Basin-wide Evaluation of the Uppermost Green River Formation's Oil-Shale Resource, Uinta Basin, Utah and Colorado

Michael D. Vanden Berg
Utah Geological Survey

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Acknowledgements

- **U.S. Bureau of Land Management – funding and data**
- **Utah School and Trust Land Administration - funding**
- **U.S. Geological Survey - data**

Outline

1) Scope
   - Development of a new basin-wide oil shale assessment

2) Methods
   - Creation of isopach maps
   - Calculating resource numbers

3) Results
   - Total in-place resource
   - Potential economic resource

Scope -
Oil Shale Resource Evaluation

1) Focus - Entire Uinta Basin
   - Data from 293 wells spread throughout the Uinta Basin

2) Determined thickness of continuous intervals averaging 50, 35, 25, and 15 gallons per ton (GPT)

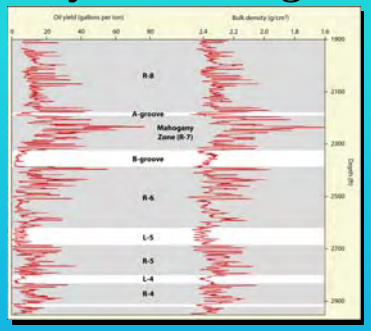
3) Created GIS-based maps
   - Isopachs for each richness zone
   - Overburden thickness – Depth to the top of each richness zone

4) Calculated resource numbers
   - Total in-place resource with certain constraints

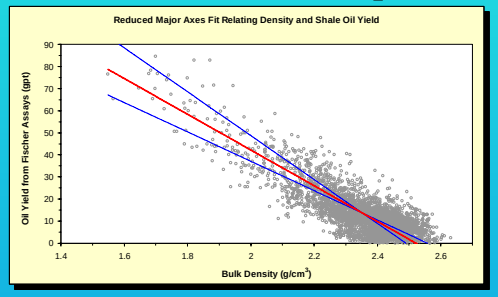
UGS Special Study 128: due out this fall

Methods

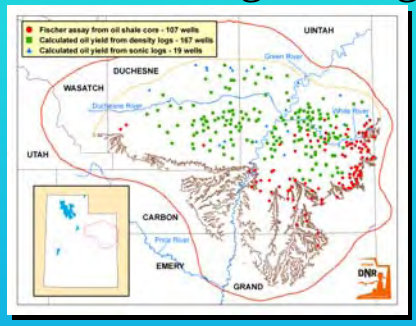
Step 1:
Oil yield vs. log



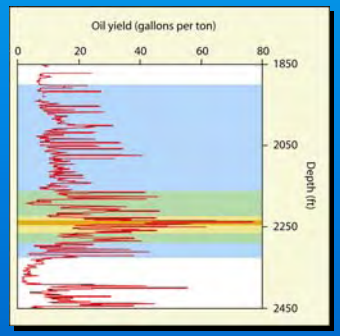
Step 2:
Create conversion equations



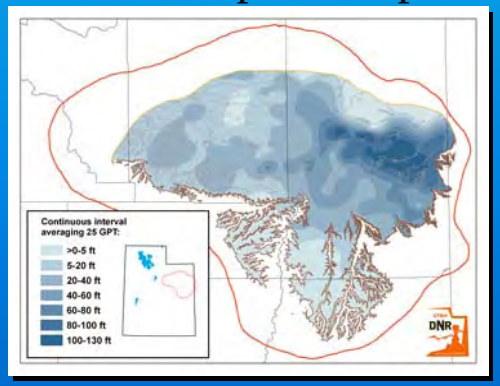
Step 3:
Locate and digitize logs



Step 4:
Calculate thickness

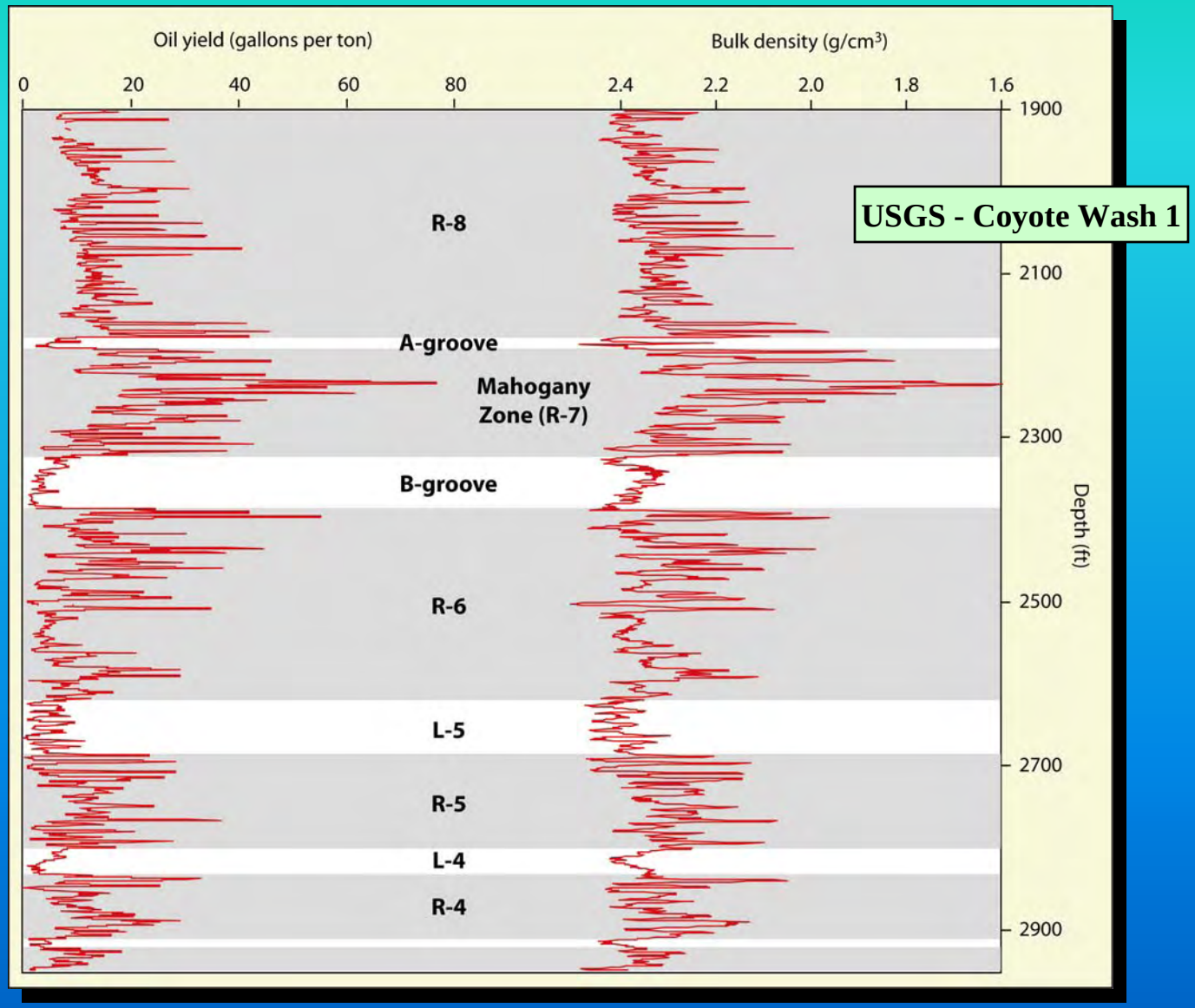


Step 5:
Create isopach maps



Step 6:
Calculate resource numbers

Step 1: Oil yield vs. geophysical log



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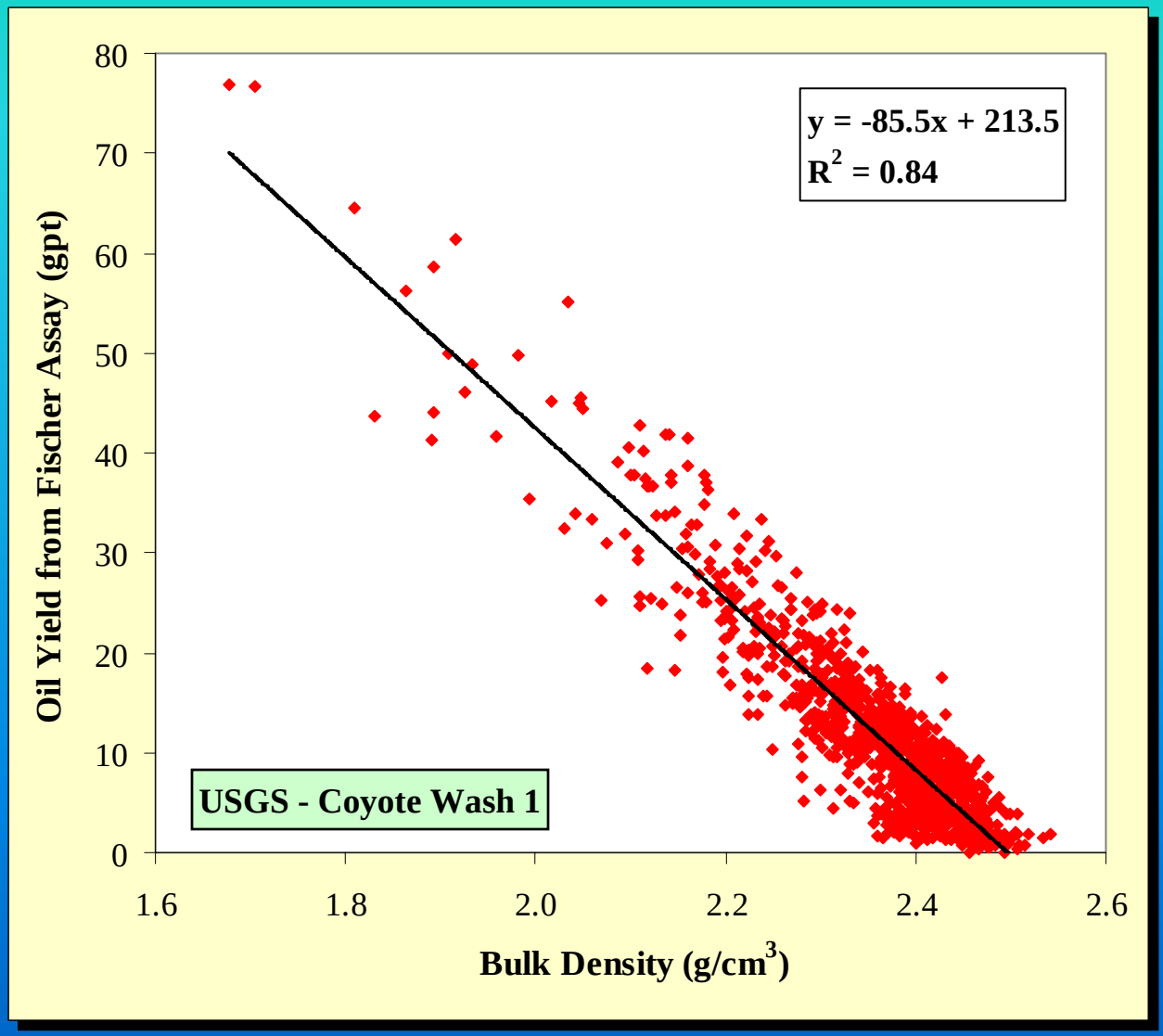
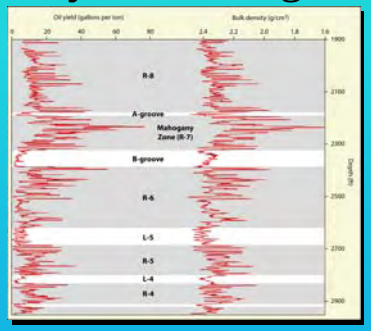


Methods

Step 1:
Oil yield vs. log



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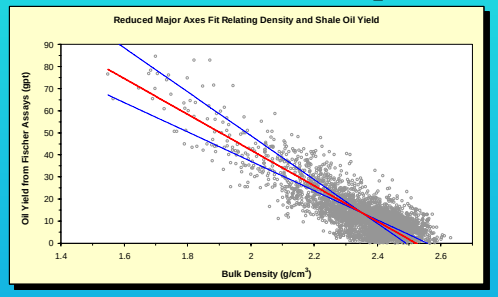

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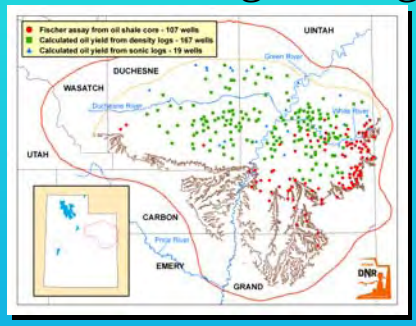

