EERC

EERC Technology… Putting Research into Practice

Introduction to CO_2 Sequestration
&
The Plains CO_2 Reduction (PCOR) Partnership

North Dakota Legislative Council Energy Development and Transmission Committee Meeting
September 16, 2009
EERC
Grand Forks, ND

PCO2R Partnership

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

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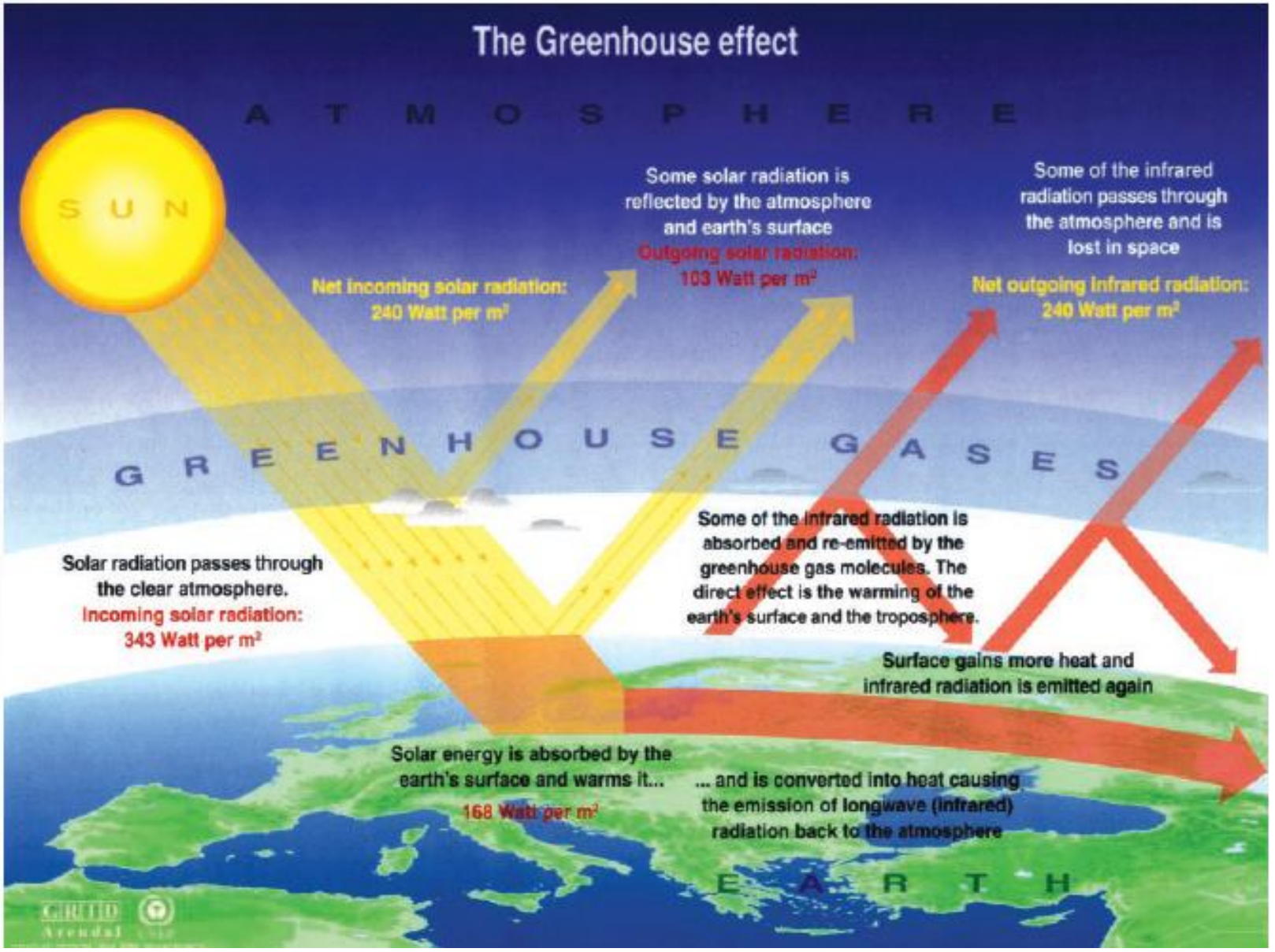
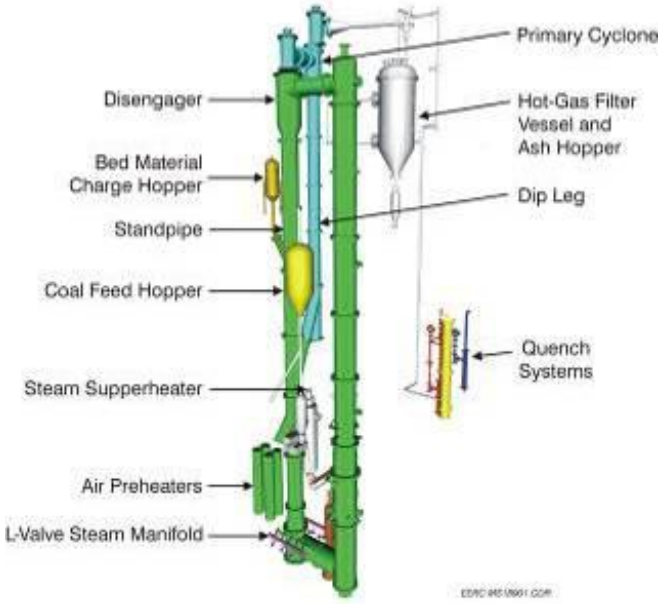
The Greenhouse Effect

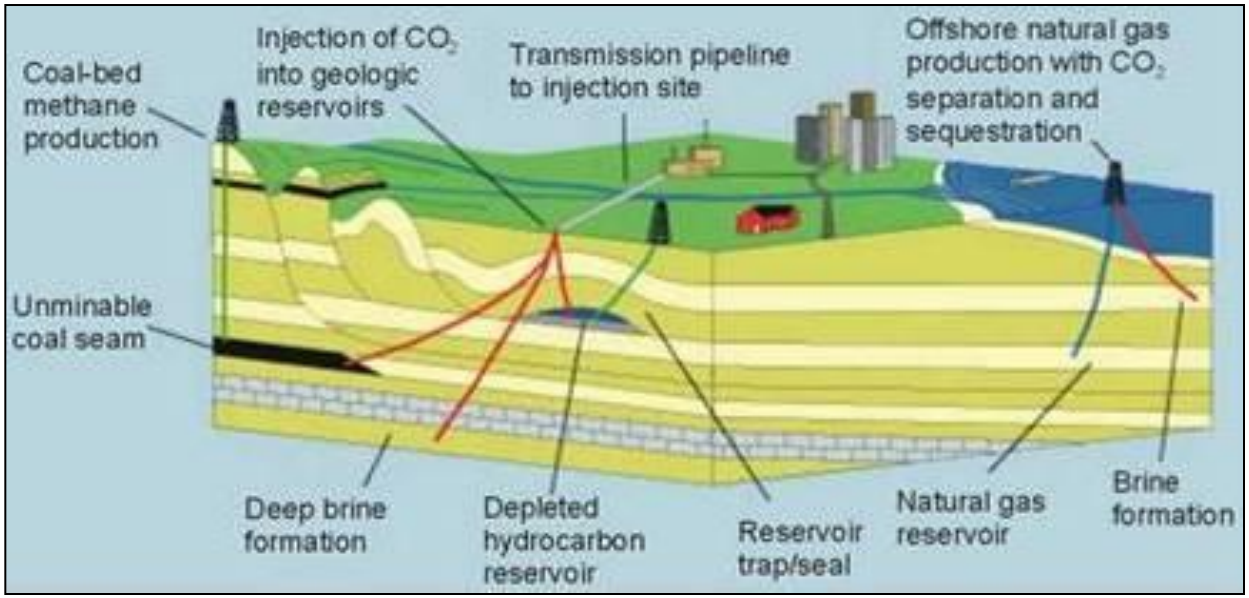


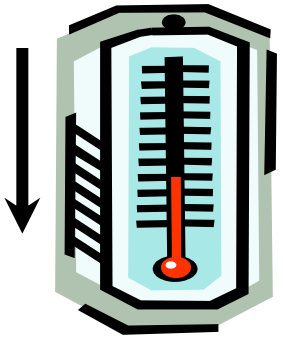
Source: Okanagan University College, Canada; University of Oxford; U.S. Environmental Protection Agency; United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO).

Methods for Reducing CO_2 Emissions

- Renewable energy technologies
- Advanced high-efficiency energy systems
- Improve efficiency on existing systems
- Reduce consumption of energy
- **Sequester greenhouse gas (GHG) emissions, often called carbon capture and storage (CCS)**

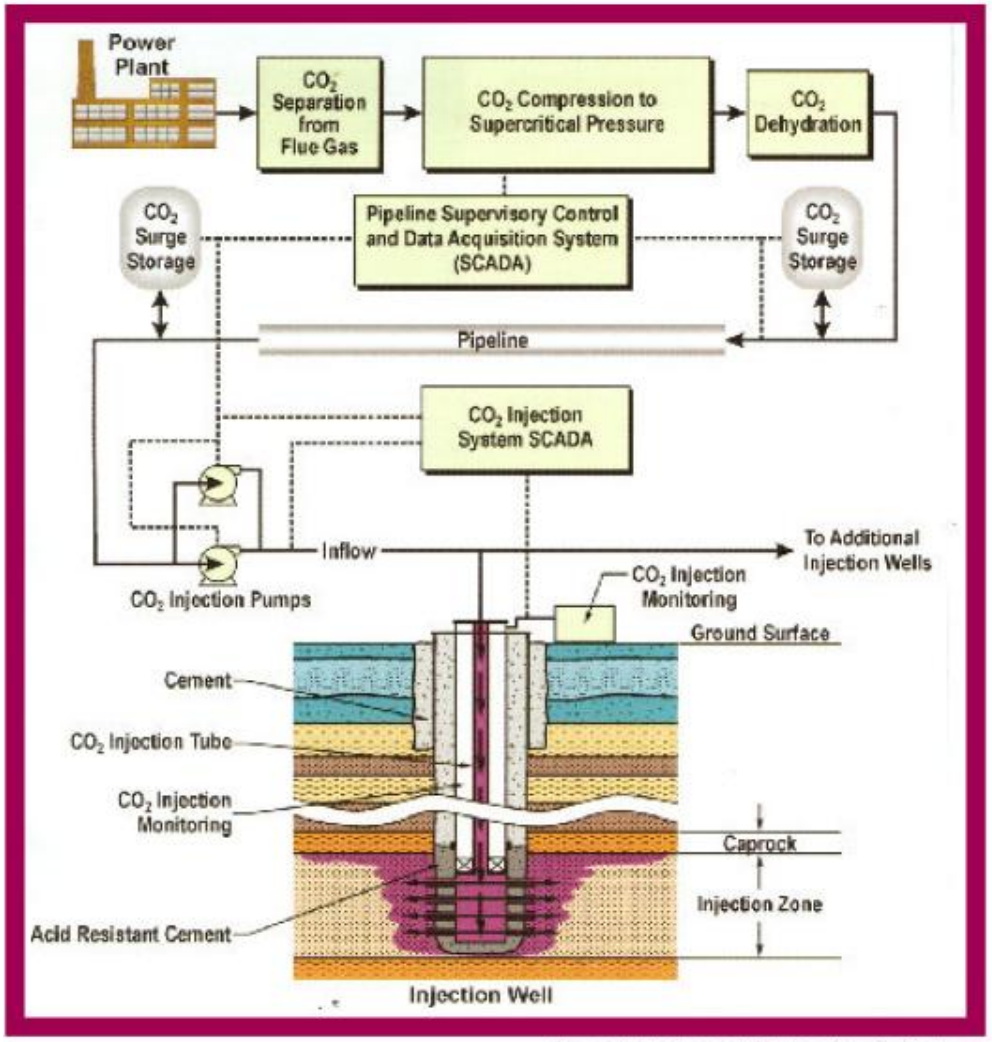






How Does CCS Work?

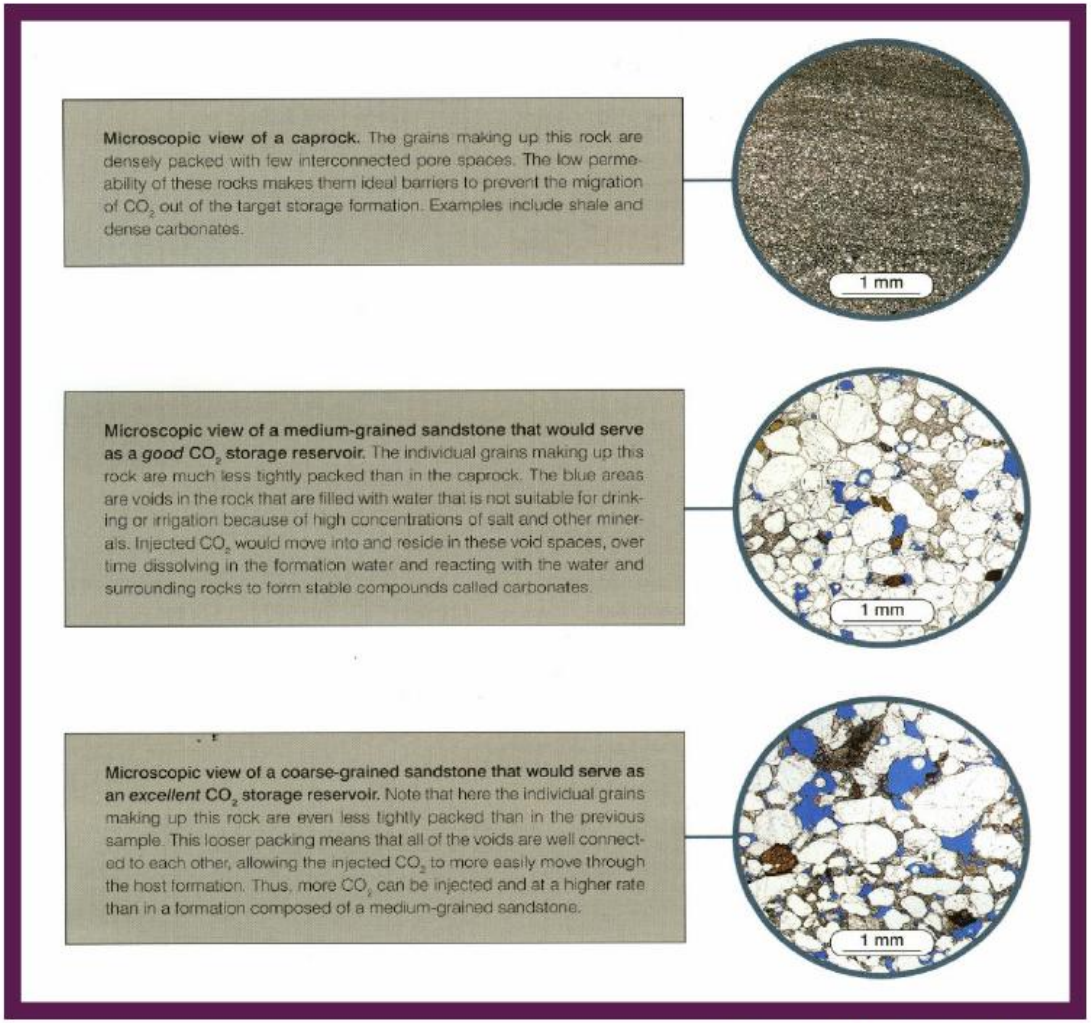
- CO_2 is captured from major stationary sources
- CO_2 is compressed and transported to a suitable storage site.
- CO_2 is pumped underground (as a liquid) at great depths into traps in the geologic structure that ensure storage over geologic time.



