

# **Saline Water Disposal into the Birds Nest Aquifer in the Uinta Basin, Utah: Updated Research on the Implications for Oil Shale Development**



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**Utah Geological Survey**

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**30<sup>th</sup> Oil Shale Symposium**

UGS project website: [geology.utah.gov/emp/UBwater\\_study](http://geology.utah.gov/emp/UBwater_study)

# Outline

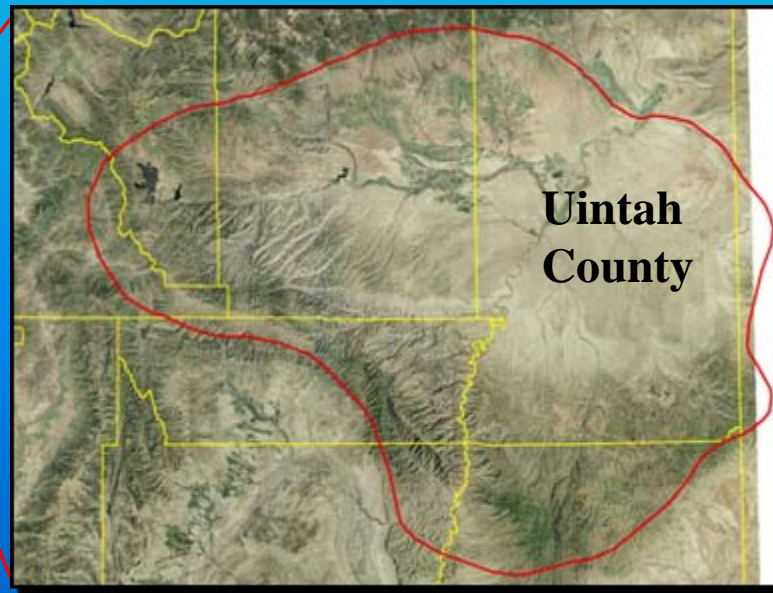
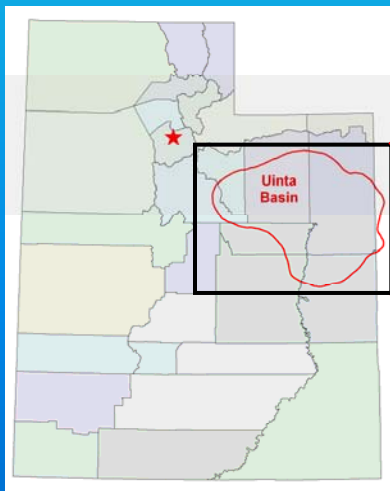
- **Birds Nest aquifer introduction**
- Examination of cores
- Examination of outcrop
- Regional cross-sections
- Relationship with gilsonite veins

## Research Project

**Overall Goal:** Assess aquifers in the Uinta Basin to determine where saline water (produced along with conventional petroleum development) can be disposed without harming freshwater resources

**Specific problem:** The Birds Nest aquifer has been identified by Uintah County natural gas producers as a zone suitable for large-scale saline water disposal; **however**, this aquifer is poorly understood and needs further study to determine potential impacts of proposed/active disposal

- Relationship to fresh water resources
- Potential effects on future oil shale development (**focus of this talk**)



### **Funding acknowledgements:**

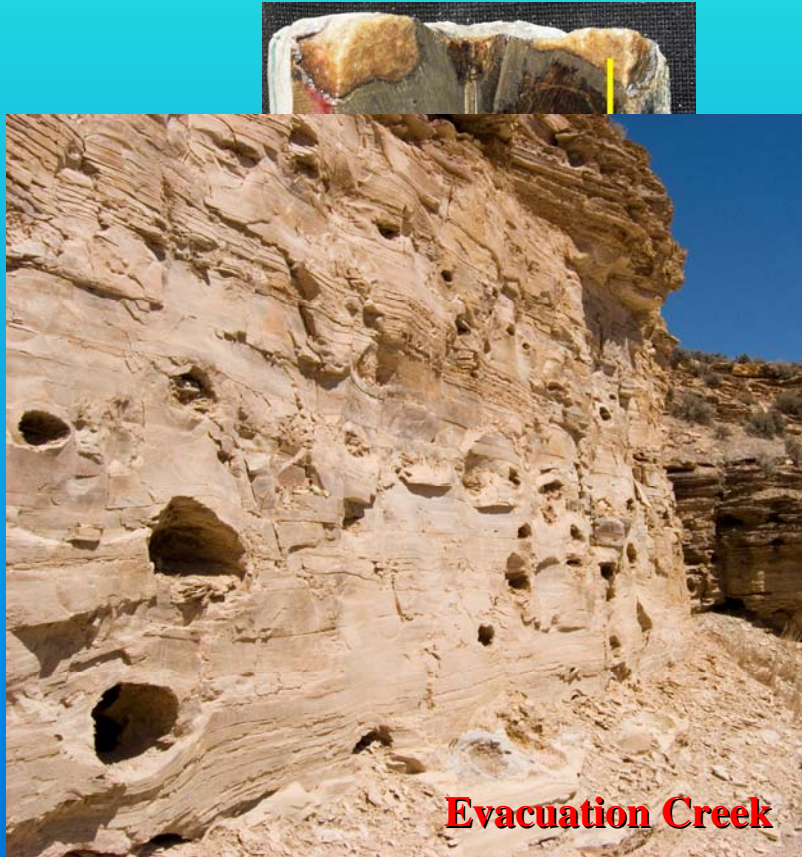
- U.S. DOE - National Energy Technology Laboratory
- Utah Geological Survey

**Description:** The Birds Nest aquifer formed from the dissolution of saline minerals (mostly nahcolite) within the upper Green River Formation oil shale zone

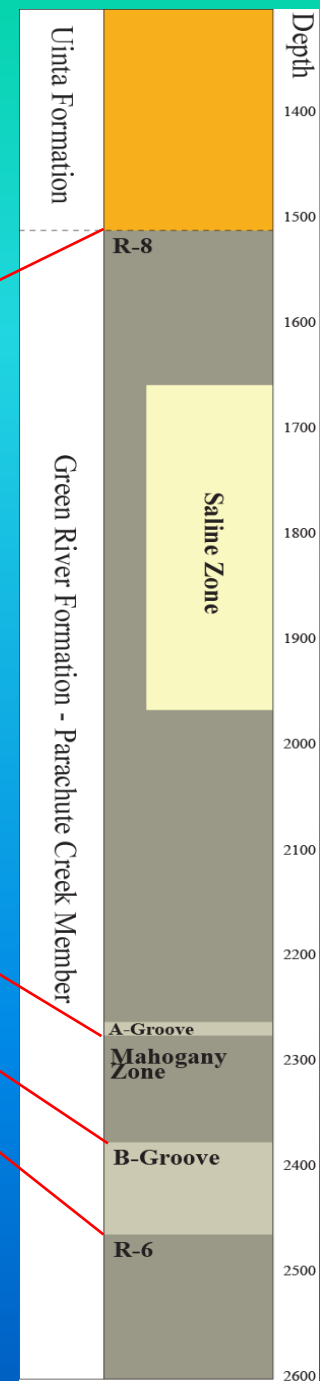
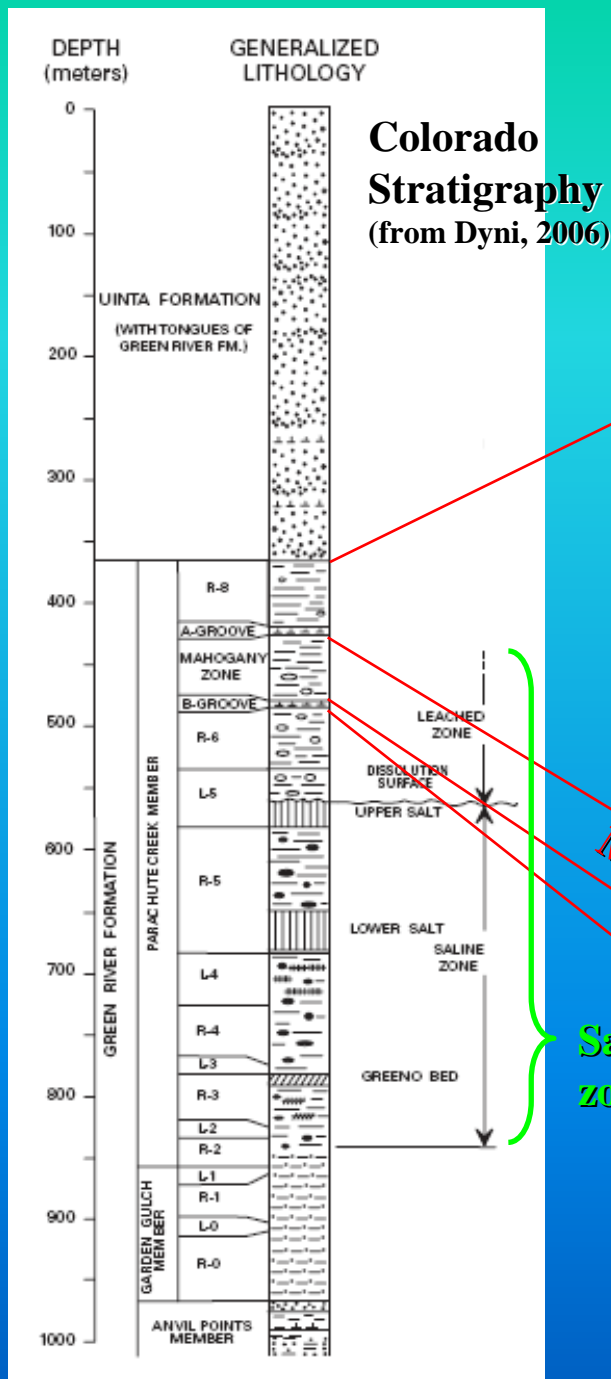