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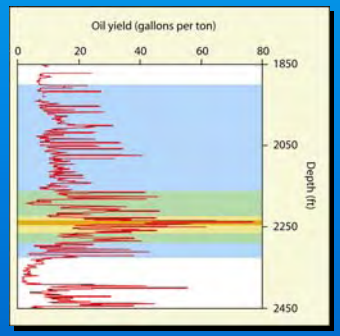

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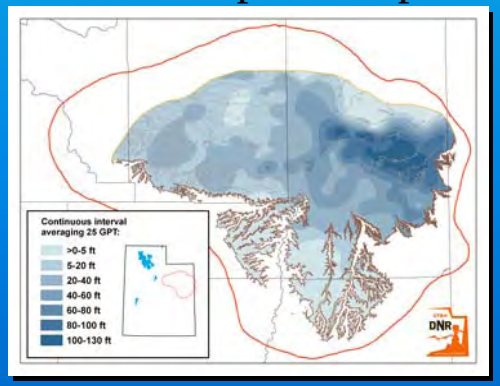
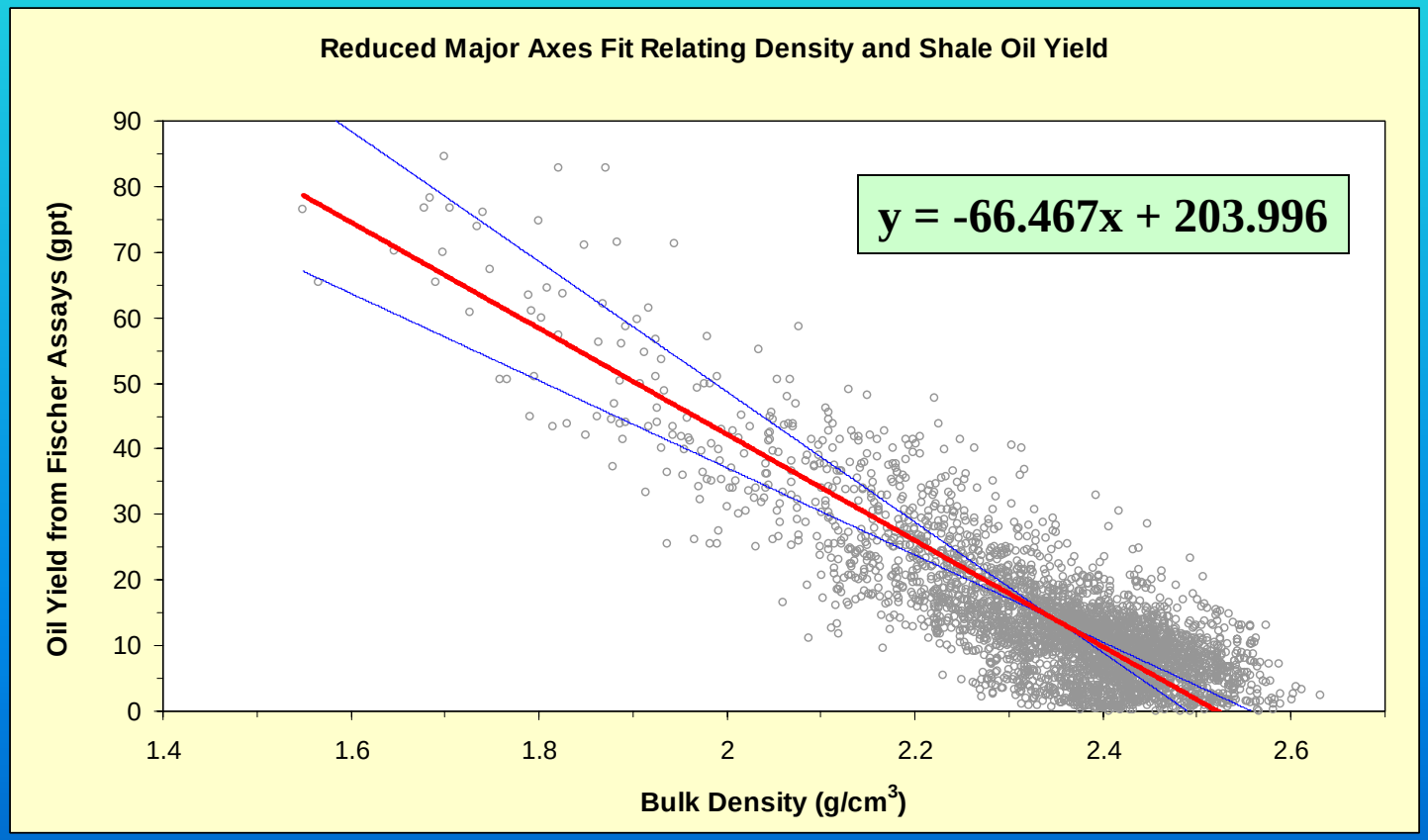
Create isopach maps



Step 6:
Calculate resource numbers

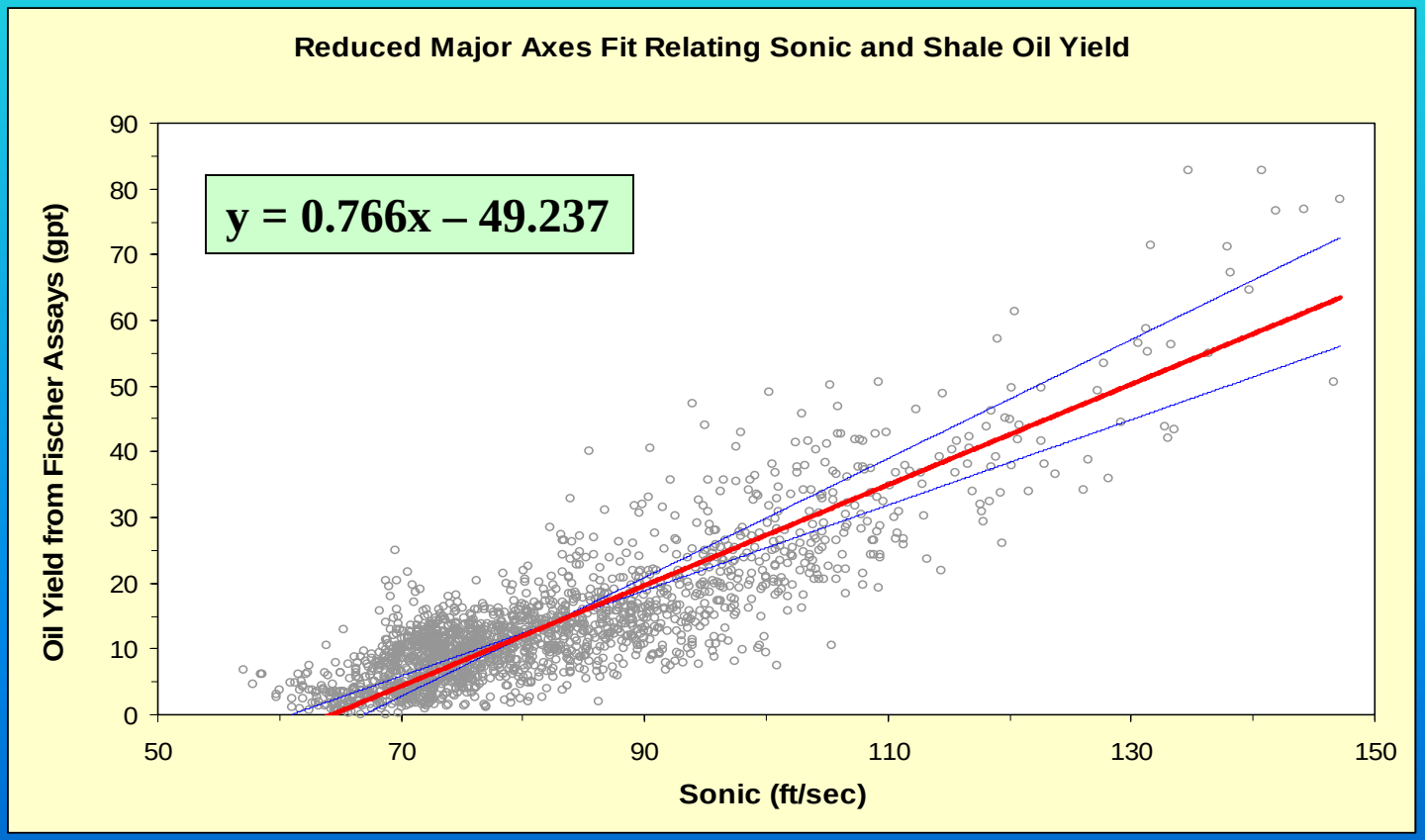
Step 2: Created equation comparing bulk density to oil yield

- Used 8 wells with R^2 ranging from 0.71 to 0.87
- Used a reduced major axes regression fit



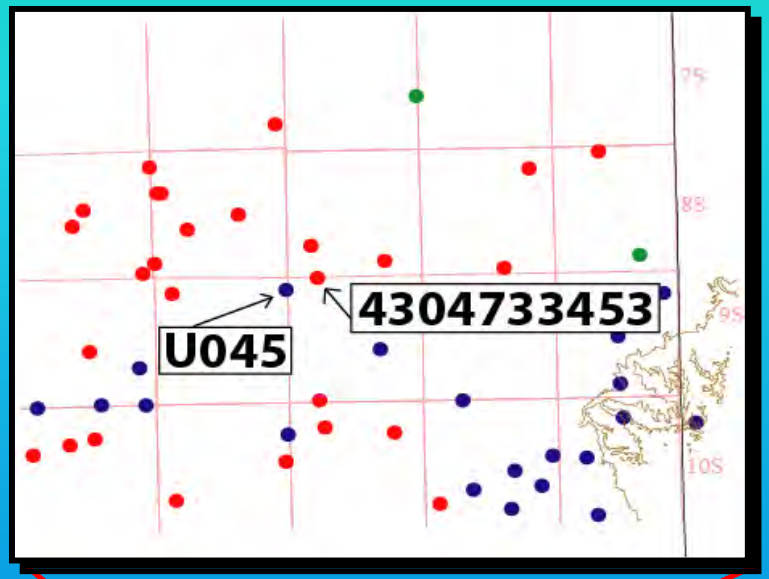
Step 2: Created equation comparing sonic to oil yield

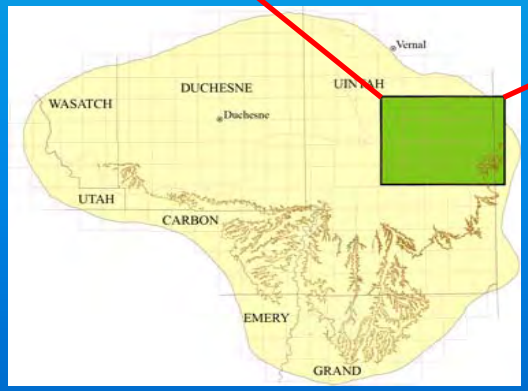
- Used 4 wells with R^2 ranging from 0.64 to 0.77
- Used a reduced major axes regression fit



Step 2:

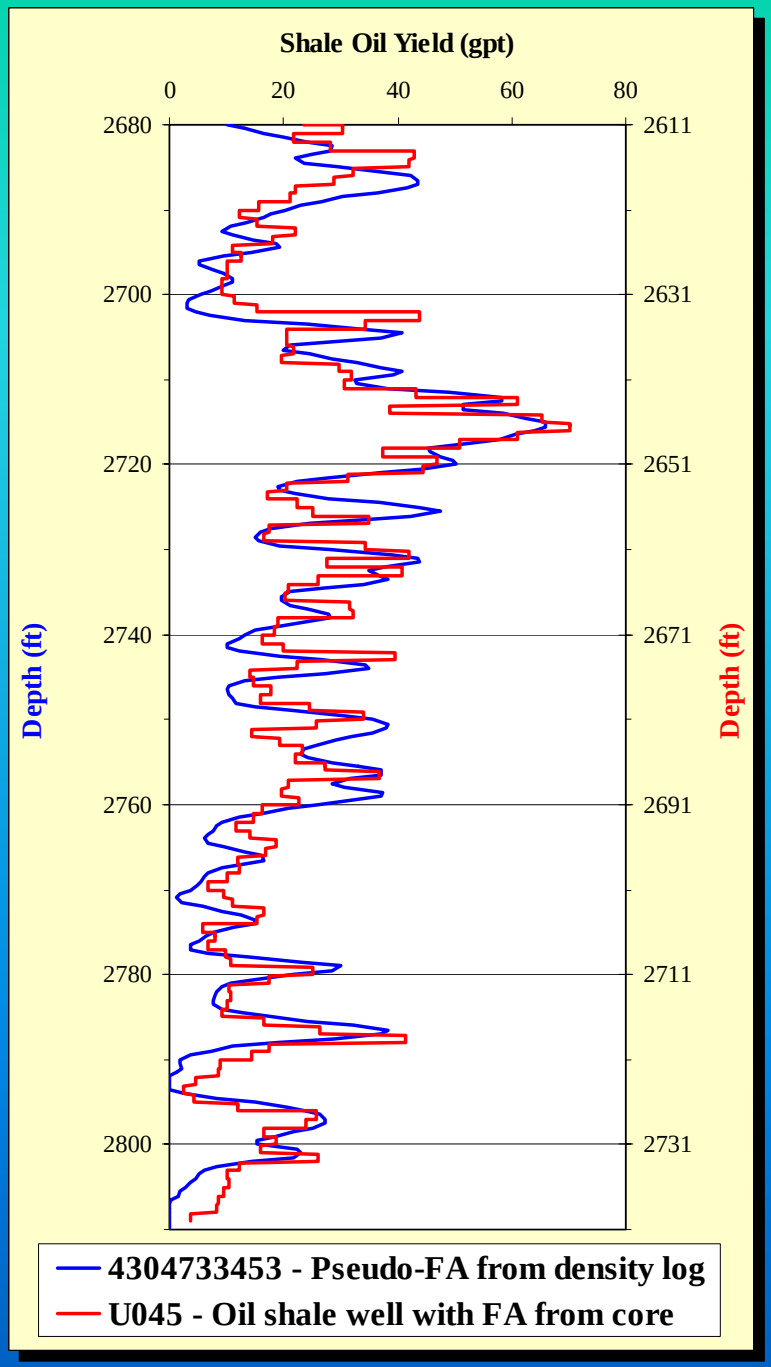
- Ground truth verses calculated yield





1.5 miles apart

Average gpt of datasets:
Gas well = 21.4 gpt
U045 = 21.7 gpt



Methods

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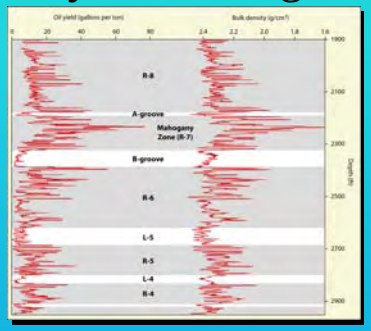