Source: JJ Dooley, et al, "Carbon Dioxide Capture and Geologic Storage," Technology Report from the Second Phase of the Global Energy Strategy Program, April 2006

What are Geologic Sinks and Seals?

- Geologic sinks are rock layers that have the capacity to store CO_2 in their pore spaces.
- Geologic seals are rock layers that don't allow for the CO_2 to move through them.
- Since CO_2 is buoyant in water, the ideal storage site consists of a sink rock that is overlain by a seal rock layer.



Source: JJ Dooley, et al, "Carbon Dioxide Capture and Geologic Storage," Technology Report from the Second Phase of the Global Energy Strategy Program, April 2006

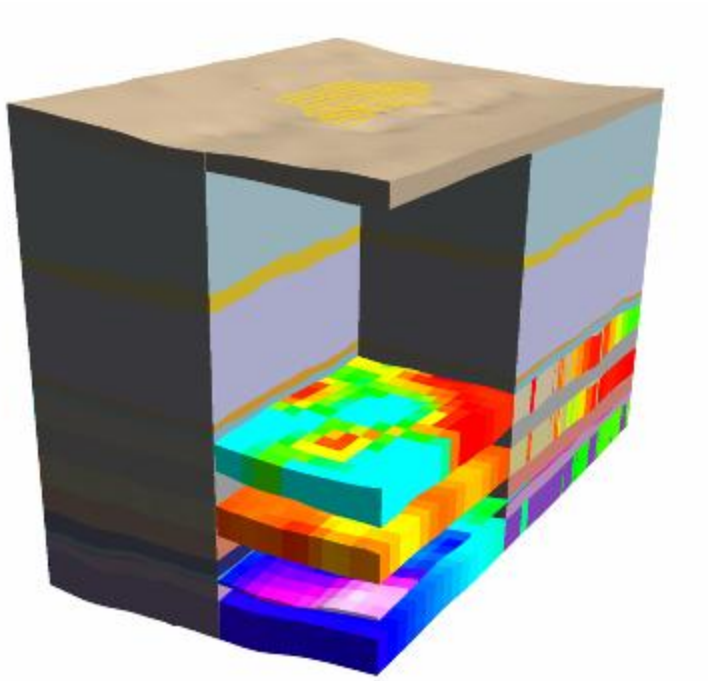
What Are the Key Questions for Choosing Good Sites for CCS?

- What is the storage capacity of the target geologic formation (sink) the area of interest?
- What is the fate of the CO_2?
- What is the potential for leakage?

Site characterization data provide the basis for a geologic model that can be used to begin answering these questions.

What Needs to Be Characterized?

- Geology
- Hydrogeology
- Injection zone
- Cap rock and seal



Baseline characterization for demonstration sites should be done at **small, medium, and large scales**.

Figure Courtesy of Saskatchewan Industry & Resources

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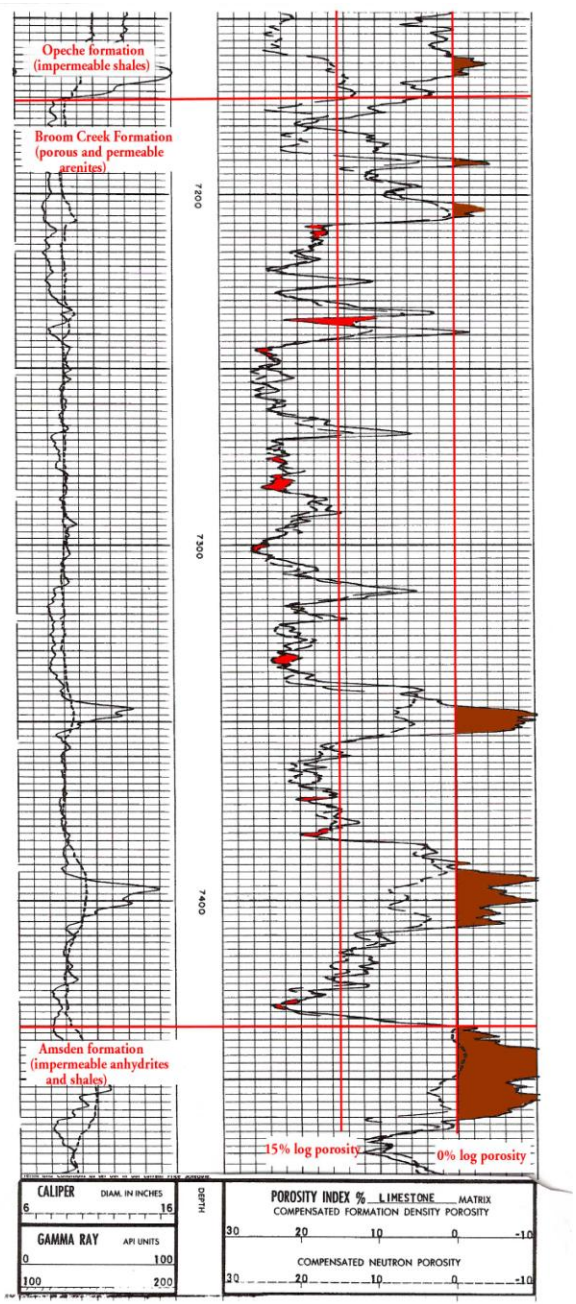
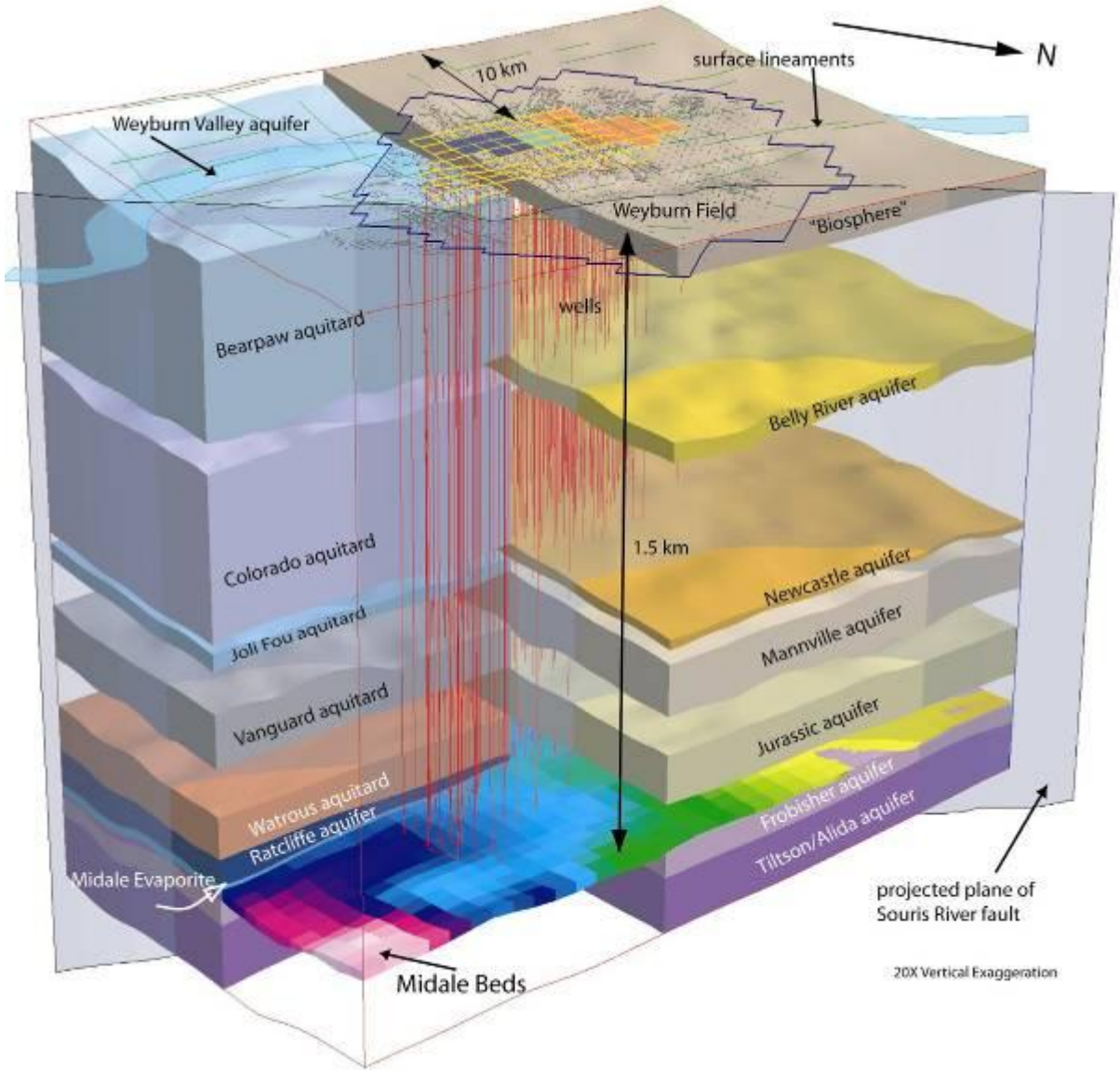
Well Logs Are Good for Initial Examinations



- Tools lowered down well boreholes generate measurements that allow for estimation of some rock properties.
- Can identify zones of relative porosity:
  - High-porosity zones may be good sinks (injection targets).
  - Low-porosity zones may indicate good seals.

Characterization Yields Geological Model

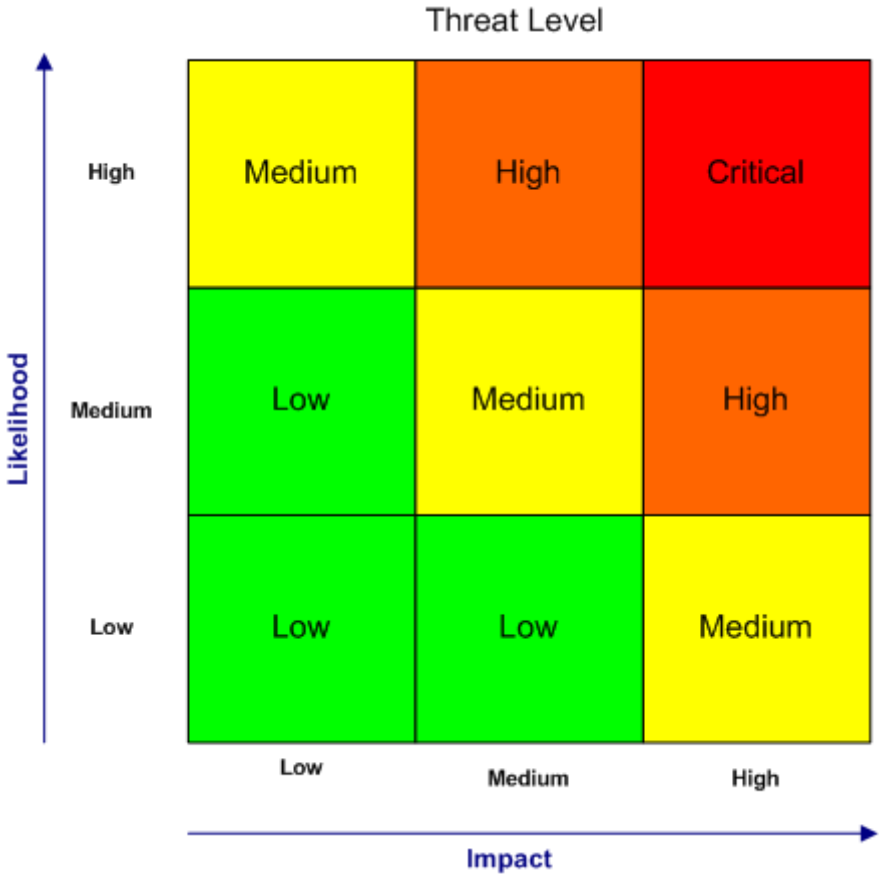
- Geological architecture of system
- Properties of system
  - Lithology
  - Hydrogeological characteristics
  - Faults
- Necessary for robust numerical modeling and risk assessment



