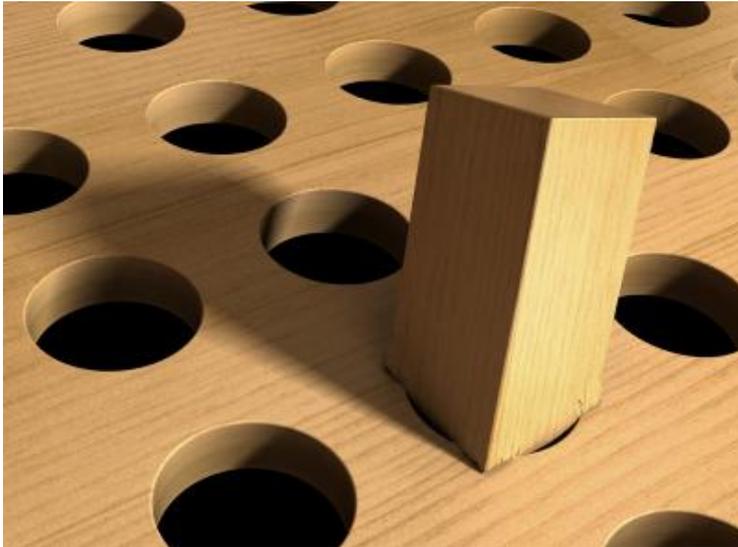
- Goal of the call was to discuss review of the Draft Capacity Coefficients report and prepare for this meeting.
- General consensus was that the IEA/DOE/EERC report and methodology is a positive contribution to the science.
- While there was general agreement that the combined DOE/CSLF methodology is a sound approach, some of the enhancements recommended in the report (coefficients based on basin types and lithologies) should not be incorporated for the first Trilateral Atlas.
- The suggestion was made to coordinate efforts with the Global CCS Institute World CCS Atlas efforts.
- Fall of 2011 was suggested as a target date for the Trilateral Atlas to be completed.



# Cross-Border Data Issues

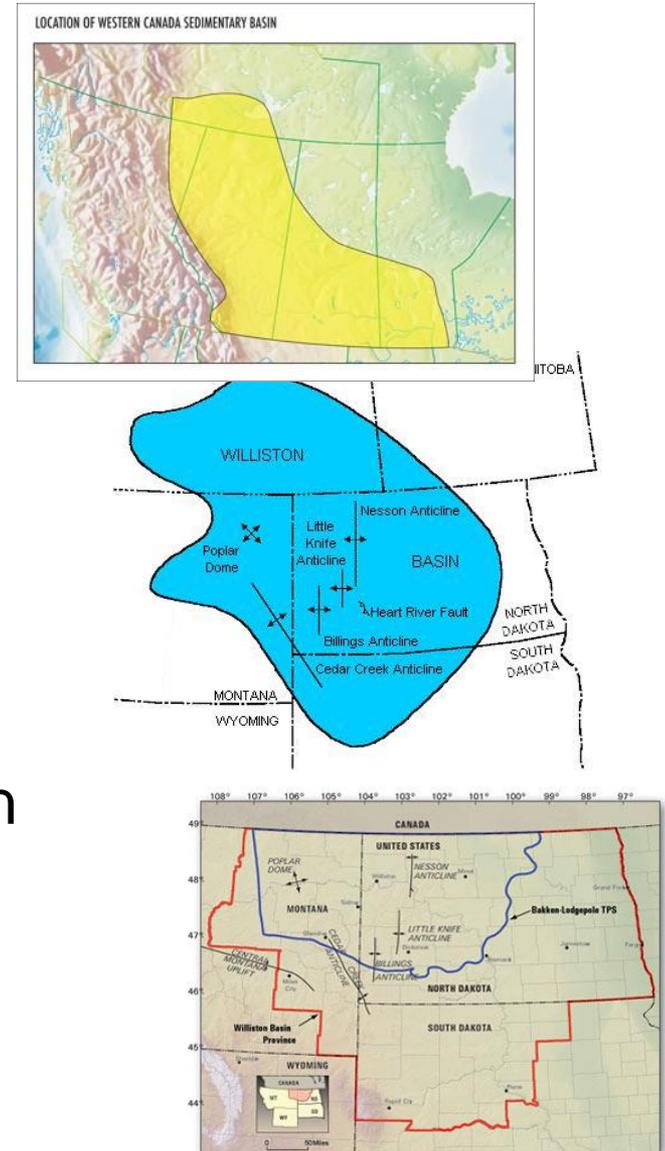
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- Cross-border issues are not confined to international differences. State-to-state and province-to-province differences also exist.