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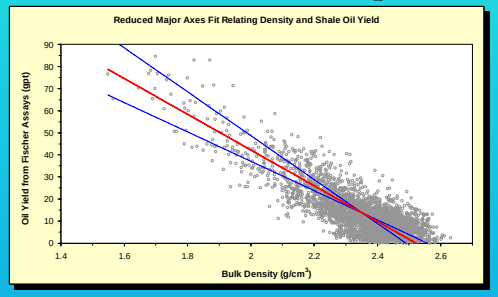

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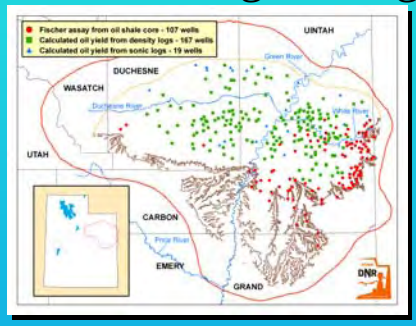

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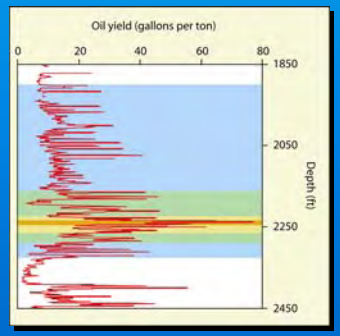

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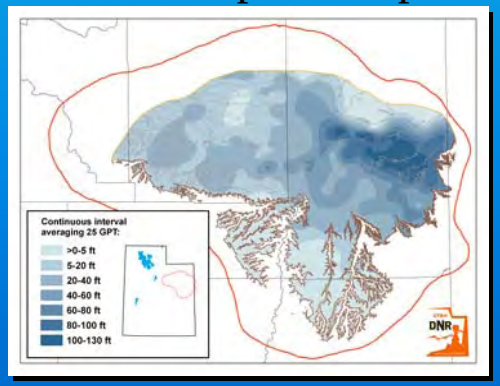
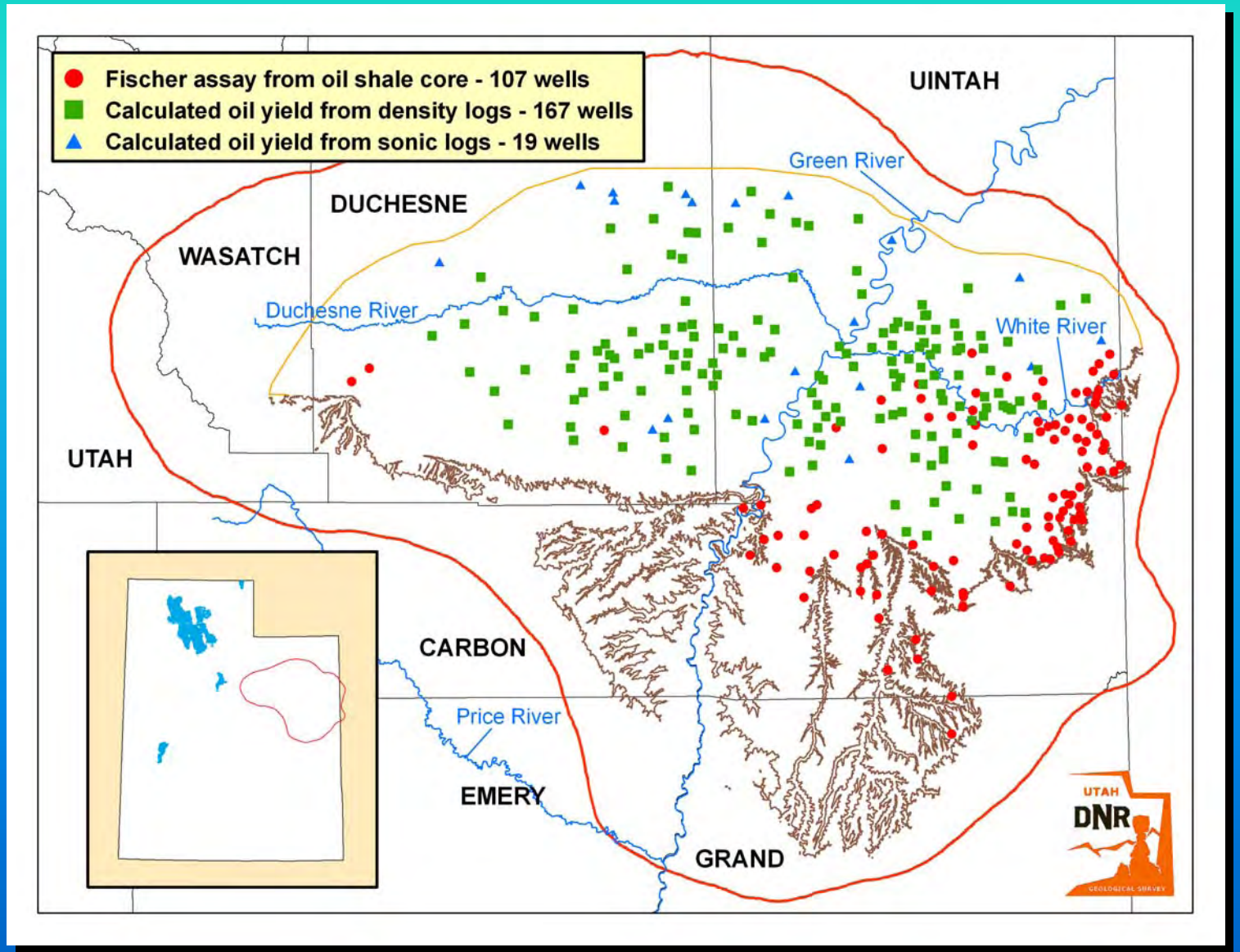


Step 6:
Calculate resource numbers

Step 3: Data distribution



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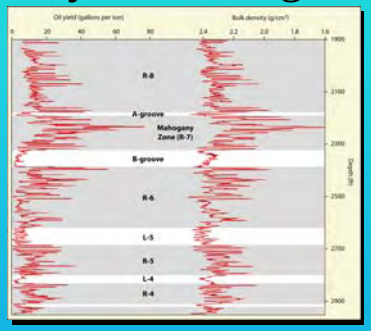

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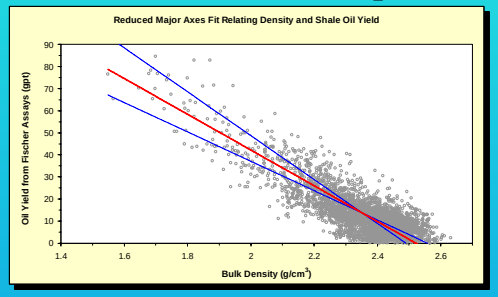

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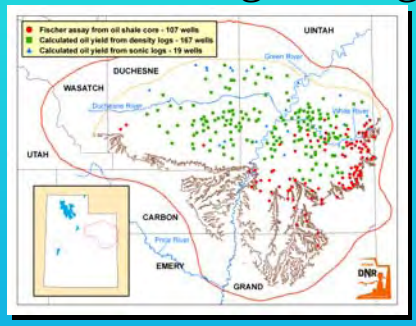

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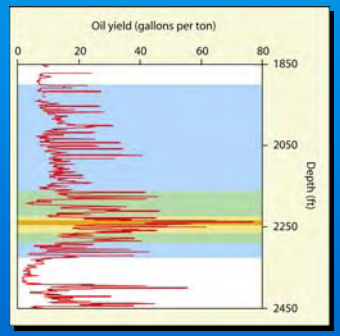

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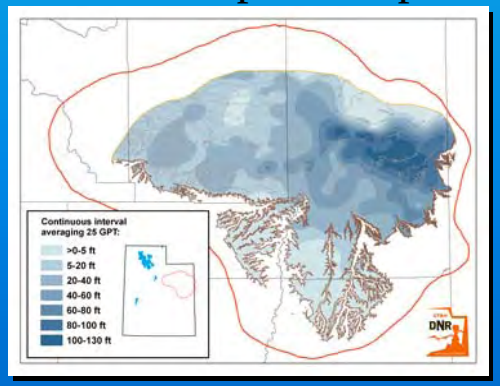


