

# Reservoir Characterization of the Deadwood Formation, Williston Basin



COLORADO SCHOOL OF  
**MINES**  
**MUDTOC**

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MS 2024



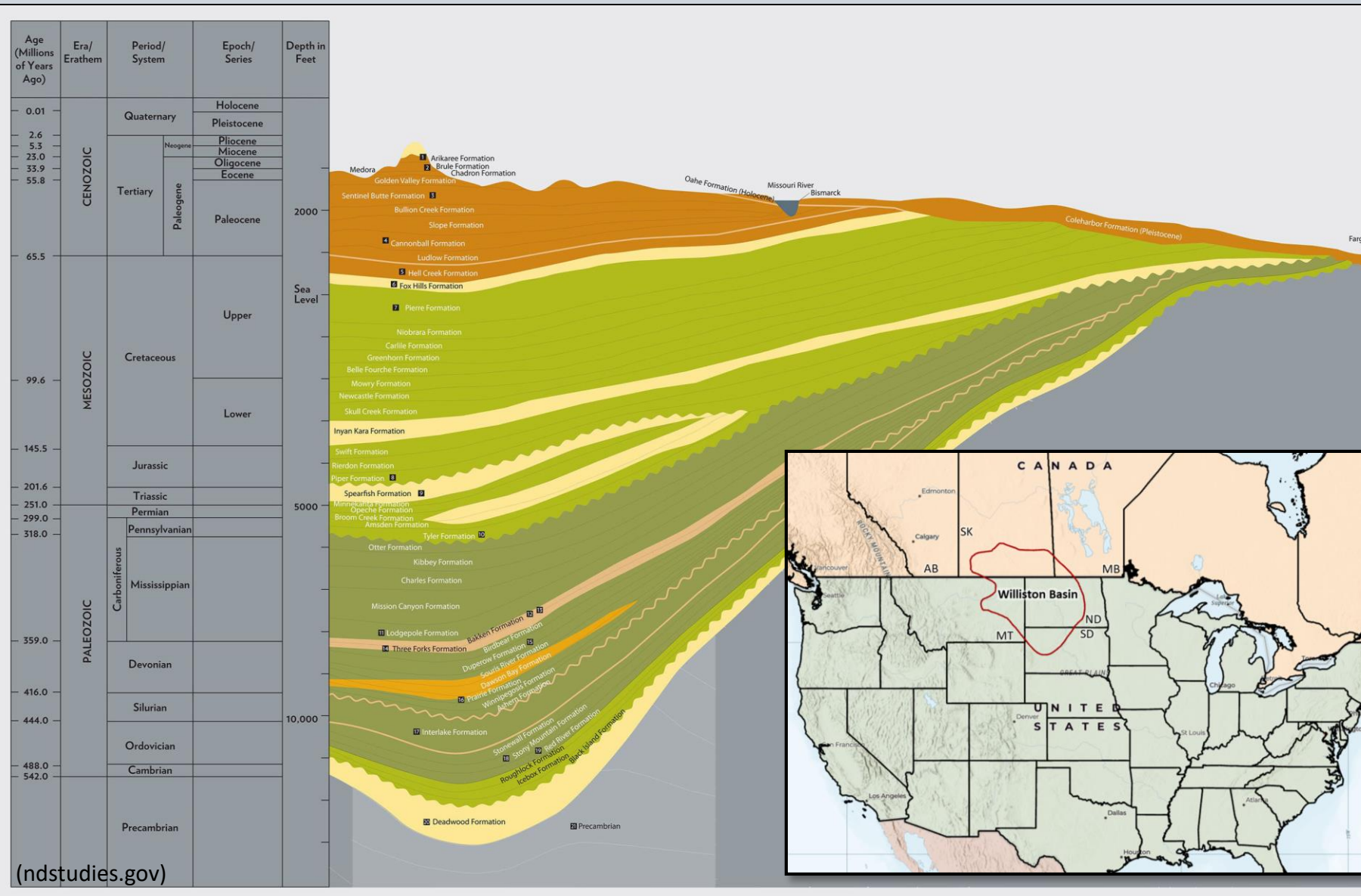
# Outline

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- Future Work
- Why Geothermal?
- Successful Geothermal Energy Production – DEEP Earth Energy Production “DEEP”
- Hypotheses



