The Big Sky Carbon Sequestration Partnership

Energy and Telecommunications Interim Committee Meeting

July 29, 2010

John Talbott, Deputy Director
BSCSP
Montana State University

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Regional Carbon Sequestration Partnerships

"Developing the Infrastructure for Wide Scale Deployment"

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WEST COAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP westcarb.org

43 States, 4 Canadian Provinces over 350 organizations including NGOs

The Big Sky Carbon Sequestration Partnership
What We Do

- **Regional Geologic Characterization**
- **Outreach**
  - General Public
  - NGOs, Environmental Groups
  - Decision Makers, Legislative Bodies
- **Pilot , Demonstration, and Commercial Projects**
  - Site Characterization
  - Three - Dimensional model development
  - Flow modeling
  - Monitoring
  - Risk Assessment
- **Policy and Regulatory Guidance**
- **Contribute to Best Practices Documents**
- **Provide an "Expert Network" on CCS**

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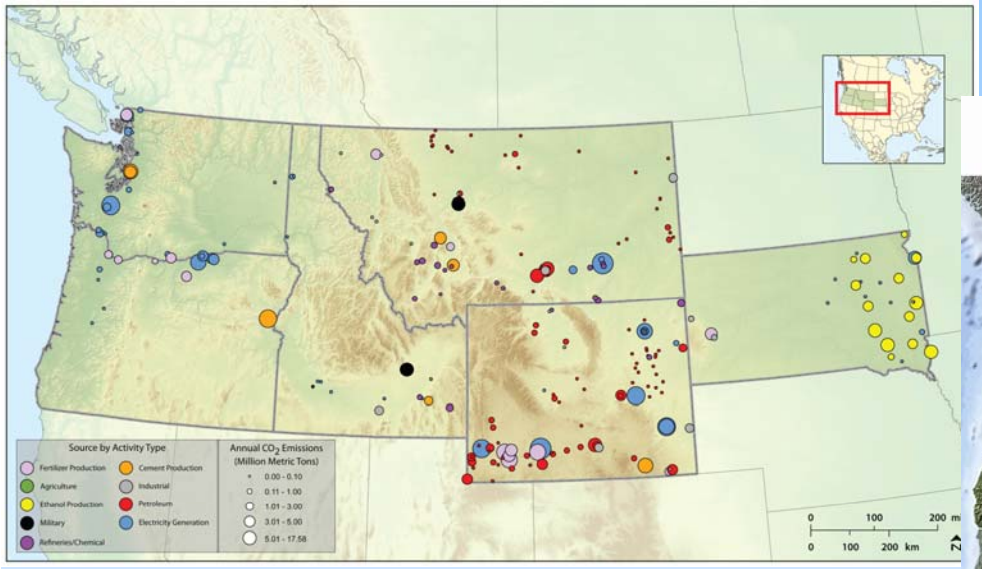
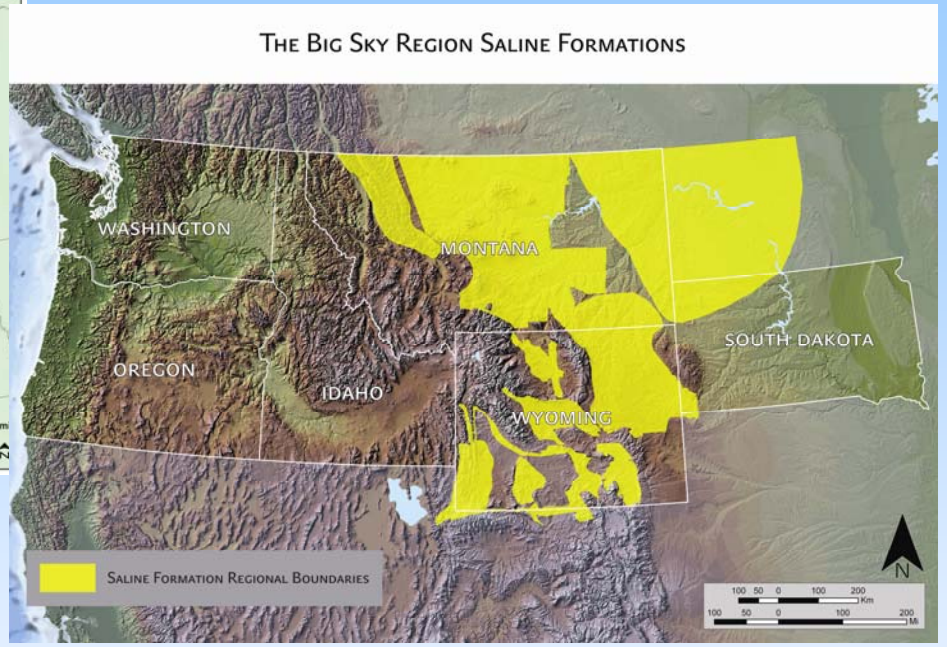
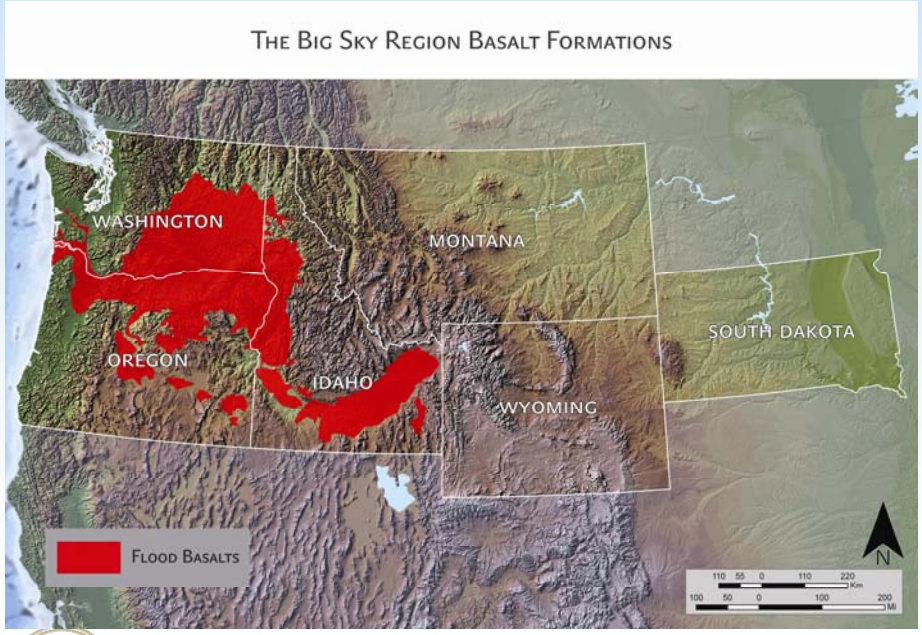
Phase I
Regional Characterization Studies

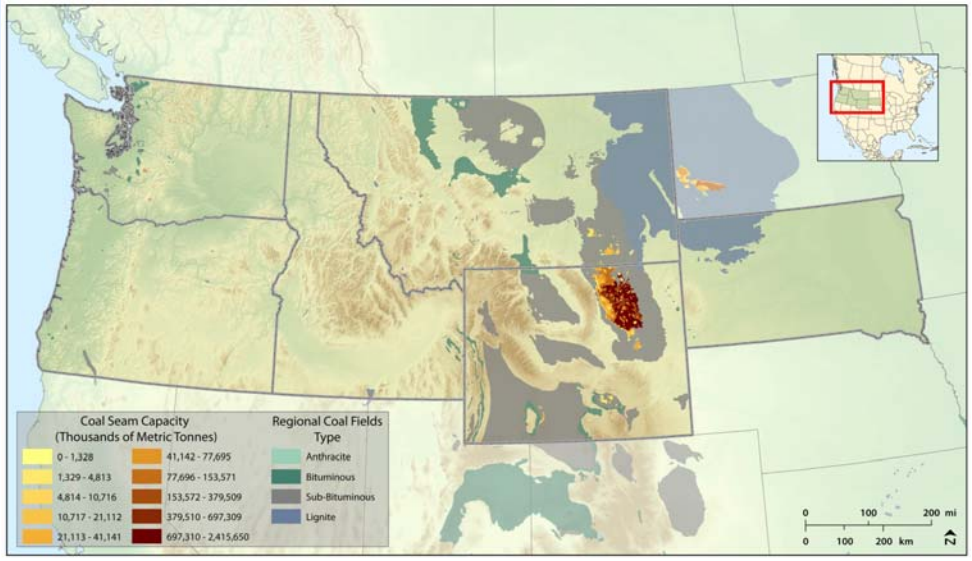
- Identification and Quantification of Stationary Sources of CO2 Emissions
- Identification and Quantification of Potential Sinks for CO2 Storage
  - Terrestrial
    - Forestry, Cropping, Tillage, and Rangelands
  - Geologic
    - Depleted Oil and Gas Reservoirs
    - Unmineable Coal Seams
    - Saline Aquifers (including Basalts)