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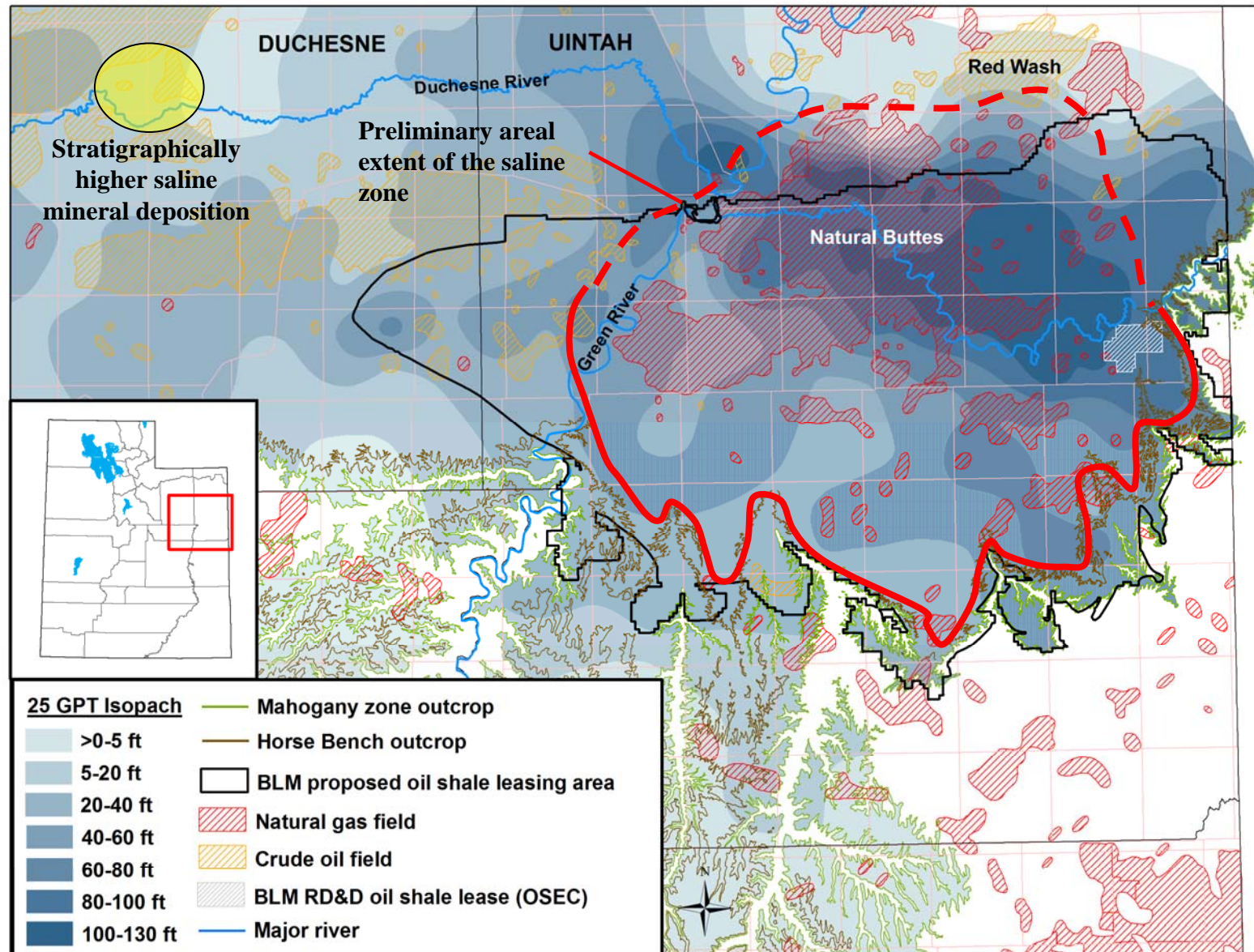


