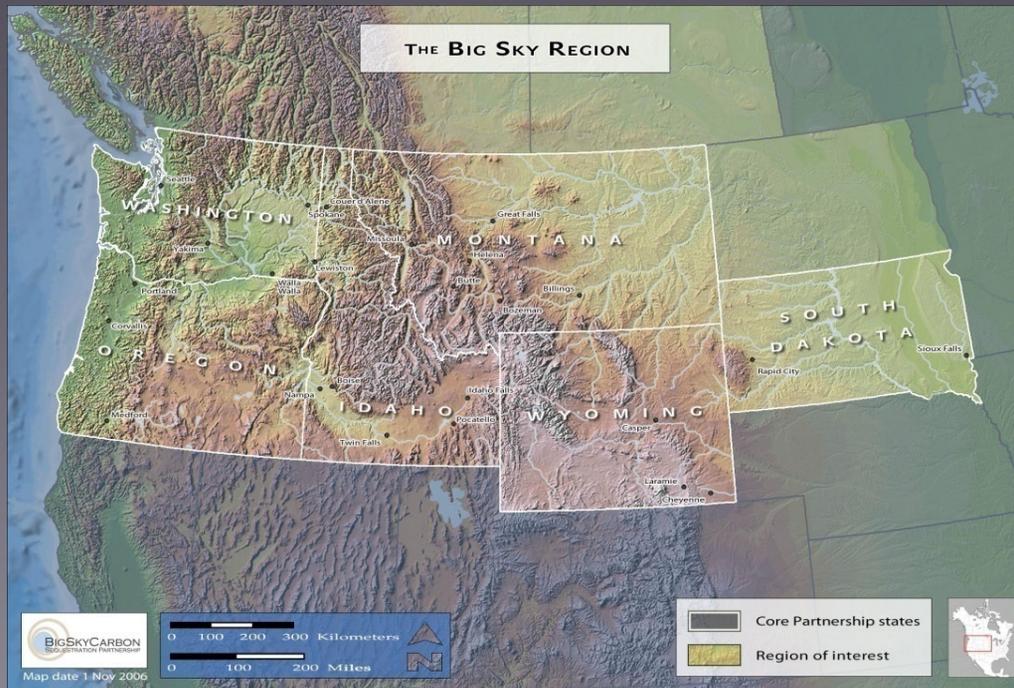


Big Sky Carbon Sequestration Partnership



DOE Annual Conference on CCS
May 7-10, 2007 Pittsburgh, PA
Director: Lee Spangler

Outline

- Overview of Partnership
- Geologic Activities & Pilots
- Terrestrial Pilots
- GIS Activities
- Economic Analyses
- Regulatory
- Public Outreach

Reactive Carbonate Reservoir Field Validation Test

Phase II Geologic Pilots

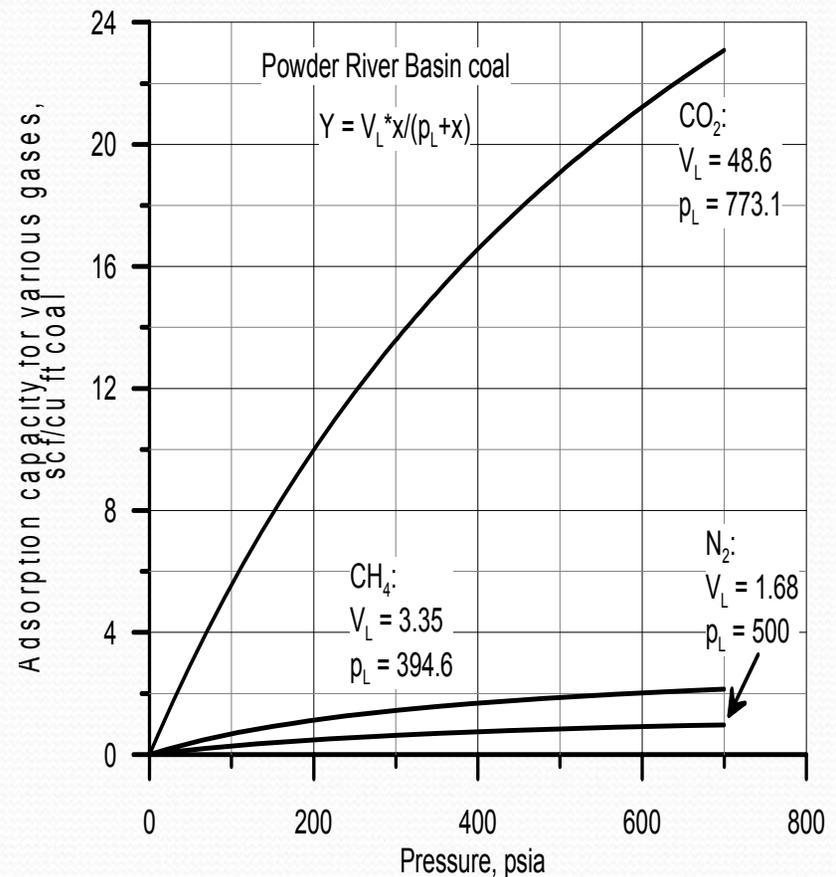
- Madison Formation: EOR operation for >20 years
- Objectives:
 - determine the material balance of injected CO₂
 - Conduct a geologic structural analysis to provide the foundation for a Phase III demonstration to evaluate MMV at commercial scale site