Phase I Regional Characterization Studies







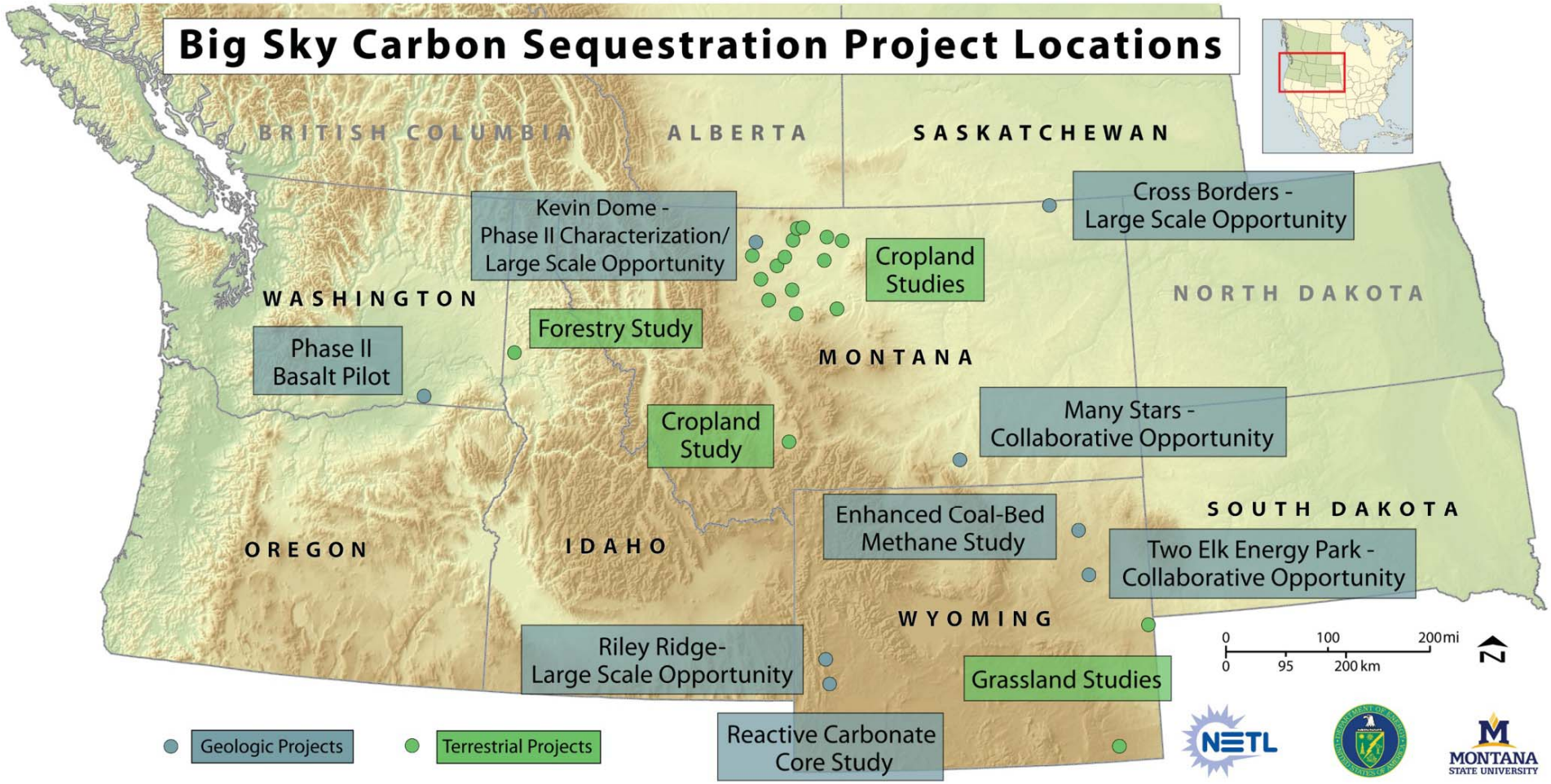


Big Sky Carbon
Sequestration Partnership

Phase II Pilot Phase

- **Regional Characterization**
  - Additional Characterization of geologic sinks
  - Analysis of MVA for Terrestrial Sequestration
- **Pilot Scale Sink Evaluation**
  - Core Studies of Regionally Extensive Sinks
    - Madison Formation
    - Duperow Formation (Kevin Dome)
  - Small Volume Injection in Basalts
  - ECBM analysis
- **Public Outreach and Education**
- **Regulatory Guidance**
- **Economic Analysis**

Phase II, III and Commercial Project Locations



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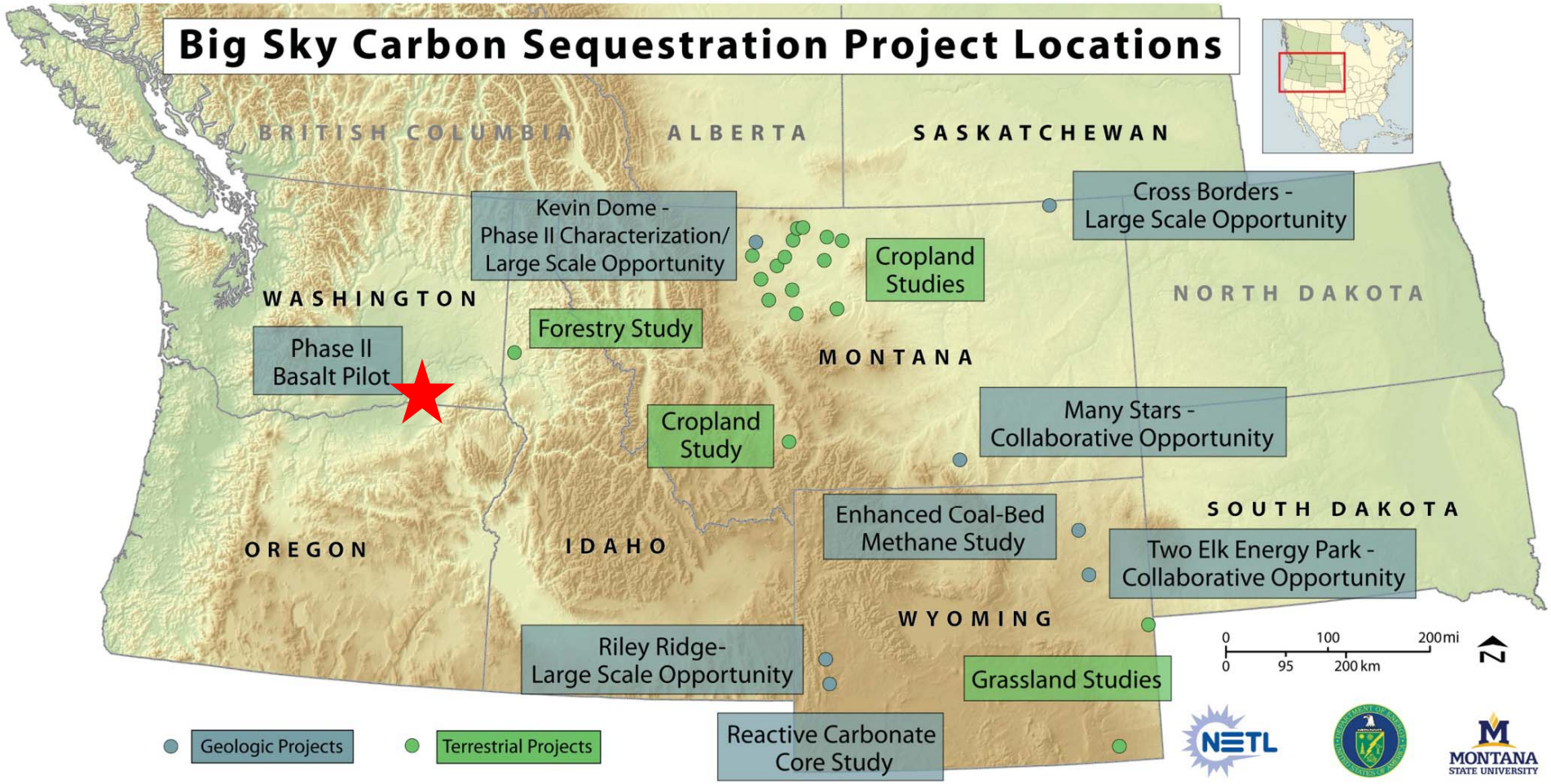
Project Locations