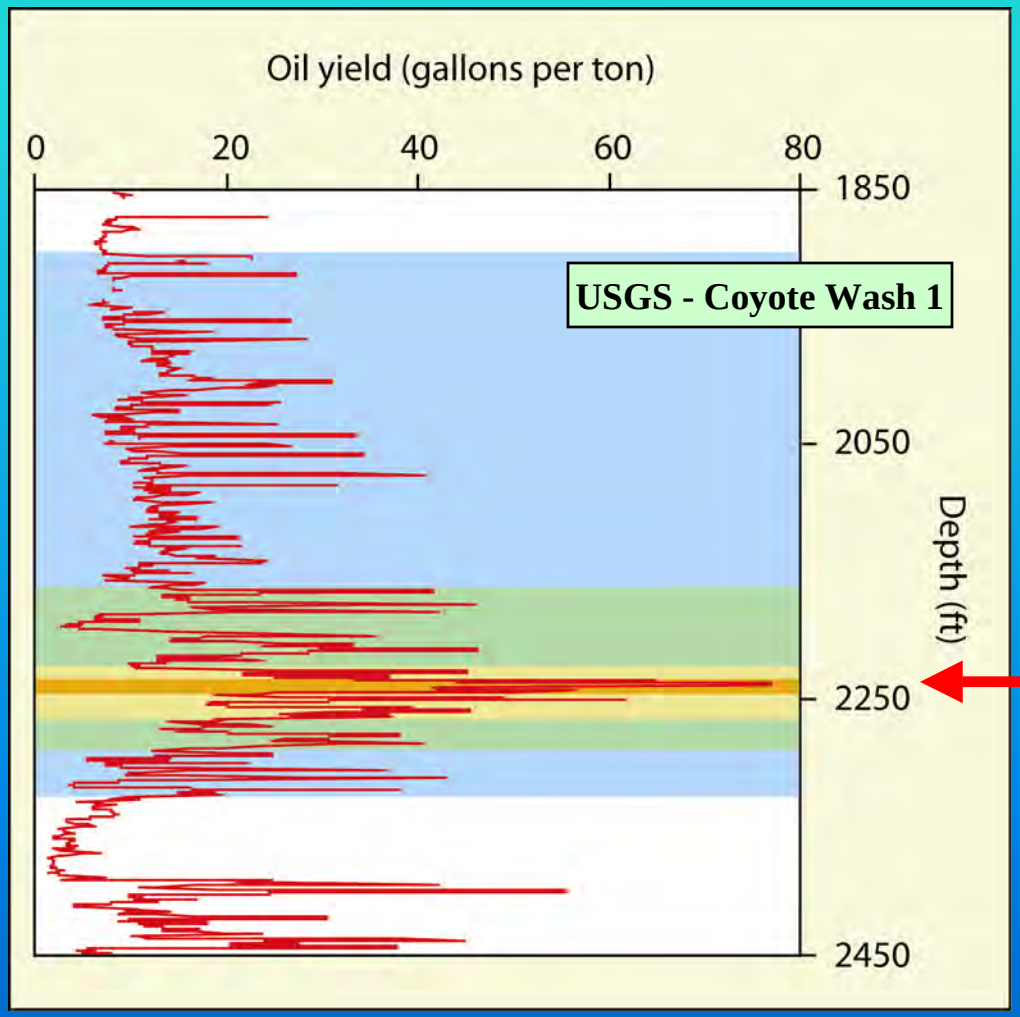
Step 6:
Calculate resource numbers

Step 4: Calculated thickness of certain richness zones

- **Zones averaging 15, 25, 35, and 50 gpt**

Average of 15 gpt

426 ft



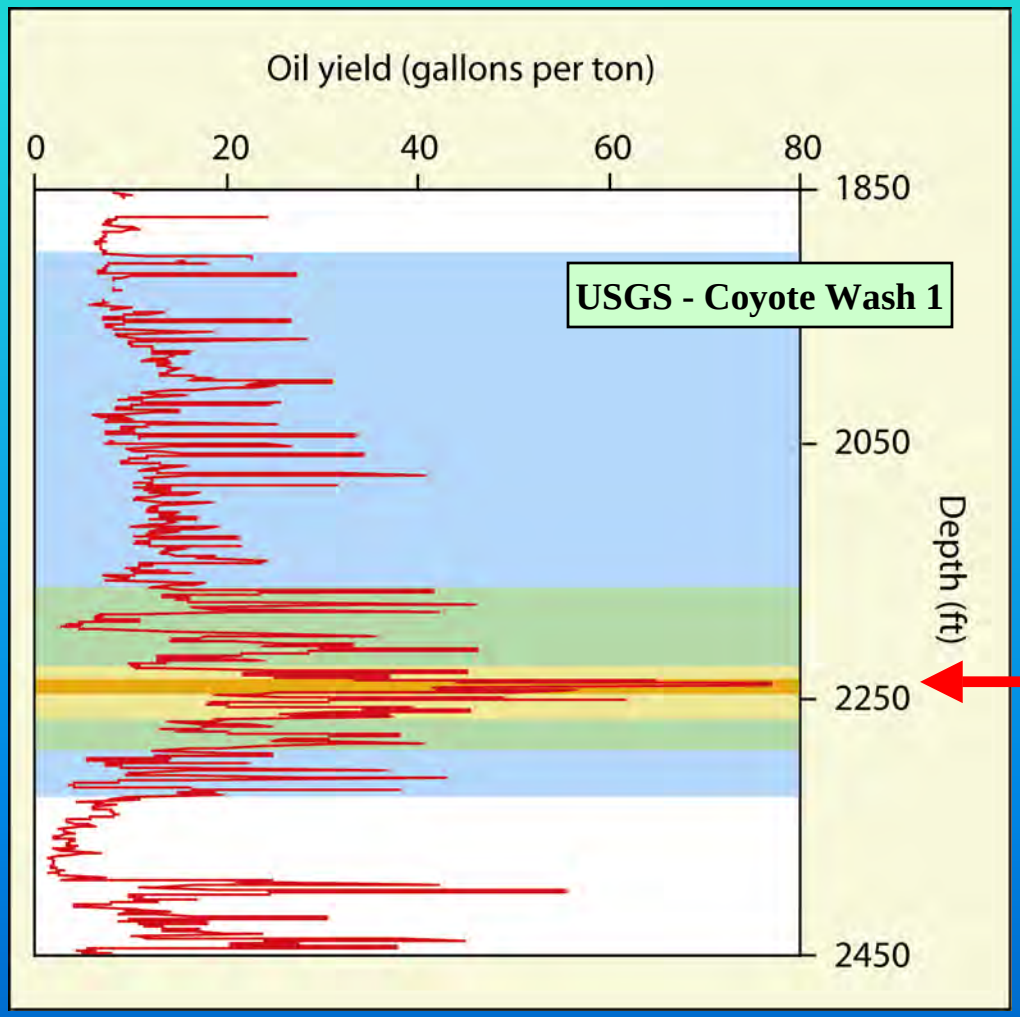
Mahogany Bed

Step 4: Calculated thickness of certain richness zones

- **Zones averaging 15, 25, 35, and 50 gpt**

Average of 25 gpt

120 ft

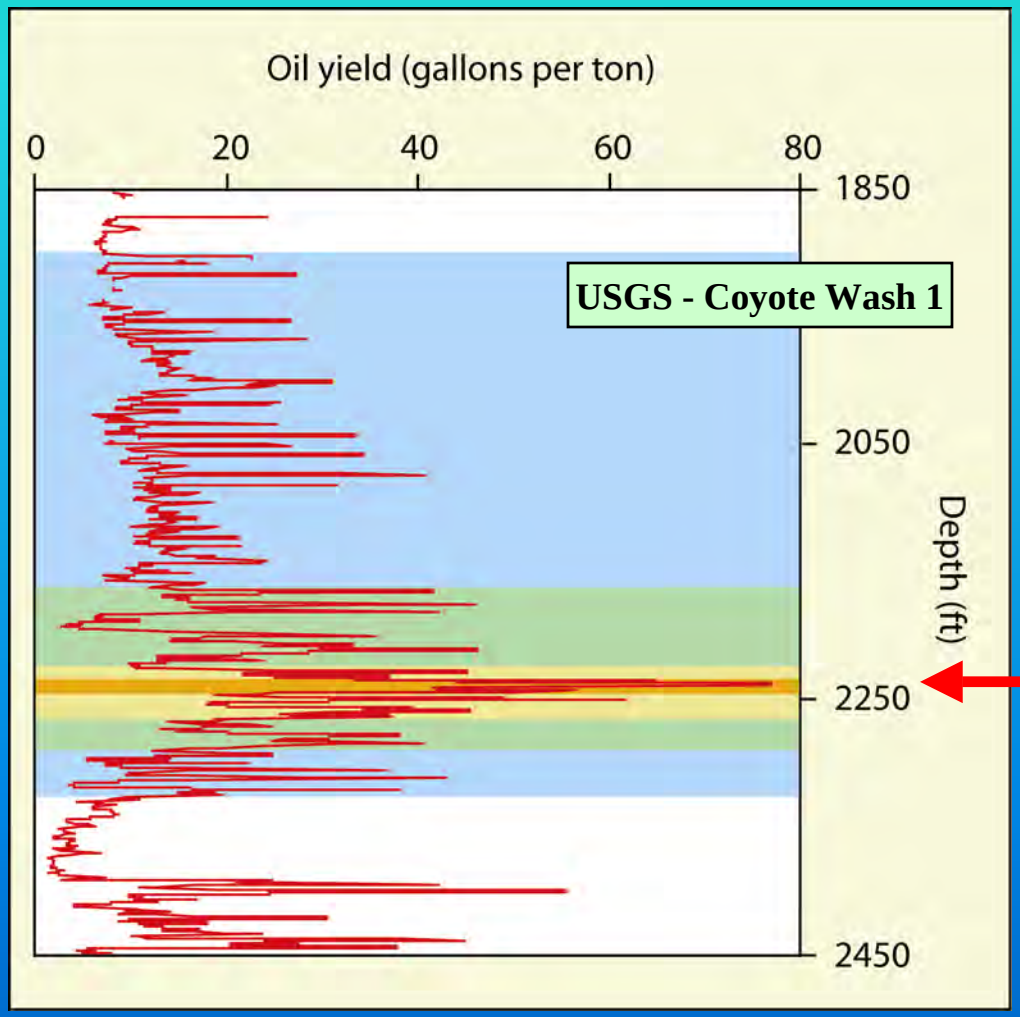


Step 4: Calculated thickness of certain richness zones

- **Zones averaging 15, 25, 35, and 50 gpt**

Average of 35 gpt

41 ft

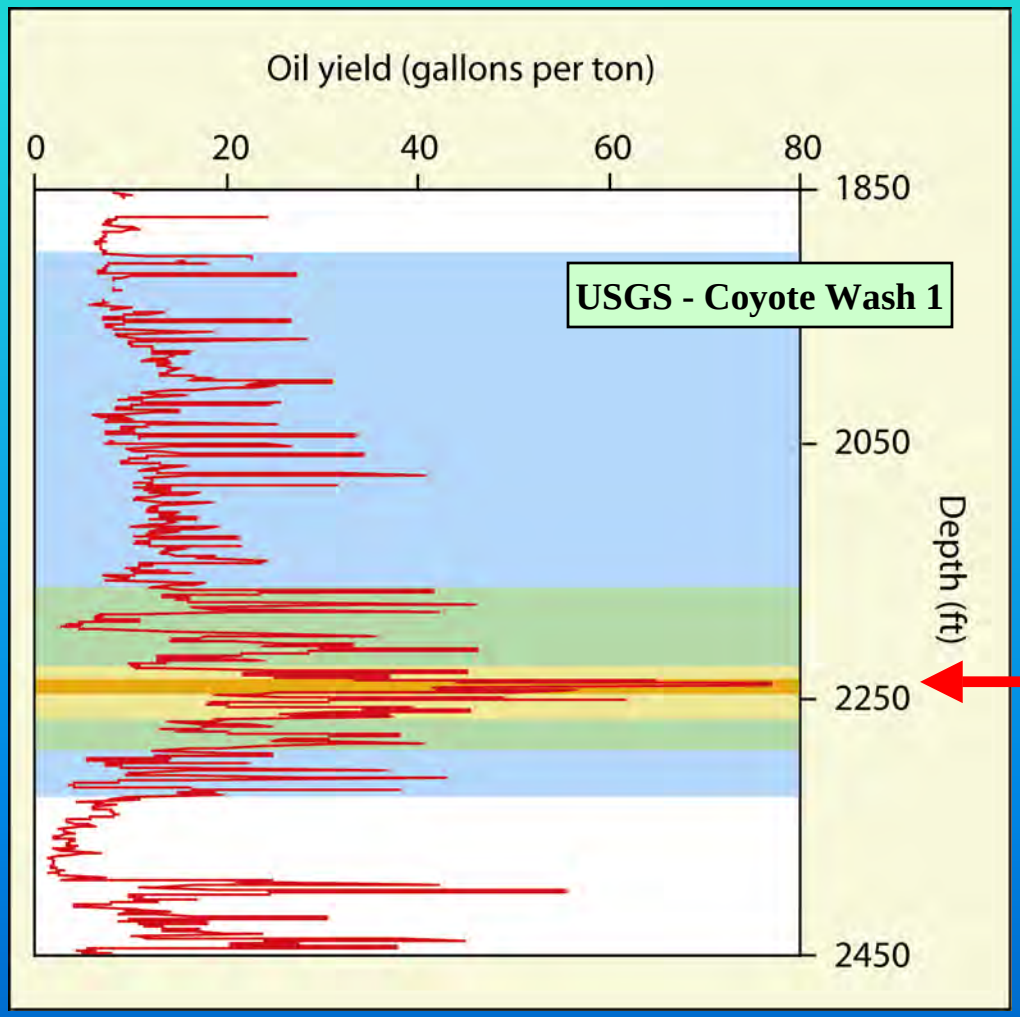


Step 4: Calculated thickness of certain richness zones

- **Zones averaging 15, 25, 35, and 50 gpt**

Average of 50 gpt

12 ft



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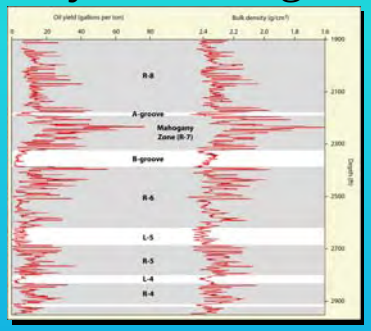

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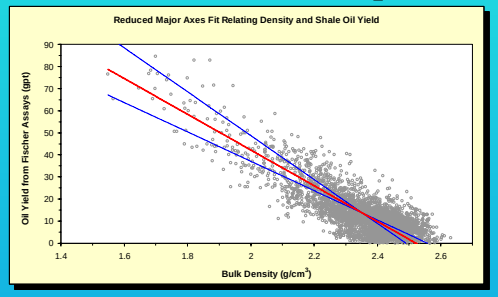

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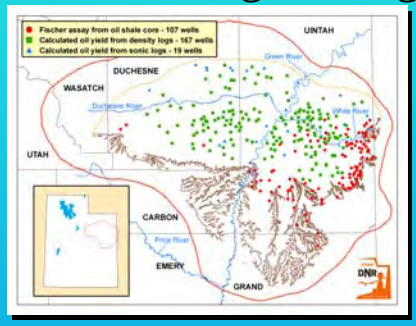

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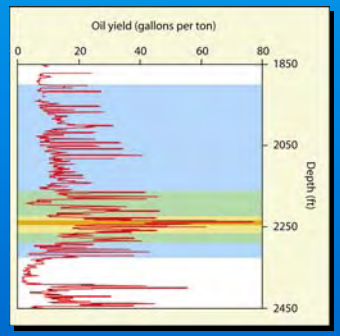