ECBM and CO₂ Sequestration

Phase II Geologic Pilots

- Big Sky region: Coal resources could be utilized to recover methane and sequester CO₂
- Objectives: Understand and demonstrate
 - Injecting a pure CO₂ into a coal seam
 - Coal swelling effects on permeability changes
- For Phase II: Develop Design Plan



Proposed Wyoming Field Validation Test

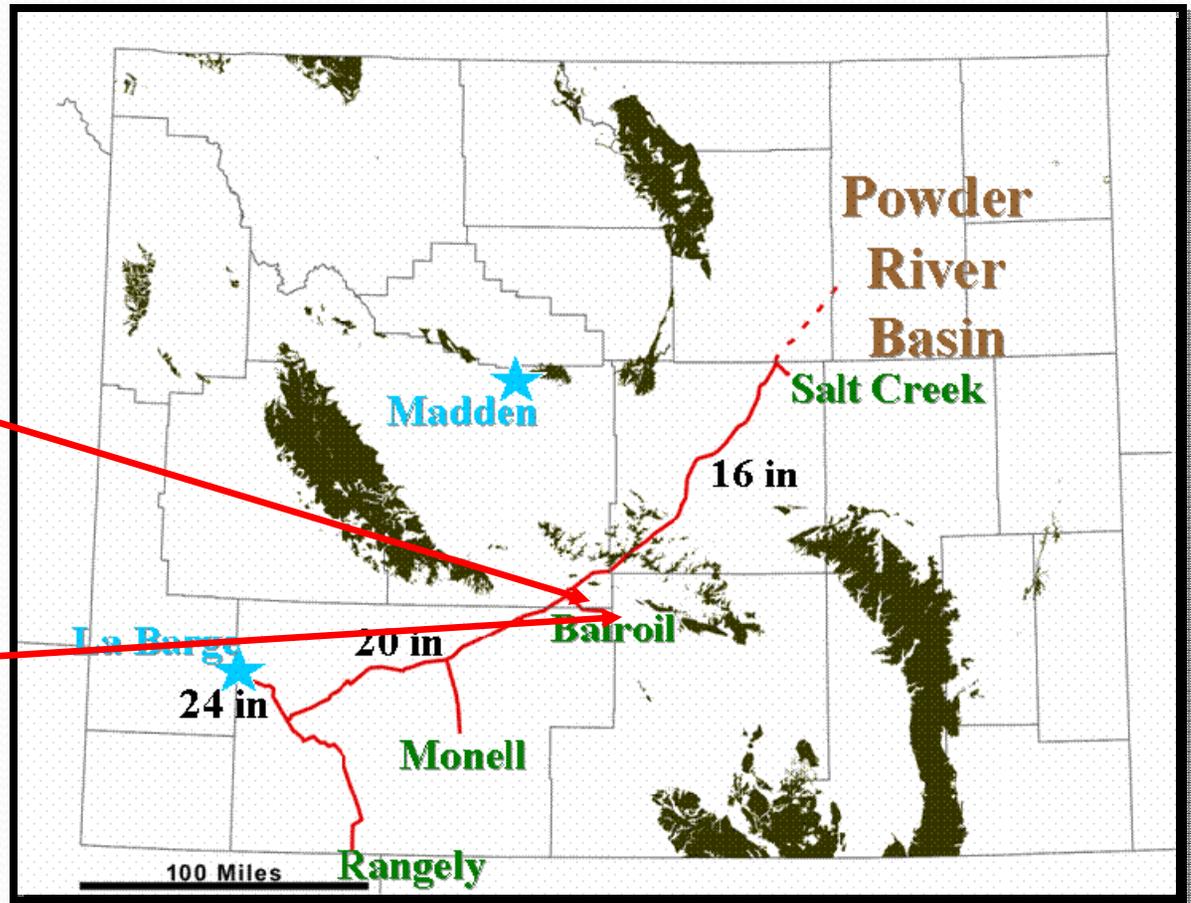
Phase II Geologic Pilots and Activities

- Objective: Assess the viability and capacity of deep saline formation as a large-scale sequestration option
 - Inject 3000 tons of super critical CO₂ into the target
- Technical objectives
 - Evaluate local and adjacent reservoir response to injection of super critical CO₂
 - Track the migration and containment of the CO₂ and compare to modeling
 - Evaluate the rate of CO₂ sequestration and compare to laboratory predictions