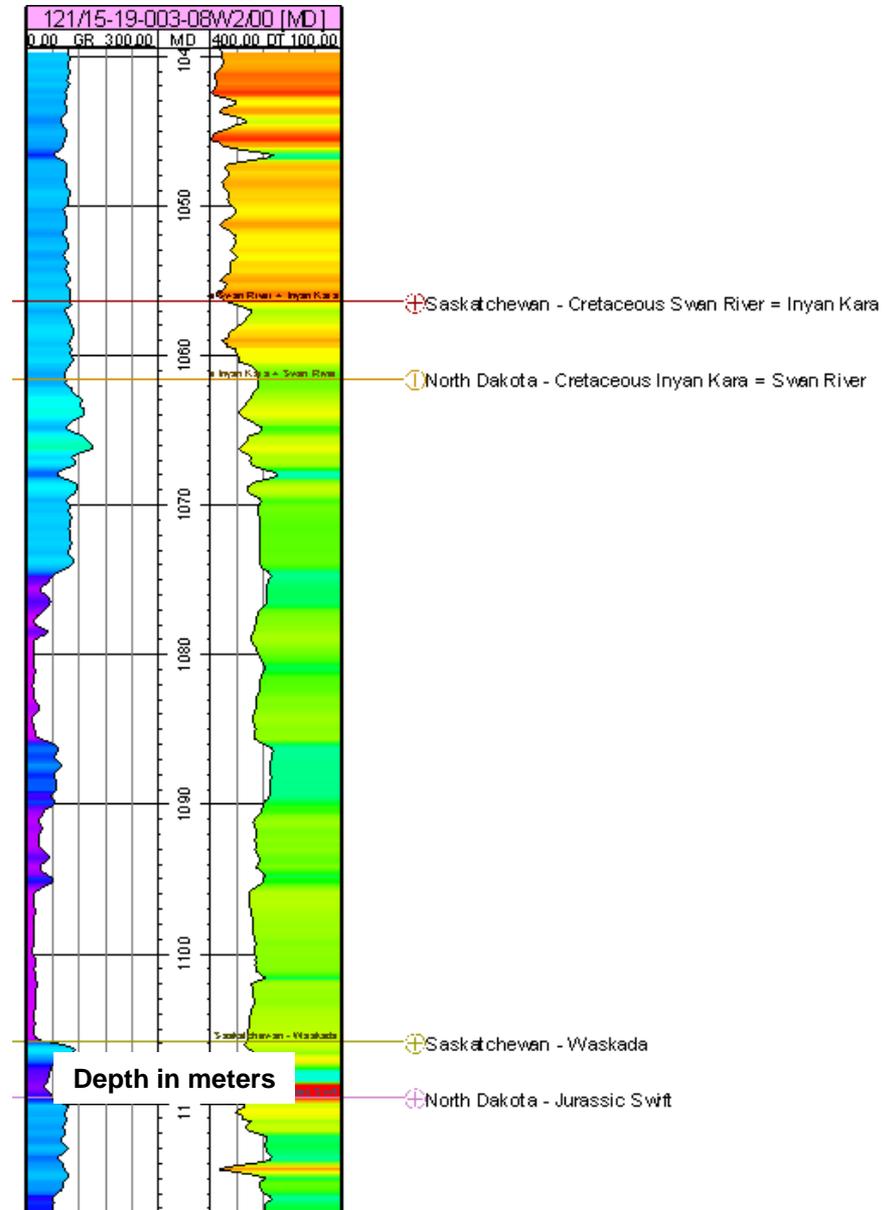
# Cross-Border Issues

- Initial conversations difficult until terminology is understood.
- Data management differences.
- Different units describing geophysical log properties.
- Stratigraphic lumpers vs. splitters.
- Standard convention for displaying information.
  - What/where is the formal boundary of the Williston Basin, Alberta Basin, Western Canadian Sedimentary Basin?