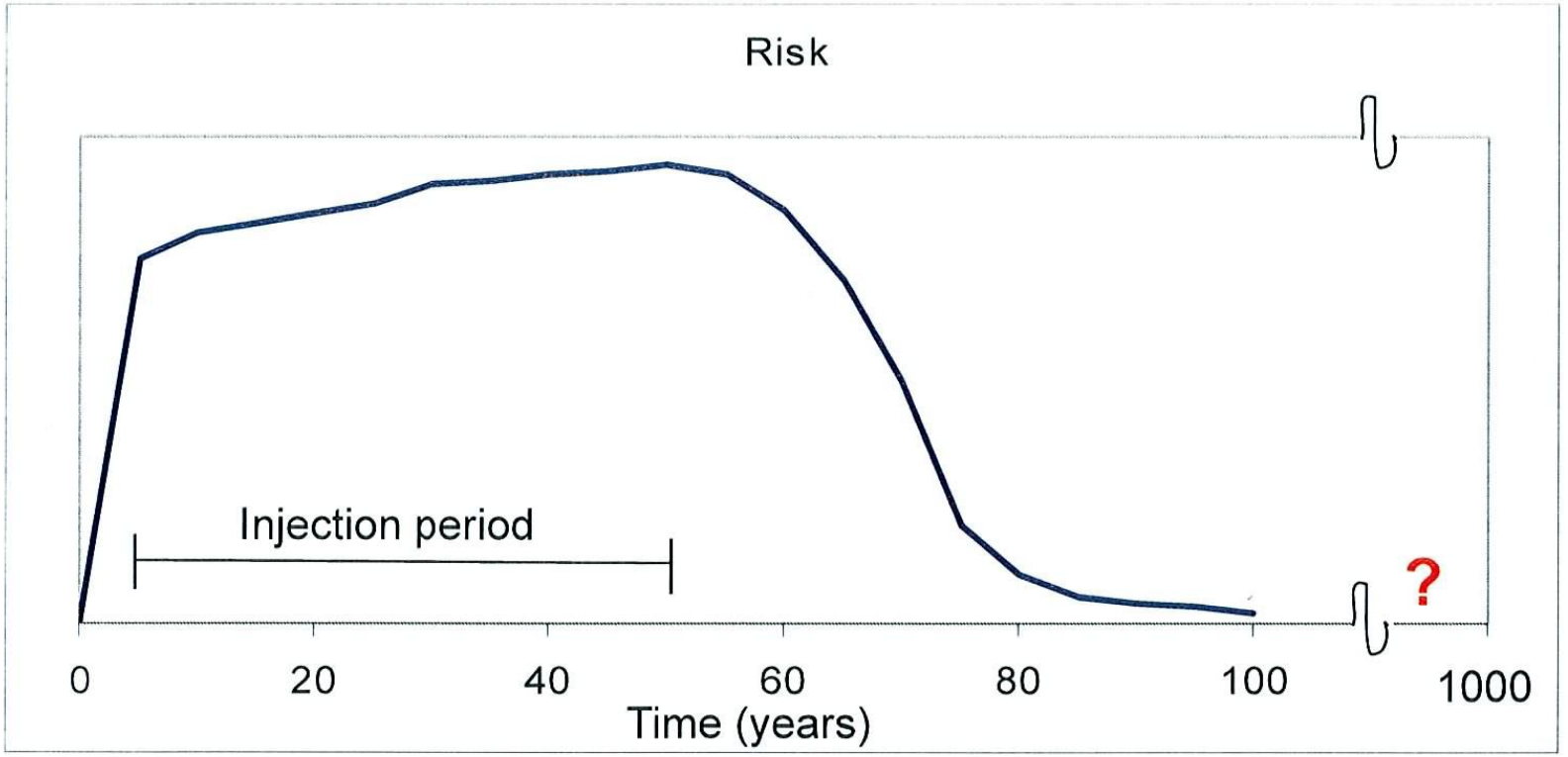
Figures Courtesy of Saskatchewan Industry & Resources

Risk Assessment Philosophy

- We work closely with our industry partners to implement cost-effective monitoring, mitigation, and verification (MMV) strategies which both add value to the projects and mitigate potential risks.



The risk timeline for leakage is heavily-laden in early times.



Why does it look like this?

Pressure driver during and post injection

Most "changes" occur in early phase

Long-term effects trap larger quantities of CO_2

Seals may be affected over long-term

Stacked Sinks

- A recently completed effort focused on multiple target formations in west-central North Dakota.

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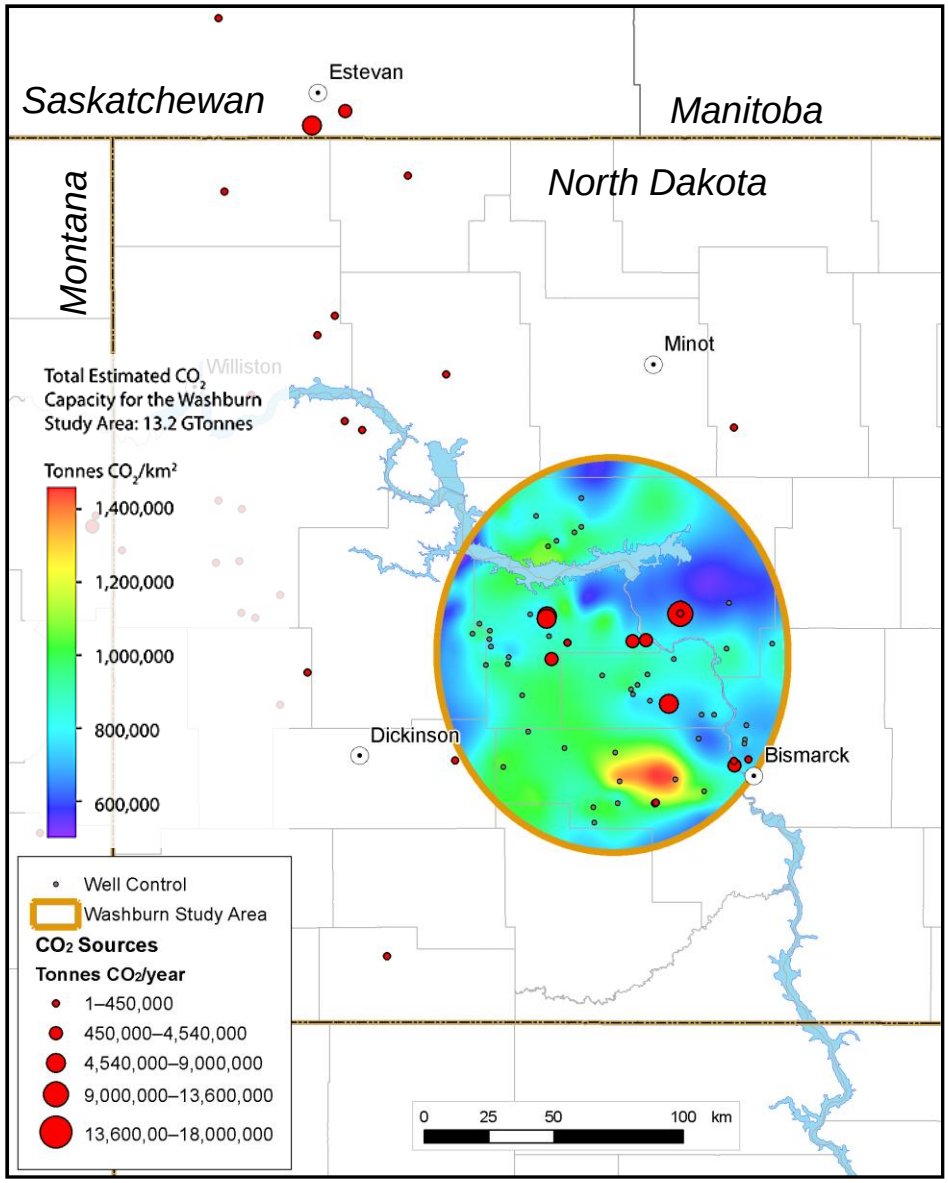
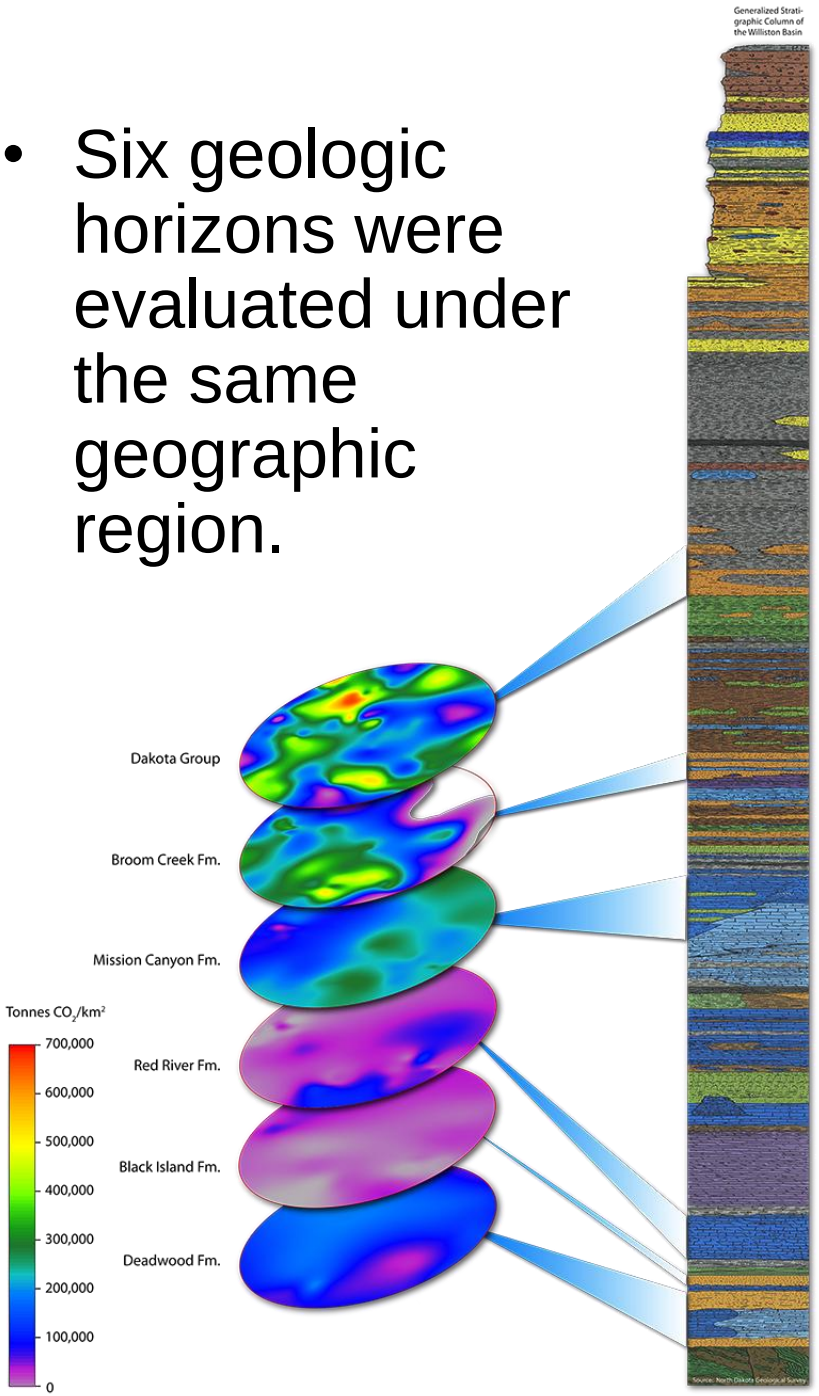
Stacked Sinks

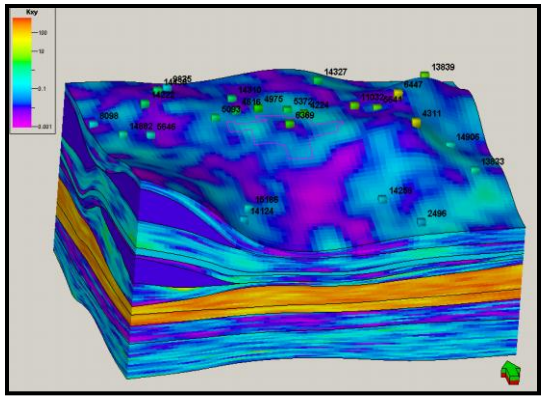


- Six geologic horizons were evaluated under the same geographic region.

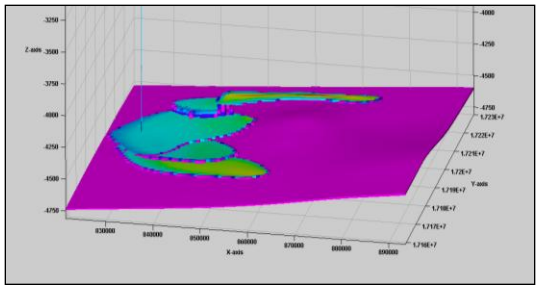


Brine-Saturated Formation Modeling

Well logs, core analyses, and geophysical data are used to create maps of key formation properties.



Maps are then used to create a petrophysical model of the sink–seal system.



Injection and plume behavior and fate can then be modeled.