(USGS, 2001)

# Geologic Background-Williston Basin



- Intra- cratonic basin
  - North American Craton
  - >16,000 ft - Phanerozoic Sedimentation
- Precambrian Basement
  - Framework for sedimentation and thermal patterns
  - Trans-Hudson Orogeny
    - Superior Craton and Wyoming Craton
- Paleozoic Sediments
  - Initial Transgression in Cambrian: Clastics
  - Carbonates
- Mesozoic & Cenozoic Sediments
  - Clastics
- Six main depositional sequences
  - Sauk, Tippecanoe, Kaskaskia, Absaroka, Zuni, Tejas
- Major structural features
  - Nesson Anticline
  - Cedar Creek Anticline

(ndstudies.gov)

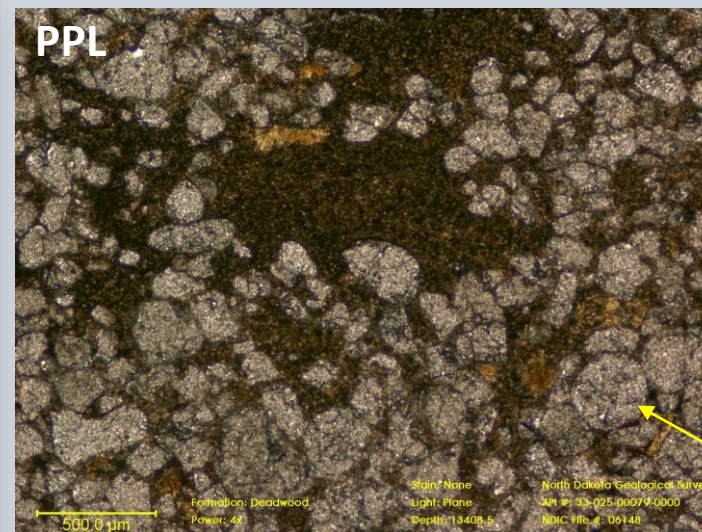
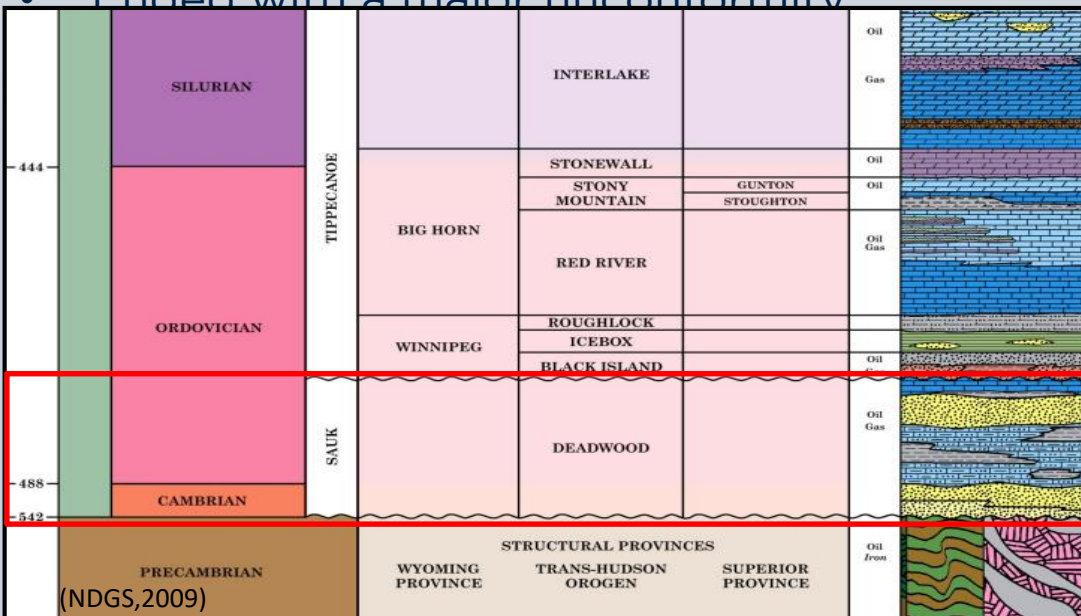