Each circle  
represents a 0.5-  
to 1-foot gap

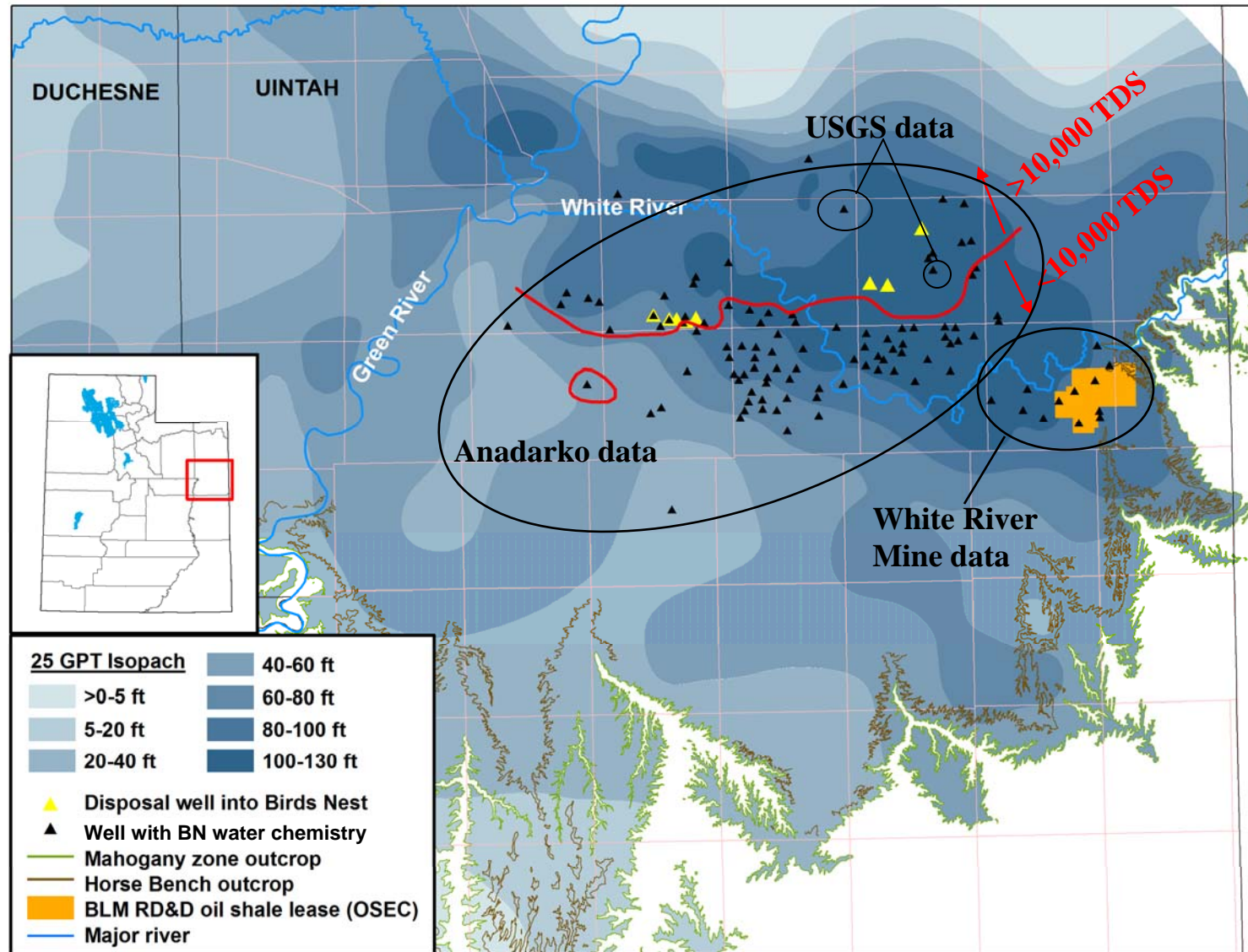




**Location:** Mostly restricted to central Uintah County

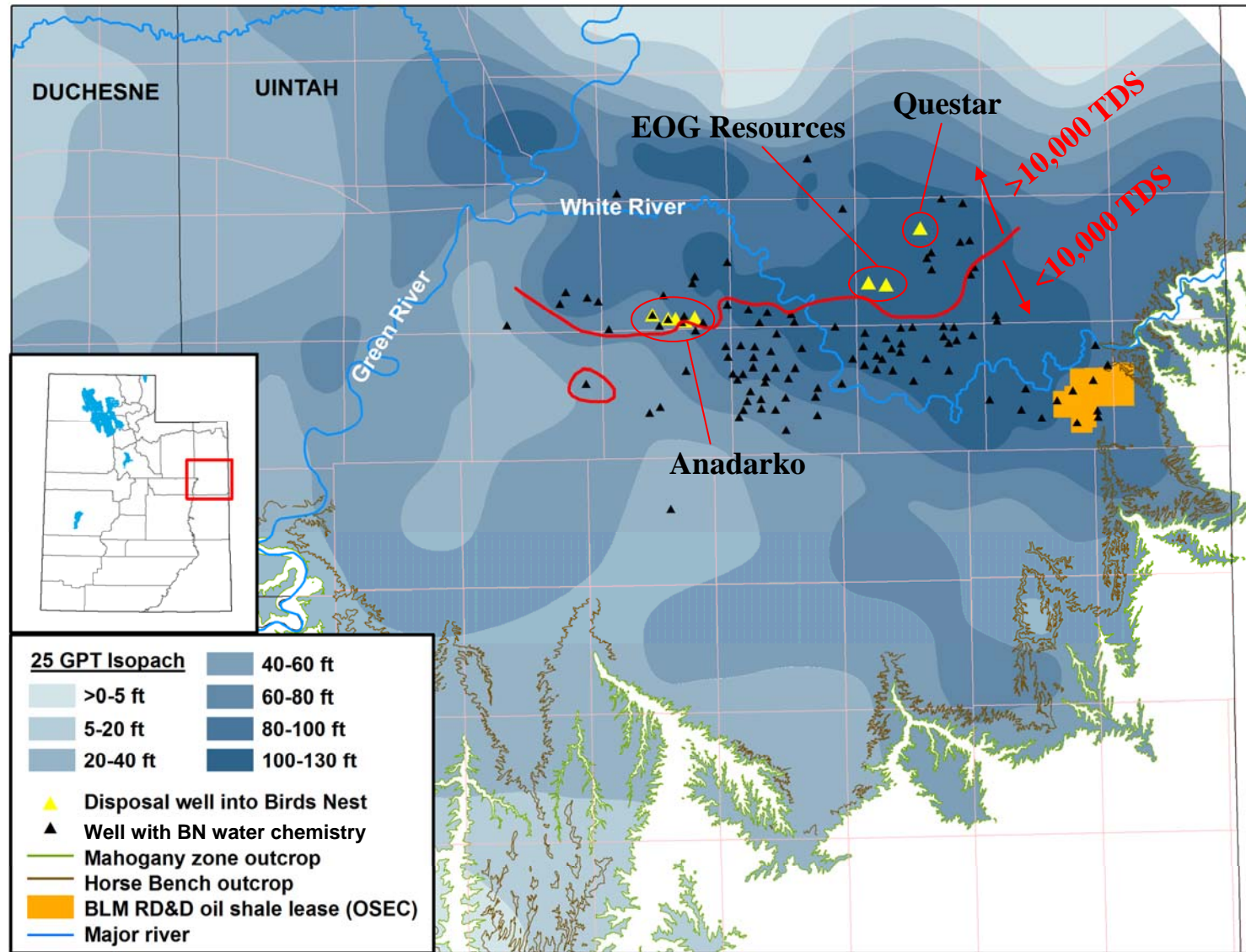


# Water quality in the Birds Nest aquifer





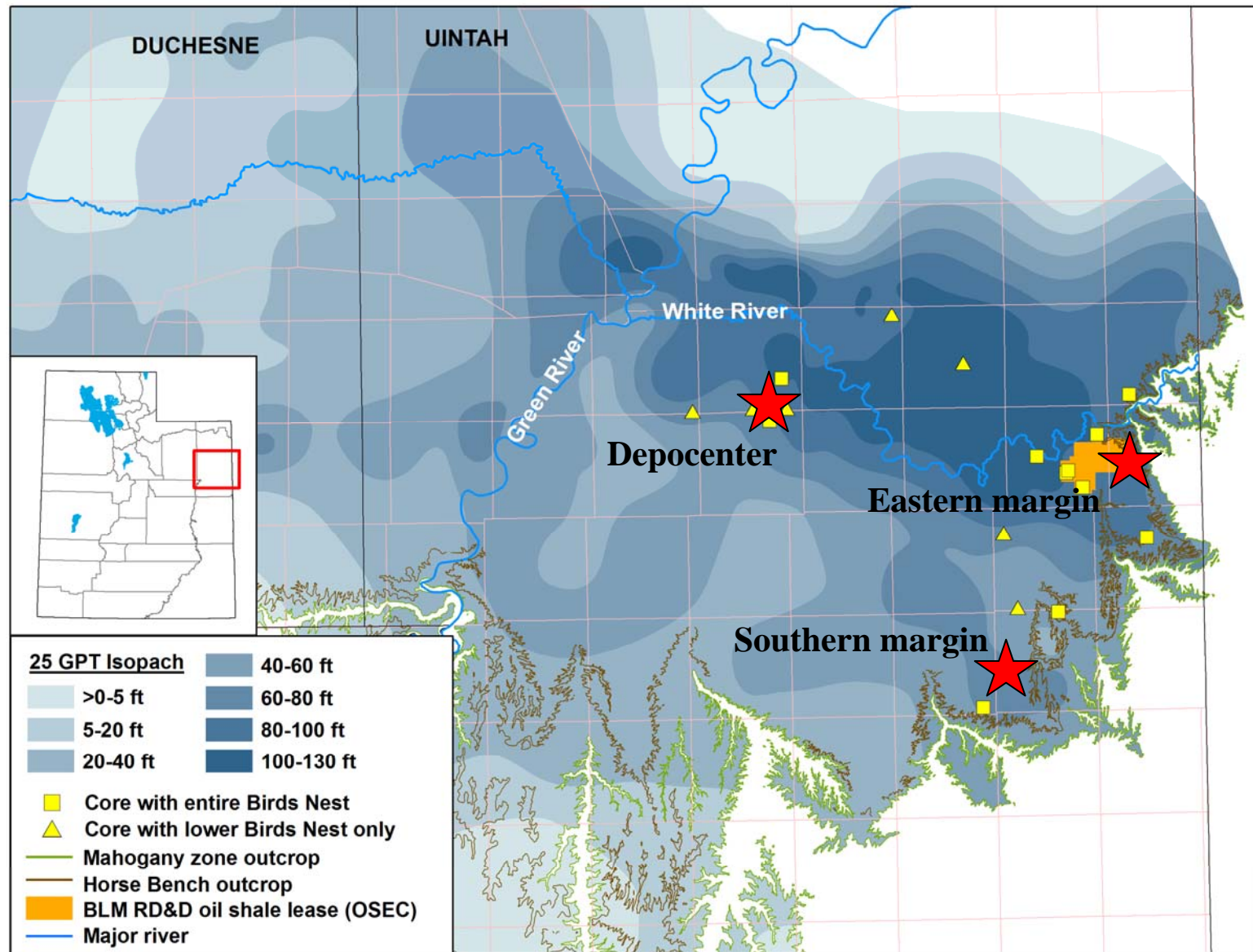