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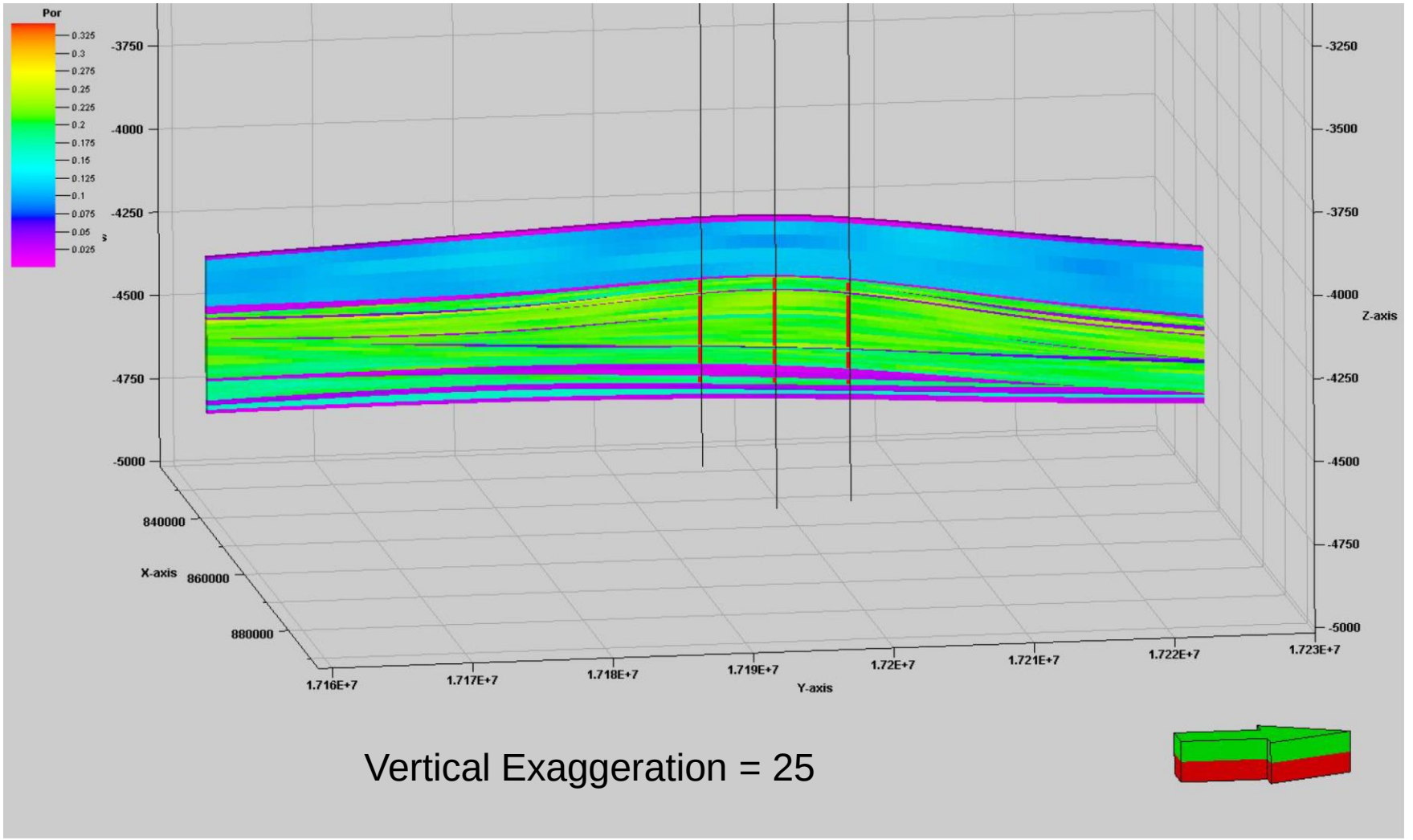
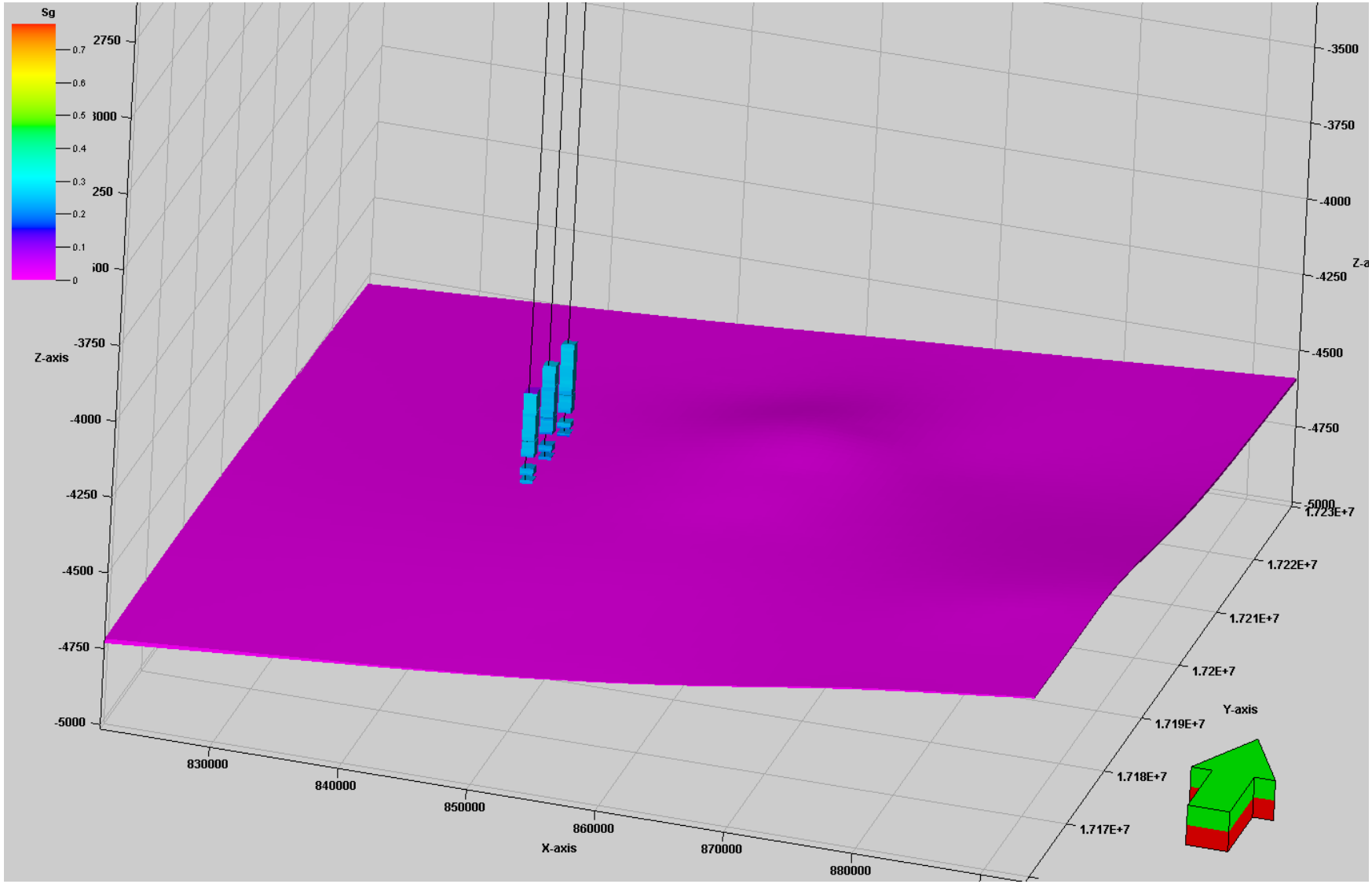


- Four perforated zones (shown in red): the high porosity sands in each well were perforated.
- The tight zones (presumed to be anhydrite stringers) between were not perforated.