# Tomāto–Tomāto

- For the most part, the rock formation definitions between the United States and Canada are correlative.
- The rock properties, not the rock names, will define the storage potential.



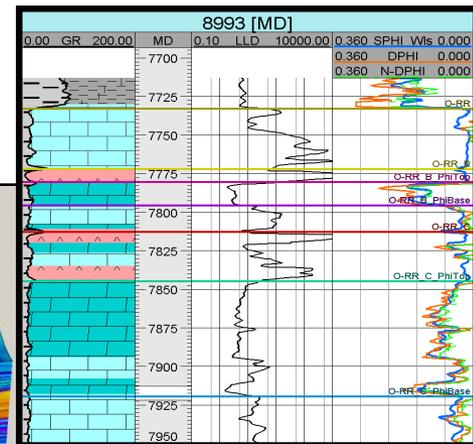
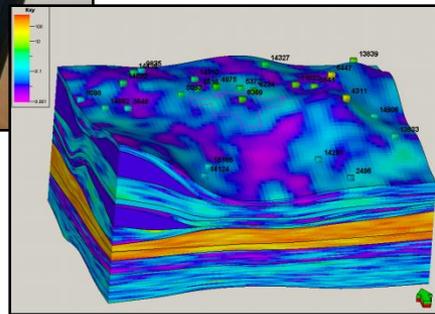
# EERC CO<sub>2</sub> Storage Capacity Work

- The Energy & Environmental Research Center (EERC) is conducting a joint venture project funded by the IEA Greenhouse Gas R&D Programme (IEA GHG) (66.7%) and the U.S. Department of Energy (DOE) (33.3%).
- “Development of Storage Capacity Coefficients for Carbon Dioxide Storage in Deep Saline Aquifers.”
- Study focus is deep saline formations.
- Draft report has been distributed to this group and is under final review by IEA Greenhouse Gas R&D Programme.