Wyoming Phase II Pilot Location

Baroil
Madison LS
and Tensleep SS
25 year EOR

Mahoney Dome
Madison LS
and Tensleep SS
Pristine saline aquifer



Wyoming Phase II Pilot Location

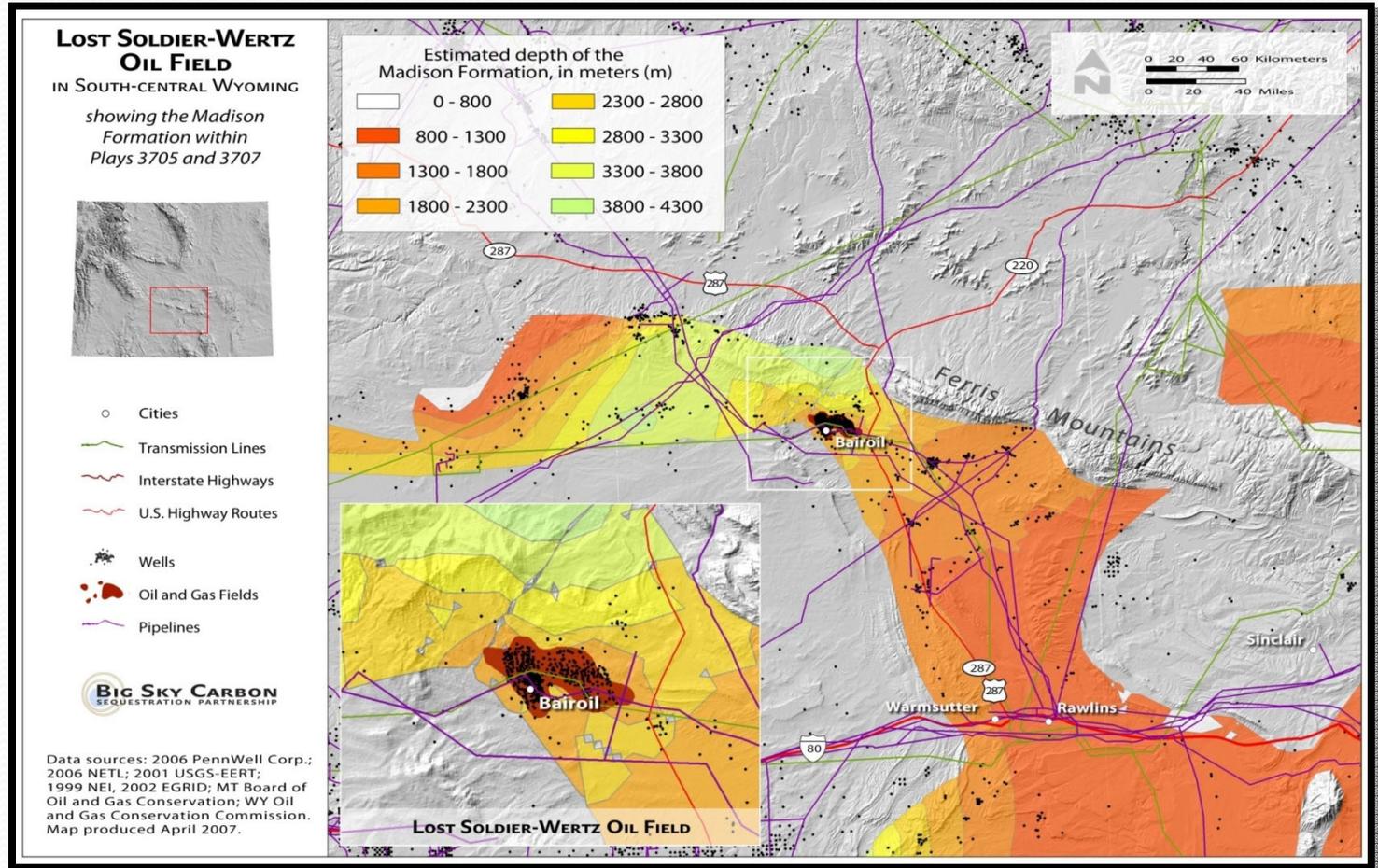
- Southern Wyoming

- Series of small anticlinal structures

- Producing Oil Fields

- Tensleep – well characterized sandstone

- Phosphoria Shale Seal

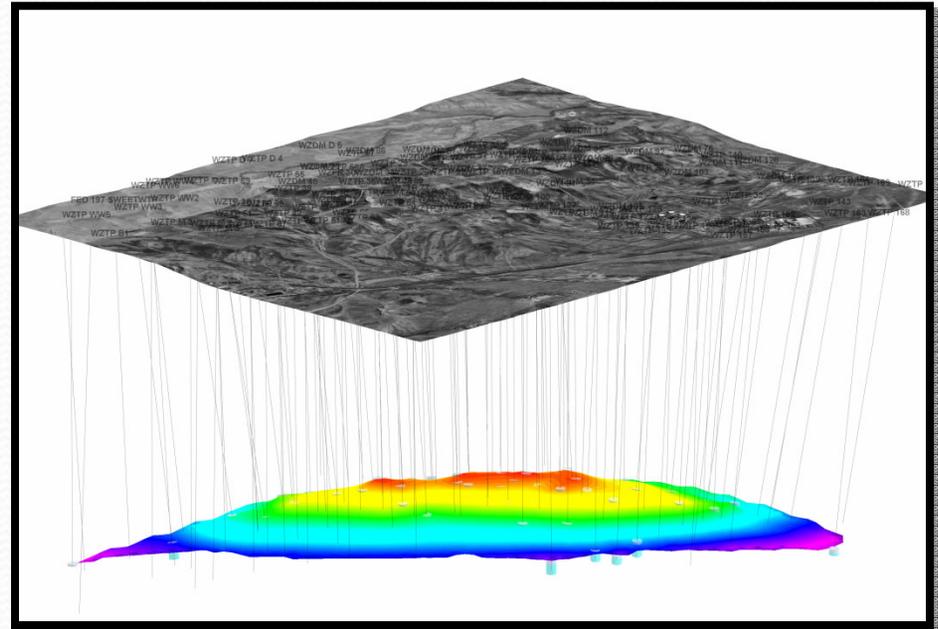


Wyoming Phase II Pilot Infrastructure

- **Source of CO₂** – CO₂ will come from existing operations at the LaBarge plant and delivered through an existing 12-inch pipeline

- **Wells** – The Wertz Field has 67 producing wells, and 72 injection wells on 10 ac spacing, and 24 shut-in wells

- **Pipelines** – The existing pipeline is sufficient for the planned activities of Phase III