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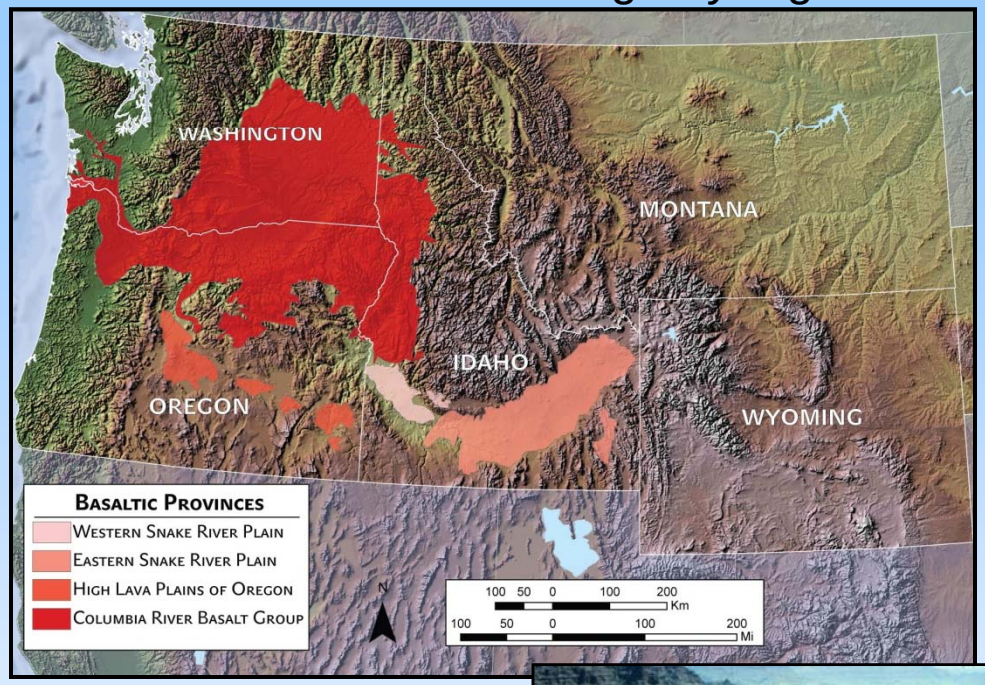
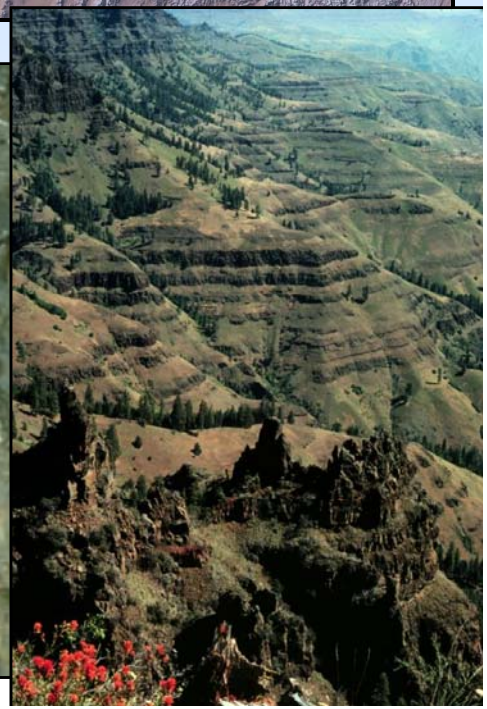
Project Overview

- **Goal:** Demonstrate and validate safe, permanent storage of CO_2 in reactive mafic basalts of the Columbia River Basalt Group
- **Objectives:** Conduct a small scale CO_2 sequestration project in deep basalts of southeastern Washington
- **Efforts include:** modeling, site characterization activities and public outreach to be followed by injection of 1000 tons of CO_2

Basaltic Provinces in the Big Sky region





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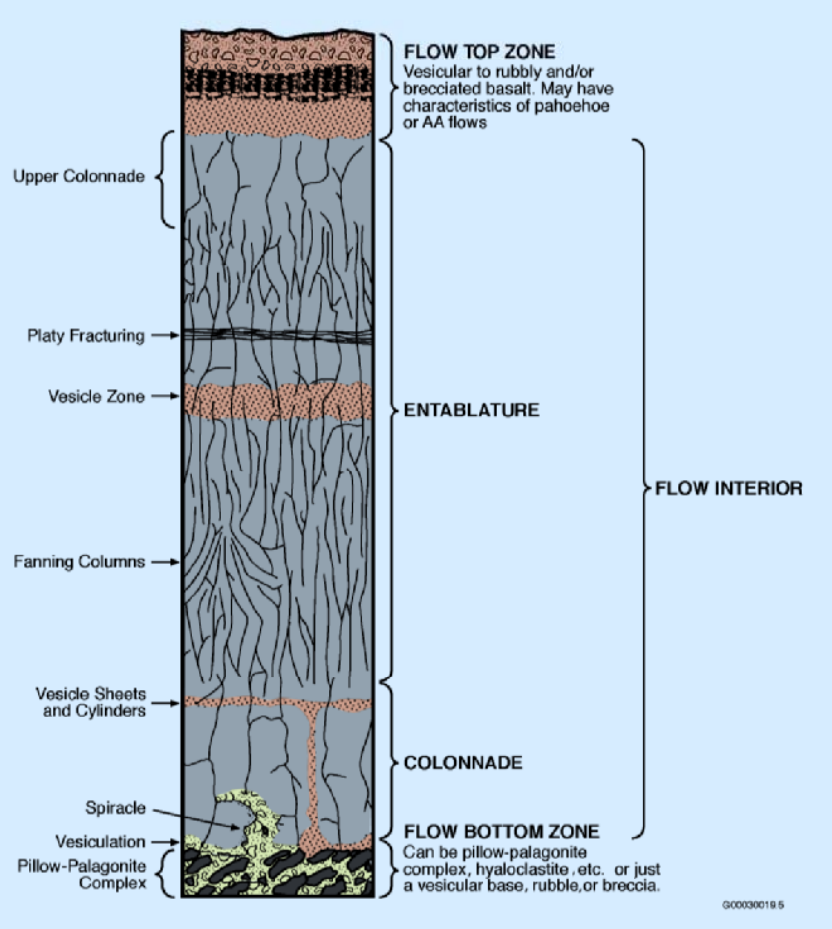
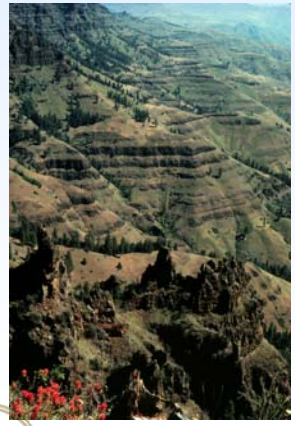
Flood Basalt Features Relevant to CO_2 Sequestration

- Formation process
  - Giant volcanic eruptions
    - Low viscosity lava
    - Large plateaus
  - Multiple layers
- Primary structures
  - Thick impermeable seals
    - Caprock (flow interior)
    - Regional extensive interbeds
  - Permeable vesicular and brecciated interflow zones
    - Injection targets
    - 15-20% of average flow