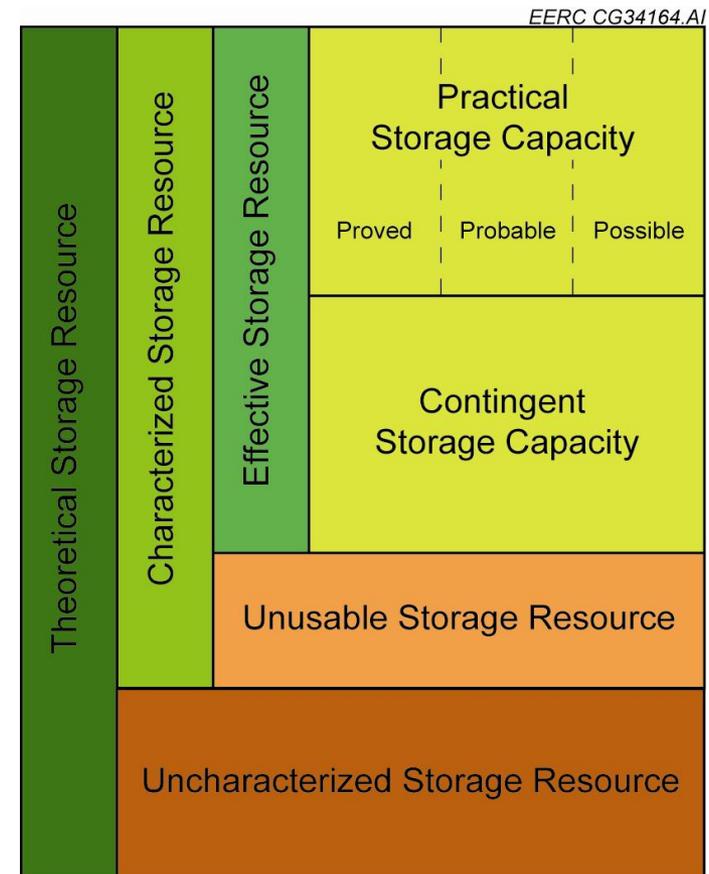
# Project Achievements

- A new storage classification system was developed.
- Three different resource estimation methods were examined and related to the proposed classification system.
- The DOE and Carbon Sequestration Leadership Forum (CSLF) methods were related to each other through a series of variables and equations.
- A series of storage coefficients were developed at levels ranging from site-specific to formation-level for different geologic scenarios.



# Proposed Storage Classification System

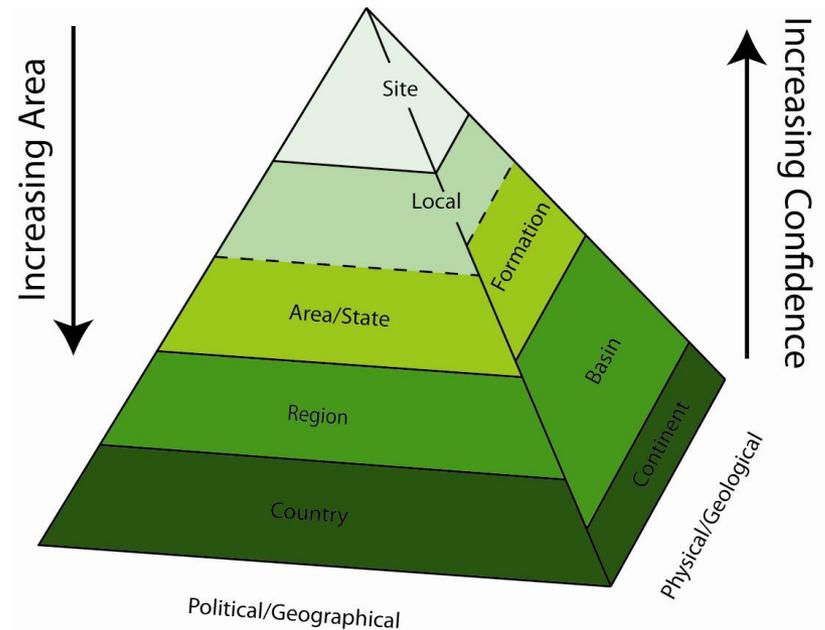
- Built based on the Carbon Sequestration Leadership Forum (CSLF) techno-economic resource pyramid, DOE CO<sub>2</sub> storage definitions, Petroleum Resource Management System, and the work of the CO2CRC.
- Makes the distinction between resource and capacity when referring to carbon capture and storage (CCS).



Proposed Storage Classification System.

# Scale of Assessment

- When performing resource/capacity estimates, the scale must be considered.
- Local and site-specific levels of assessment – high data quality.
- Large-scale assessments – decreased confidence.



EERC CG34193.AI

Scale of Assessment pyramid, separating the political/geographical definitions from the physical/geological.

# Storage Resource Estimation in Deep Saline Formations

- Open and closed systems were considered and related to the resource classification system.
- Open system – DOE and CSLF methodologies.
- Closed system – compressibility method.