# The Deadwood Formation

- Cambrian/ early Ordovician (480 - 540 ma)
- Sauk Sequence
- First record of Transgression of the Phanerozoic on top of a low relief Precambrian Basement
- Dominated by Siliciclastic Sediments sourced by the Precambrian Basement
- Six members A-F
- Depositional environments:
  - Shallow marine to alluvial plains
- Key Diagnostic Mineral: Glauconite
- Ended with a major unconformity



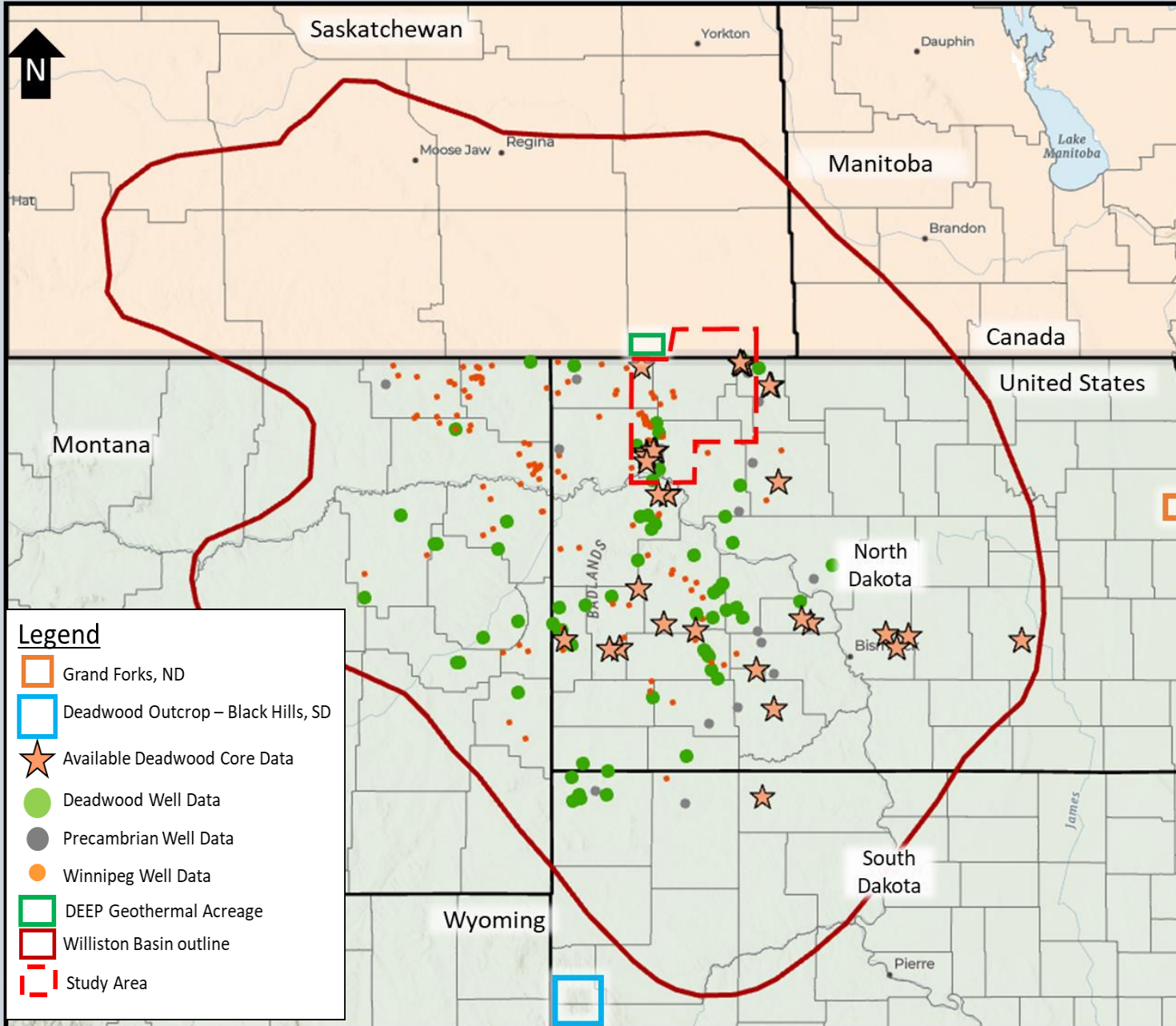
Deadwood Outcrop in Deadwood, SD (USGS,2001)