Layered Basalt Flow





Flowtop Breccia

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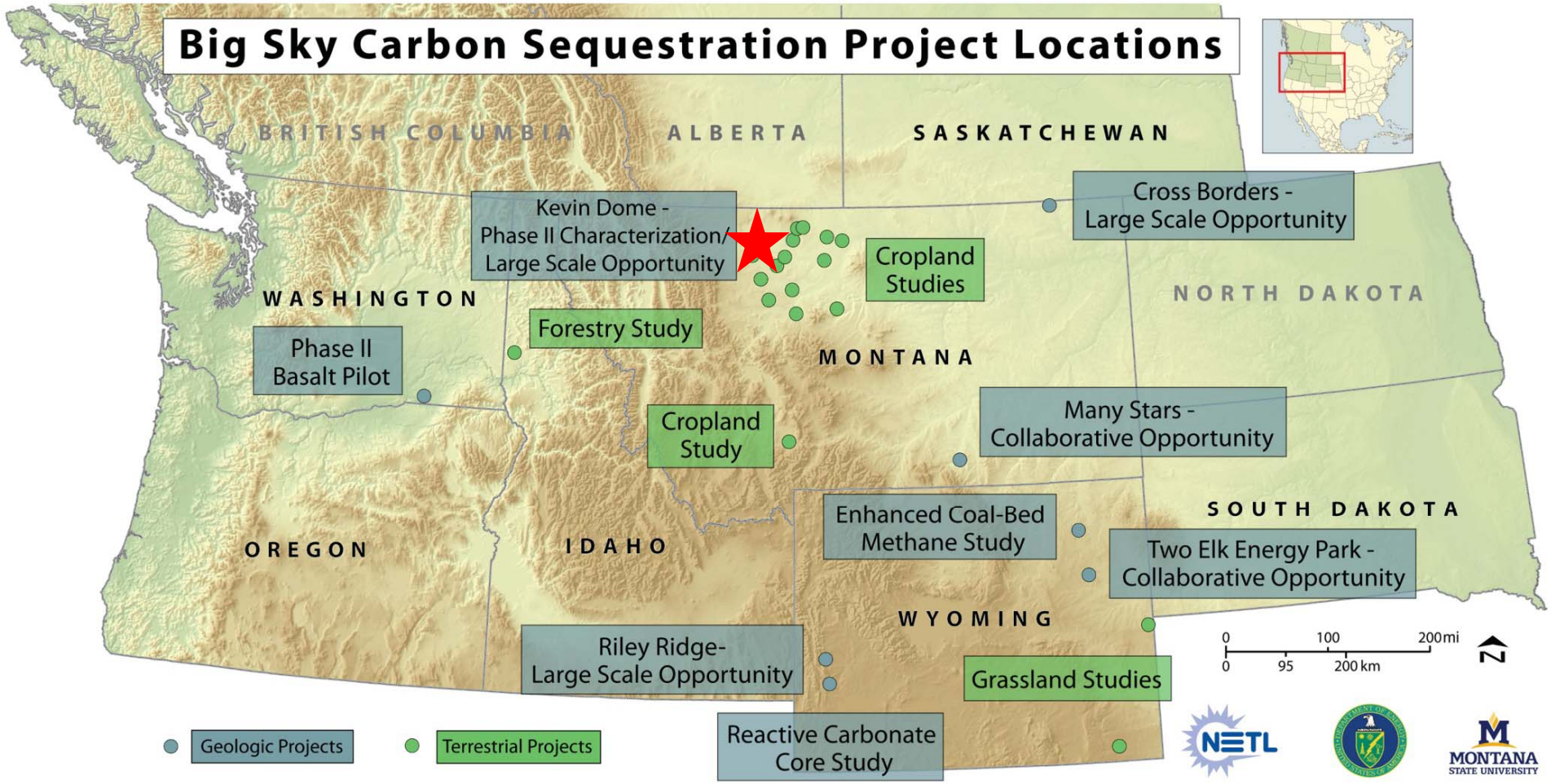

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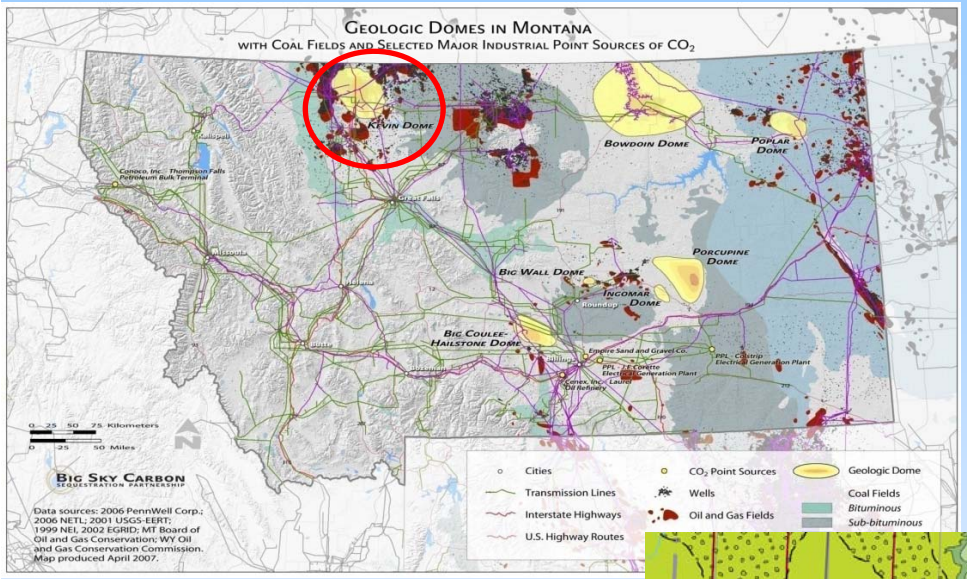
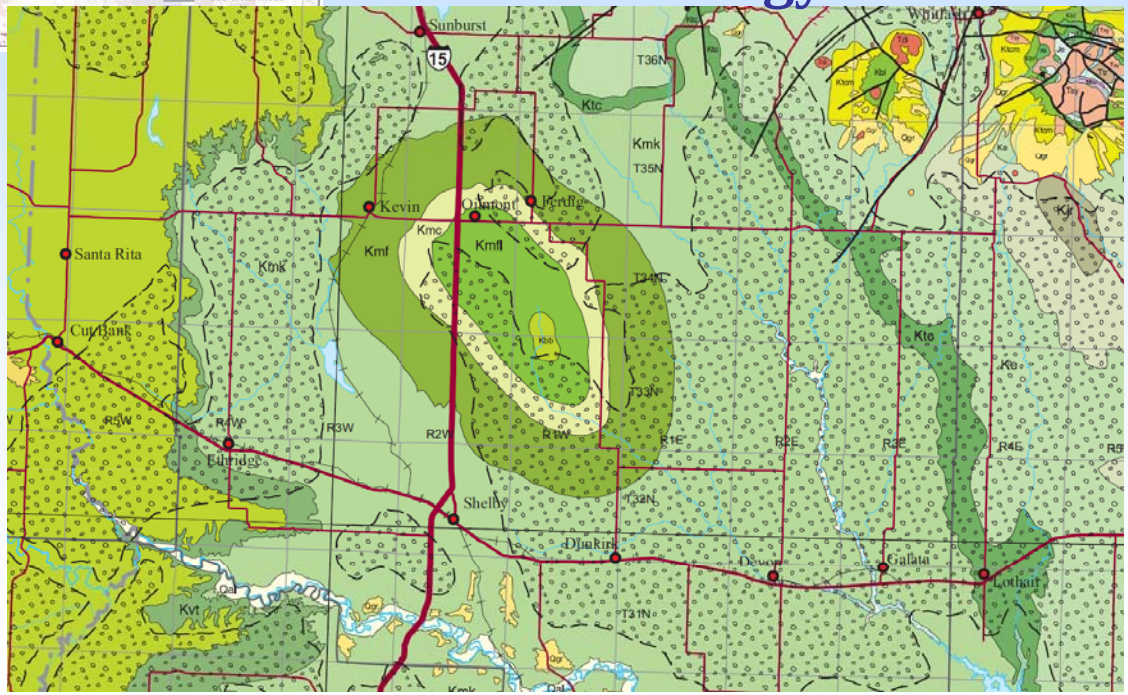
Kevin Dome Characterization Project