1 Year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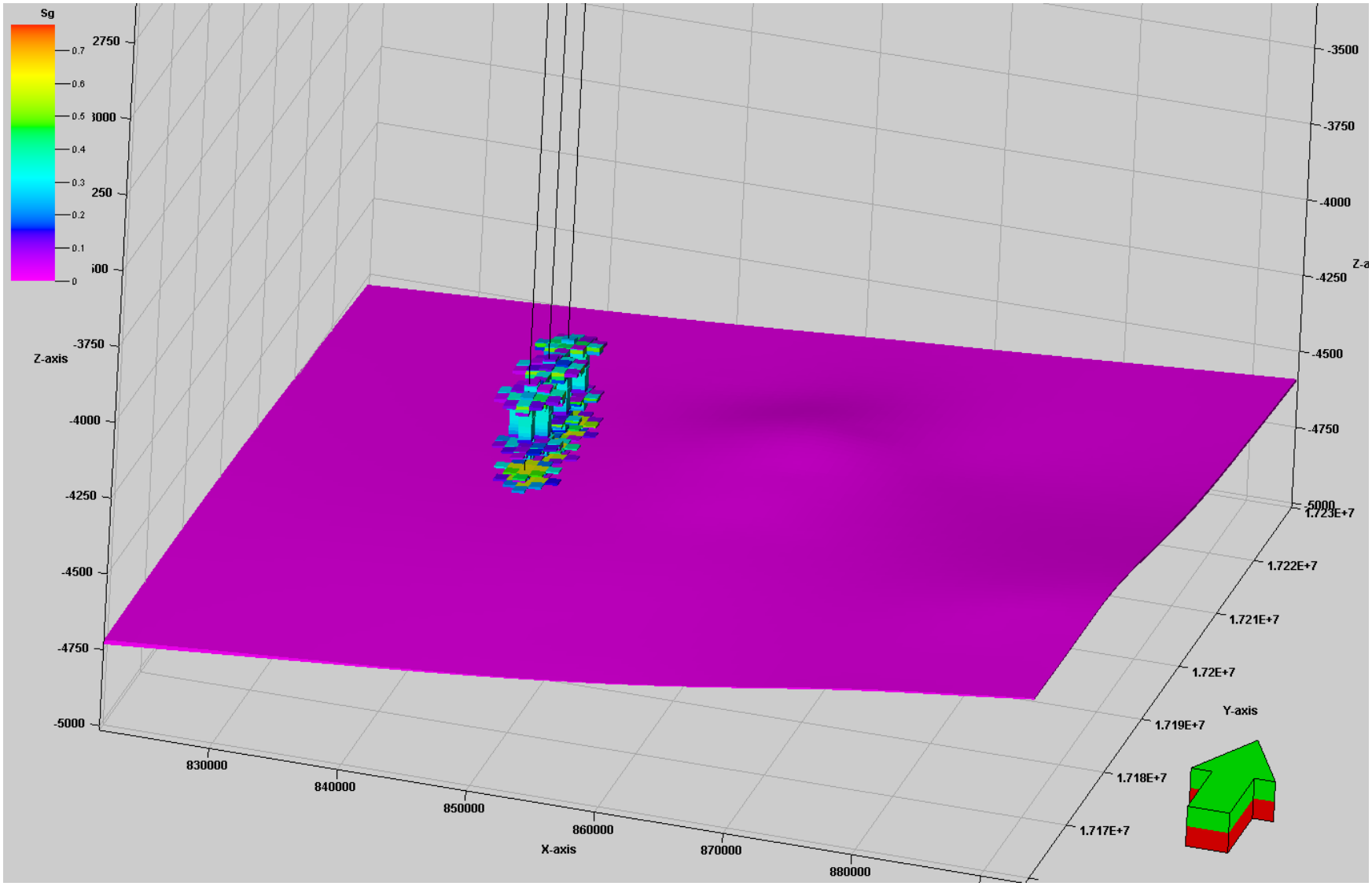
Y-axis

10 Years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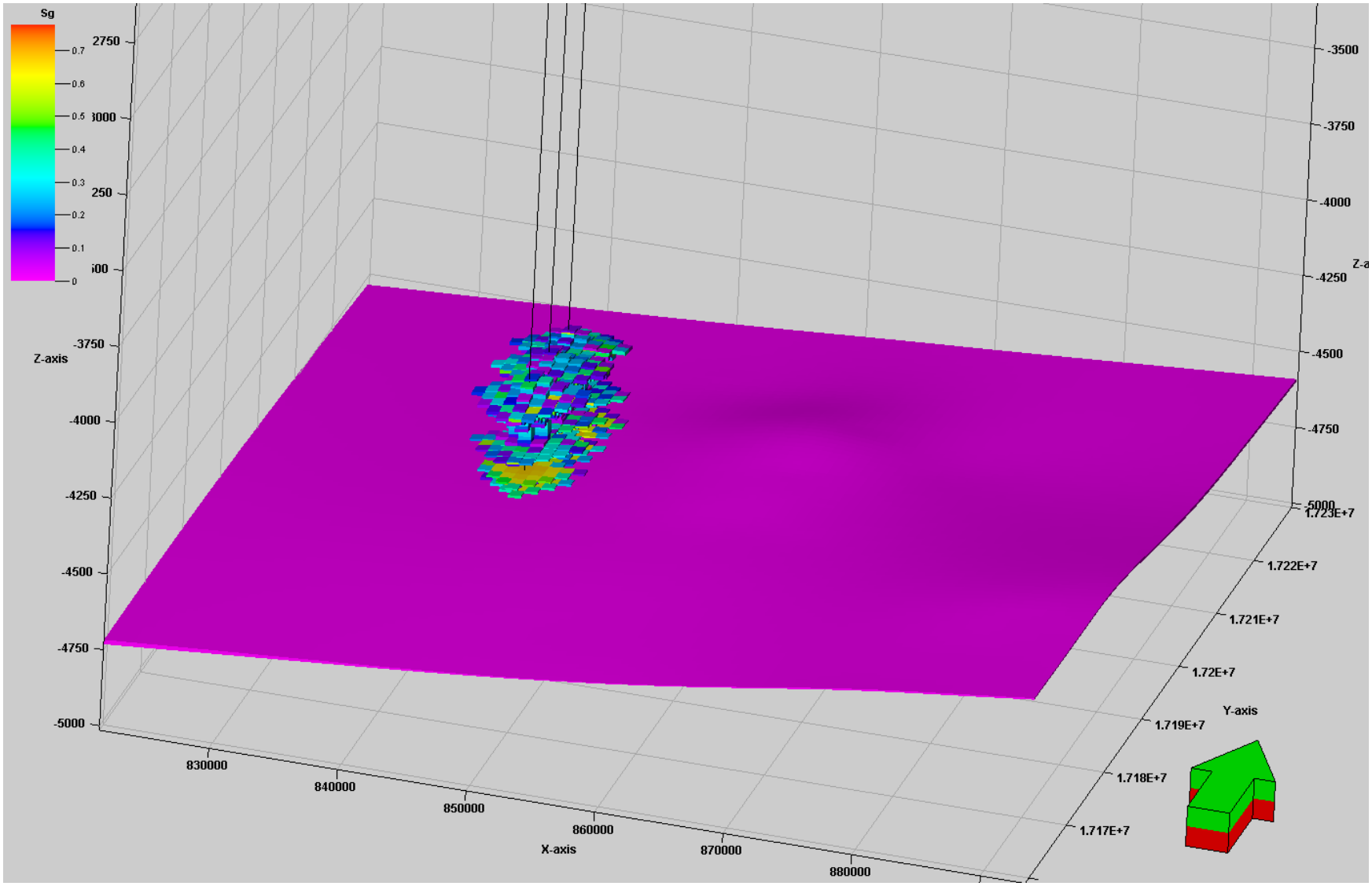
Y-axis

25 Years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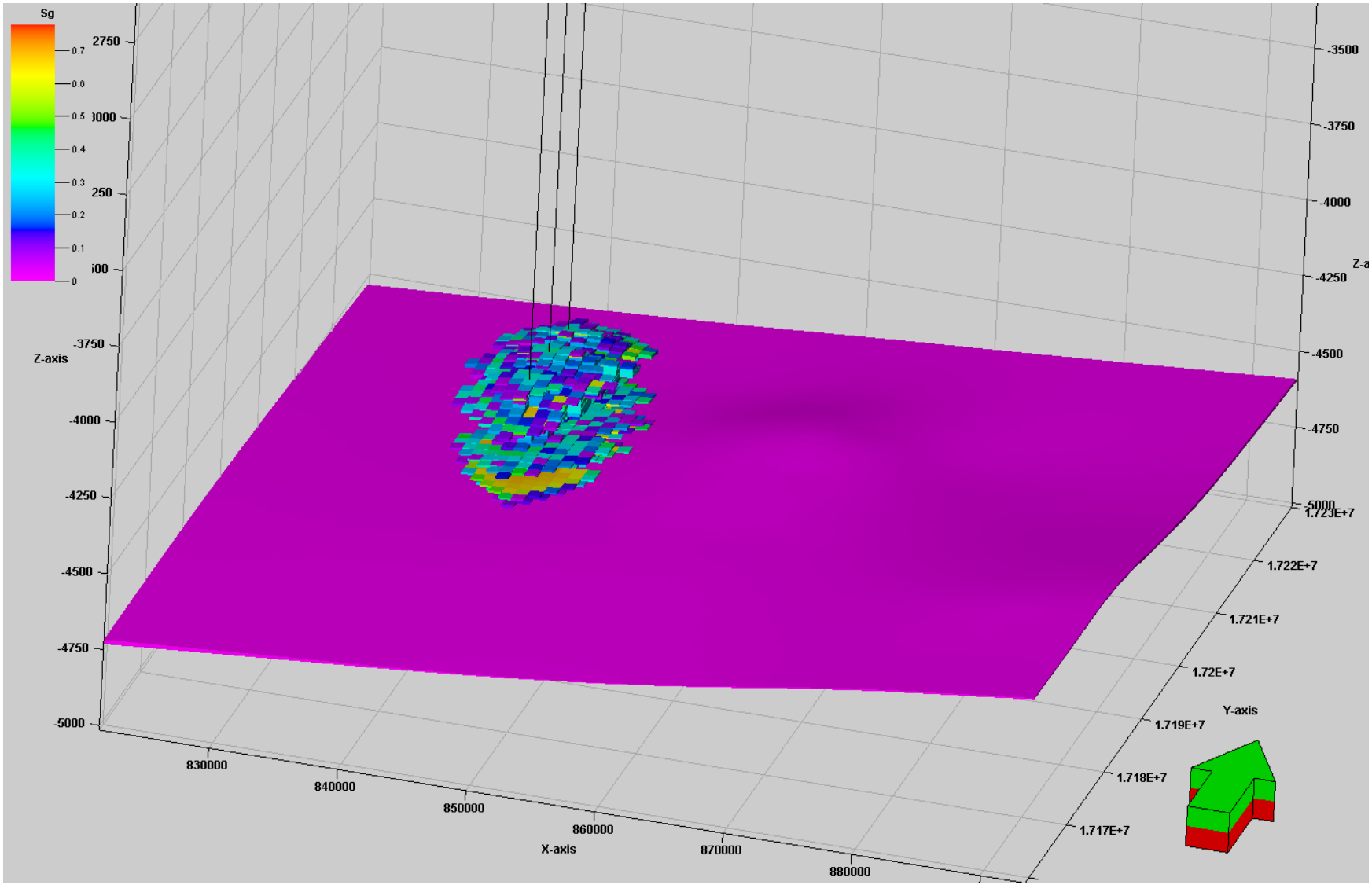
Y-axis

50 Years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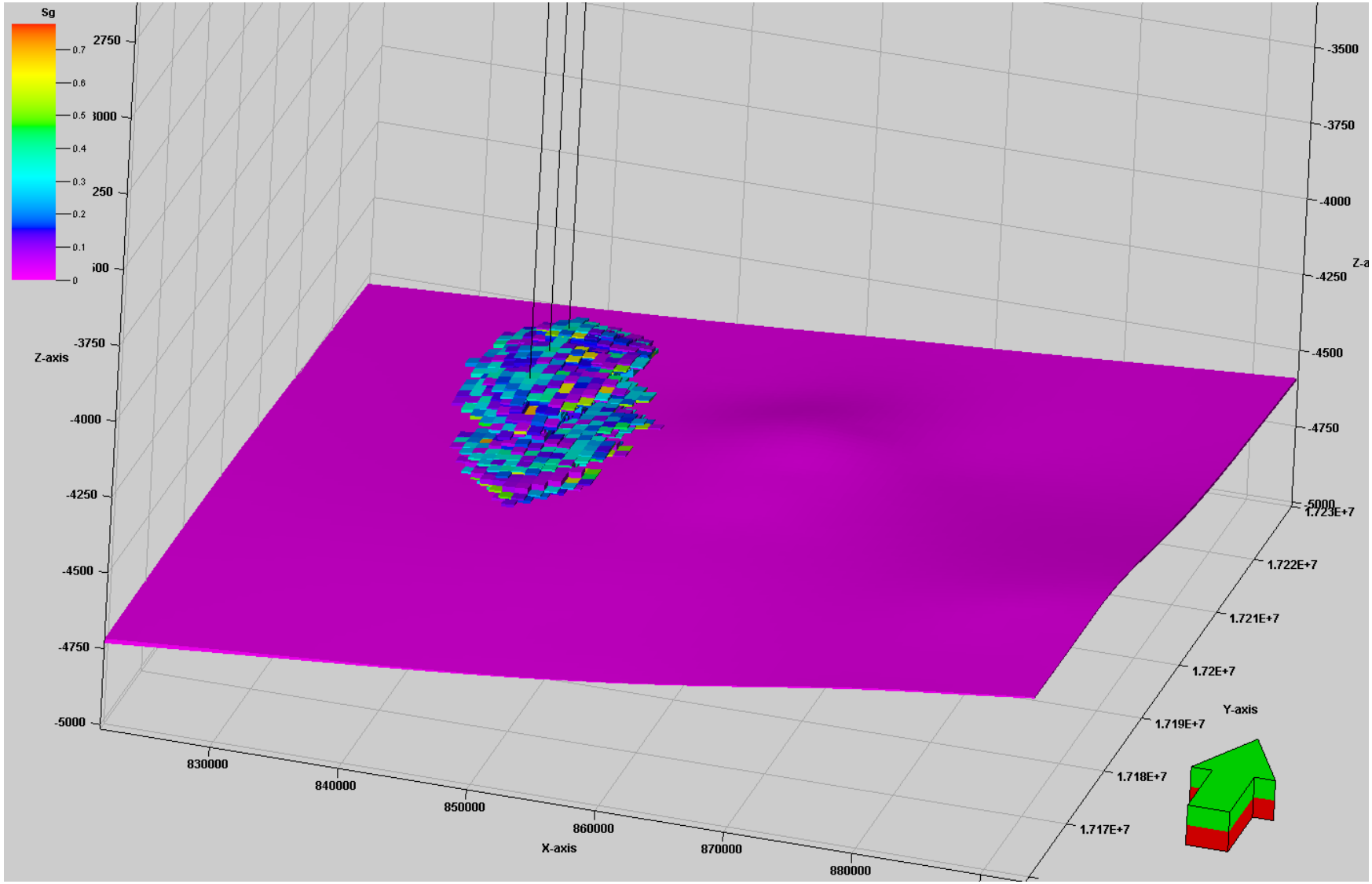
100 Years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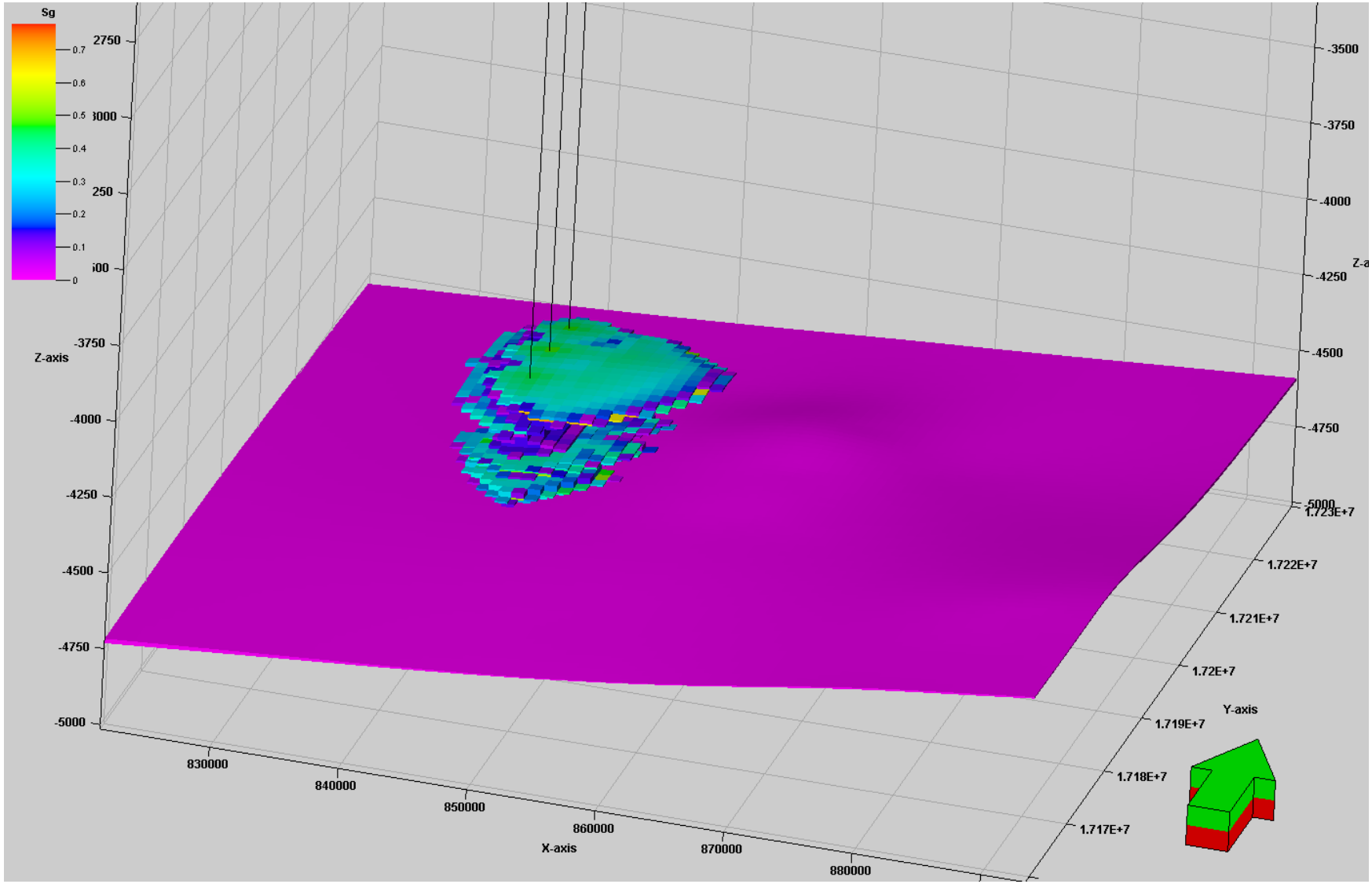
500 Years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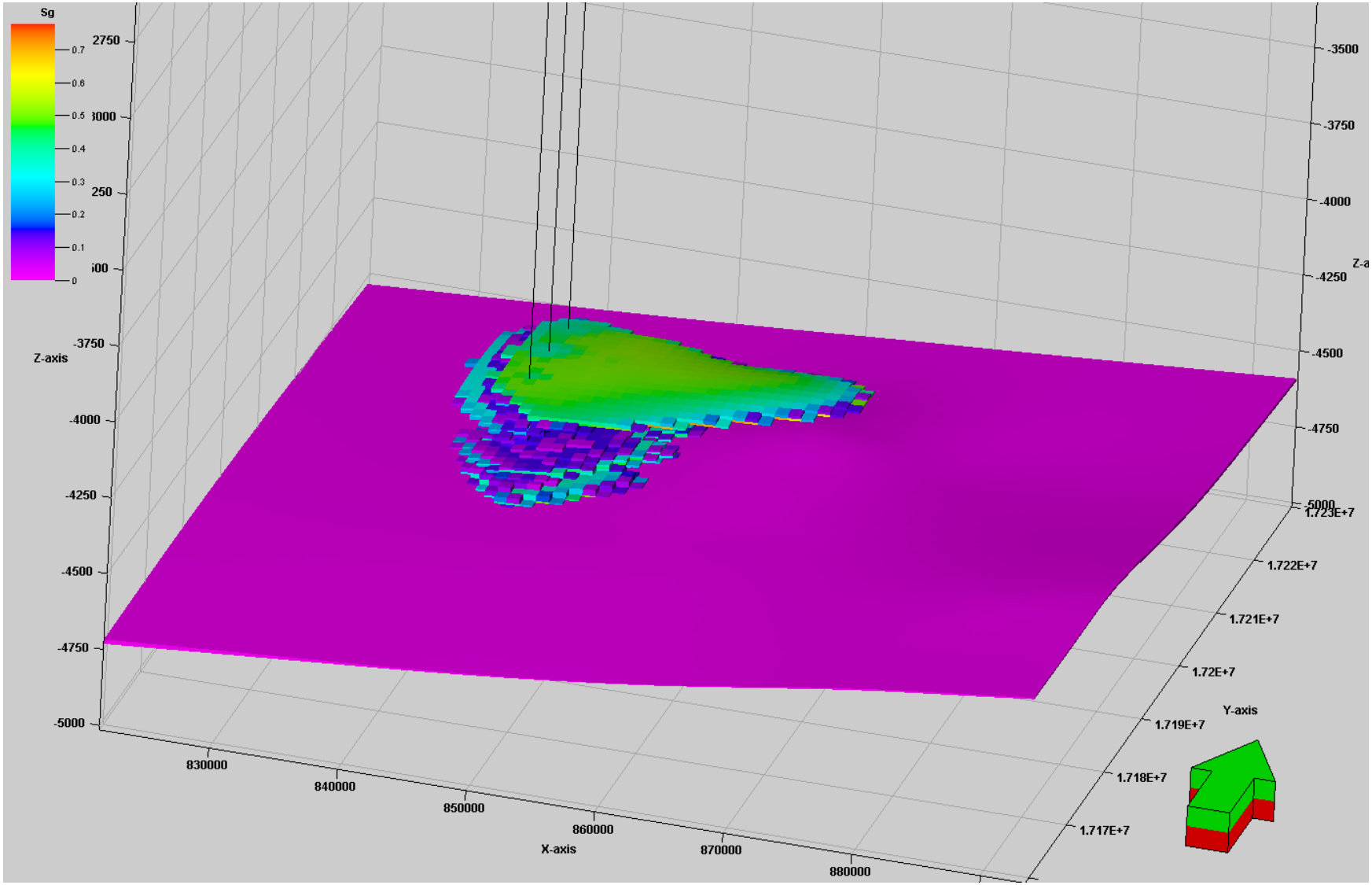
1500 Years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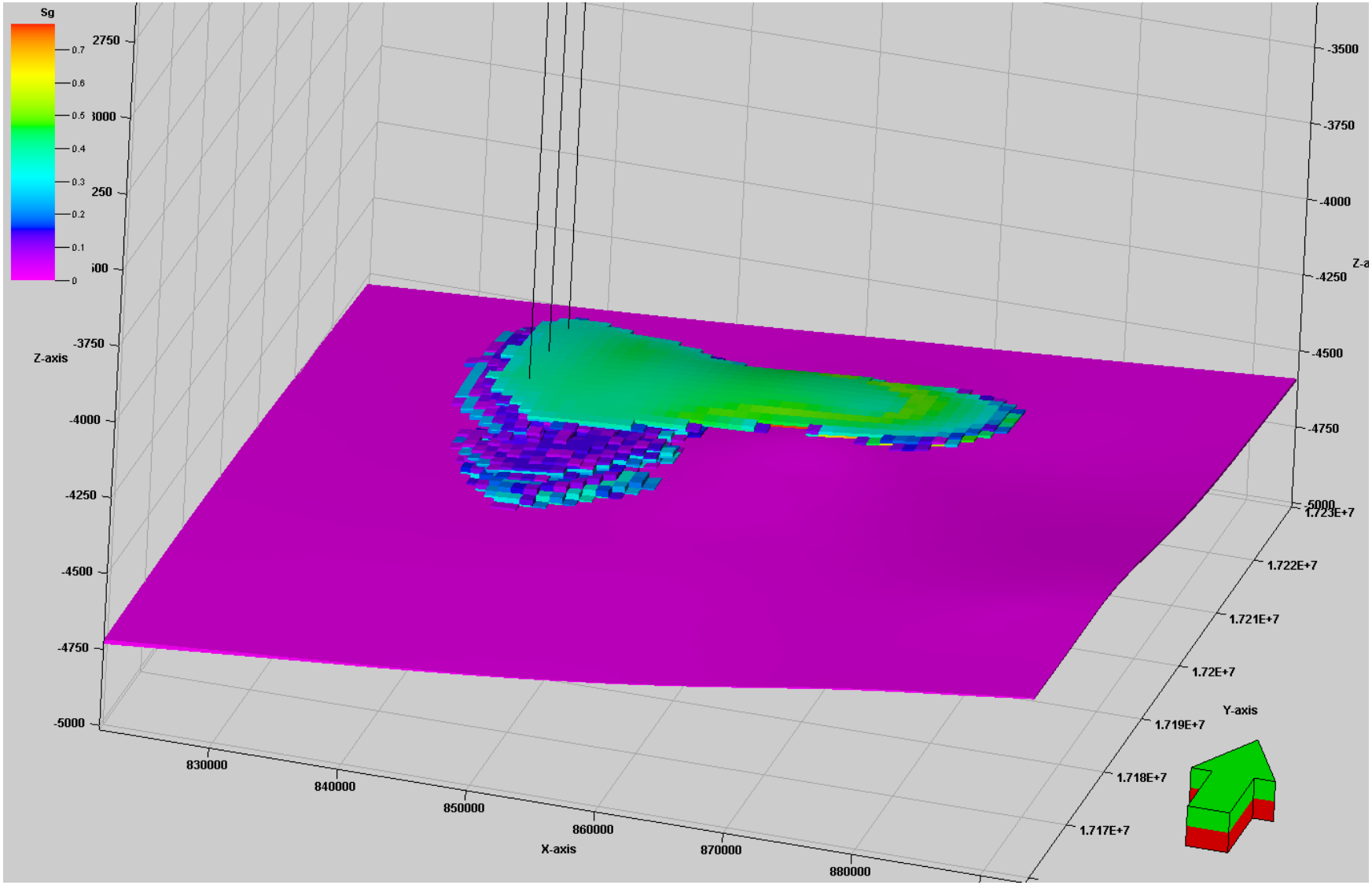
3000 Years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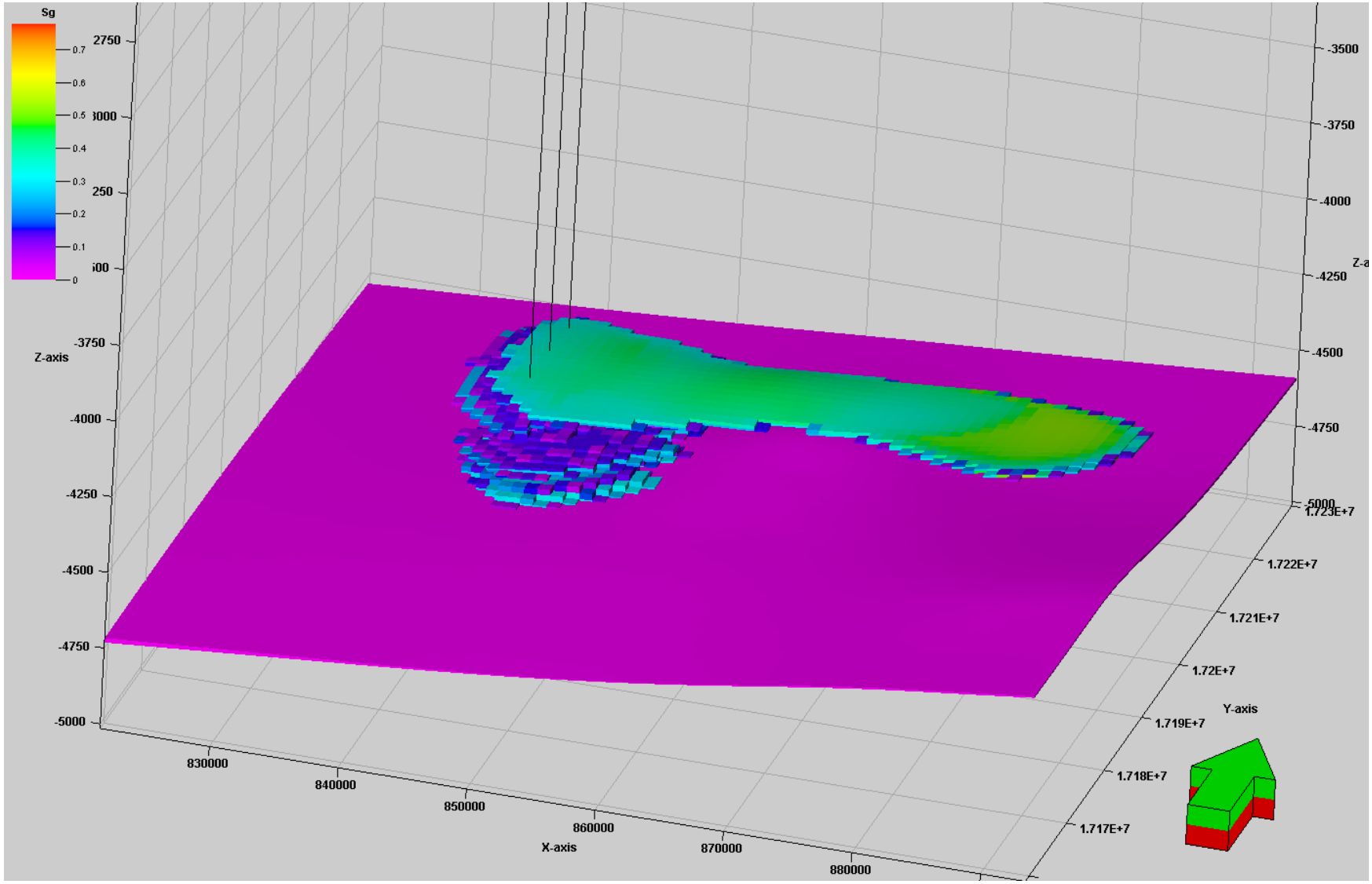
4500 Years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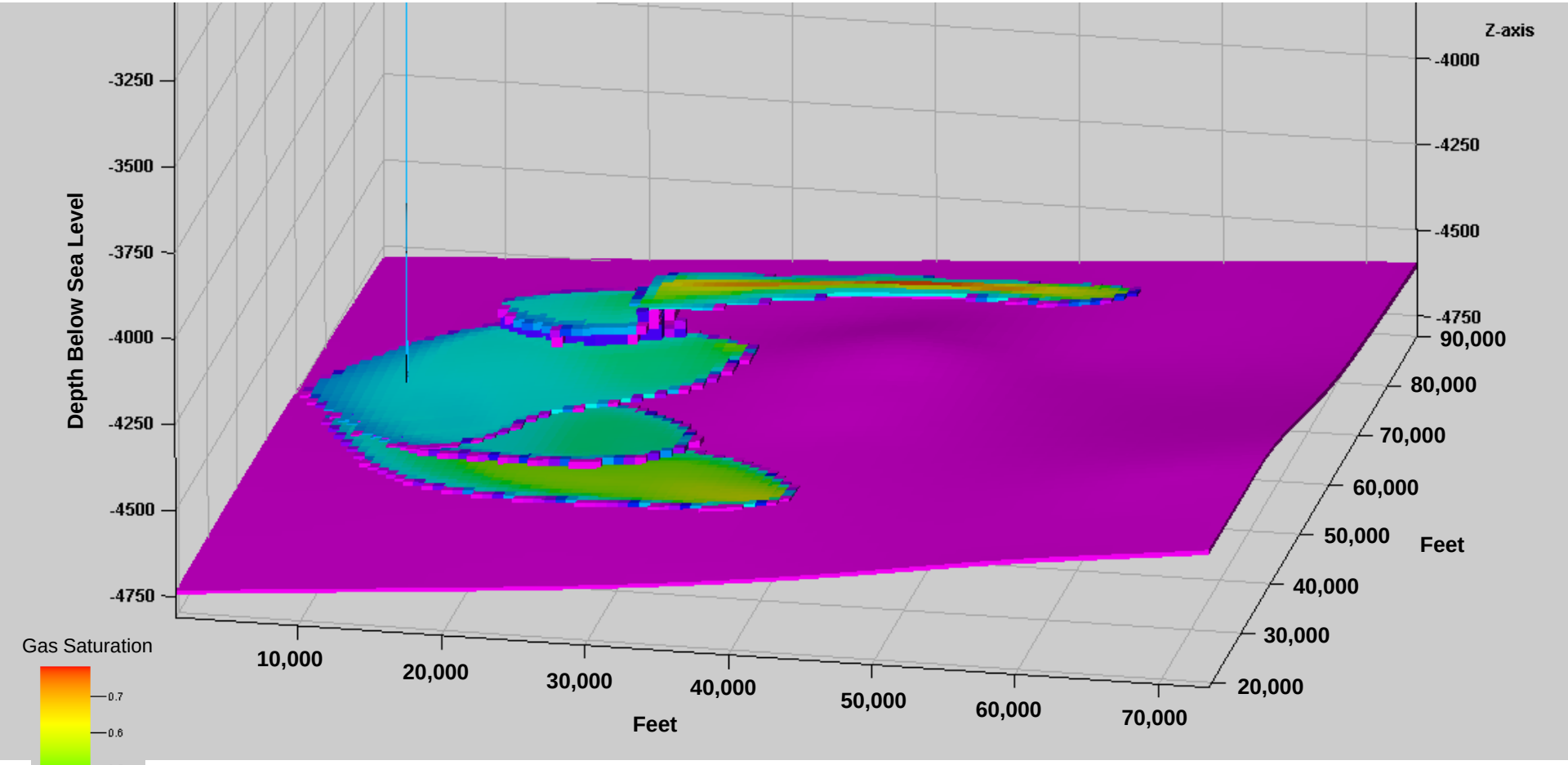
T= 50 years (End of injection)