ANDREW M. HEISER #1- 13408.5'  
North Dakota Core Library

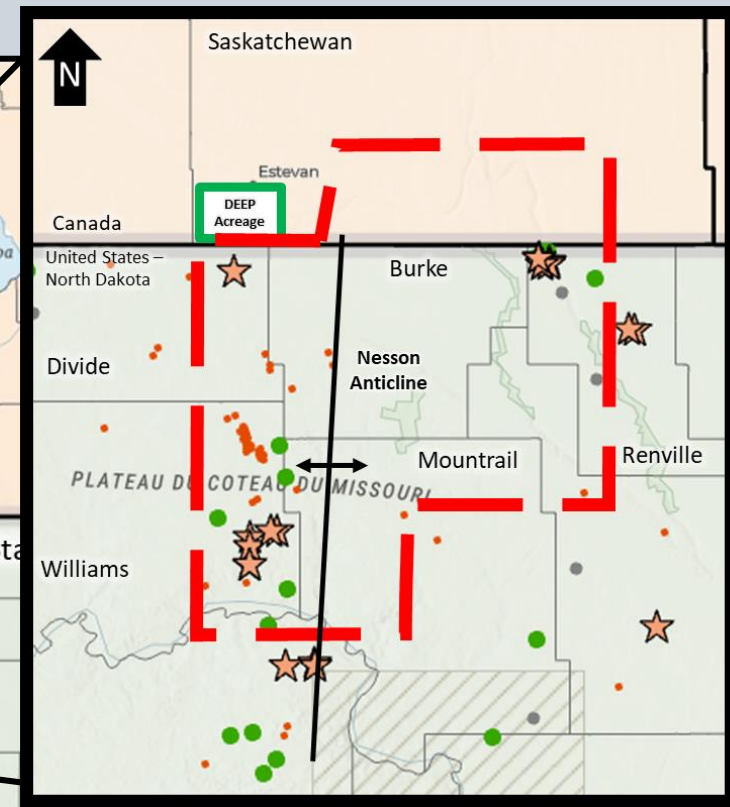
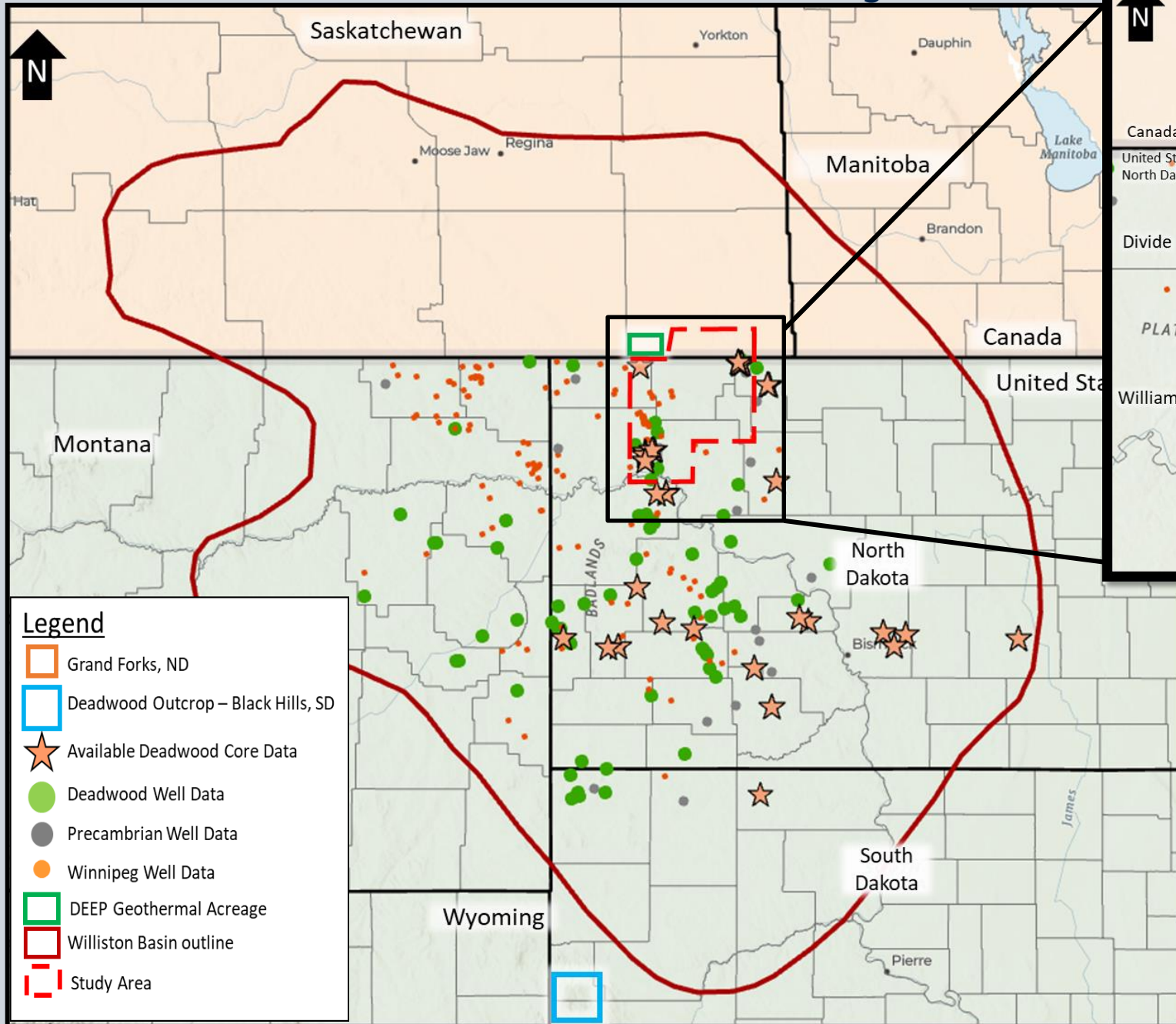