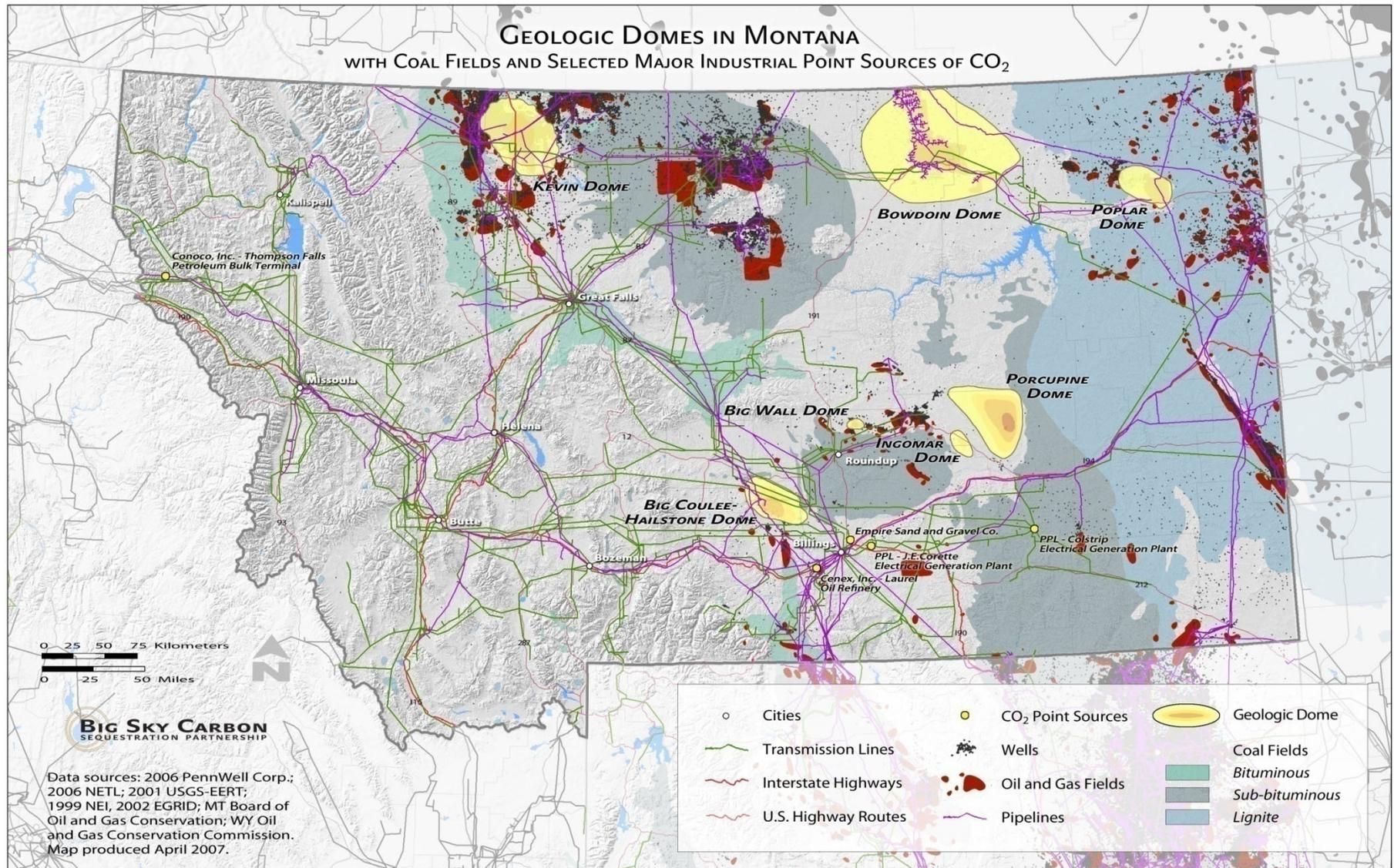


Proposed Montana Field Validation Test

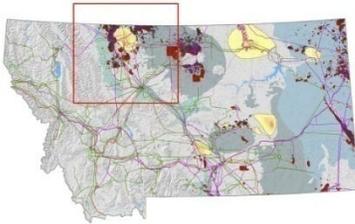
Phase II Geologic Pilots and Activities

- Objective: Assess the viability and capacity of a deep saline formation located within a geologic dome as a large-scale geologic sequestration and storage option
 - Inject 100-150 tons super critical CO₂ into target and evaluate the efficacy of EOR using produced and stored CO₂ from the dome.