Injection of 1 Million tons/yr into the Broom Creek Formation over 50 years

EERC CO_2 CCS Work

- The EERC is one of seven Regional Carbon Sequestration Partnerships that the US DOE and other partners are funding to demonstrate CCS across North America.
- We are finishing four Phase II small-scale demonstrations and developing two Phase III commercial-scale demonstrations.

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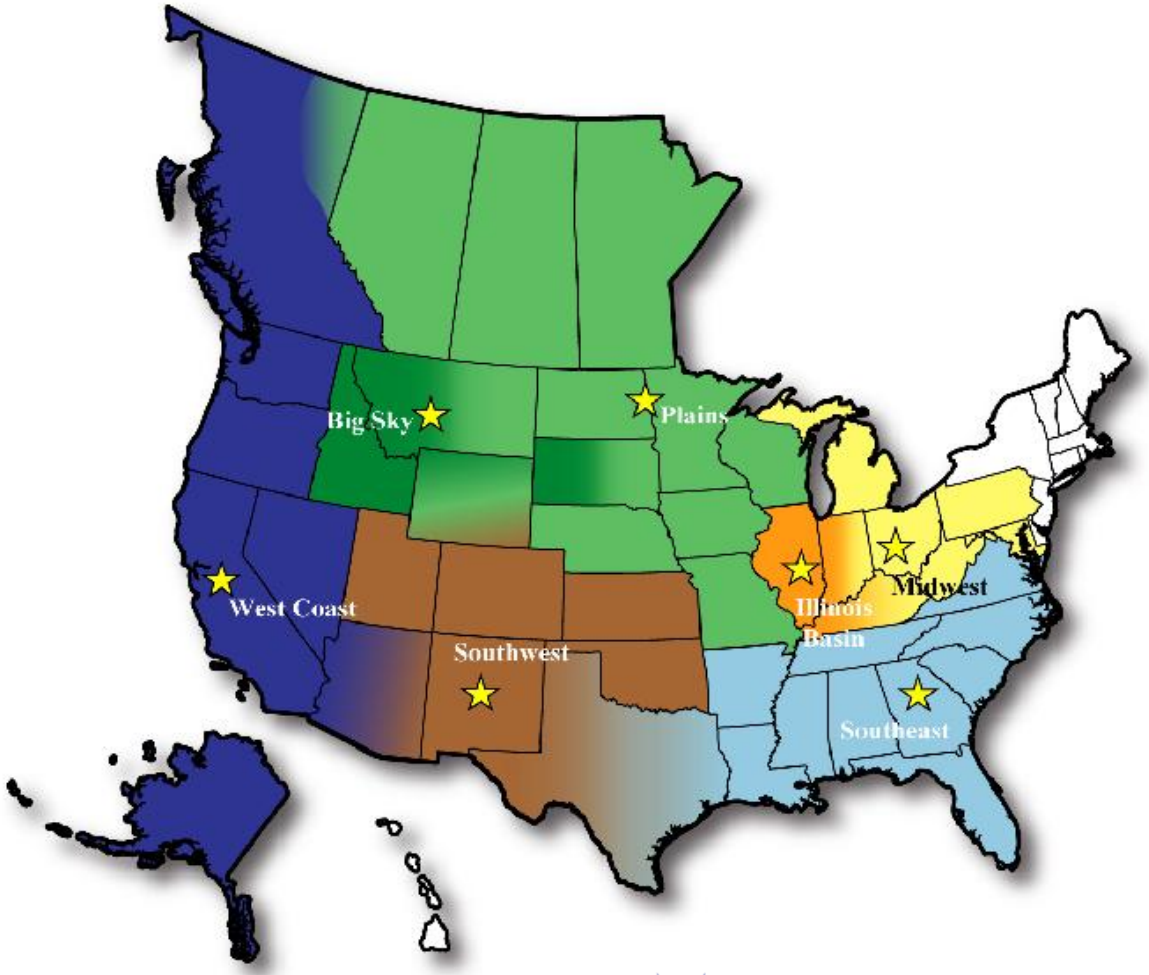
Regional Carbon Sequestration Partnerships