# Data Located and Compiled










- **Deadwood Core**
  - USGS CRC: Lakewood, Co: 4
    - 159 feet
  - North Dakota Core Library: 34
    - 3675 feet
- **Temperature Data**
  - SMU Geothermal Database
- **Well Data**
  - Enverus
  - North Dakota Oil and Gas Commission Website
- **Data TBD**
- **Deadwood Core, Well and Temperature Data- Saskatchewan, Canada**
  - Currently in contact with Geologists at the Saskatchewan Geological Society
- **Temperature Maps**
  - USGS Temperature Maps of the Williston Basin

# Study Area



## Legend

-  Grand Forks, ND
-  Deadwood Outcrop – Black Hills, SD
-  Available Deadwood Core Data
-  Deadwood Well Data
-  Precambrian Well Data
-  Winnipeg Well Data
-  DEEP Geothermal Acreage
-  Williston Basin outline
-  Study Area

- **Deadwood Core**
  - USGS CRC: Lakewood, Co: 3
    - 48 feet
  - North Dakota Core Library: 9
    - ~850 feet
- **Well Data**
  - Enverus
  - North Dakota Oil and Gas Commission Website
- **Study Area will be defined once data is received from SGS**

# Future Work

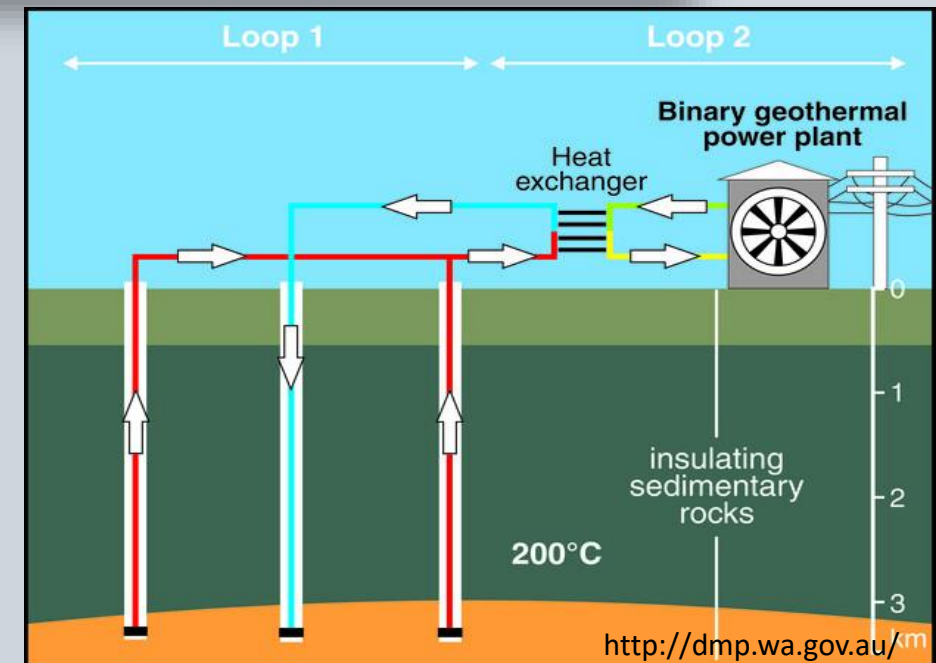
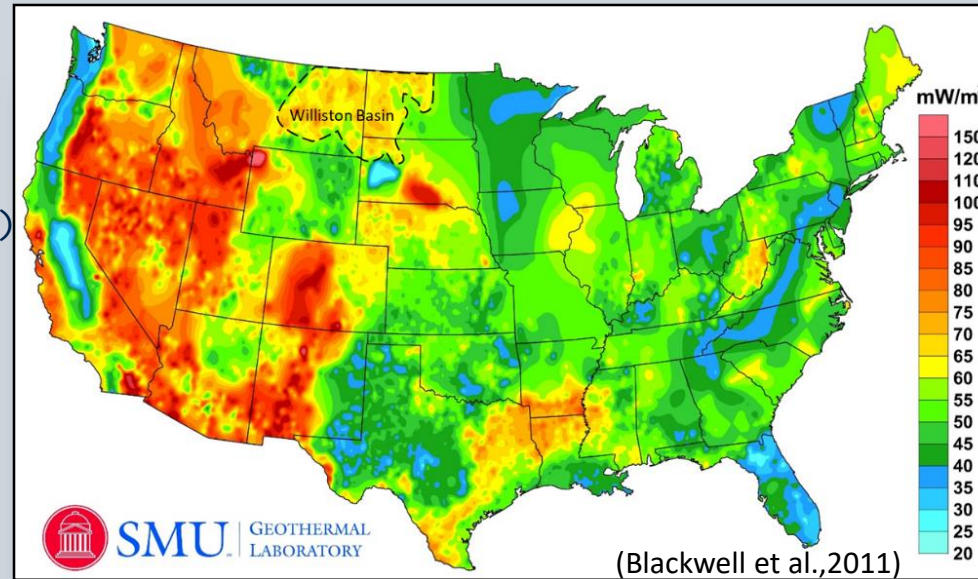
- May 3 – USGS CRC Visit
- Create an Itinerary to visit Grand Forks, ND
- Continue communication with SGS in Saskatchewan
- Dive into Research
  - Core Descriptions
  - Begin XRD & XRF analysis
  - BHT Temperature Mapping
  - Continue Literature Review
- Solidify Study Area
- Finish up coursework in Fall 2023