 - Characterize Kevin Dome's potential as a temporary storage site for CO
- Technical objectives:
 - Detailed subsurface geological characterization
 - Determine volume of natural CO₂ in dome and potential volume for CO₂ seq.
 - Regionally characterize other large-scale domes
 - Evaluate the potential for expanded EOR efforts

Kevin Dome Location



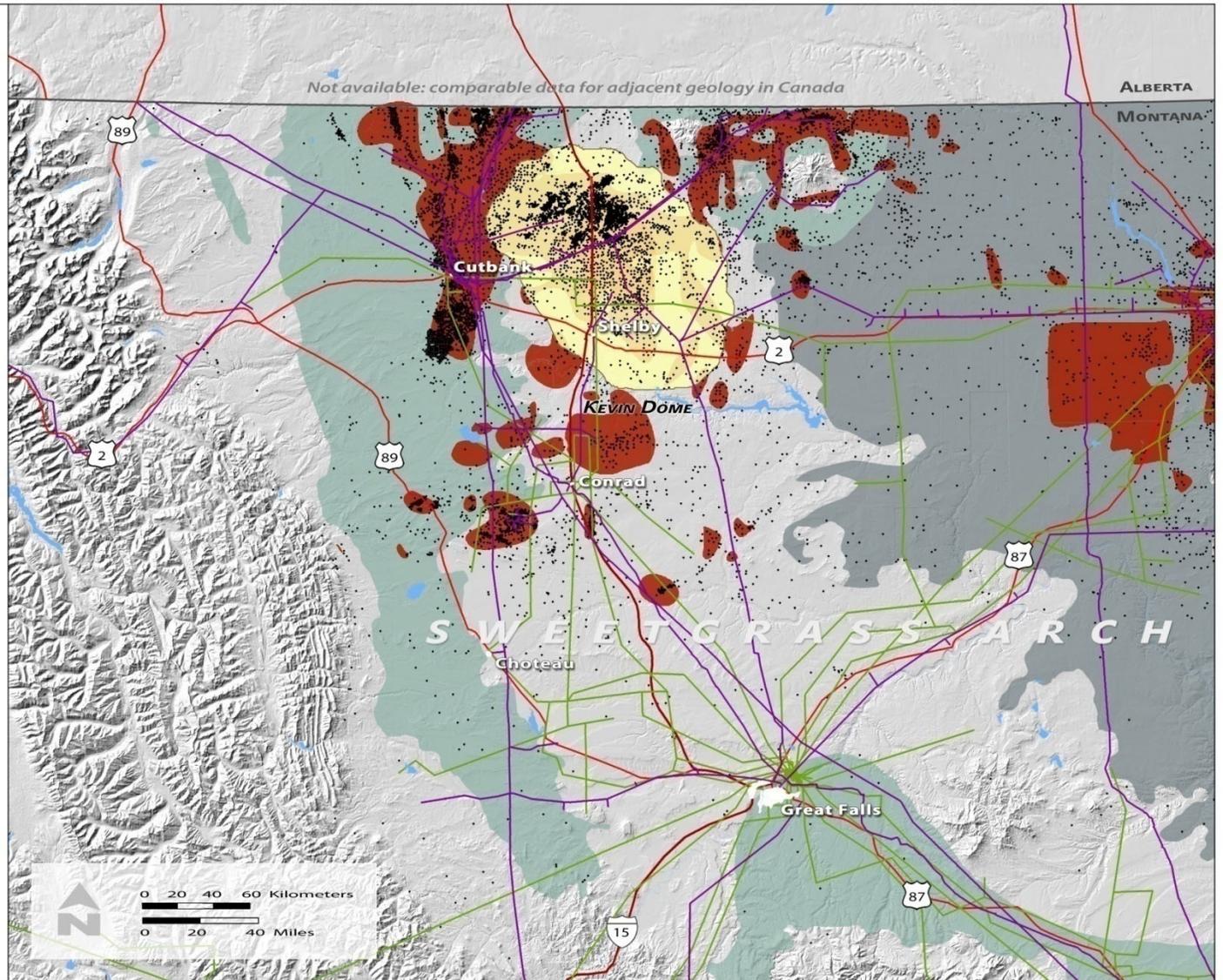
KEVIN GEOLOGIC DOME IN NORTH-CENTRAL MONTANA