- **Naturally occurring CO_2 reservoir.**
- **Possible "buffer" storage for EOR.**
- **Possible location for additional storage.**

Surface Geology – Kevin Dome



(modified from MBMG, 2007)

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DOE Phase III Requirements

- Site characterization
  - Potential for commercial use
  - Deep saline reservoir strongly preferred
- Public outreach
- Baseline monitoring
- Injection of at least 1 MM Tonnes over 4 yrs
  - Second project may influence amounts
  - Anthropogenic source of CO_2 preferred
- Monitoring
- Reservoir flow modeling (predict CO_2 behavior)
- Post-injection monitoring 2-3 yrs
- Site abandonment, transfer

Large Scale Test

Requirements for Storage

Regulatory Compliance

Capacity

Formation thickness

Areal extent

Porosity

Compartment size

Water Quality

Injectivity

Permeability

Compartment size

Geochemistry

Mechanical properties

Storage Security

Seal impermeability

Seal continuity

Seal thickness

Geochemistry

Mechanical Properties

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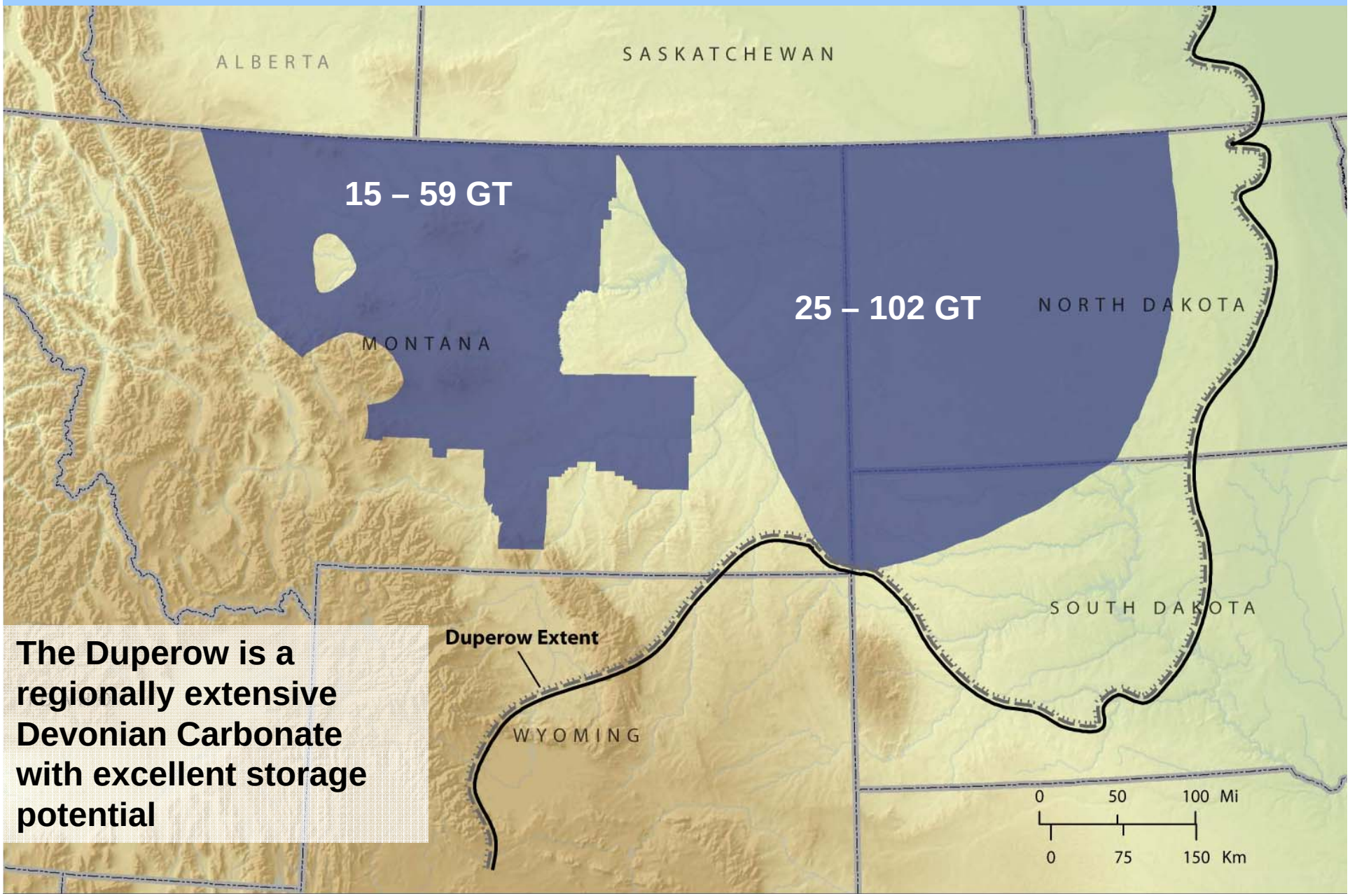
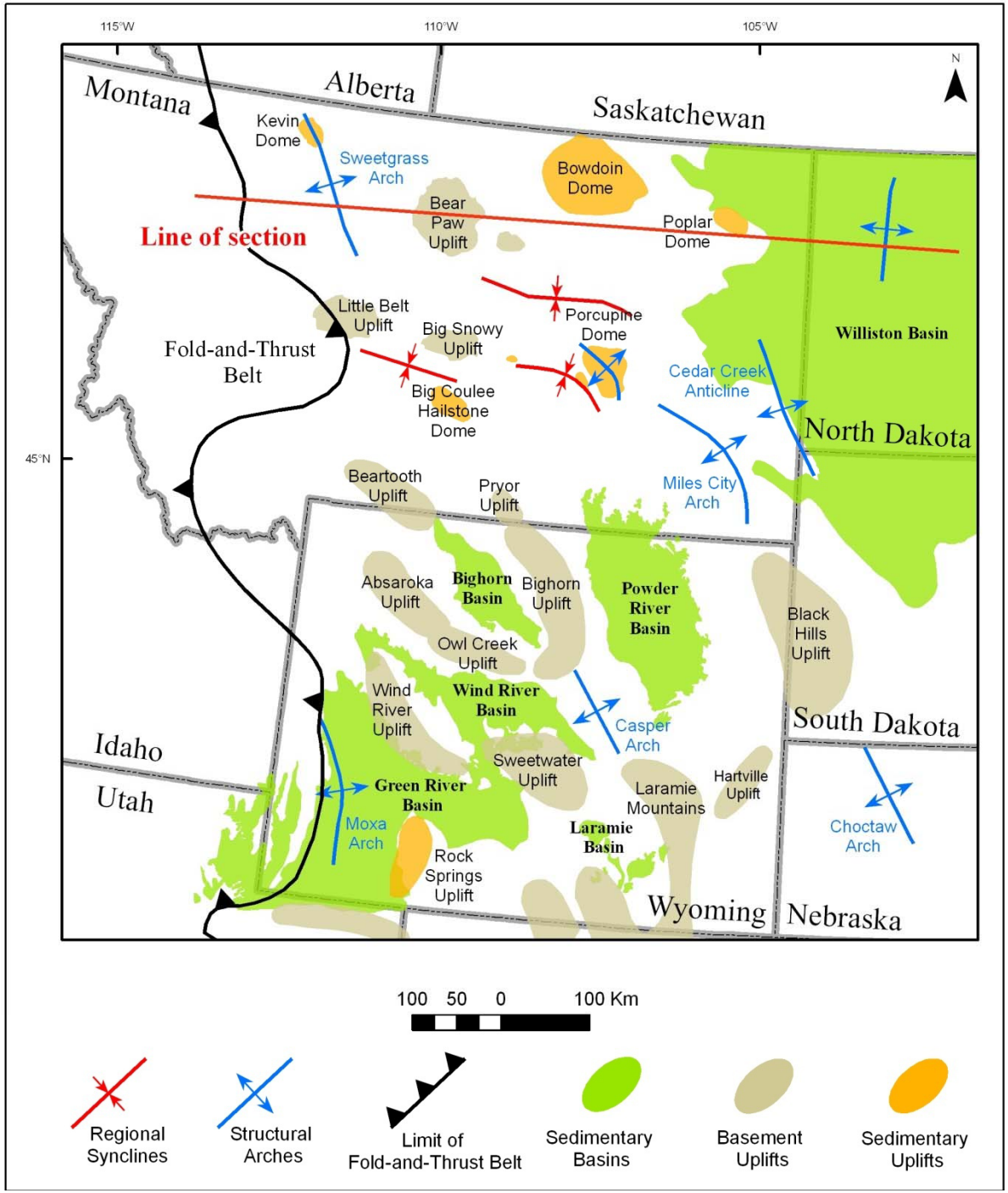
Duperow Extent / Resource Estimate



The Duperow is a regionally extensive Devonian Carbonate with excellent storage potential

Large structural closures, and in particular, domes, represent an attractive early sequestration target in the Big Sky region.