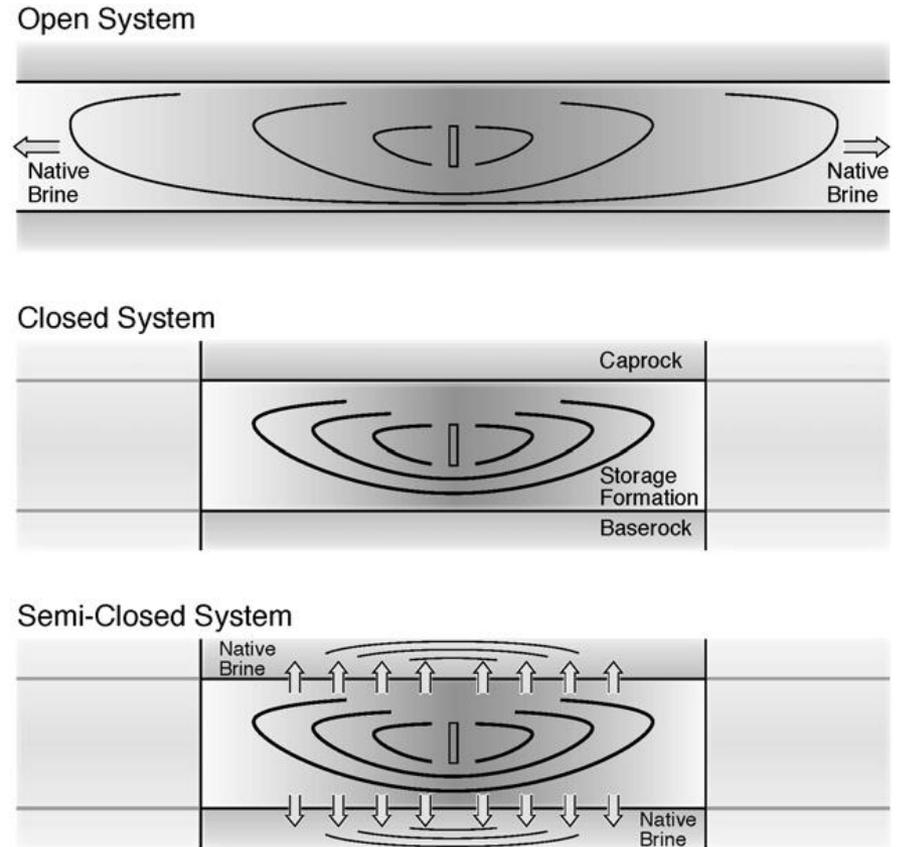


Diagram representing the three potential storage systems from Zhou et al., 2008.

# Comparison of Open-System Methodologies

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- Fundamentally, the CSLF and DOE methods are the same method.
- Any storage volume estimated with one method can be compared to the other, as long as the assumptions made are the same.