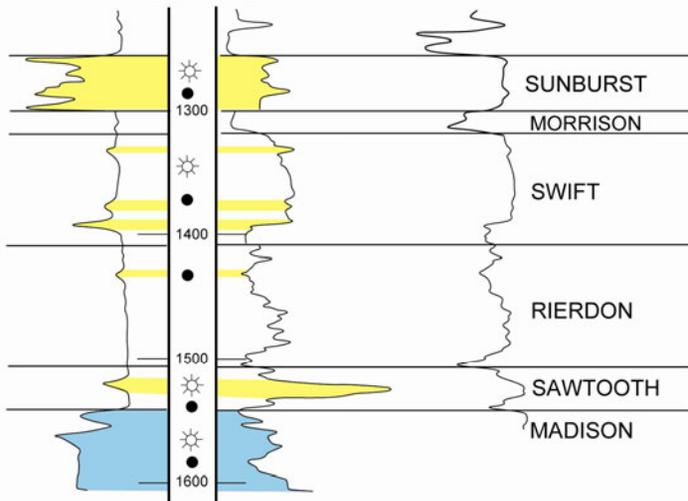
-  Urbanized Areas
-  Transmission Lines
-  Interstate Highways
-  U.S. Highway Routes
-  Wells
-  Oil and Gas Fields
-  Pipelines
-  Geologic Dome
-  Coal Fields
-  Bituminous
-  Sub-bituminous



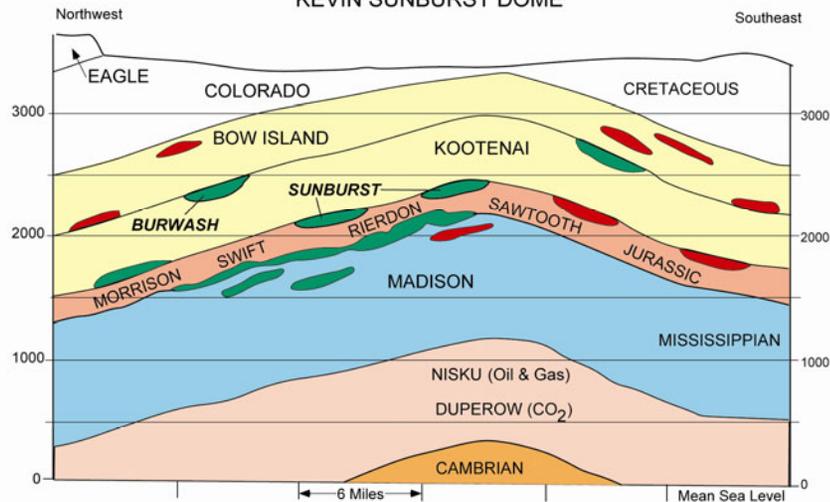
Data sources: 2006 PennWell Corp.;
2006 NETL; 2001 USGS-EERT;
1999 NEI, 2002 EGRID; MT Board of
Oil and Gas Conservation; WY Oil
and Gas Conservation Commission.
Map produced April 2007.