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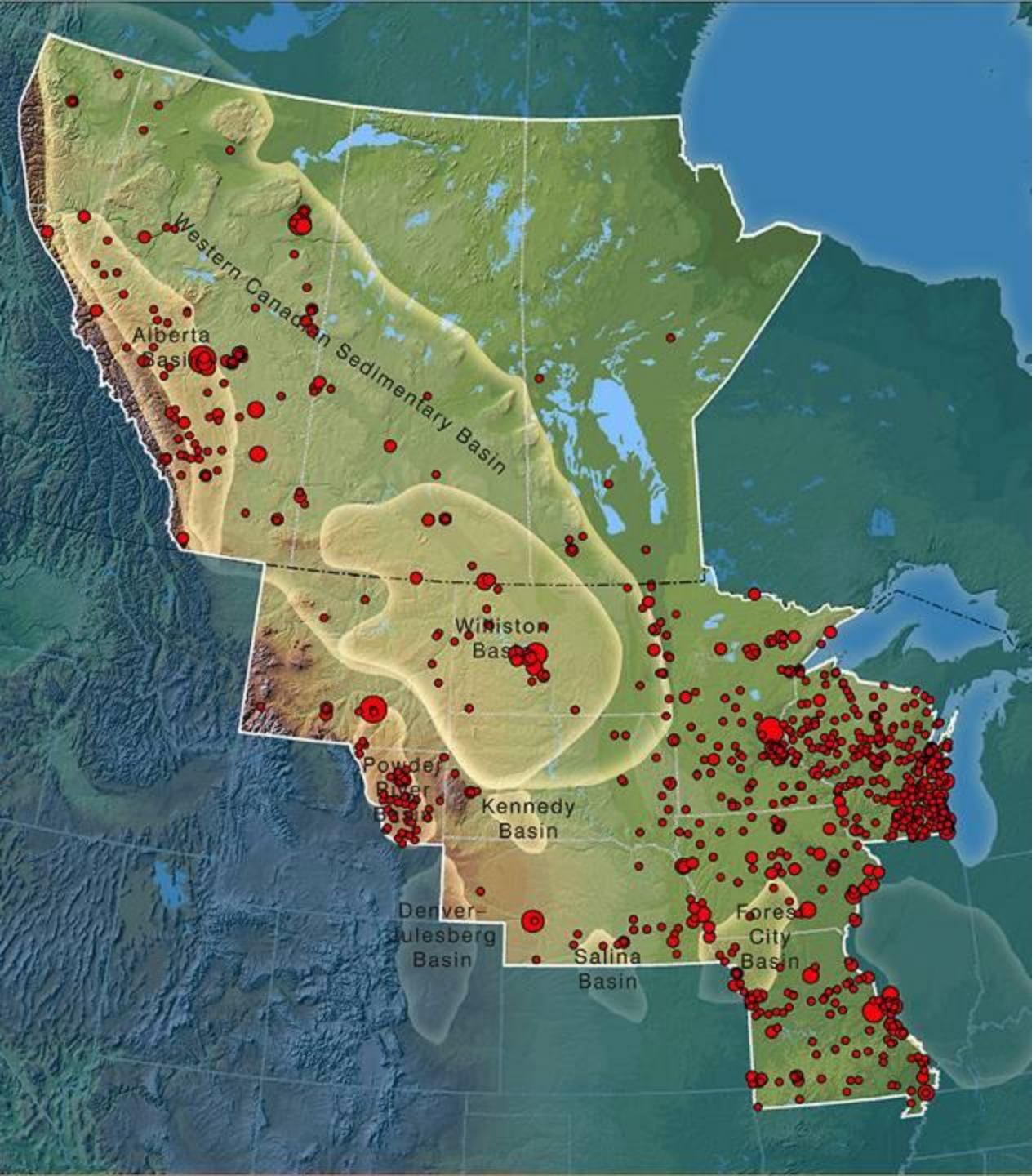
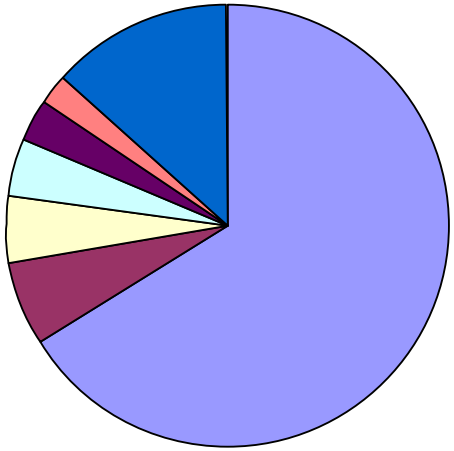


Sources

1225 stationary sources

Total CO_2 emissions:
≈ 559 million tons/yr

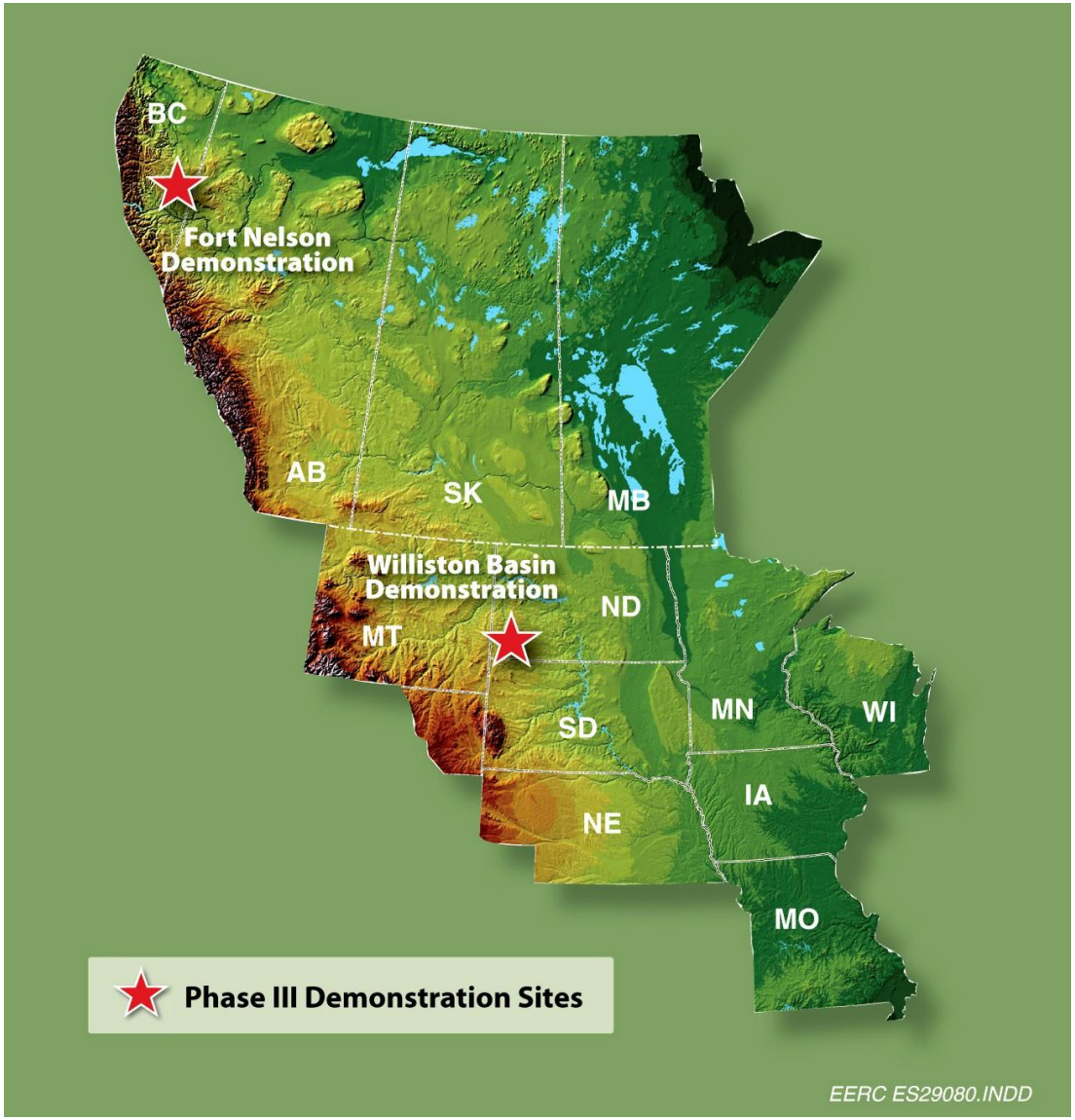


- Electricity Generation (66%)
- Paper and Wood Products (6.1%)
- Petroleum and Natural Gas Processing (5.2%)
- Ethanol Production (4%)
- Petroleum Refining (3.2%)
- Cement/Clinker Production (2.1%)
- All Others (agricultural processing, industrial/institutional heat and power, manufacturing, etc.) (13.4%)

The PCOR Partnership has brought together the key stakeholders to make geologic CO_2 sequestration a viable option for carbon management in our region.

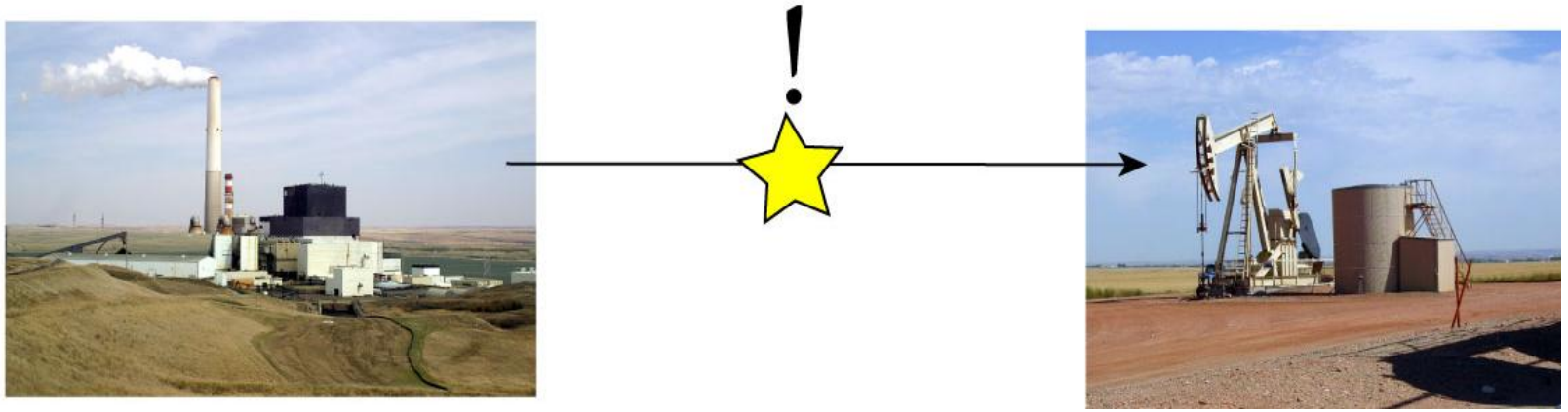
PCOR Phase II Field Validation Tests

We Are Planning Two Phase III Efforts



Williston Basin Phase III – Concept

- Capture approximately 1 Mt/yr of CO_2 at an existing coal-fired power plant in central North Dakota.
- Transport via pipeline to Williston Basin oil field.
- Meet or exceed all of the U.S. Department of Energy Phase III objectives.
- Conduct MMV activities to document integrity of storage.
- Ultimately monetize credits.



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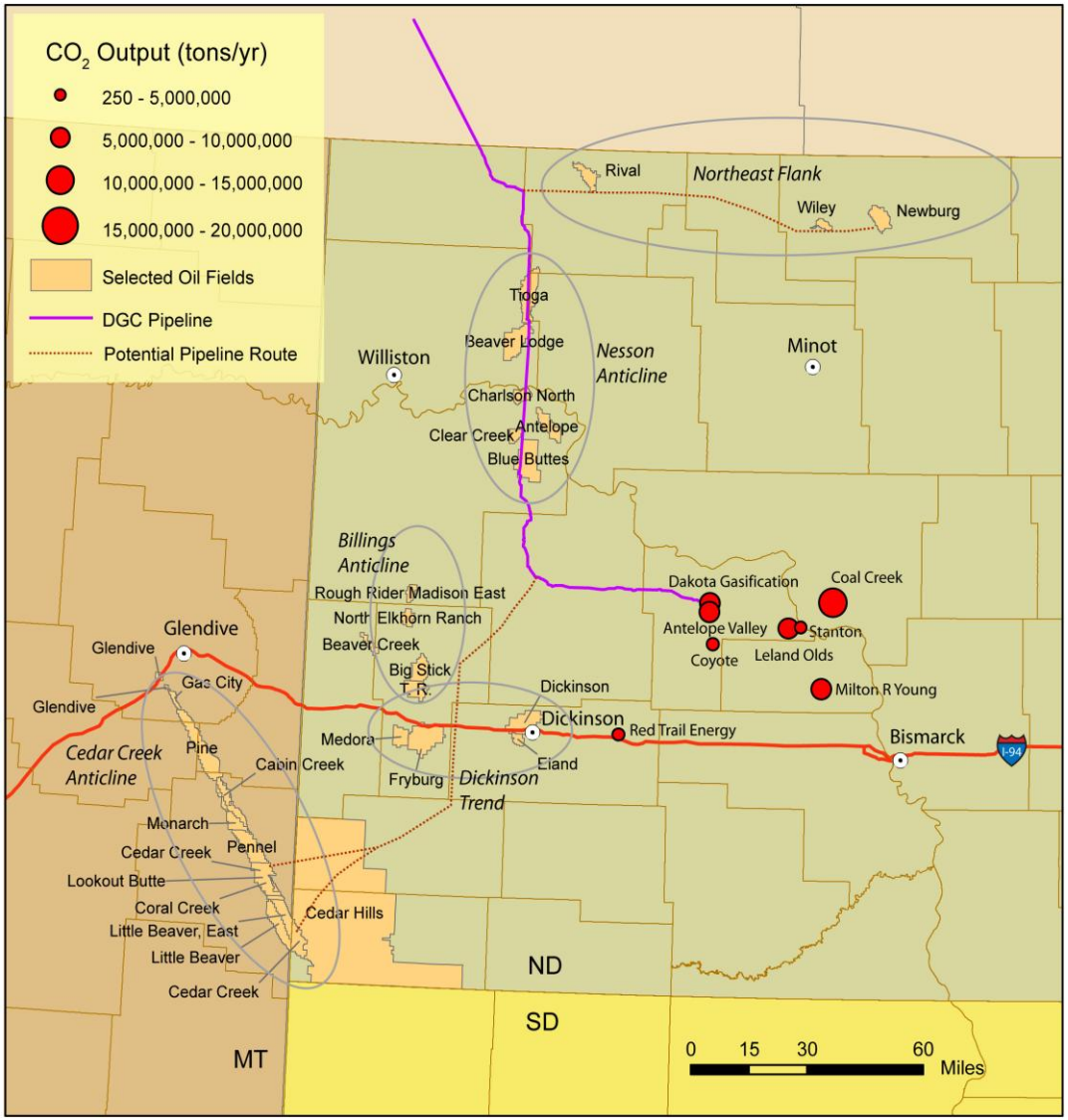
Williston Basin Candidate Oil Fields