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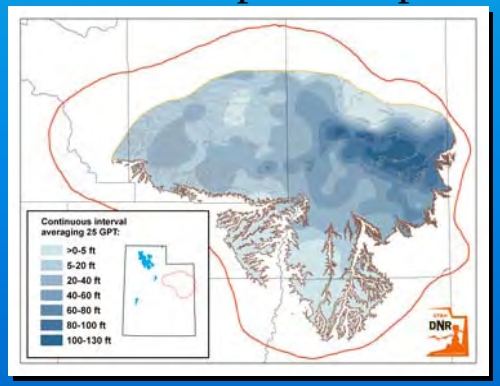


Step 6:
Calculate resource numbers

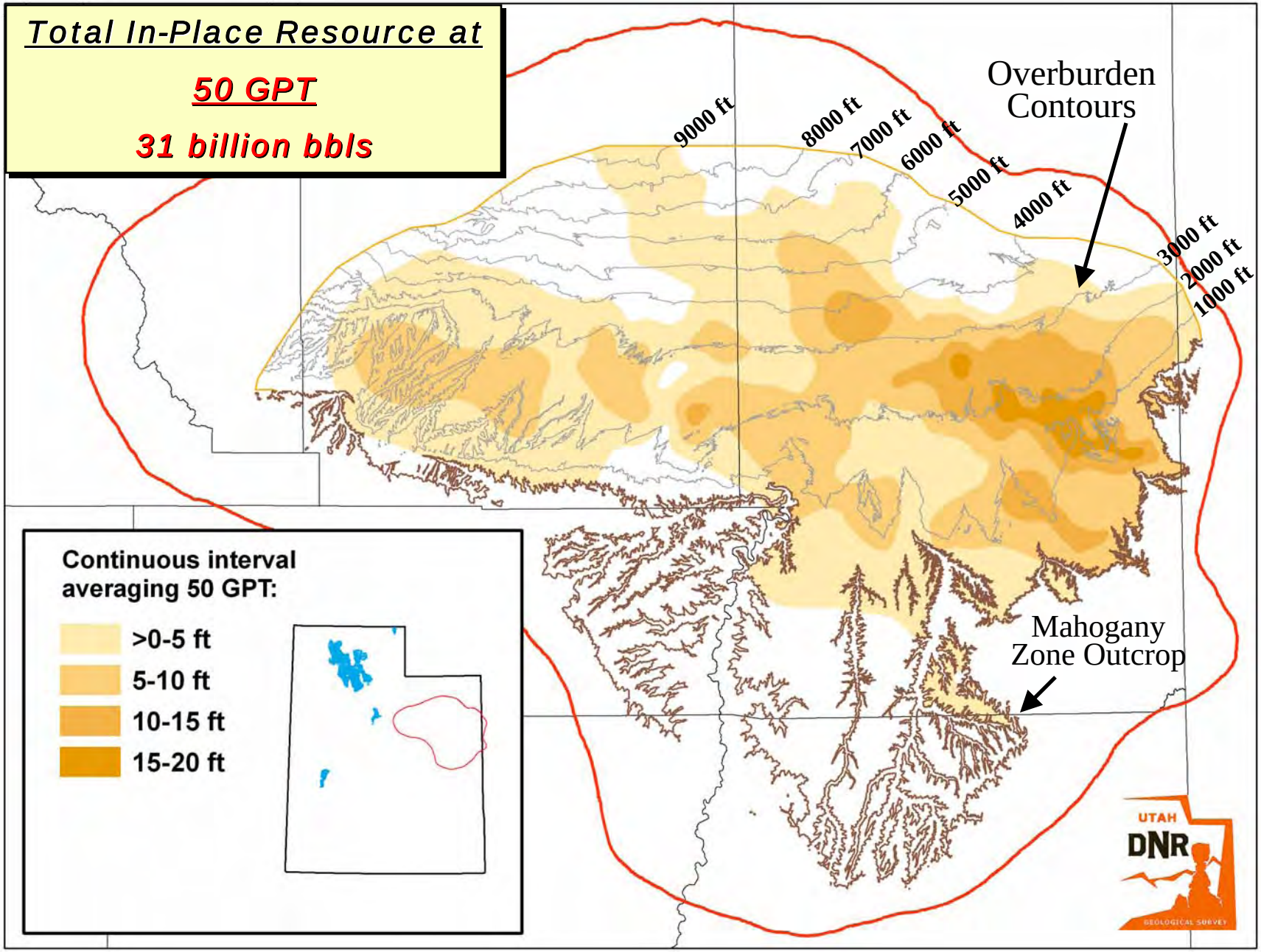
Step 5: Created isopach maps in ArcGIS

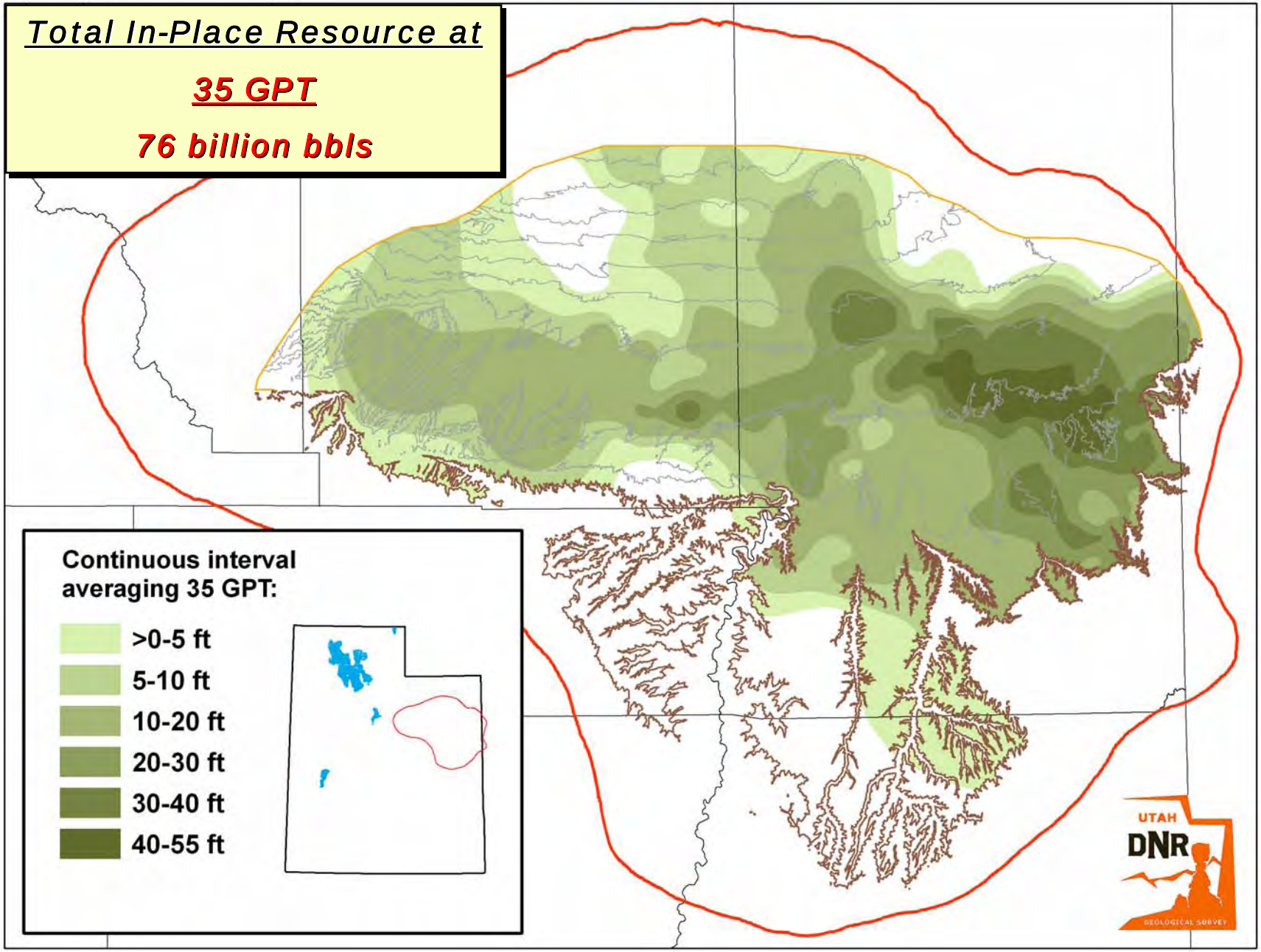
Step 6: Calculated resource numbers

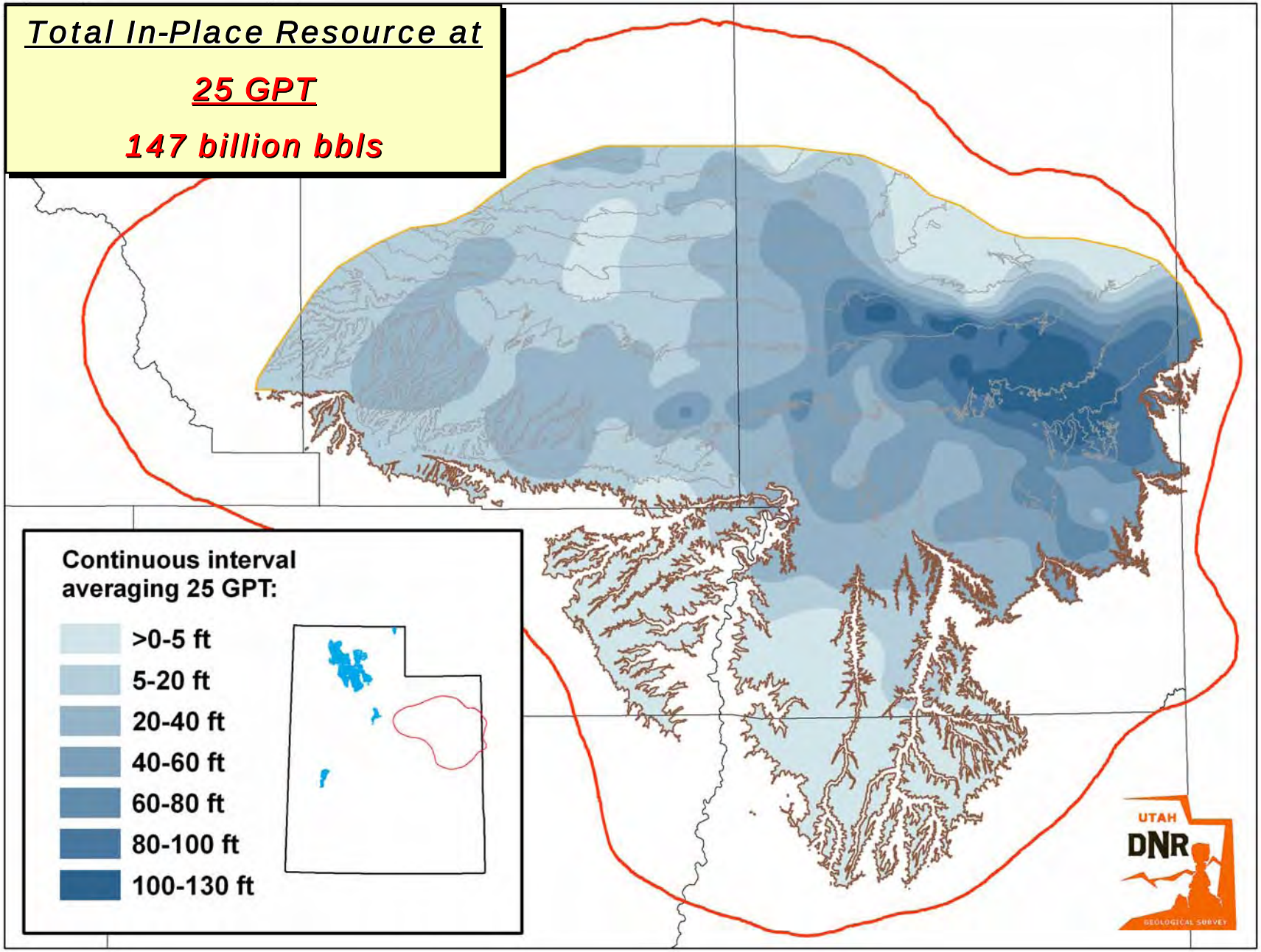
- Calculated resource for each richness zone (15, 25, 35, and 50 gpt)
- Calculated **volumes** in ArcGIS for each richness zone at several thickness intervals
- Used the density of each richness to convert **volume to mass**
  - 50 GPT = 1.90 g/cm^3
  - 35 GPT = 2.09 g/cm^3
  - 25 GPT = 2.21 g/cm^3
  - 15 GPT = 2.34 g/cm^3
- Used the richness (i.e., 50 gal per ton) to convert **mass to barrels**