TYPICAL LOG KEVIN-SUNBURST FIELD



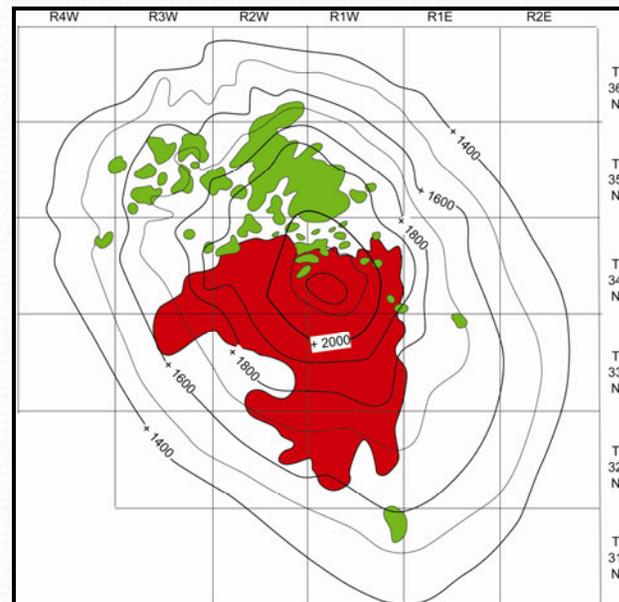
DIAGRAMMATIC CROSS SECTION KEVIN SUNBURST DOME



Typical log, Kevin-Sunburst Field and diagrammatic cross-section. Shows both the Karst-related (Madison) distribution of sandstone reservoirs and development of channel-related (Cretaceous) sandstone horizons (from Montana Geological Society, 1985).

Kevin Dome

- Inject in Duperow (dolomite) off flank of dome
- Inject below CO₂- water contact
- Safe place to study relatively large dips
- Allows simultaneous study of natural analog



KEVIN - SUNBURST DOME

Toole County, Montana
STRUCTURE CONTOURS ON
MADISON LIMESTONE
C.I. = 100 FT

■ OIL PRODUCING AREA
■ GAS PRODUCING AREA

Kevin-Sunburst Dome (after Montana Geological Society, 1985).

Proposed Basalt Hosted Saline Aquifer Characterization Test

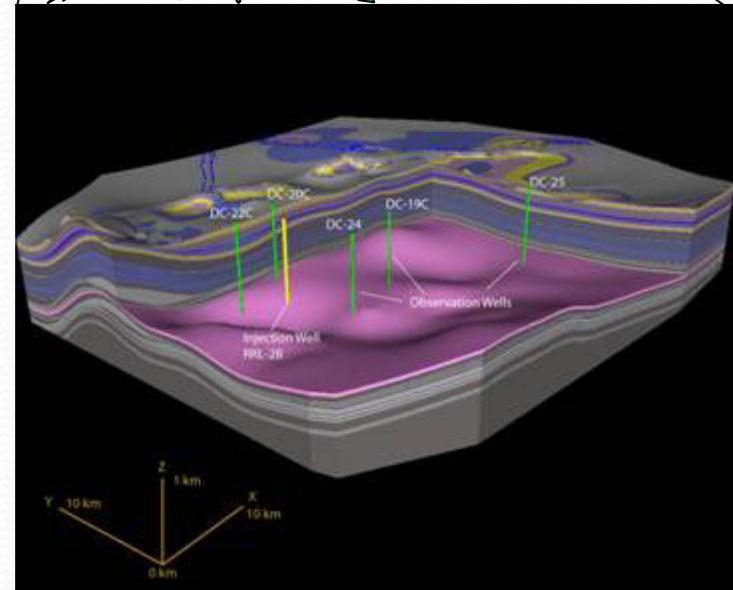
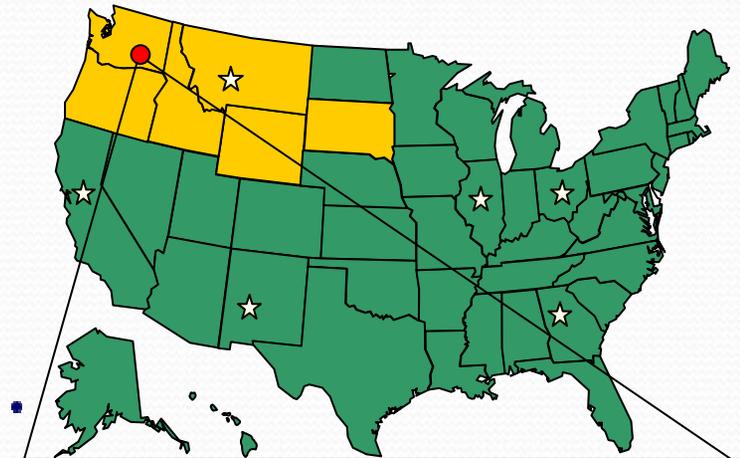
Phase II Geologic Pilots and Activities