$$V_{CO_2,DOE_E} = A * h * \phi * E_E$$

$$V_{CO_2,CSLF_E} = A * h * \phi * (1 - S_{wirr}) * C_C$$

$$E_E = C_C * (1 - S_{wirr})$$

$$V_{CO_2,DOE_E} = V_{CO_2,CSLF_E}$$

# Storage Resource Estimation in Deep Saline Formations

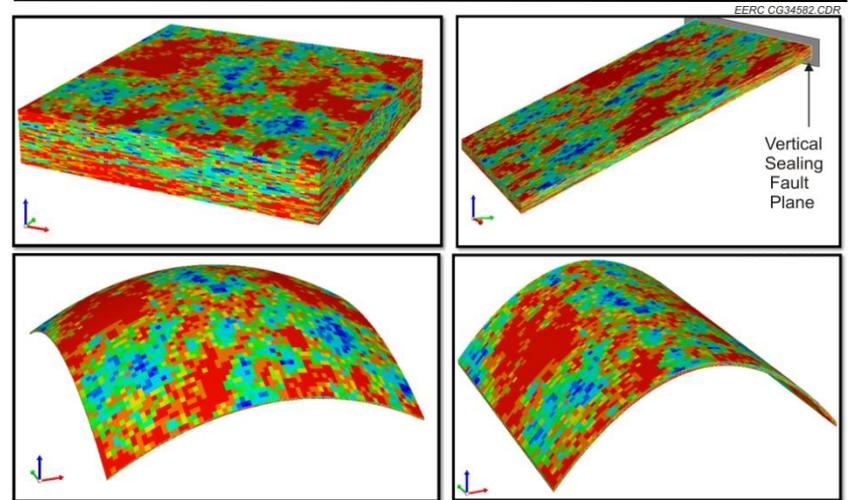
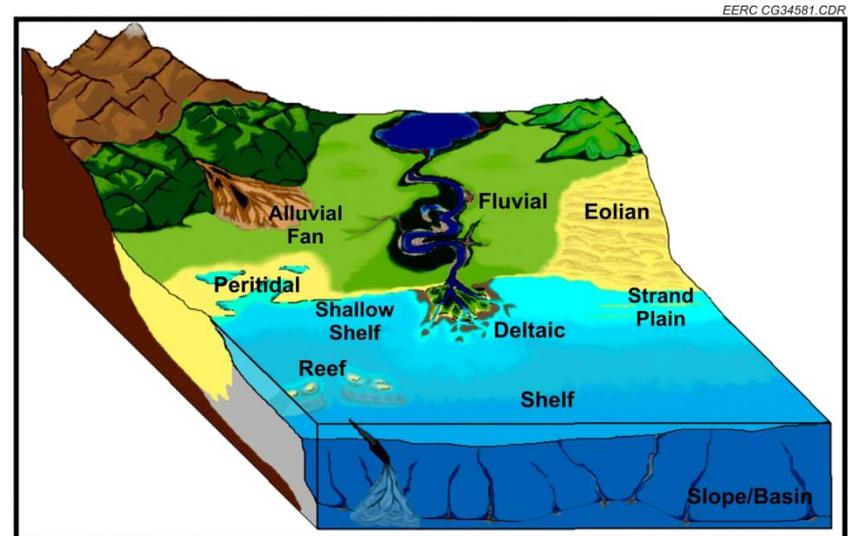
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- Data source
  - Examined worldwide field-based CCS projects.
  - Compiled a database with reservoir properties from hydrocarbon reservoirs – Average Global Database (AGD).
- Evaluation strategy
  - Constructed homogeneous models to test the strength of single parameters on storage resource.
  - Constructed heterogeneous models to test a wide range of parameters under different geologic settings on storage resource.
  - Storage coefficients were developed at the site-specific level and then extrapolated out to the formation-level.



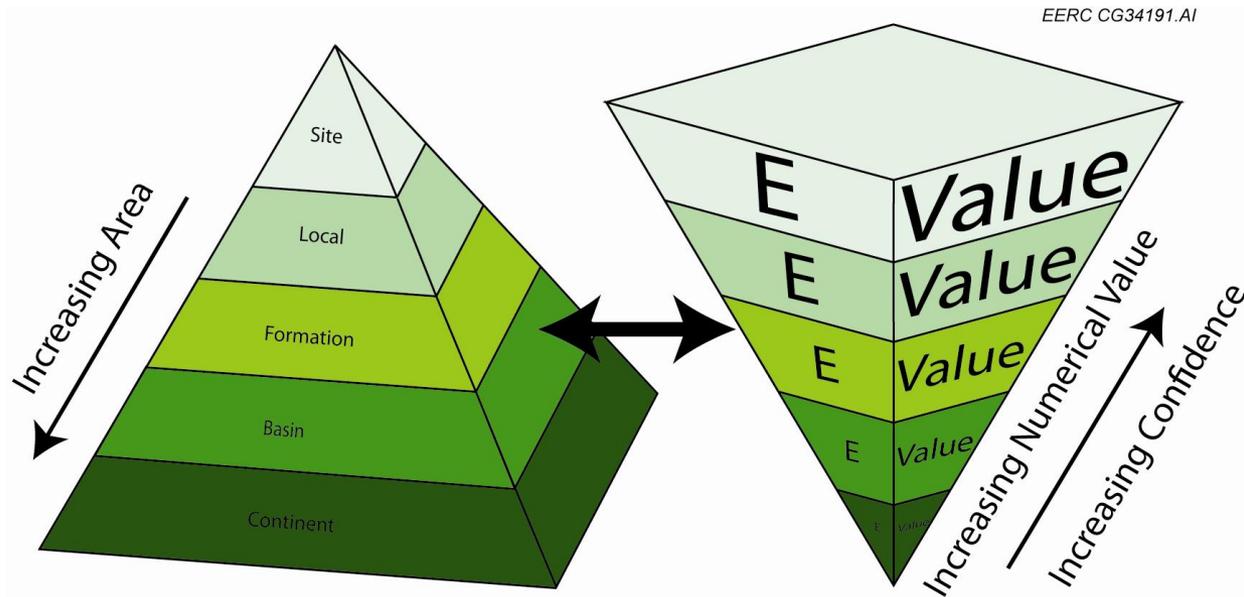
# Heterogeneous Model Testing

- Heterogeneous models were developed to determine the effects of lithology, depositional environment, and structure on the storage coefficients.
- Three lithologies, 10 depositional environments, and five structural settings were tested.
- In all, 195 simulations were run to determine the effects of a wide range of variables on resource estimates and storage coefficients.