# Water quality in the Birds Nest aquifer



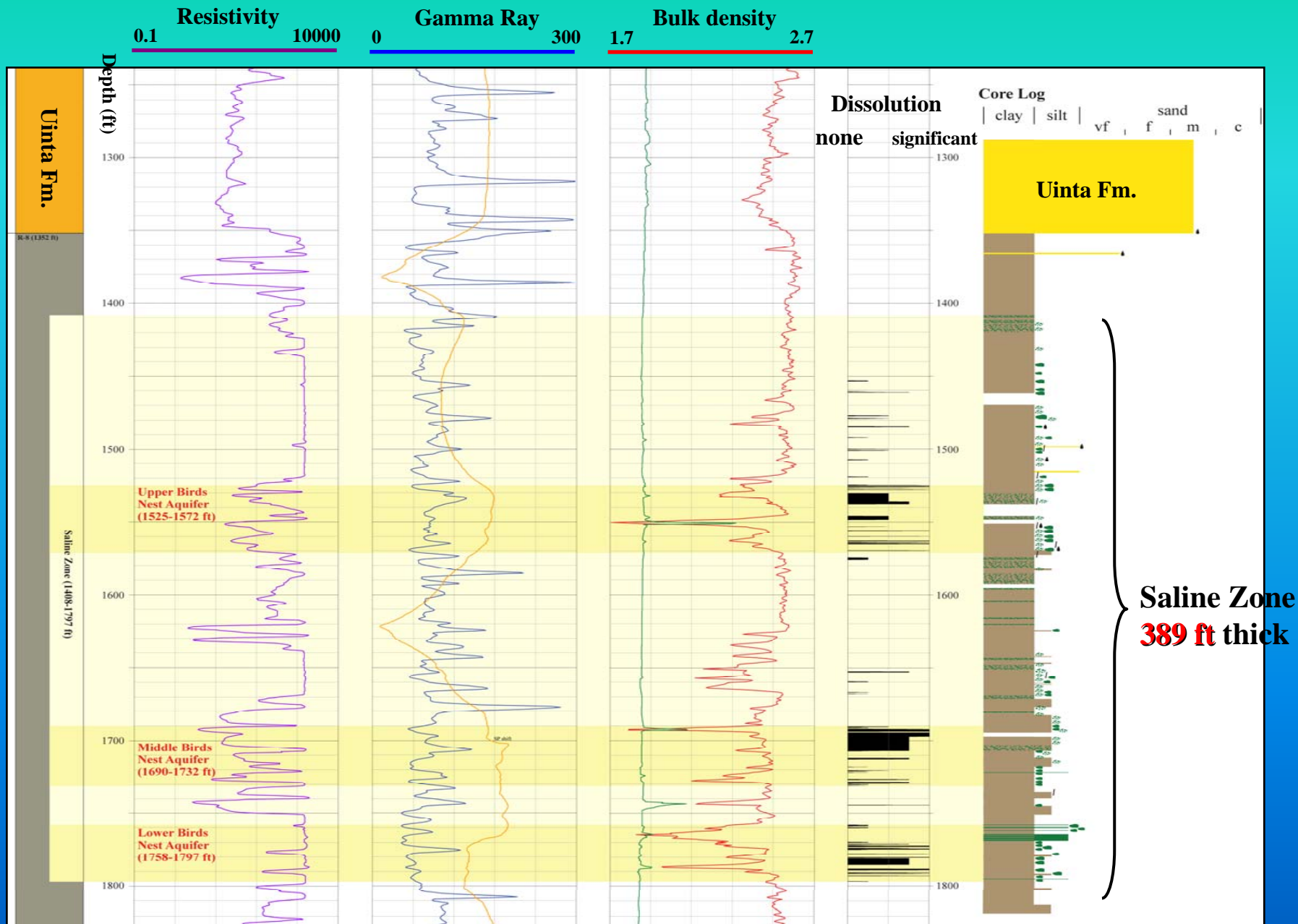
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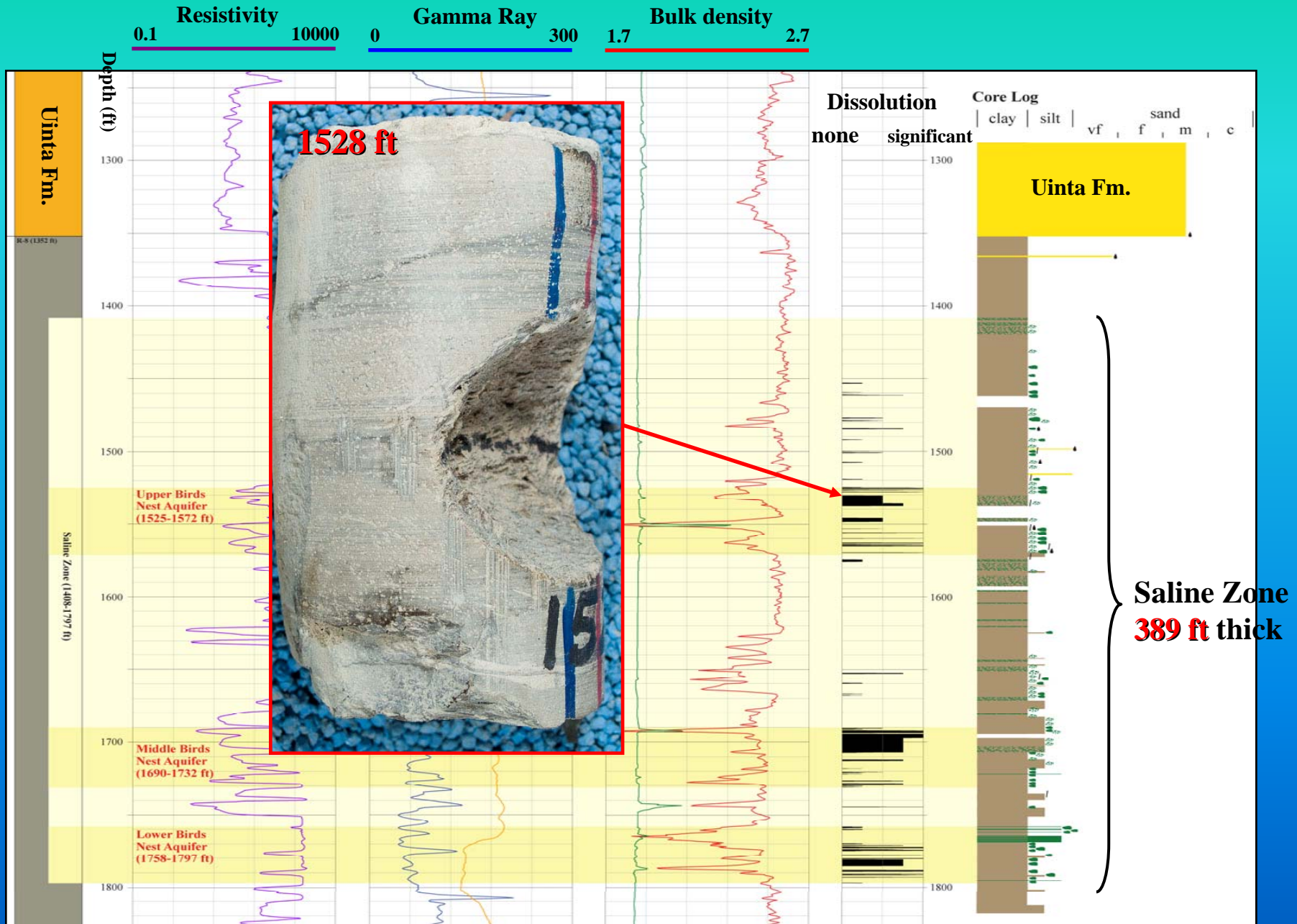
- Birds Nest aquifer introduction
- **Examination of cores**
- Examination of outcrop
- Regional cross-sections
- Relationship with gilsonite veins