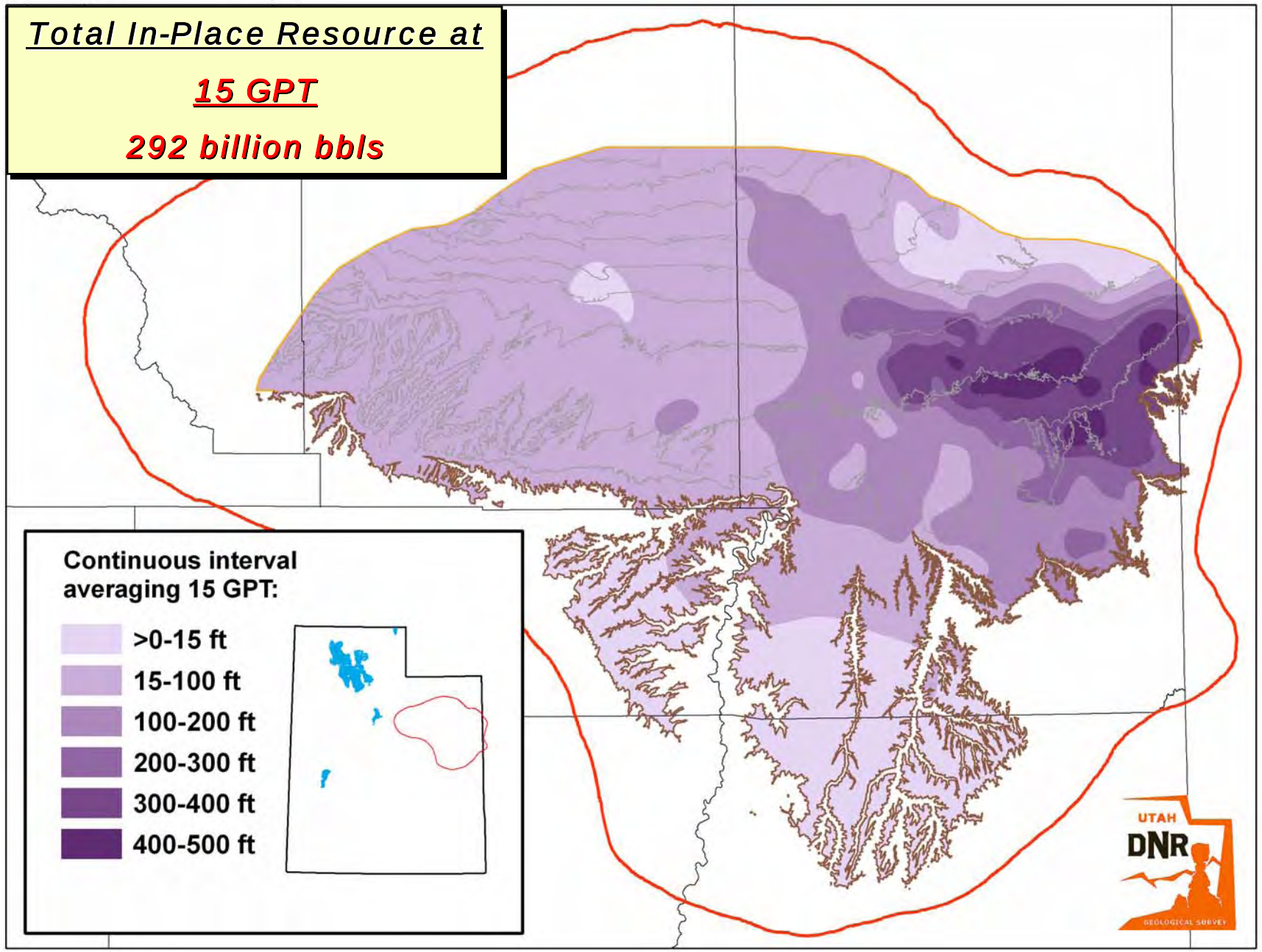
Results

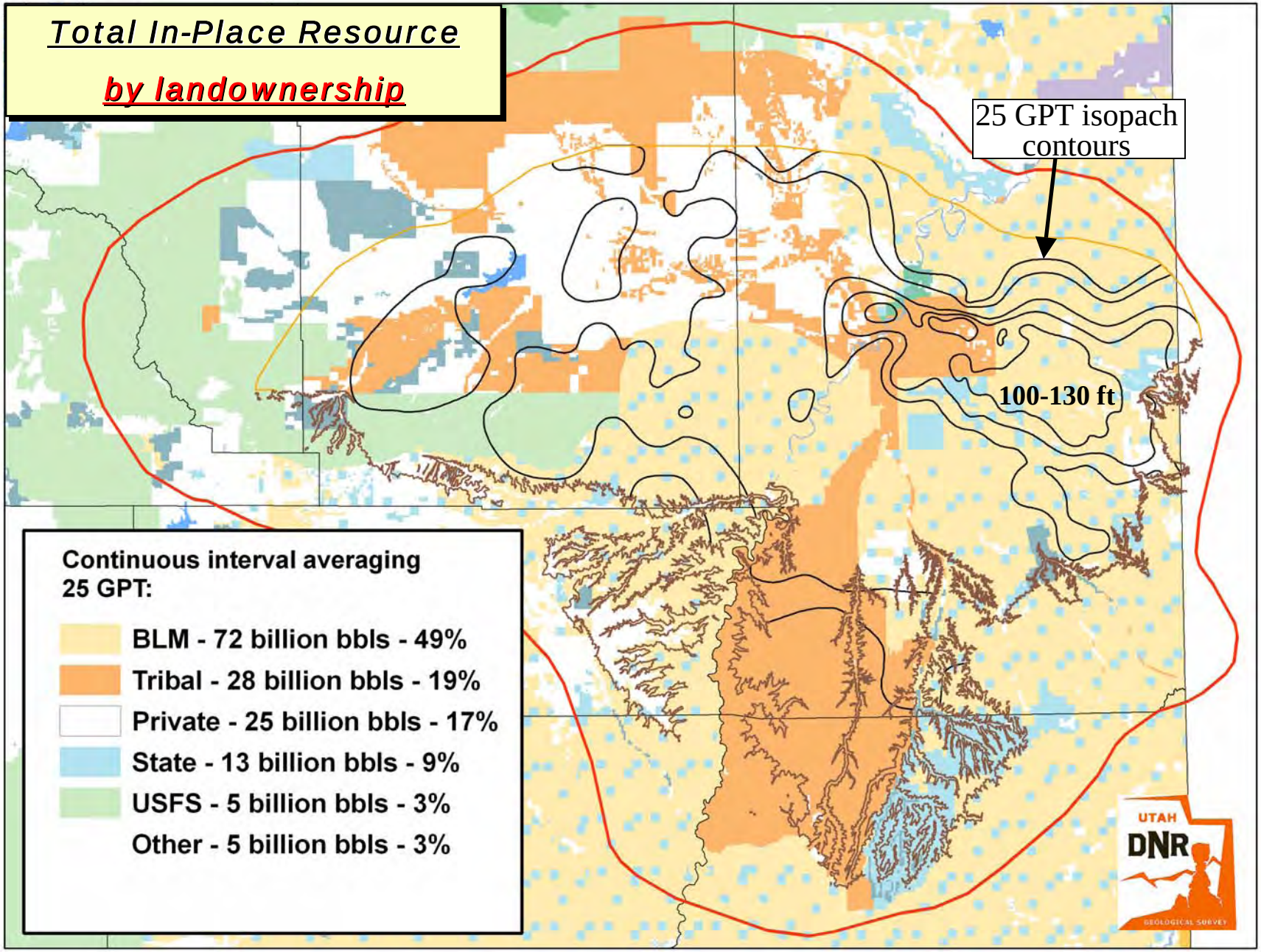
New Oil Shale Resource Estimates for Utah

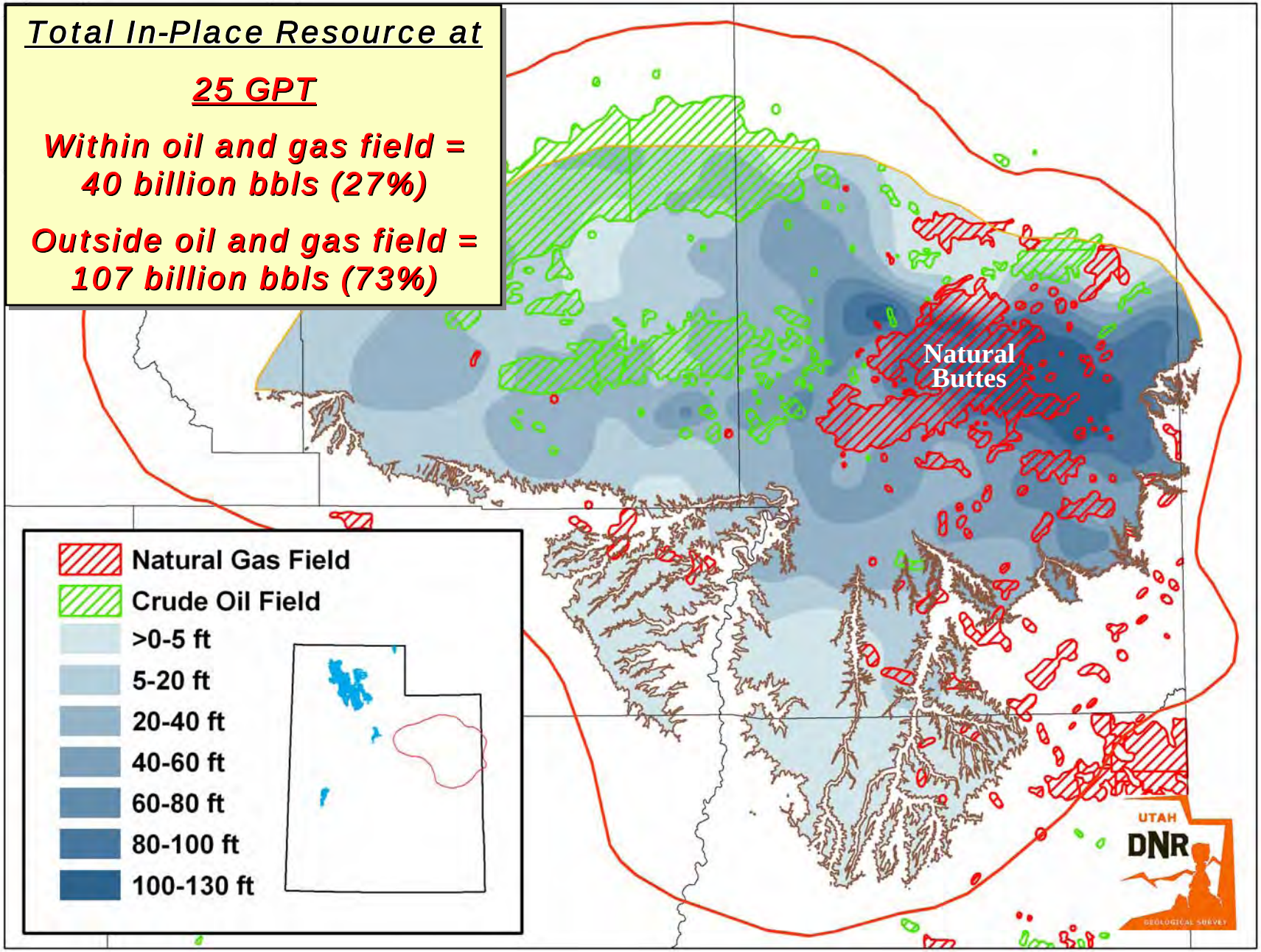

Total In-Place Resource at
50 GPT
31 billion bbls
Overburden Contours
9000 ft
8000 ft
7000 ft
6000 ft
5000 ft
4000 ft
3000 ft
2000 ft
1000 ft
Mahogany Zone Outcrop
Continuous interval averaging 50 GPT:
>0-5 ft
5-10 ft
10-15 ft
15-20 ft
UTAH
DNR
GEOLOGICAL SURVEY