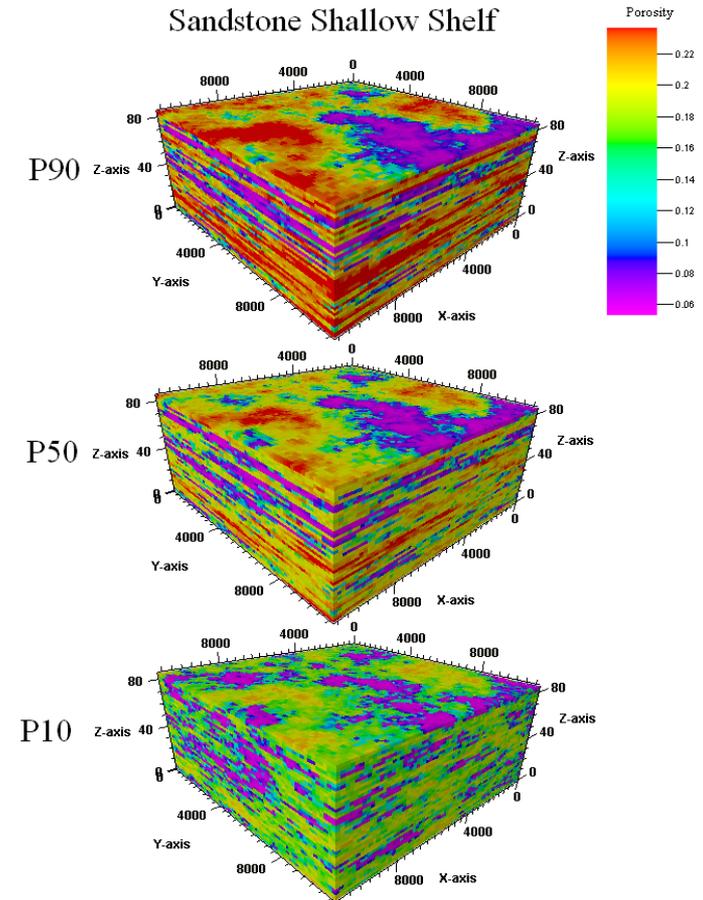
# Storage Coefficients at Different Scales

- Storage coefficients were developed at two scales, site-specific and formation-level.
- Site-specific coefficients were extrapolated out to formation-level coefficient.



# Conclusions

- A new storage classification system was developed.
- The DOE and CSLF storage resource methodologies were related to each other and the proposed classification system.
- A series of storage coefficients were developed for both the DOE and CSLF methods at the site-specific and formation-level scale based on the results of 195 simulation runs on a variety of lithologies, depositional environments, and structures.



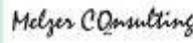
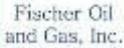
# Acknowledgments

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- Computer Modeling Group
- Schlumberger