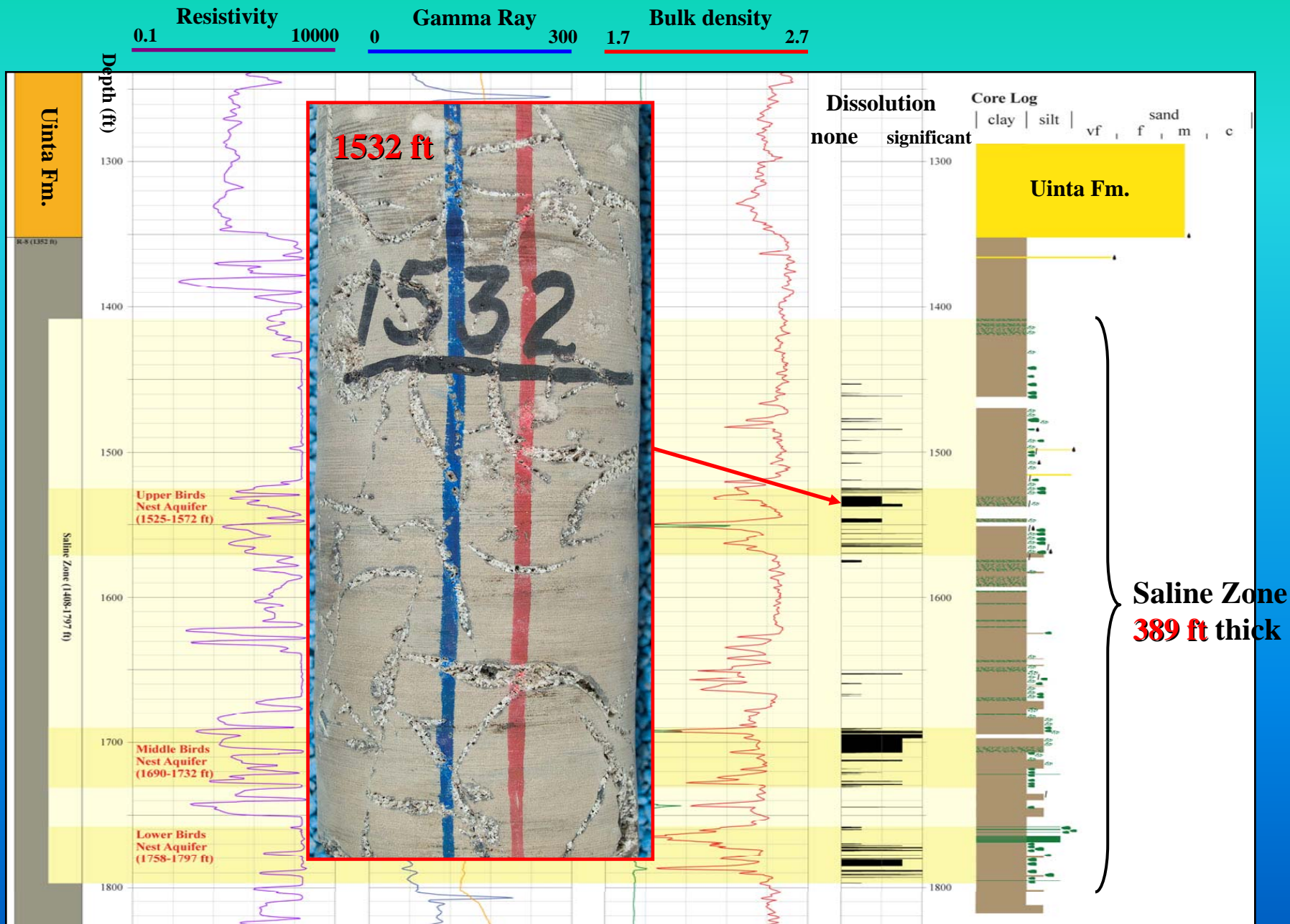
## Core is the key to understanding the Birds Nest Aquifer