# Why Geothermal?

## Low-Temperature Geothermal (LTG)

- **Clean source of power and heat**
  - Can utilize temperatures as low as 150°C (300°F)
  - LTG power generation is doable by using binary cycle power generation (NREL)
- **Three variables**
  - Heat
  - Permeable rock to transfer heat
  - Water saturation
- **Applications for Geothermal Resources**
  - Direct use
  - Indirect use
  - Co-Produced Resources
    - 823,000 O&G wells in the US produce hot water along with oil and gas (USDOE,2013)
- **Apply O&G Exploration and Production Techniques to Geothermal Resource Production**
- **Cool Science**

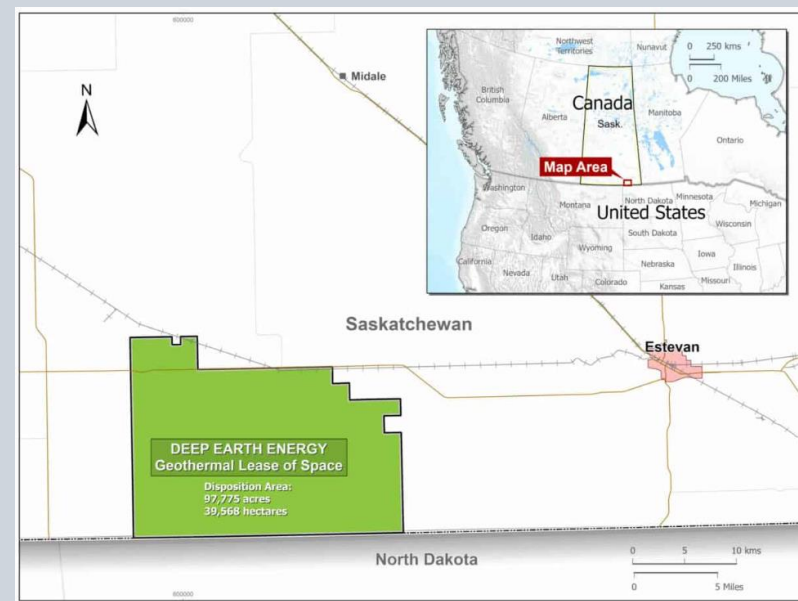






# Successful Geothermal Production

## DEEP Earth Energy Production Corp. “DEEP”



<https://deepcorp.ca/about/>



(Groenewoud and Marcia,2020)

- **Goal: Provide renewable baseload power to the SaskPower grid**
- Dec 2018: Border–01 geothermal test well
  - Target Formation: Basal Clastics and Precambrian basement
  - Summer 2019: Border-01 flow test
- 2019/2020: Four additional wells drilled
- 2021: Border–05 - Canada’s first Horizontal Geothermal well
  - 3,500 m TVD and 2,000 m lateral
- Sustainable application of modern-day oil and gas drilling and completions techniques
- Anticipated to be the first 100% naturally sourced geothermal power facility
- Potential CO2 storage in other stratigraphic intervals within their acreage

Well Name	Border-01	Border-02A	Border-02B	Border-03	Border-04
Type	Vertical	Directional	Whipstock Dir.	Directional	Vertical
Depth measured / true vertical (m)	3530	3840   3496	3890   3624	3681   3560	3731
Total core cut / recovered (m)	199/195	11/6	62/57	77/77	35/35
Drilling days	38	37	26	22	30

(Groenewoud and Marcia,2020)

<https://deepcorp.ca/about/>

# Hypotheses

- Where are the geothermal anomalies geographically within the Williston Basin?
- How will porosity, permeability, and other reservoir quality factors affect the geothermal resource potential?
- Where within the Deadwood Formation would be the best possible location to explore for geothermal energy resources?
- What type of subsurface technology will be best for geothermal energy development?
- Is the coproduction of geothermal energy and natural gas a potential way to develop these resources?





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