These domes provide the additional security of structural trapping and, in some cases, have already shown the ability to trap CO_2 over geologic timescales.



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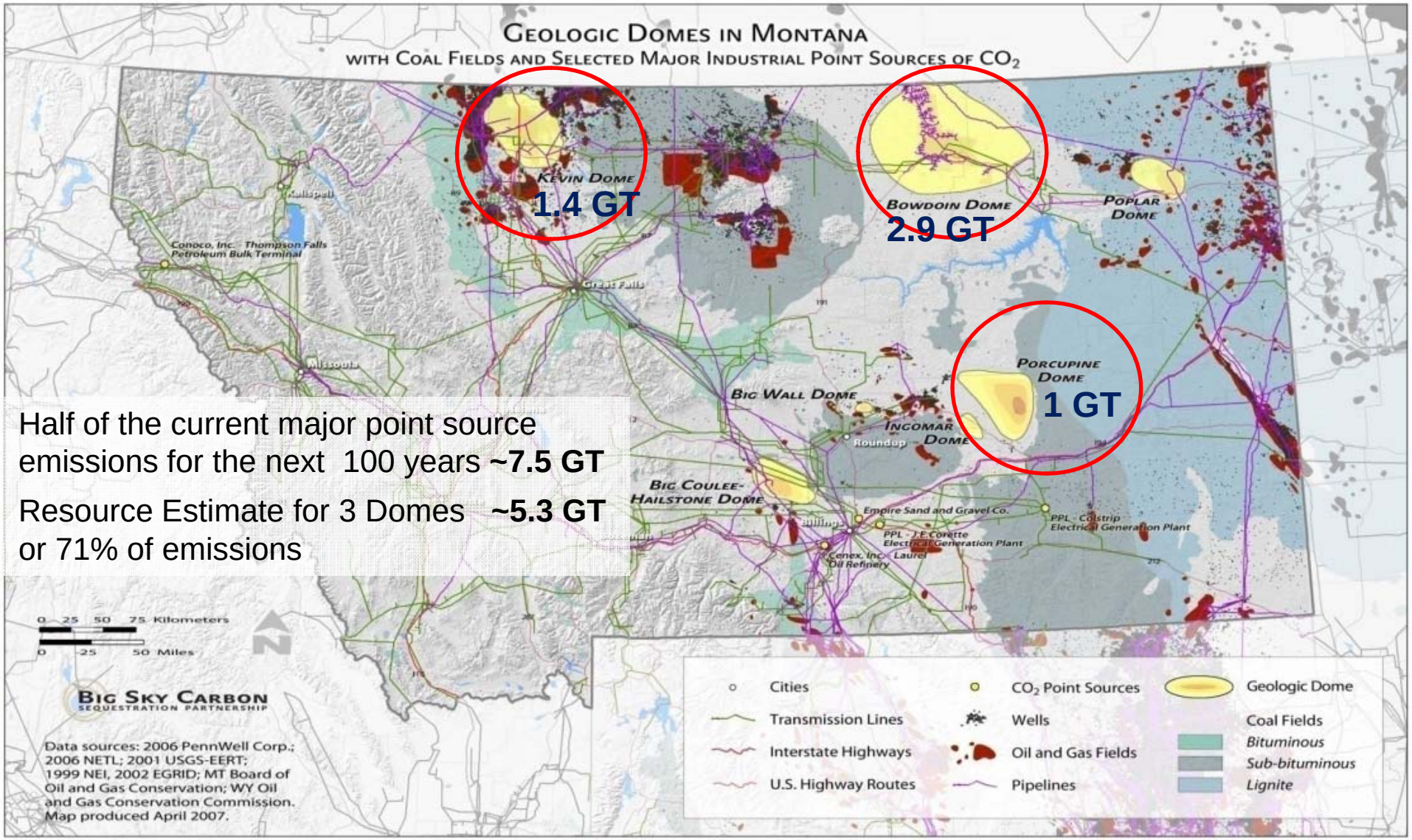
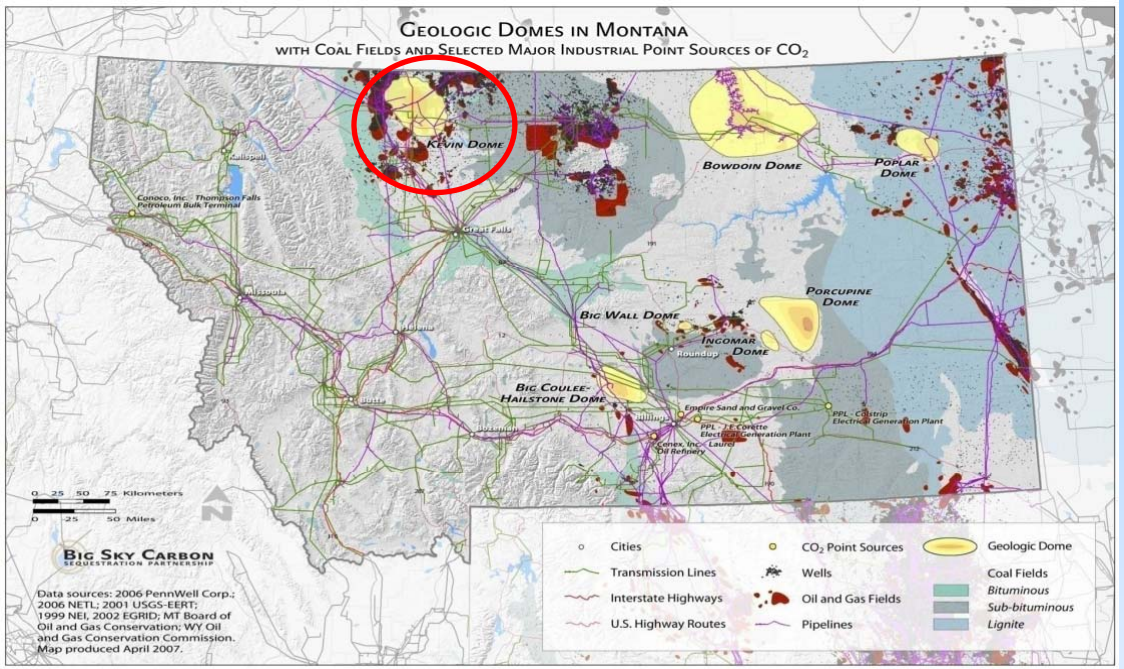
Resource Estimate for Three Montana Domes

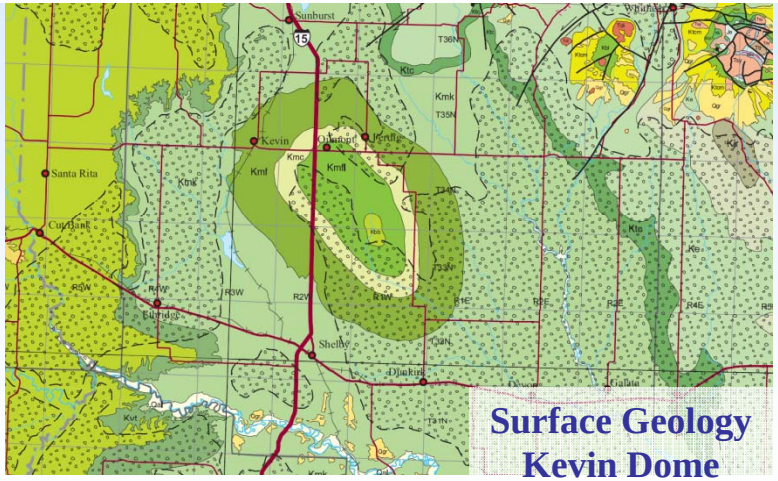


Half of the current major point source emissions for the next 100 years **~7.5 GT**