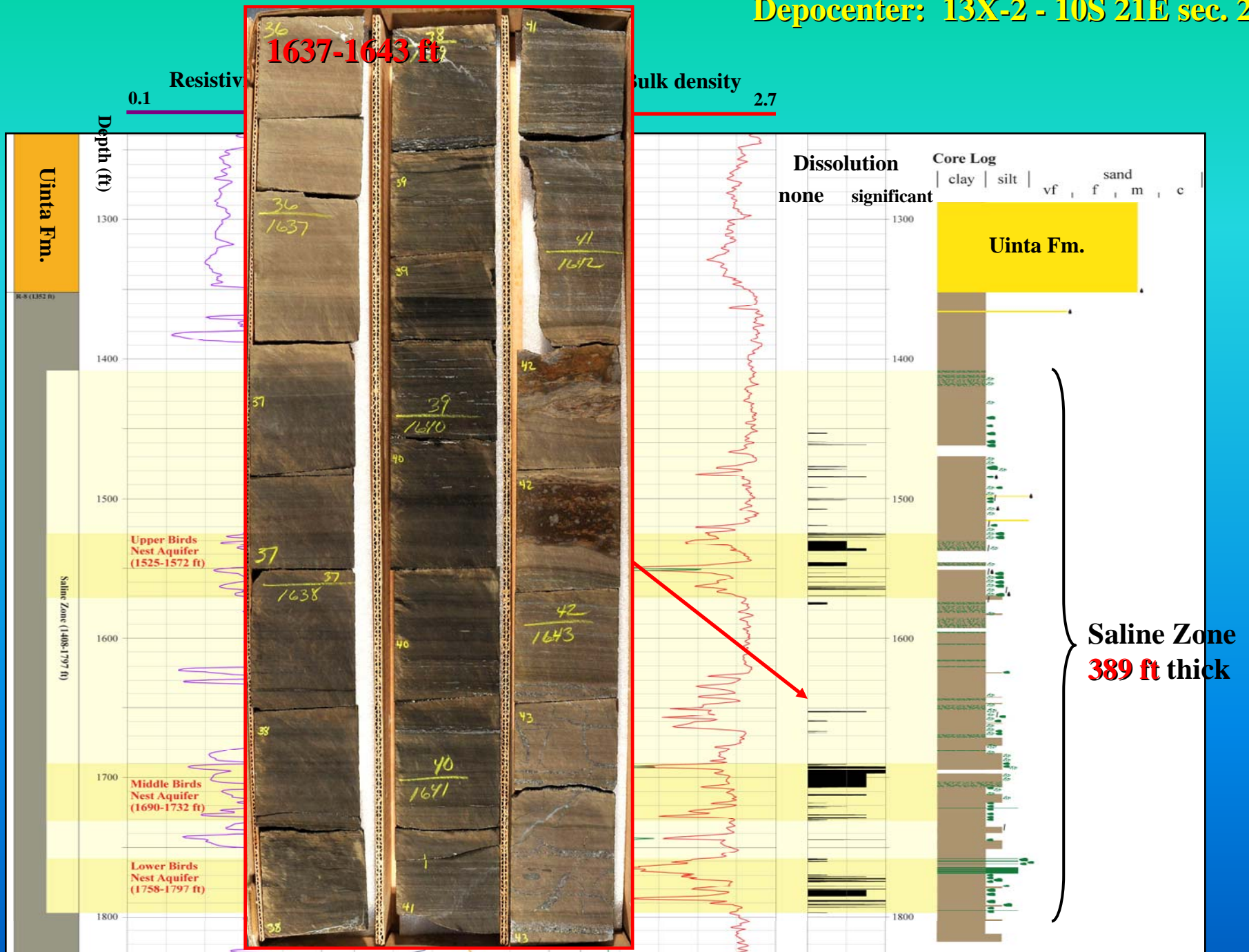




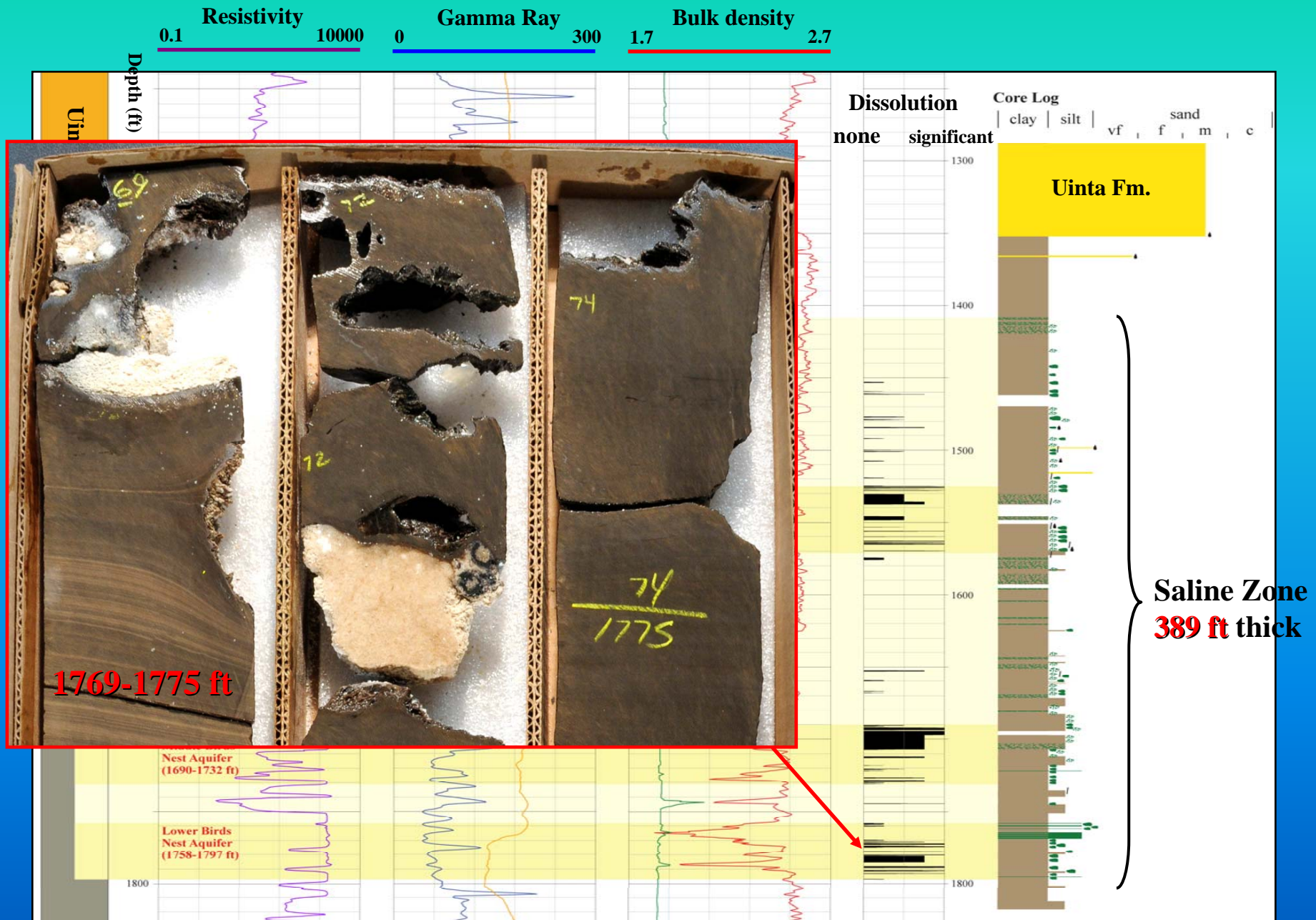




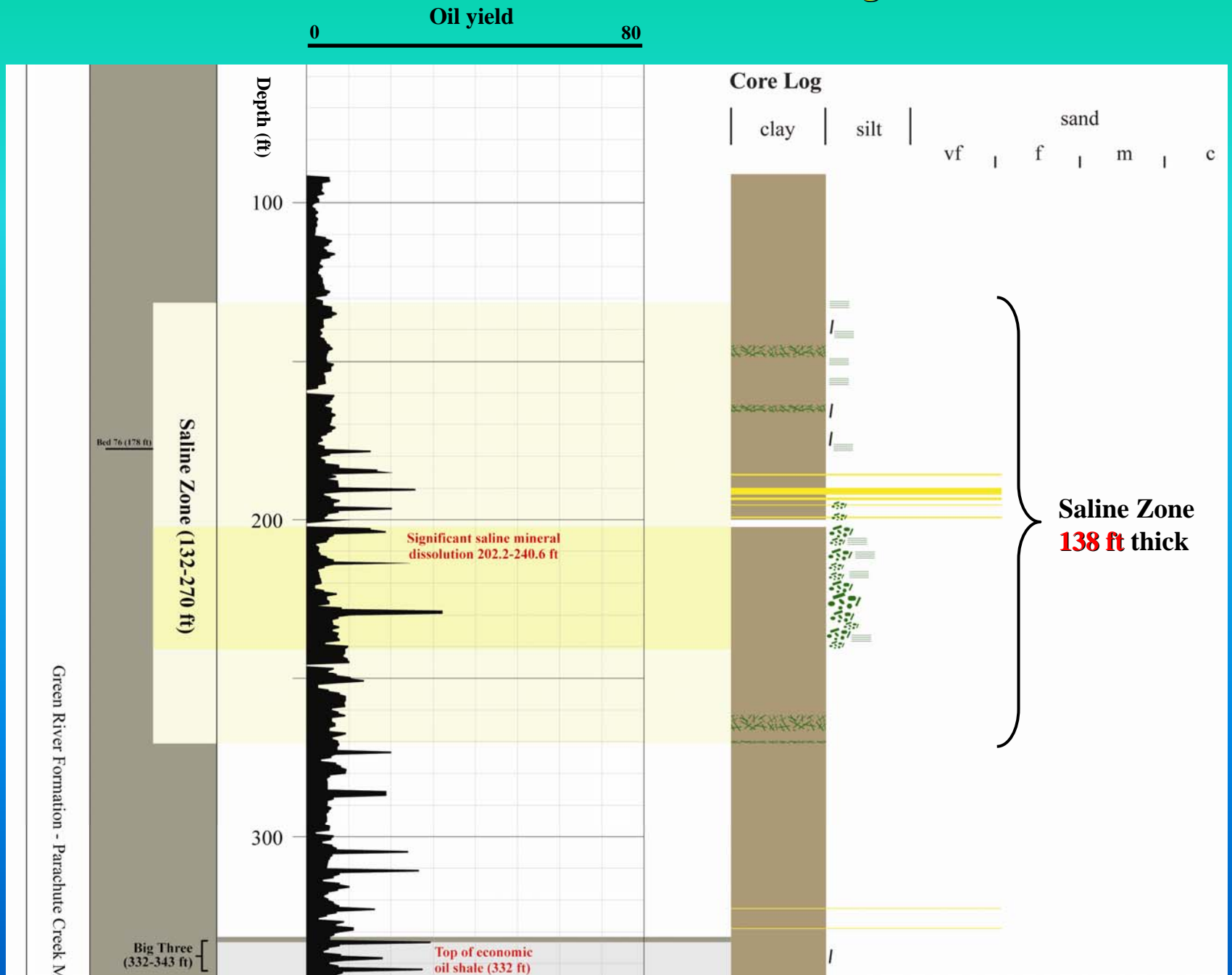




# Depocenter: 13X-2 - 10S 21E sec. 2



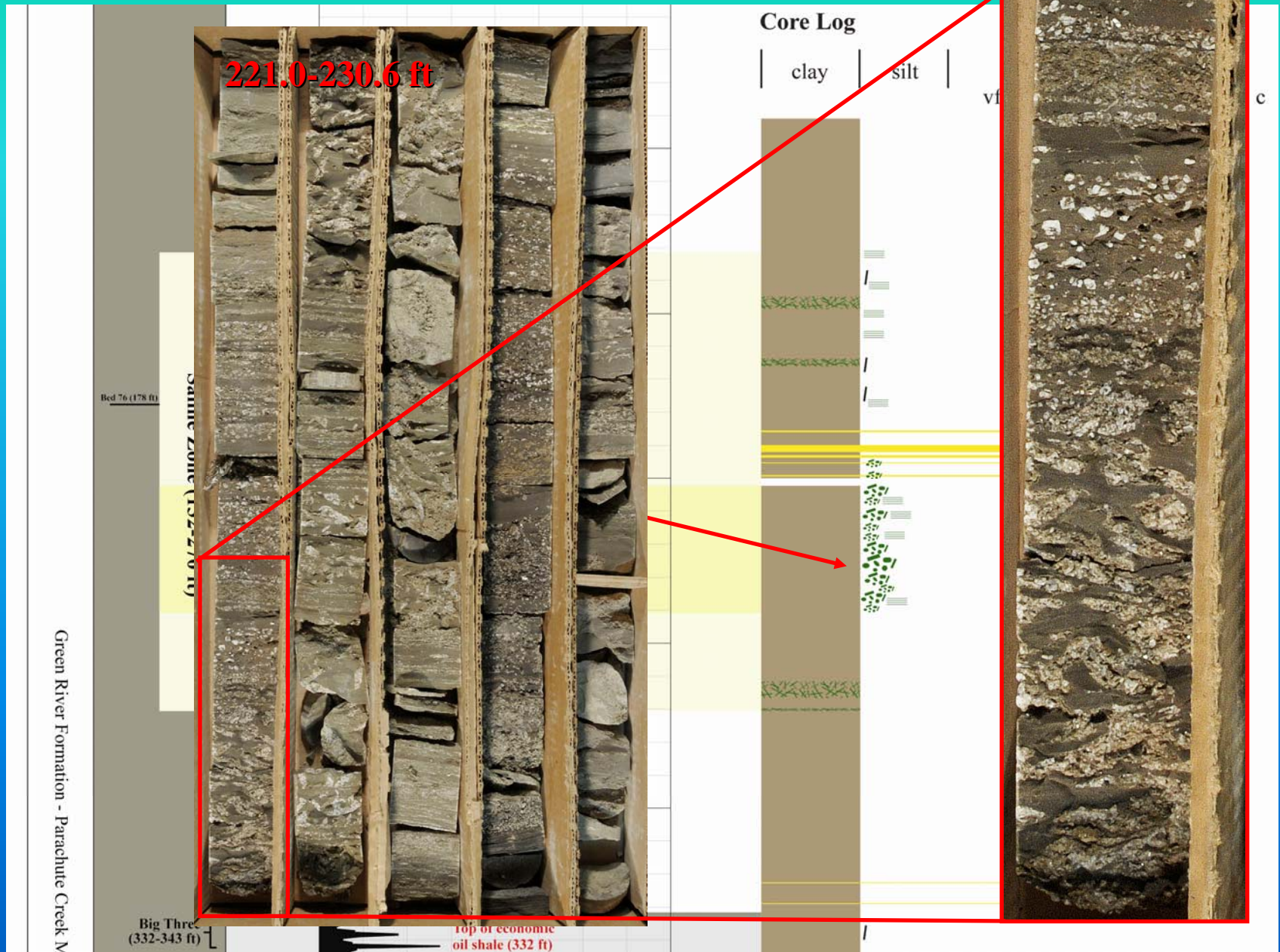
# Southern margin: SUB 12 - 12S 24E sec. 19