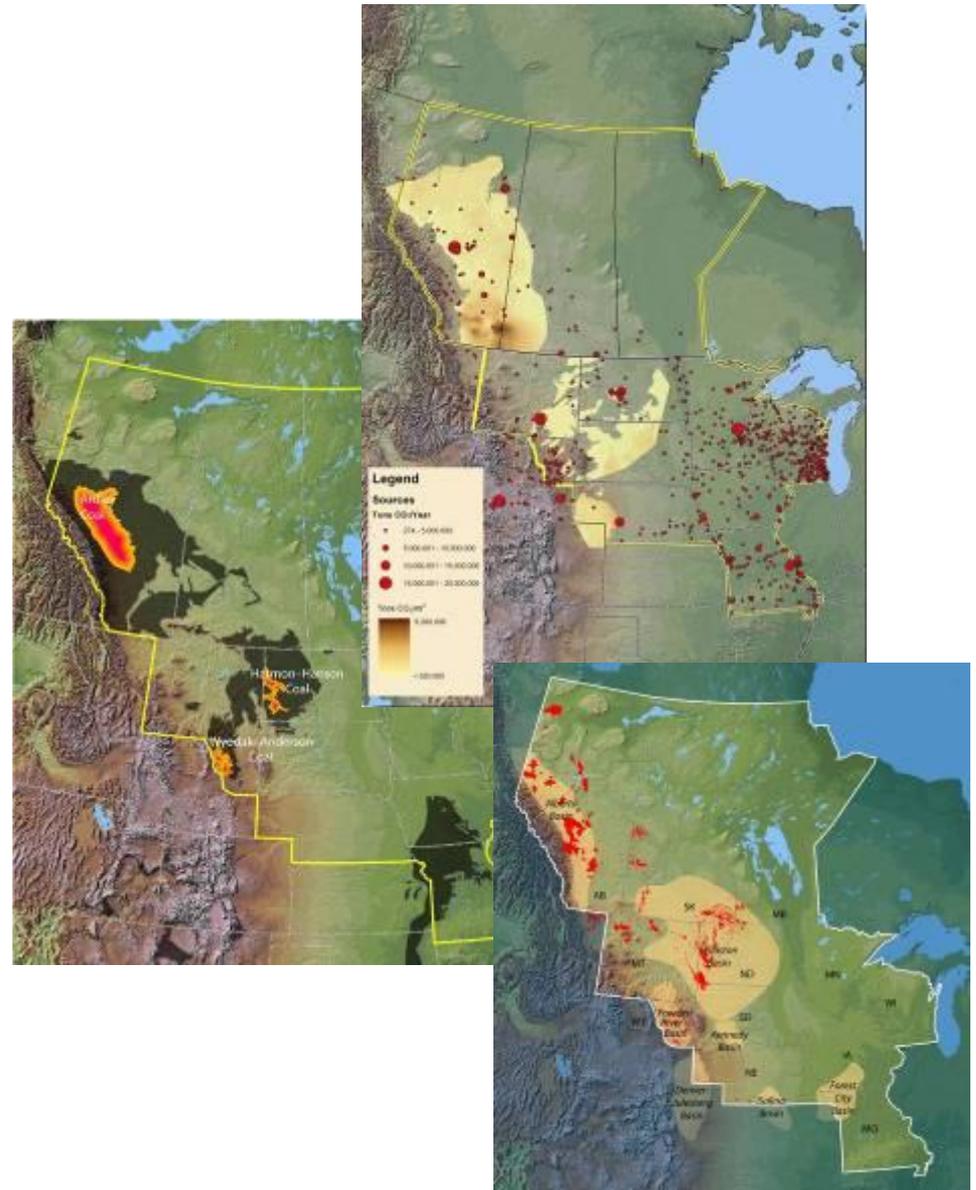


**PCOR Partnership  
2003–Present**



# Wrap-Up

- Where do we go from here?
  - Can we agree on a standard methodology?
  - Assign tasks
  - Cross-border issues?





**For more information on  
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- A topographic map of North America, showing the United States and Canada. Six numbered stars are placed on the map to indicate the locations of CO2 sequestration sites. Stars 1 and 5 are in the western US (Colorado and Wyoming). Stars 2, 3, 4, and 6 are in the central US (North Dakota, South Dakota, and Nebraska).
1. Phase II Zama Acid Gas Injection Site
  2. Phase II Lignite CO2 Sequestration ECBM Site
  3. Phase II Prairie Pothole Wetlands Terrestrial Sequestration Site
  4. Phase II CO2 Sequestration in Deep Saline Formation/EOR Site
  5. Phase III Fort Nelson Demonstration Test
  6. Phase III Williston Demonstration Test