Resource Estimate for 3 Domes **~5.3 GT** or 71% of emissions

Kevin Dome Characterization Project





(modified from MBMG, 2007)

A Kevin Dome Project Would Allow Study Of:

- **Storage in the regionally significant Duperow.**
- **Storage in regionally significant domes.**
- **Comparison of a natural analog to new storage including geochemical changes.**
- **Potential for stacked storage**
- **Potential for detection limit tests**
- **Impact of additional storage at flanks of domes**

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Geology of Kevin Dome

- Structure of dome is very large: over 1000 square miles of closure and 800 ft of structural relief
- CO_2 is naturally trapped in the Devonian Duperow (dolomite) Formation proving *seal integrity*, *compatibility* of formation with CO_2, and *trap integrity* over geologic time
- Structure is not full to the spill-point with CO_2 at the Duperow level
- A brine aquifer extends beyond the limits of the dome →greater potential for sequestration
- The Nisku (predominantly limestone) contains some small zones of porosity and permeability
- The Souris River formation may have sequestration potential, but there is very little well control to confirm
- The Potlach Anhydrite caps the Nisku, tight carbonates with interbedded evaporites cap the Duperow and separate the upper and lower Duperow

CO_2 Volumes in Duperow Formation at Kevin Dome – Equivalent to Commercial Scale Site

- CO_2 in place and sequestration capacity per square mile
  - Upper Duperow = 1,084,323 Tons (19 BCF CO_2)
  - Lower Duperow = 1,198,694 Tons (21 BCF CO_2)
  - Total Duperow = 2,283,017 Tons (40 BCF CO_2)

- 324 sq.miles with Upper Duperow CO_2 X 19 BCF/ sq. mile = 6.156 TCF CO_2 in place

- 216 sq. miles with Lower Duperow CO_2 X 19 BCF/sq. mile = 4.104 TCF CO_2 in place

- Potentially 10+ TCF CO_2 in place (~600MM tons)

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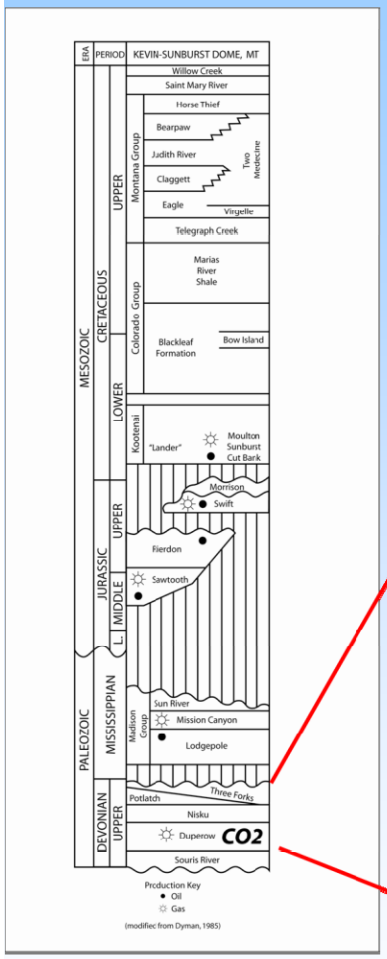
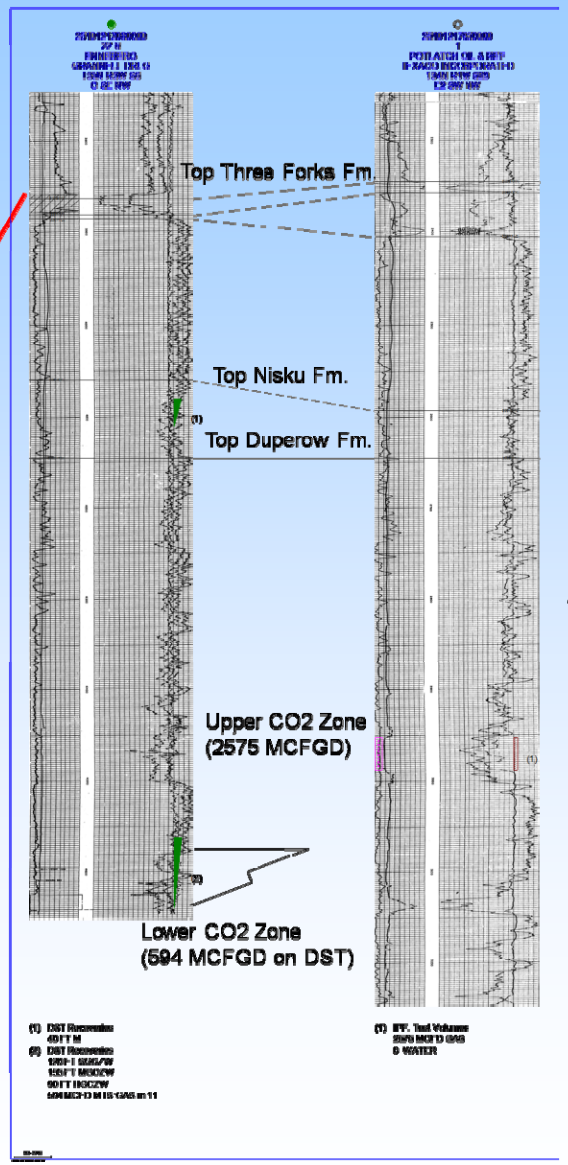
Stratigraphy





Bakken Sh.
(Regional Seal)

Potlatch Anhydrite
(Regional Seal)

Caprock
Upper Duperow
Anhydrites

100 feet

Nisku Limestone
~ 50 – 75 ft total thickness with a 10 – 25 ft thick porosity zone

Potlach Top

~ 175' Anhydrite

Nisku Top

Duperow Top

Upper Duperow ~200' tight carbonates and anhydites caprock

~ 100' Duperow Porosity (CO_2)

Souris River Top

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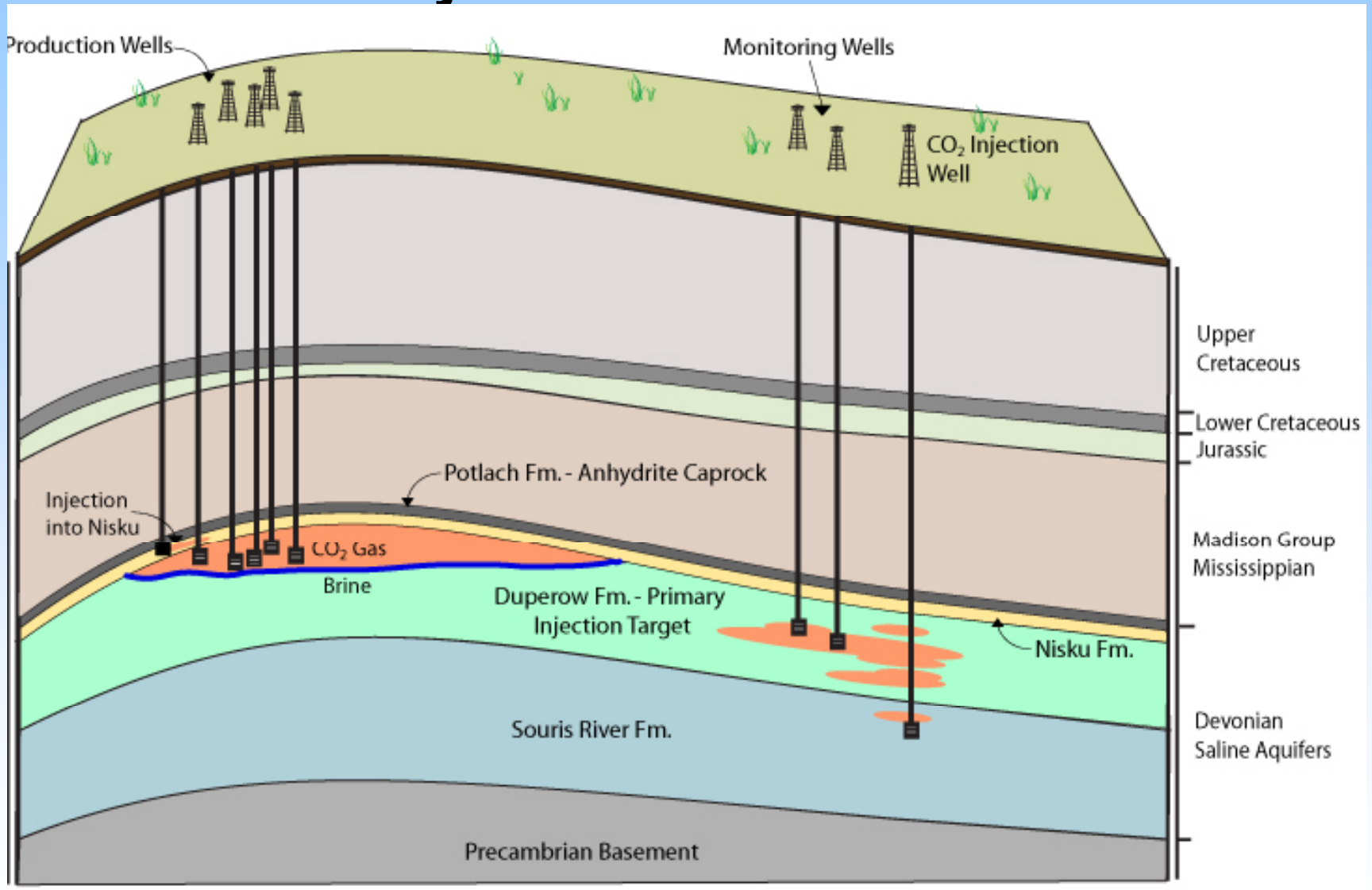
Project Schematic