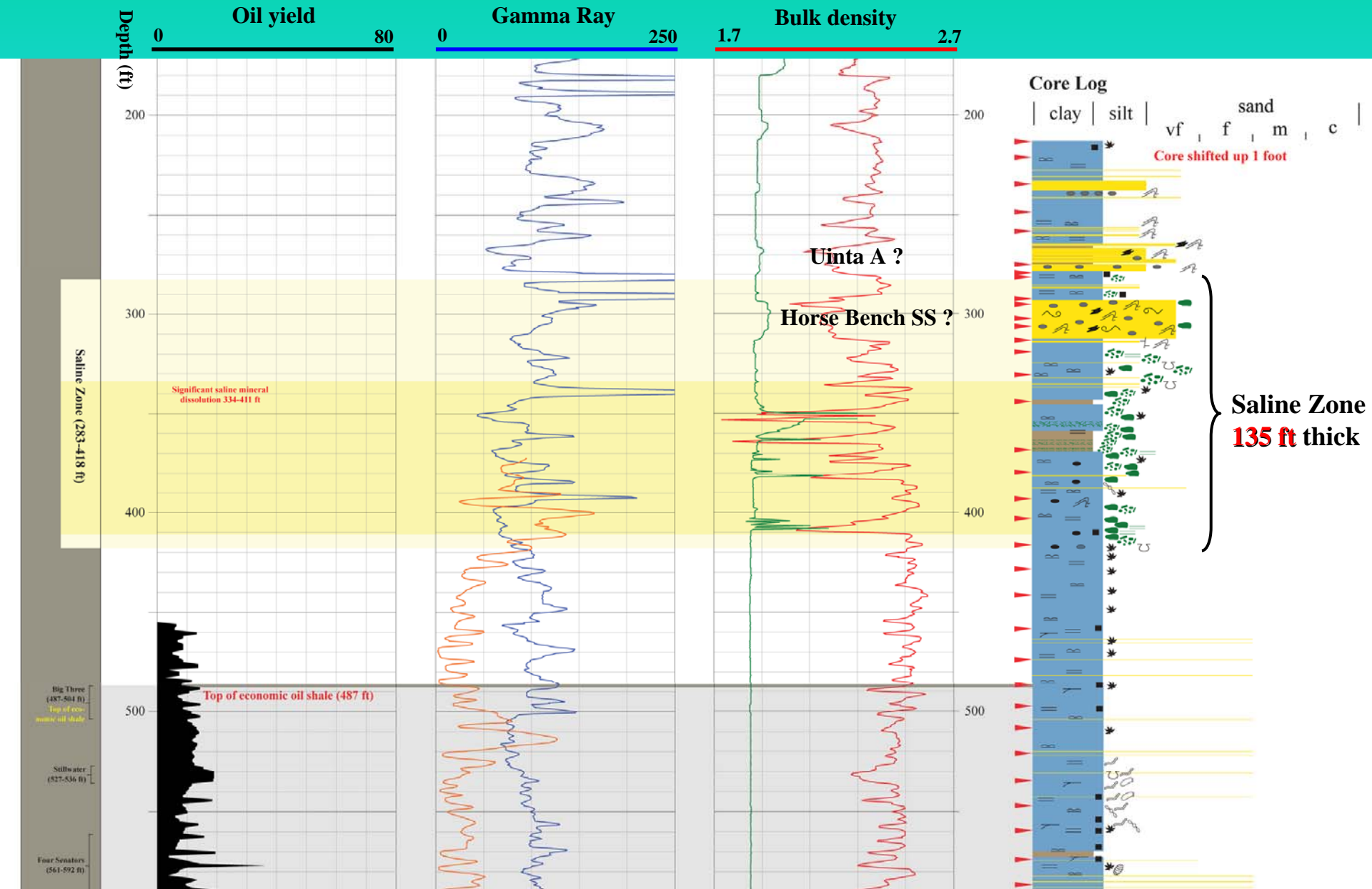


# Southern margin: SUB 12 - 12S 24E sec. 19

Oil yield  
0 80

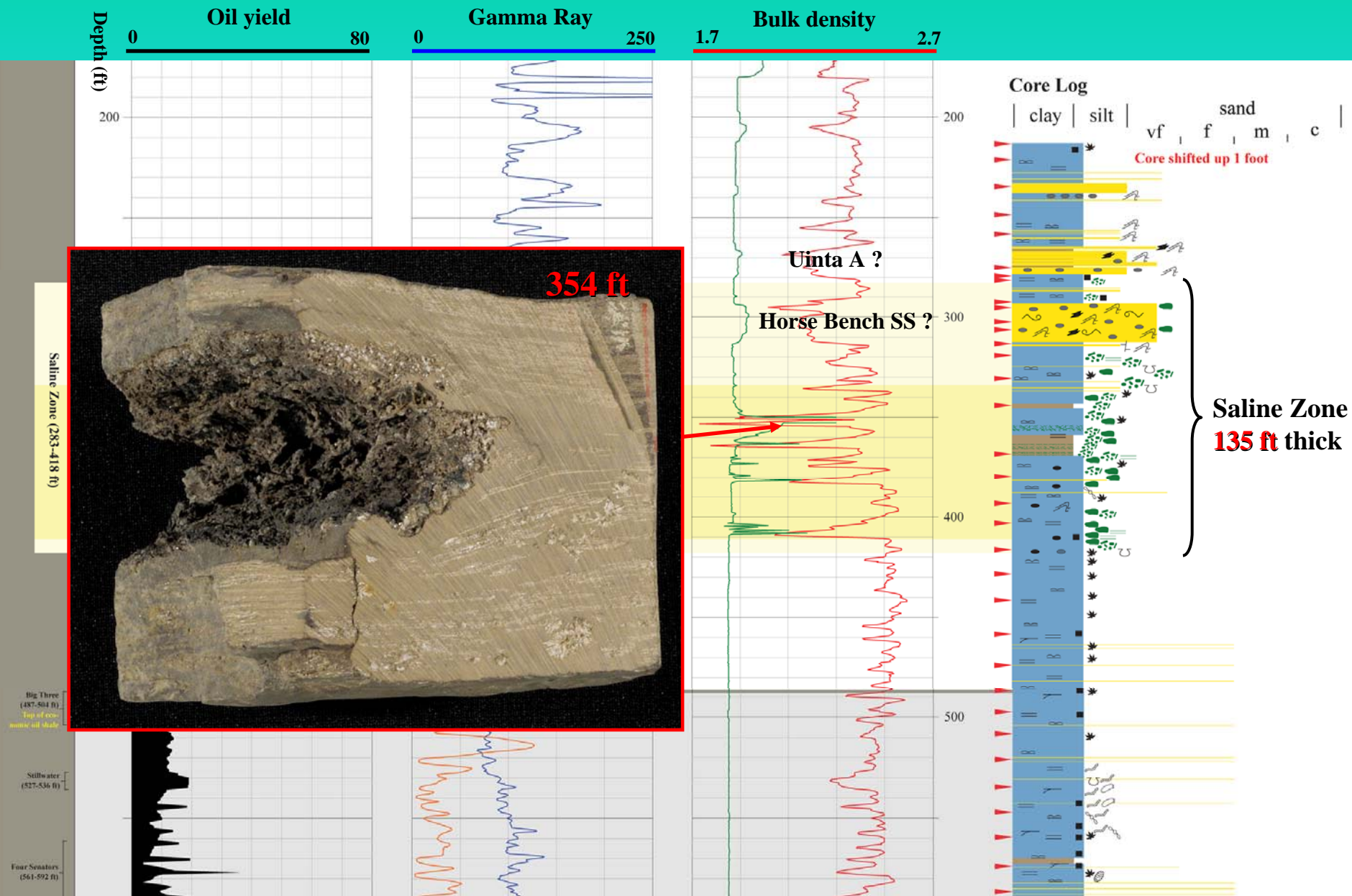


# Eastern margin: P-4 - 10S 25E sec. 19



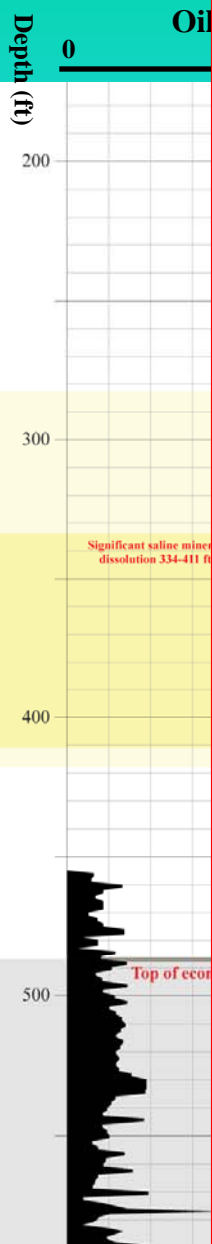
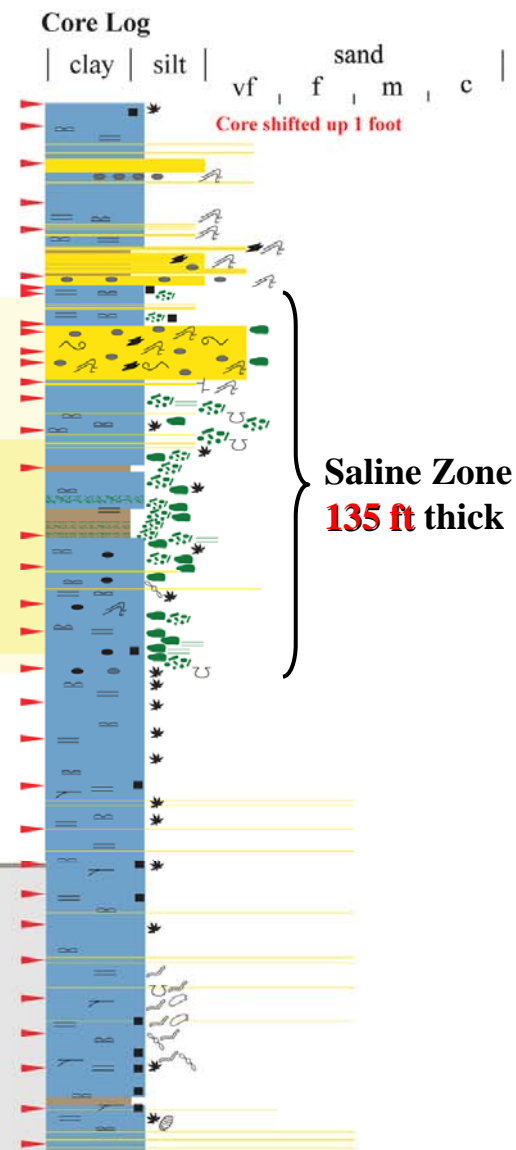
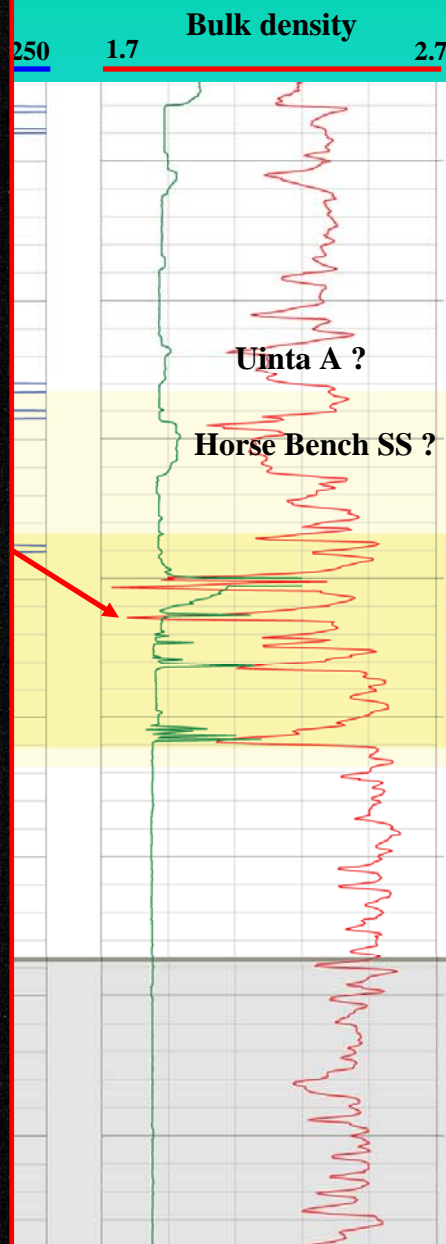


# Eastern margin: P-4 - 10S 25E sec. 19





# Eastern margin: P-4 - 10S 25E sec. 19







A photograph of a geological outcrop showing two distinct sedimentary units. The upper unit is labeled 'Horse Bench SS' and the lower unit is labeled 'Saline zone'. Both units are characterized by horizontal layering and contain numerous small, dark, circular features, likely fossil burrows. The outcrop is set against a background of arid hills under a clear sky. The foreground shows some low-lying vegetation.