Williston Basin CO_2-Based EOR Potential

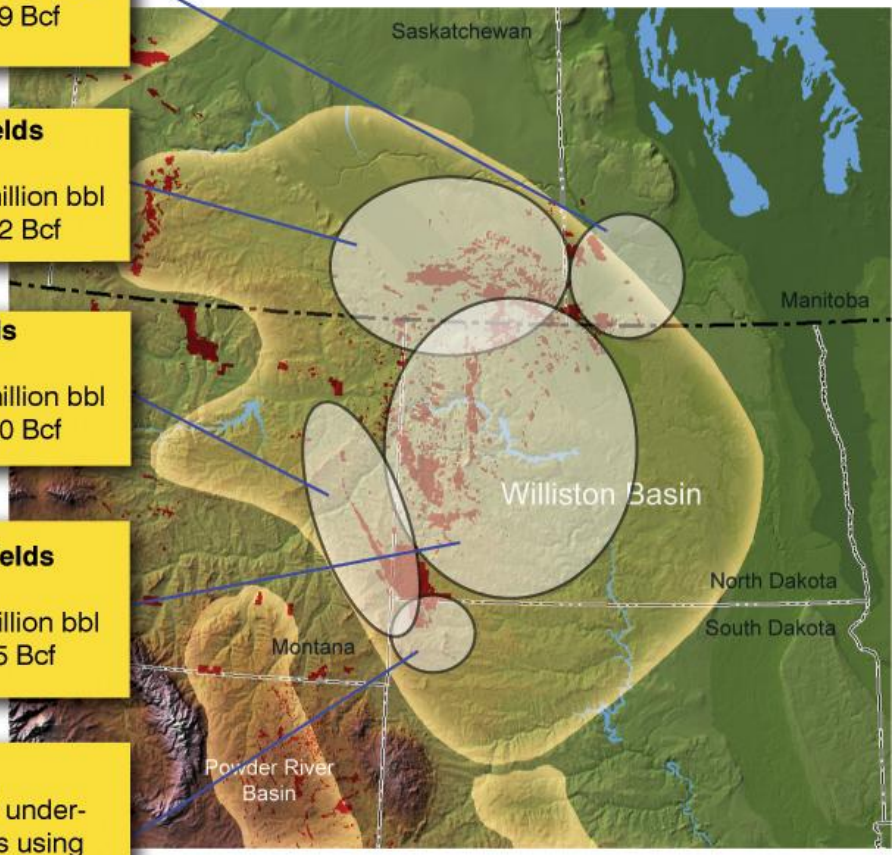
Selected Manitoba Oil Fields
- Three fields
- Potential incremental oil = 39 million bbl
- Total CO_2 needed for EOR = 319 Bcf

Selected Saskatchewan Oil Fields
- 11 fields
- Potential incremental oil = 331 million bbl
- Total CO_2 needed for EOR = 2652 Bcf

Selected Montana Oil Fields
- Ten fields
- Potential incremental oil = 390 million bbl
- Total CO_2 needed for EOR = 3120 Bcf

Selected North Dakota Oil Fields
- 28 fields
- Potential incremental oil = 262 million bbl
- Total CO_2 needed for EOR = 2095 Bcf

Buffalo Field, South Dakota
- Portions of this field are currently undergoing tertiary recovery operations using air injection.
- CO_2-based EOR may be technically feasible.



Public Outreach and Education Results

Consistent, fundamental information on CO_2 sequestration in a variety of readily usable formats

- Five videos (three completed, two in production).
- Over a dozen fact sheets.
- Public Web site with monthly updates.
- 50+ page regional atlas.
- Over 20 technical reports.

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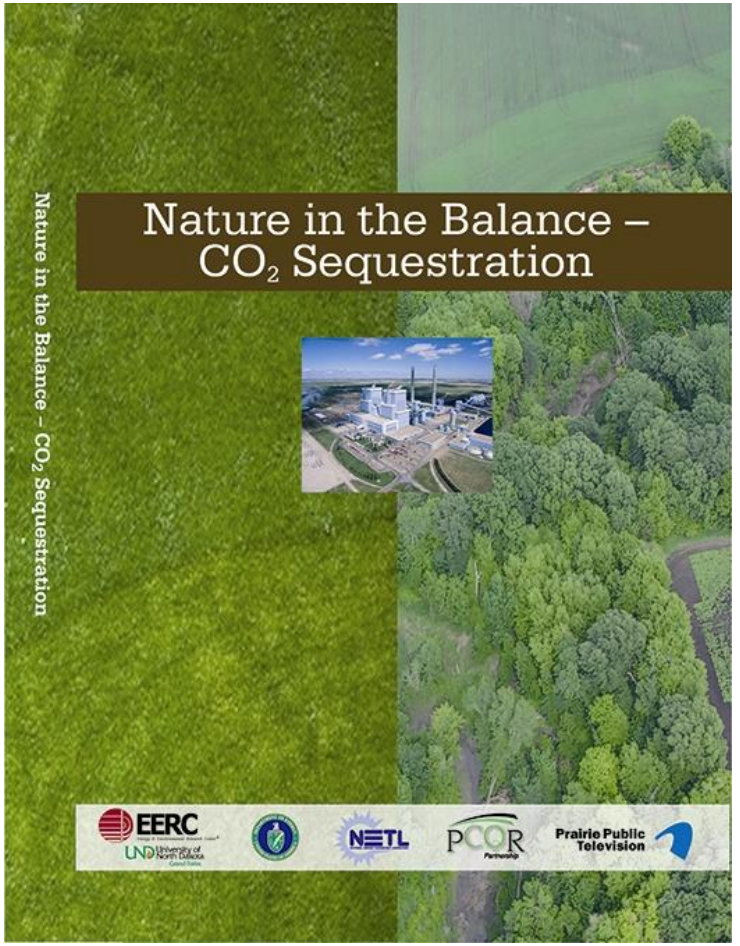
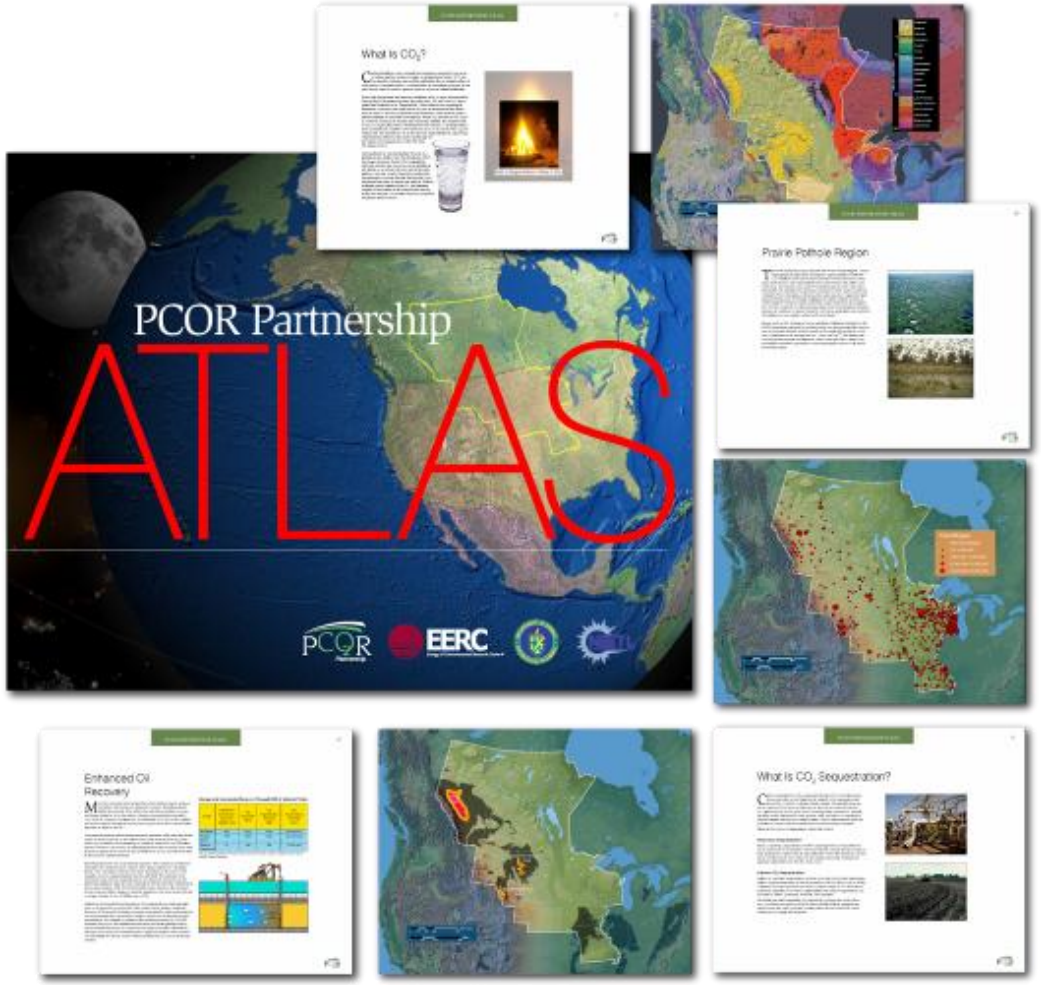
Public Television Documentaries

- Broadcast to households in U.S. and Canadian portions of PCOR Partnership region.
- Viewed by 26,000 of the 520,000 households in the Prairie Public portion of the PCOR region.
- Multiple formats (broadcast, DVD, streaming video on public Web site)
- Available to markets nationwide
- Broadcast in over 100 public television markets nationwide.



PCOR Partnership Regional Atlas



The PCOR Partnership Atlas provides a general overview of CO_2 sequestration. It also provides a graphical summary of major CO_2 sources and sinks in the PCOR Partnership region.

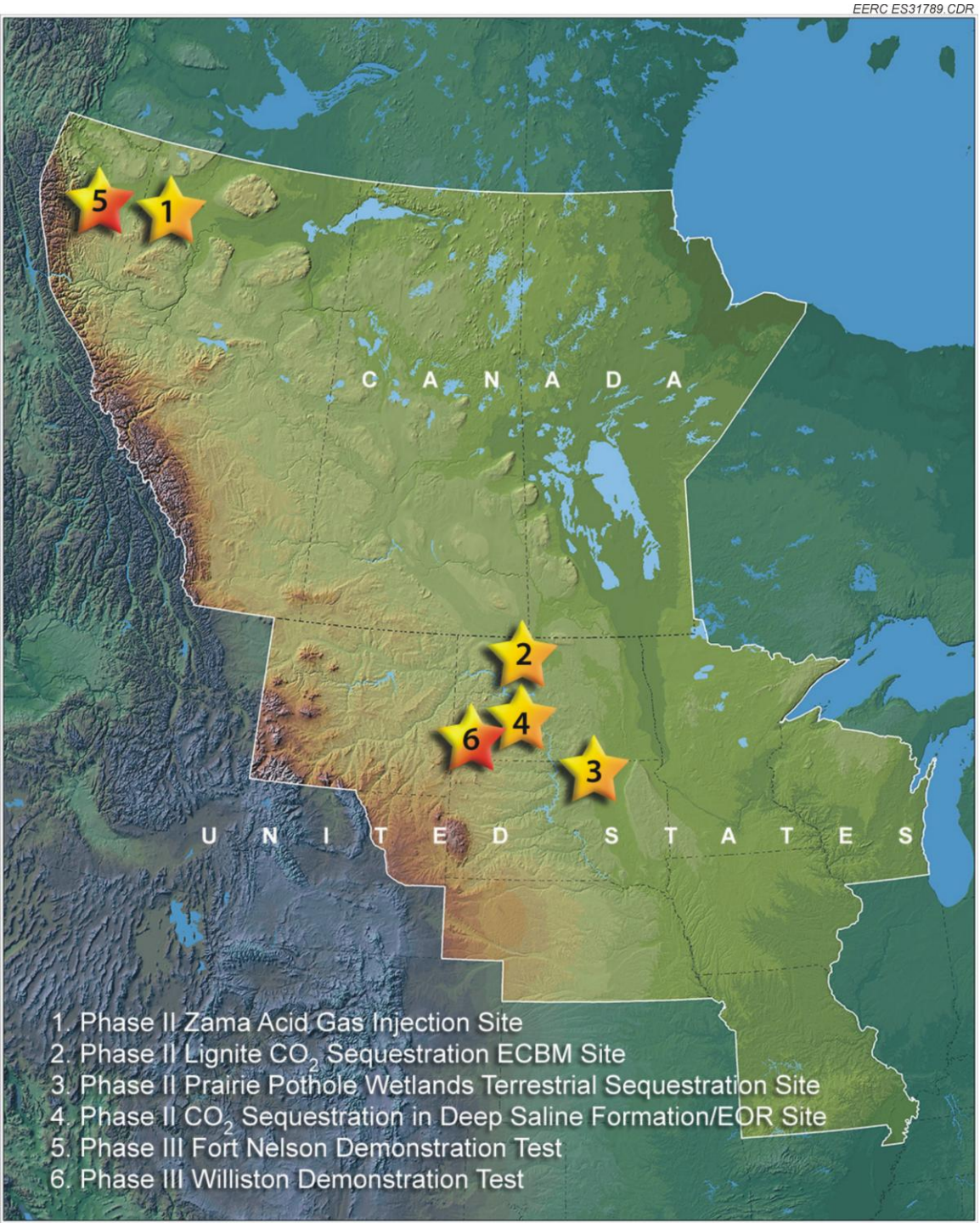
PCOR Partnership

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

NETL NATIONAL ENERGY TECHNOLOGY LABORATORY

EERC Energy & Environmental Research Center

UND University of North Dakota



PCO2R Partnership

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