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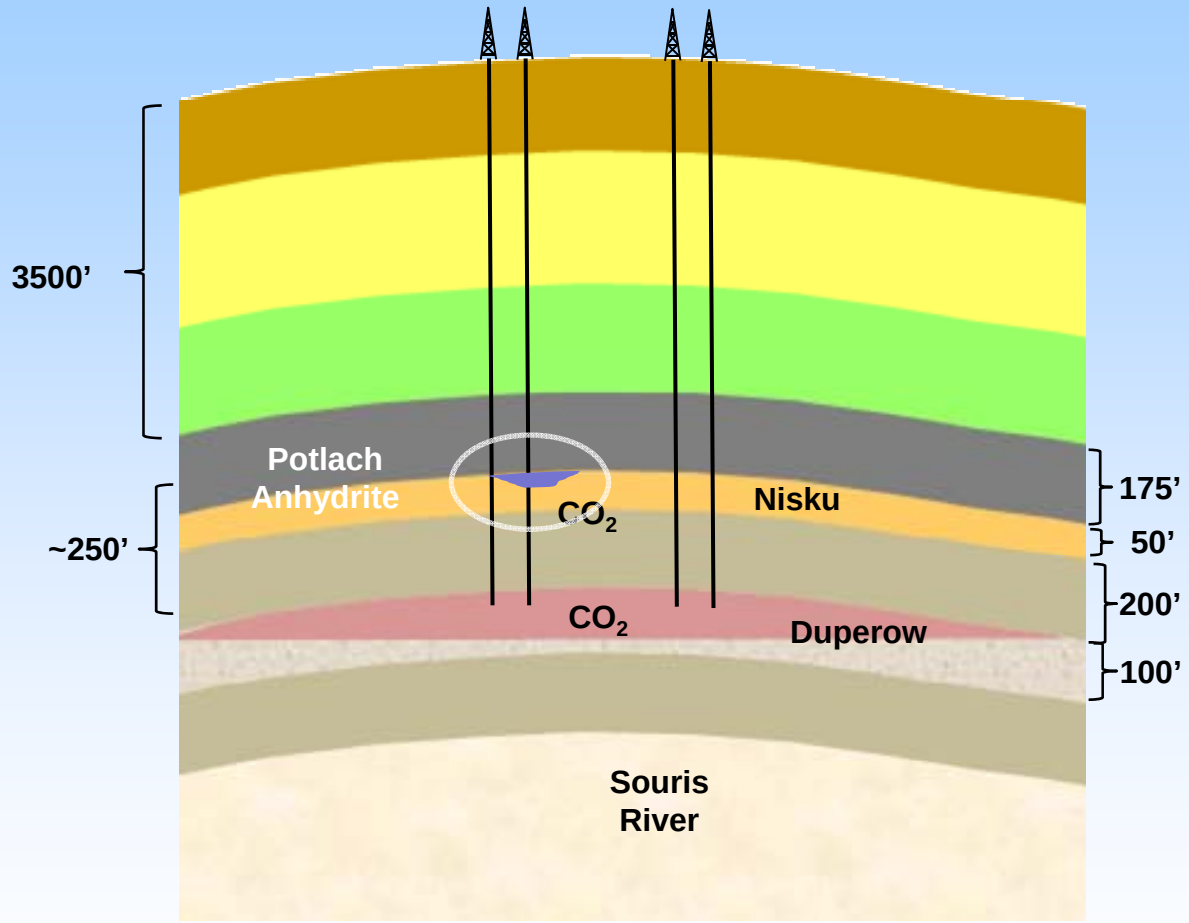
Kevin Dome Stacked Storage Detection Schematic



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Project Parameters

- **Initial injection is proposed into the saline aquifer of the Devonian Duperow formation down-dip from naturally occurring CO_2 on Kevin Dome.**
- **The Souris River formation will also be investigated for potential stacked storage**
- **A small injection into the Nisku above the CO_2 reservoir will allow tests of detection limits for stacked storage**
- **The Potlach anhydrite (~150 ft thick) provides a highly competent seal above all injection targets**
- **Two regions are being considered. If economic, one may be tied to hydrocarbon production.**

Geologic Sequestration

Requirements	Wyoming	Montana	North Dakota	Washington
UIC Primacy	Yes	No	No	Yes
Pore Space Owner	Surface Owner	Surface Owner	Surface Owner	State and SO
Split Estate w/ Minerals	Mineral Estate Dominant – no injection in structures with HC	Equal Standing	Equal Standing	Equal Standing
Regulating Agency	DEQ/WOGCC	MBOG/DEQ/ DNRC	Industrial Commission/Health Department	WDOE
Unitization Requirement	75%	60%	60%	Not Defined
Fee Structure	Application Fee	per/T charge TBD	per/T charge TBD	Application Fee
Financial Responsibility	Surety Bond TBD	Surety Bond TBD	Surety Bond TBD	Financial Assurance Mechanism
Release of Liability to third party	Previously UIC Requirement – No State Ownership Revised to 10 years	30	10	Determined post-closure and minimum of 20 years post injection
Other constituents allowed in injection stream	Yes	Yes	Yes	No
Area of Review beyond predicted plume size	1 Mile	½ Mile	¼ Mile	10 Miles minimum
Separate Process for Research Wells	Yes	No	Yes	Yes

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Current Legislative and Congressional Activities

- States
  - CO investigating GS legislation
  - AZ investigating GS legislation
  - NV, NM investigating fossil energy powered generating stations with CCS as eligible to claim offsets, PTCs, etc.
  - CA postpone AB 32
- Congress
  - Kerry-Lieberman
  - Cantwell-Collins
  - Bingaman
  - Waxman-Markey
  - Enzi

  Many others in draft or not yet assigned to committee

Expected Regulatory Activities

Activity	OR	ID	WY	MT	ND	SD	WA
Emissions Reporting*	Y	Y	Y	Y	Y	N	Y
CO2 Pipelines	N	Y	Y	Y	Y	Y	N
Financial Assurance	N	N	Y	Y	Y	N	N
Liability	N	N	Y	Y	Y	N	N
Indemnification**	N	N	Y	Y	Y	N	N
Fluid Displacement	N	N	Y	N	N	N	Y

* Regulatory responses to draft EPA rules governing emissions for EOR and CCS
** Regulatory responses to Congressional action

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Questions and/or Comments?

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