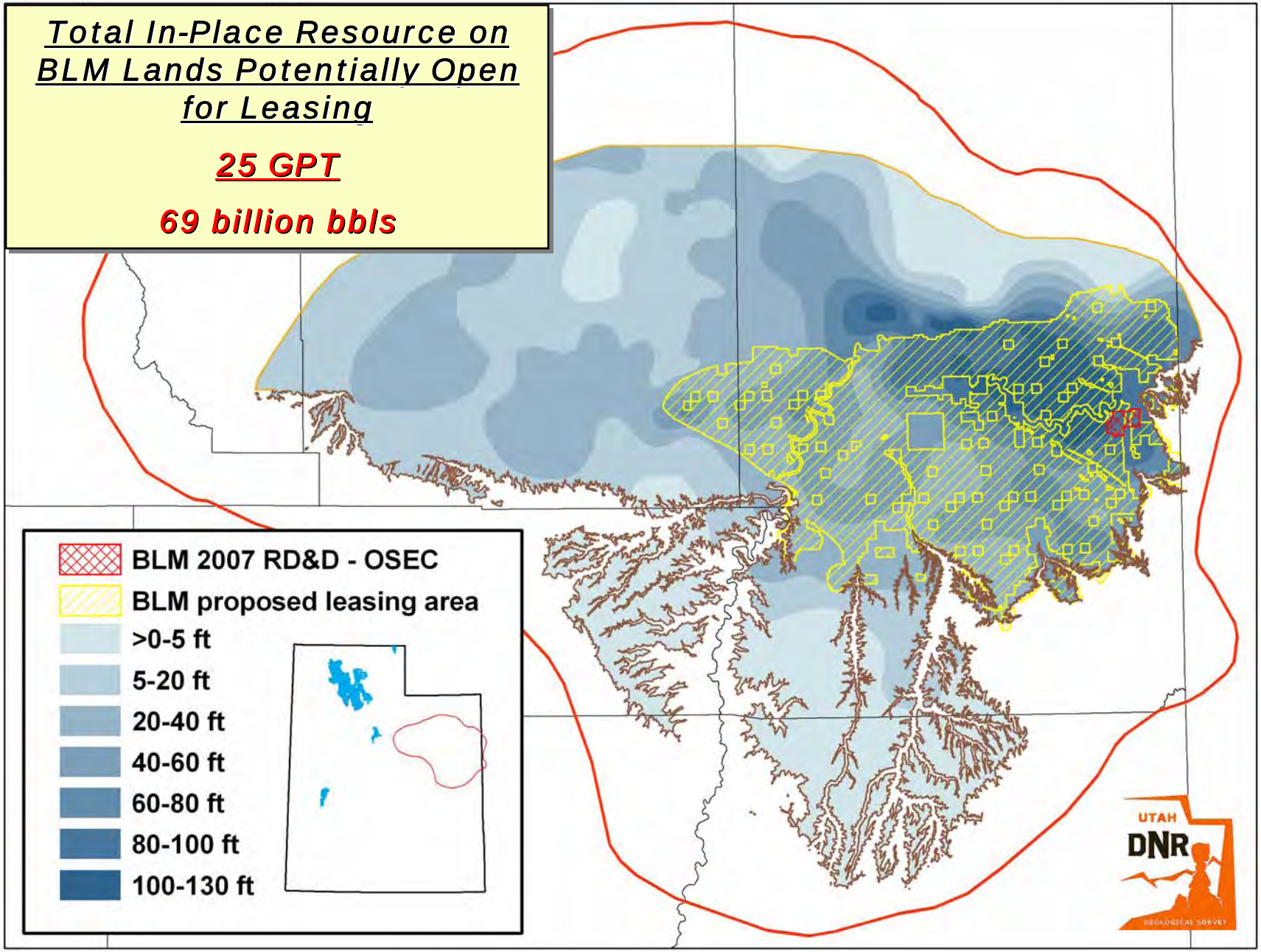

Total In-Place Resource at
35 GPT
76 billion bbls
Continuous interval averaging 35 GPT:
>0-5 ft
5-10 ft
10-20 ft
20-30 ft
30-40 ft
40-55 ft
UTAH
DNR
GEOLOGICAL SURVEY


Total In-Place Resource at
25 GPT
147 billion bbls
Continuous interval averaging 25 GPT:
>0-5 ft
5-20 ft
20-40 ft
40-60 ft
60-80 ft
80-100 ft
100-130 ft
UTAH
DNR
GEOLOGICAL SURVEY


Total In-Place Resource at
15 GPT
292 billion bbls
Continuous interval averaging 15 GPT:
>0-15 ft
15-100 ft
100-200 ft
200-300 ft
300-400 ft
400-500 ft
UTAH
DNR
GEOLOGICAL SURVEY


Total In-Place Resource
by landownership
25 GPT isopach contours
100-130 ft
Continuous interval averaging 25 GPT:
BLM - 72 billion bbls - 49%
Tribal - 28 billion bbls - 19%
Private - 25 billion bbls - 17%
State - 13 billion bbls - 9%
USFS - 5 billion bbls - 3%
Other - 5 billion bbls - 3%
UTAH
DNR
GEOLOGICAL SURVEY

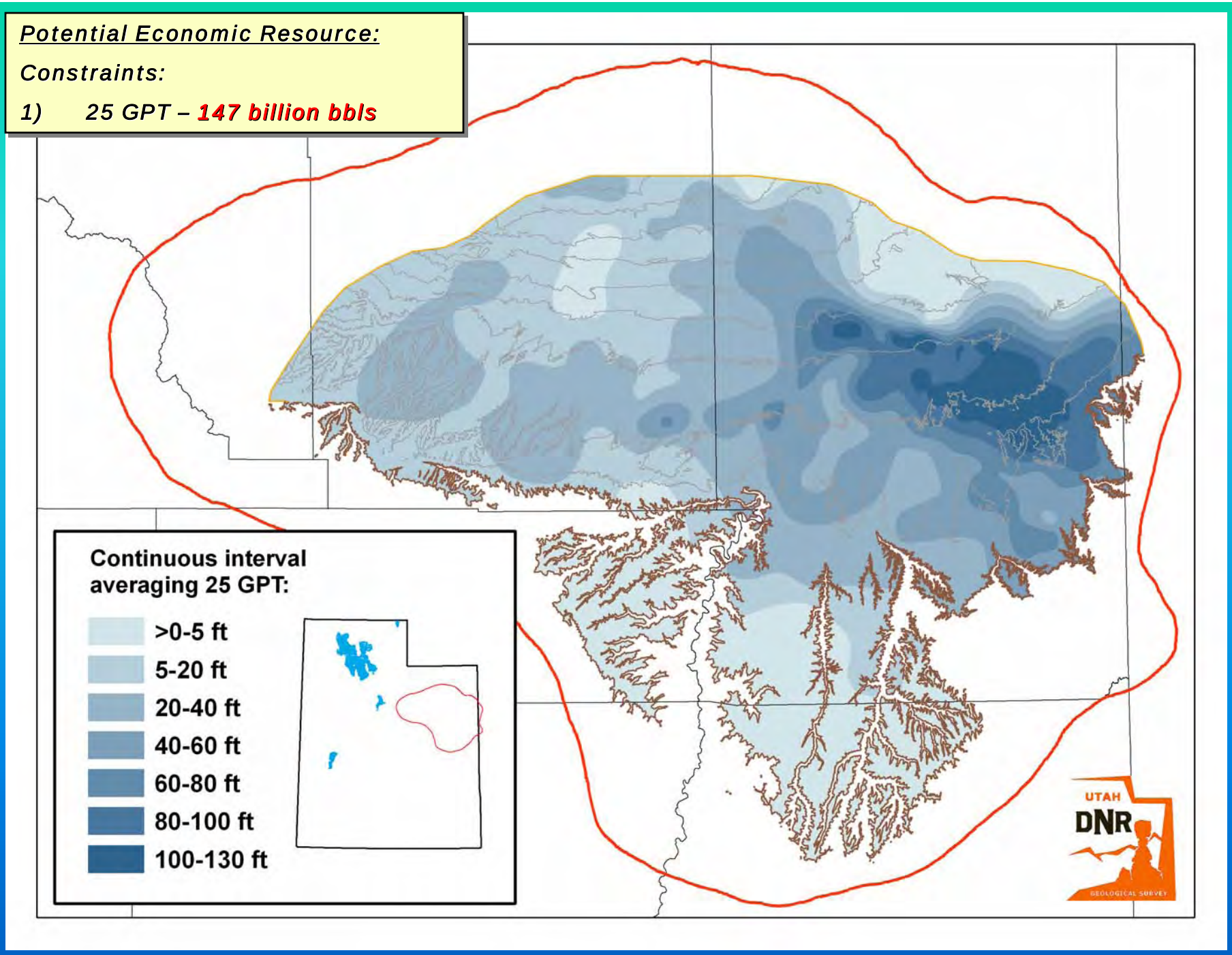

Total In-Place Resource at
25 GPT
Within oil and gas field =
40 billion bbls (27%)
Outside oil and gas field =
107 billion bbls (73%)
Natural
Buttes
Natural Gas Field
Crude Oil Field
>0-5 ft
5-20 ft
20-40 ft
40-60 ft
60-80 ft
80-100 ft
100-130 ft
UTAH
DNR


Total In-Place Resource on BLM Lands Potentially Open for Leasing
25 GPT
69 billion bbls
BLM 2007 RD&D - OSEC
BLM proposed leasing area
>0-5 ft
5-20 ft
20-40 ft
40-60 ft
60-80 ft
80-100 ft
100-130 ft
UTAH
DNR
GEOLOGICAL SURVEY

Potential Economic Resource:

Constraints:

1) 25 GPT – 147 billion bbls

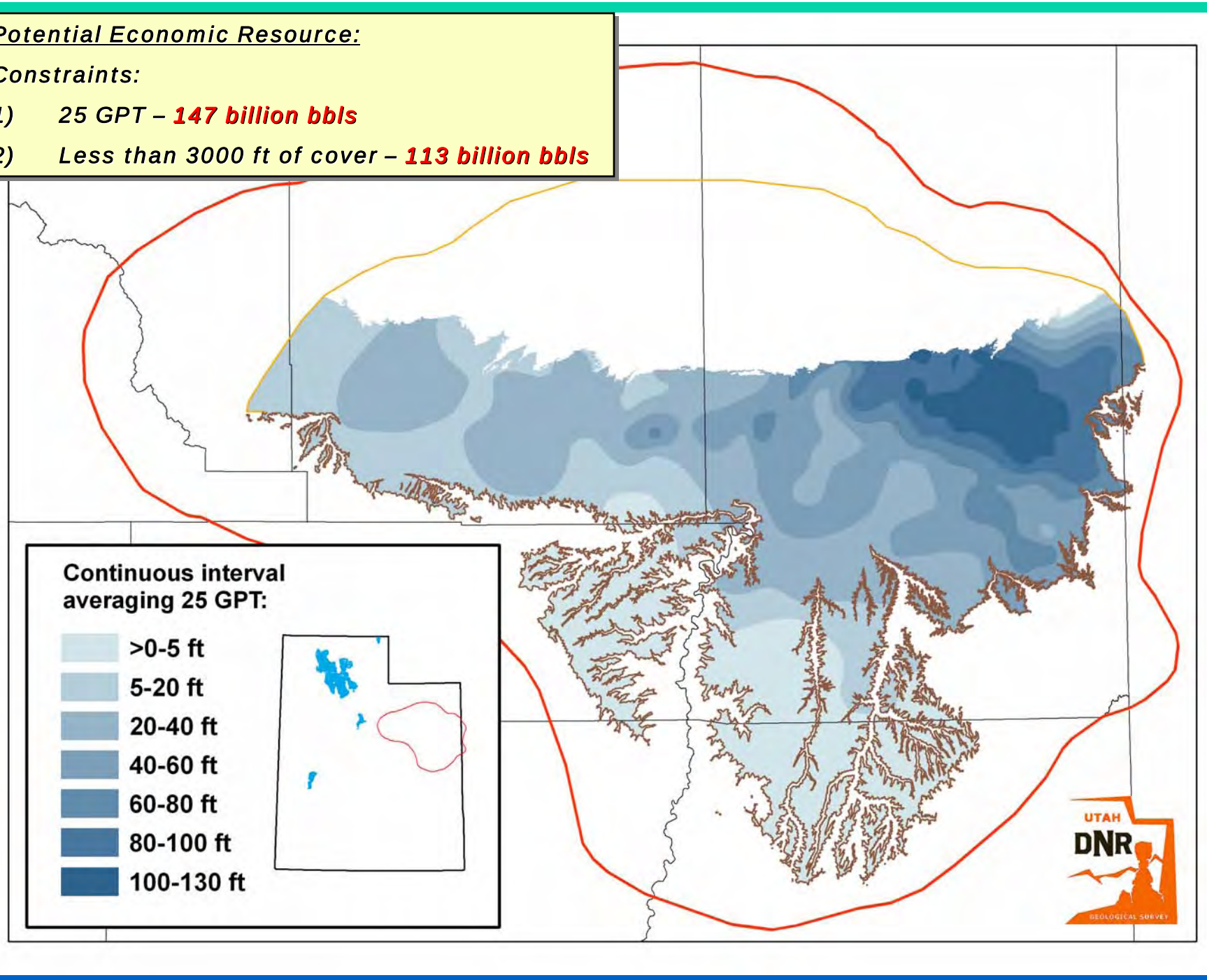


Potential Economic Resource:

Constraints:

1) 25 GPT – 147 billion bbls

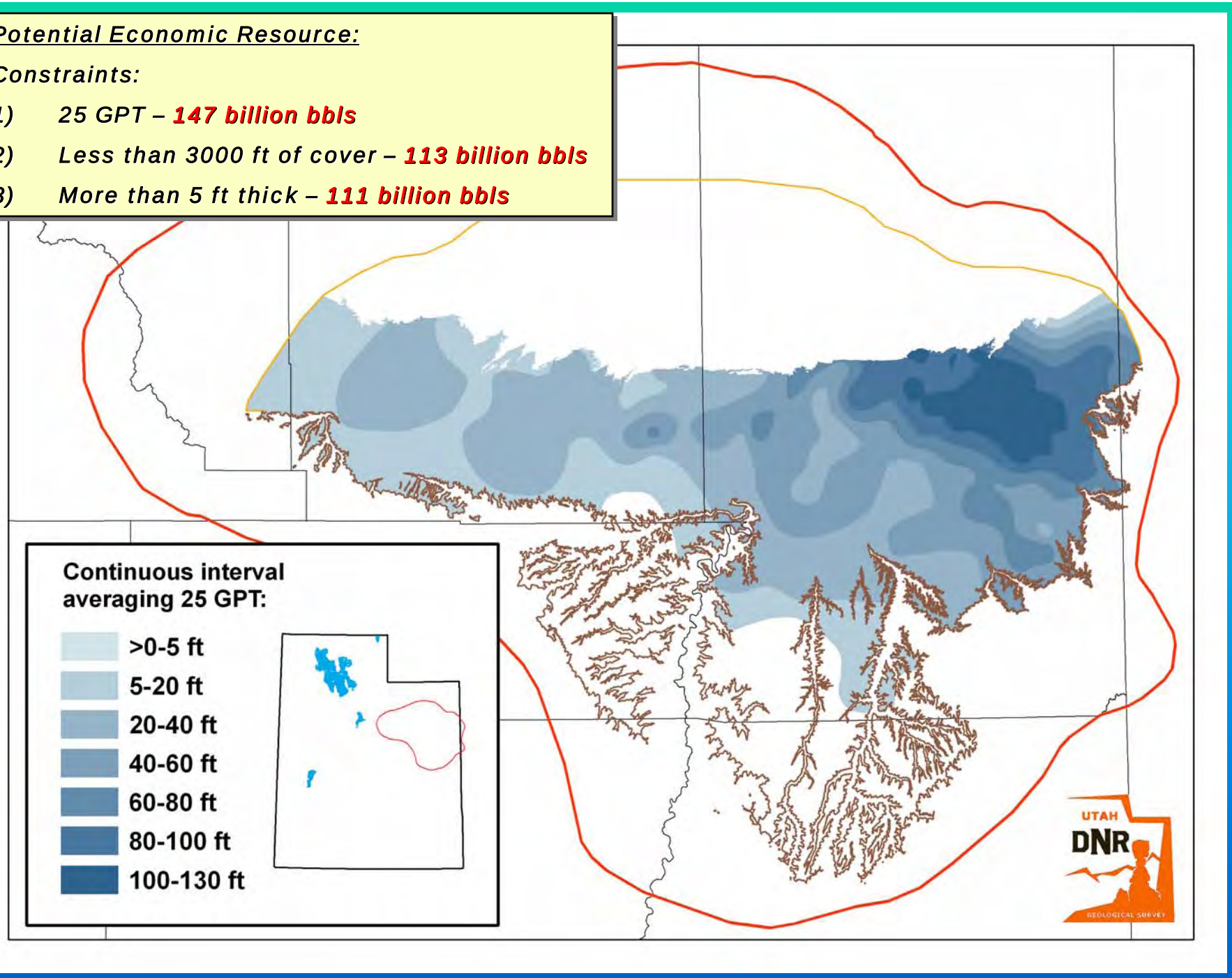
2) Less than 3000 ft of cover – 113 billion bbls



Potential Economic Resource:

Constraints:

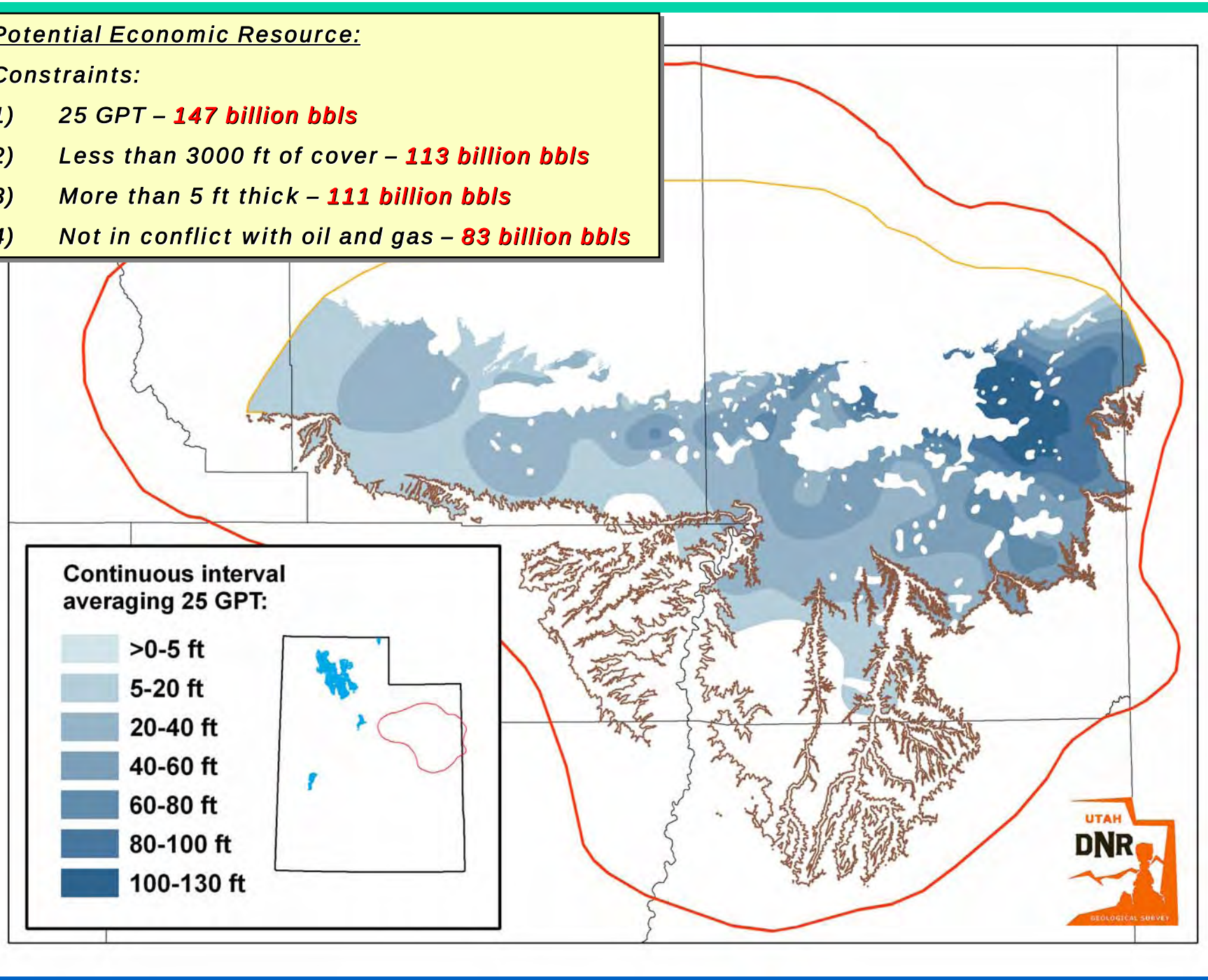
1) *25 GPT – **147 billion bbls***
2) *Less than 3000 ft of cover – **113 billion bbls***
3) *More than 5 ft thick – **111 billion bbls***



Potential Economic Resource:

Constraints:

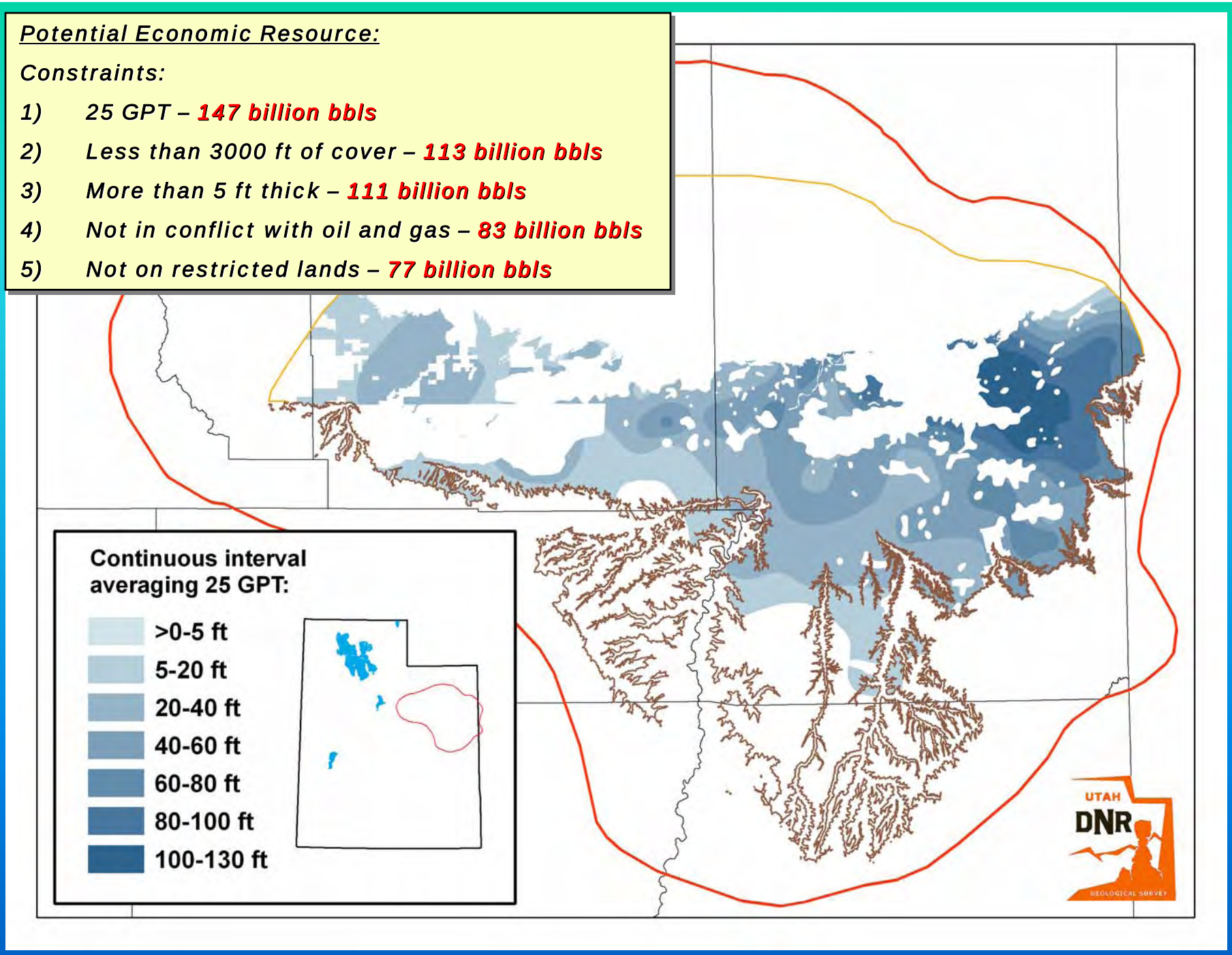
1) *25 GPT – **147 billion bbls***
2) *Less than 3000 ft of cover – **113 billion bbls***
3) *More than 5 ft thick – **111 billion bbls***
4) *Not in conflict with oil and gas – **83 billion bbls***



Potential Economic Resource:

Constraints:

1) *25 GPT – **147 billion bbls***
2) *Less than 3000 ft of cover – **113 billion bbls***
3) *More than 5 ft thick – **111 billion bbls***
4) *Not in conflict with oil and gas – **83 billion bbls***
5) *Not on restricted lands – **77 billion bbls***



Take Home Message

- Utah's Potential Economic Oil Shale **Resource** =

77 billion barrels

- Roughly **75% less** than numbers frequently quoted, but **still very large and very significant**

- The UGS supports the advancement of **pilot projects** to firm up technology and answer pressing questions

Additional UGS Projects - Upper Green River Formation

1) University of Utah - Energy and Geoscience Institute and Department of Chemical Engineering
   - Depositional heterogeneity and fluid flow modeling of the oil shale interval of the Green River Formation, eastern Uinta Basin, Utah
2) Dr. Jessica Whiteside - Brown University
   - Multiproxy paleoclimate reconstruction of Earth's most recent extreme hothouse - Milankovitch cyclicity in the upper Green River Formation
3) TerraTek, a Schlumberger Company, Salt Lake City, UT
   - Continuous unconfined compressive strength profiling (TSI™ scratch testing) and other physical property analyses of upper Green River oil shales
4) UGS - NETL/DOE funded project
   - Water-related issues affecting conventional oil and gas recovery and potential oil shale development in the Uinta Basin, Utah