- Objectives:
 - Determine capacity, injectivity and mineralization rates in deep basalts in a field setting
 - Address technical issues of injection and fate and transport of CO₂ in interflow zones in a deep basalt formation
 - Engage industry partners to provide sufficient financial resources
 - Participate in public outreach activities



Basalt Pilot

- Up to 1000 MT of CO₂ transported by rail from refinery
- Utilize existing deep well infrastructure to minimize drilling costs for injection and monitoring
- Target is Grande Ronde basalt formation (1100 m depth)
- Post injection core sampling to verify mineralization reactions
- Validate supercomputer simulations of CO₂ dispersion, dissolution, and trapping in basalt using suite of geophysical, hydrologic, and tracer methods



Cropland Field Validation Test

Phase II Terrestrial Pilots and Activities

- **Objectives**

- Quantify and determine management practices to optimize C sequestration
- Develop MMV protocols

- **Sub-tasks**

- Soil Sampling and calibration
- MMV
- Planning Handbook



Rangeland Sequestration Potential Assessment

Phase II Terrestrial Pilots and Activities

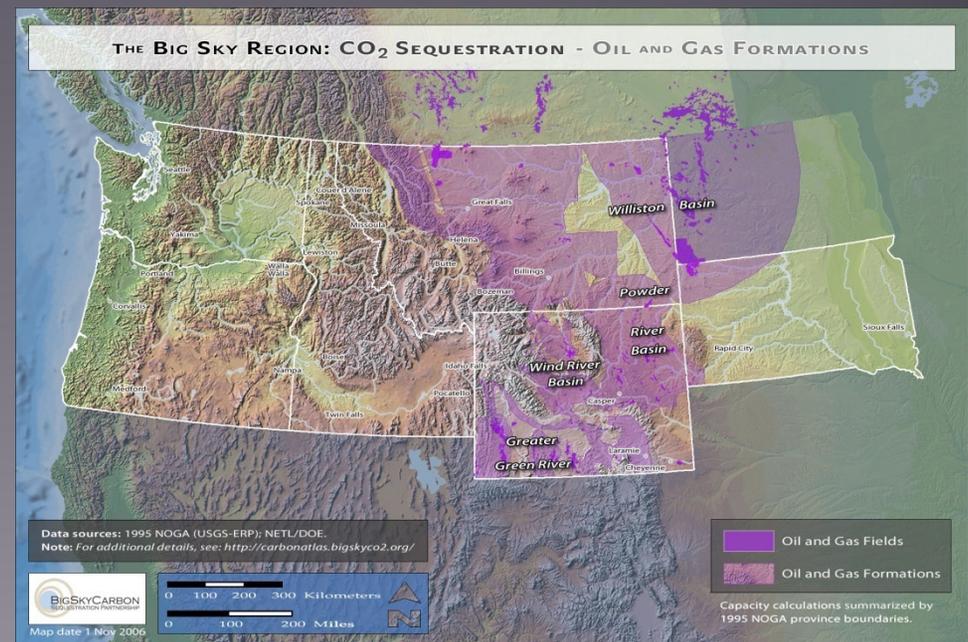
- **Objectives**
 - Quantify C sequestration potential
 - Determine Best Management Practices
- **Sub-tasks**
 - Baseline and calibration
 - MMV
 - GIS Integration
 - Rangeland BMP Handbook



Geographic Information Systems

Phase II Pilots and Activities

- Big Sky Knowledge Base
 - Big Sky Carbon Atlas
 - Big Sky Data Library
- National Mafic Rock Atlas
- GIS coordination with others regional and nationally
- GIS links with Education and Outreach



Economic Analysis

Phase II Pilots and Activities

- Economic Model Framework for geologic sequestration
- Economic Analysis of geologic sequestration potential for geologic systems
- Economic Model Framework and Analysis for terrestrial sequestration
- Large scale deployment report
- Assess feasibility of a cross-partnership Economic Analysis Initiative

Carbon Market Explorations

Phase II Pilots and Activities

- **Development of Carbon Market Portfolios**
 - Work with landowners
 - Collaborate with The Sampson Group
 - Create contracting documents and work w/potential buyers
 - Summarize Best Management Practices
- **C-Lock and Terrestrial Carbon Credits**
 - Goal: reduce overall transaction costs for C trades
 - Compare results with other C-based models: COMET, and Century for assessment of C sinks

Public Outreach

- Big Sky Energy Future Coalition
- Annual Big Sky Energy Forum
- Big Sky Annual Energy Report
- State Legislative C Sequestration Symposium
- Web site and materials
- Local, regional, national and international recognition
- National Outreach Working Group



Regulatory Compliance

- Regulatory and Public Involvement Action Plan
- Regulatory Permitting Guidelines
- Prepare and file regulatory permits required for field tests

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