**Horse  
Bench SS**

**Saline  
zone**

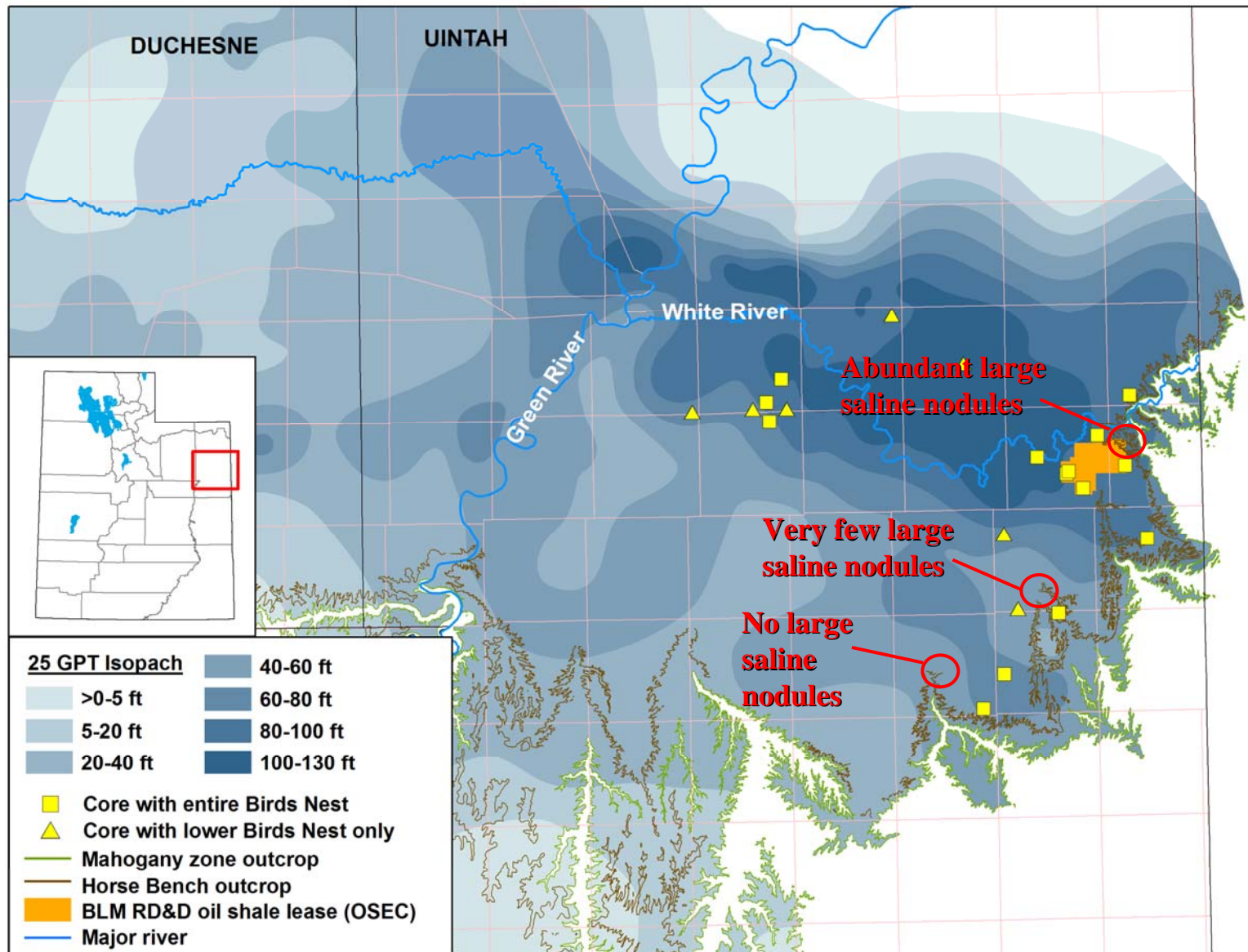
**Evacuation Creek**

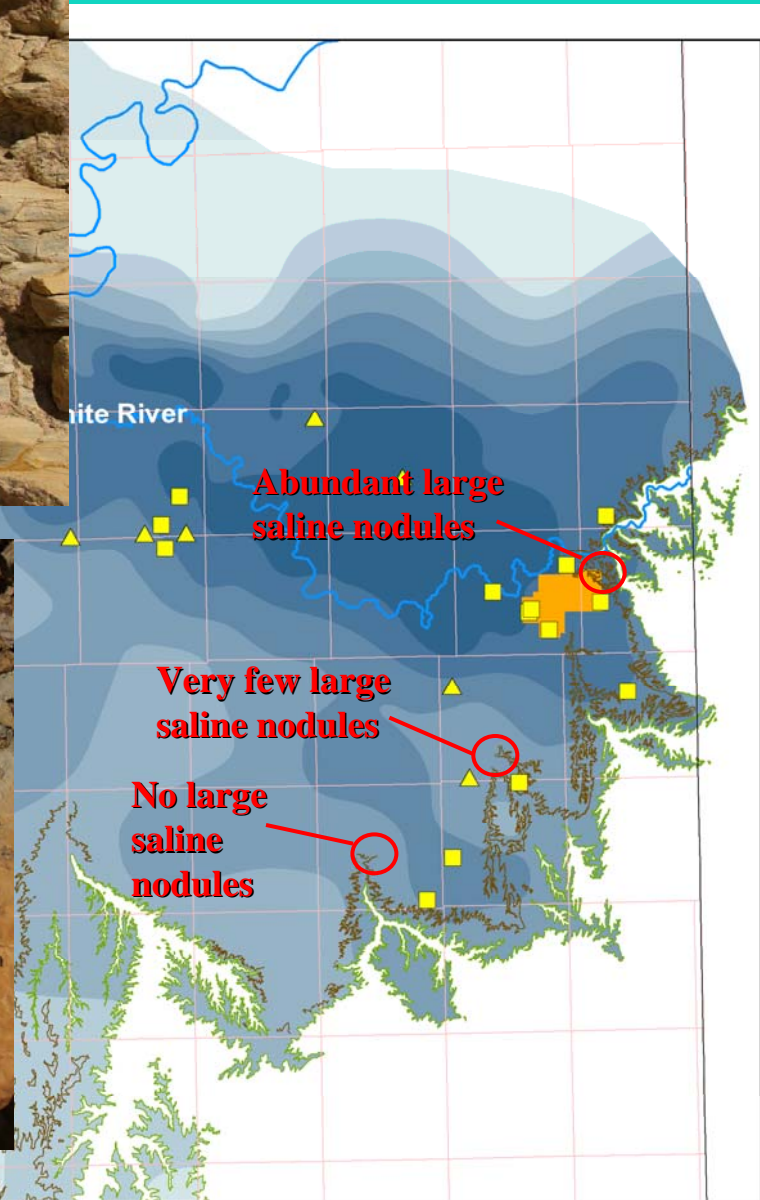
# Outline

- Birds Nest aquifer introduction
- Examination of cores
- **Examination of outcrop**
- Regional cross-sections
- Relationship with gilsonite veins



# Outcrop studies



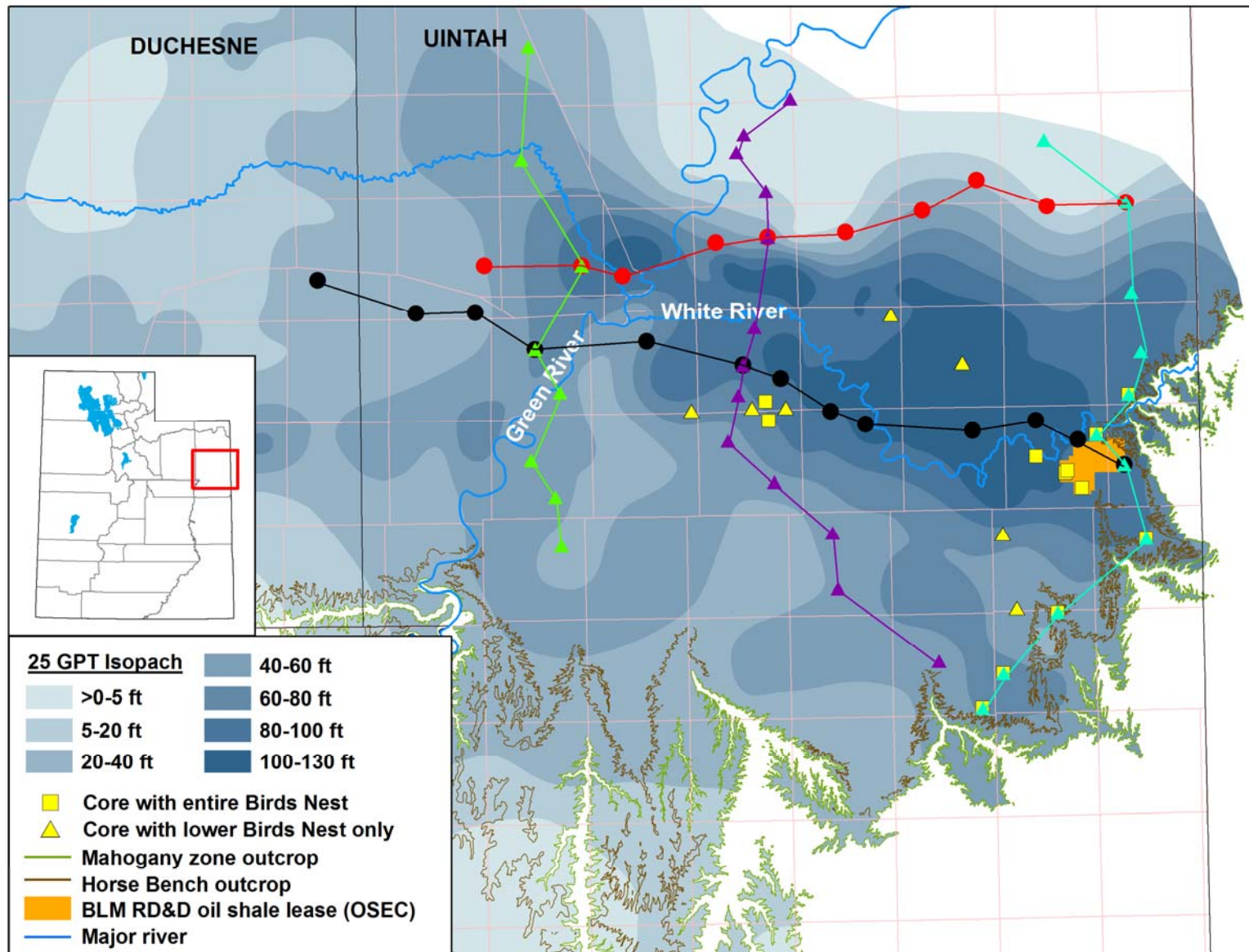


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- **Regional cross-sections**
- Relationship with gilsonite veins

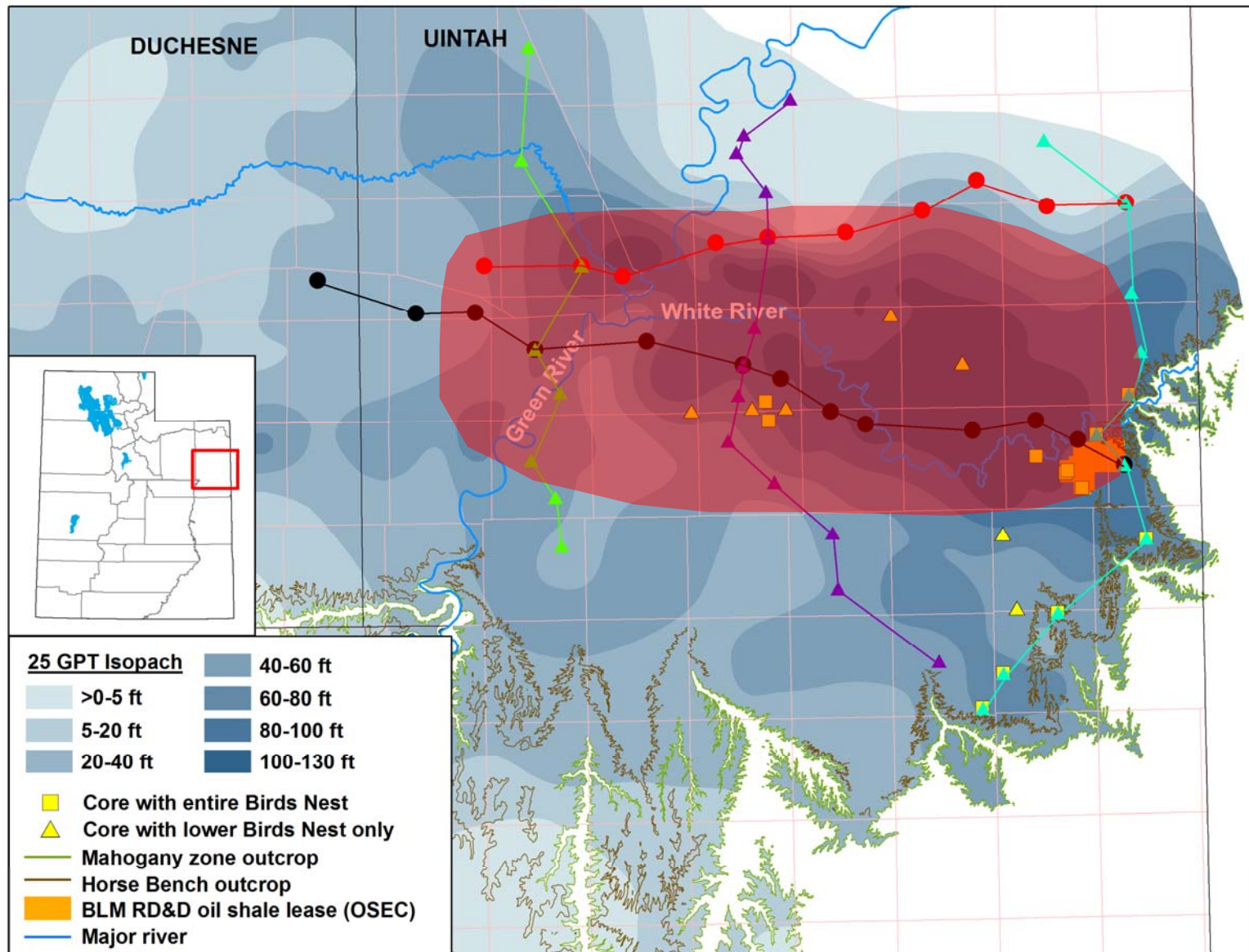


## Regional Cross Sections



## Regional Cross Sections

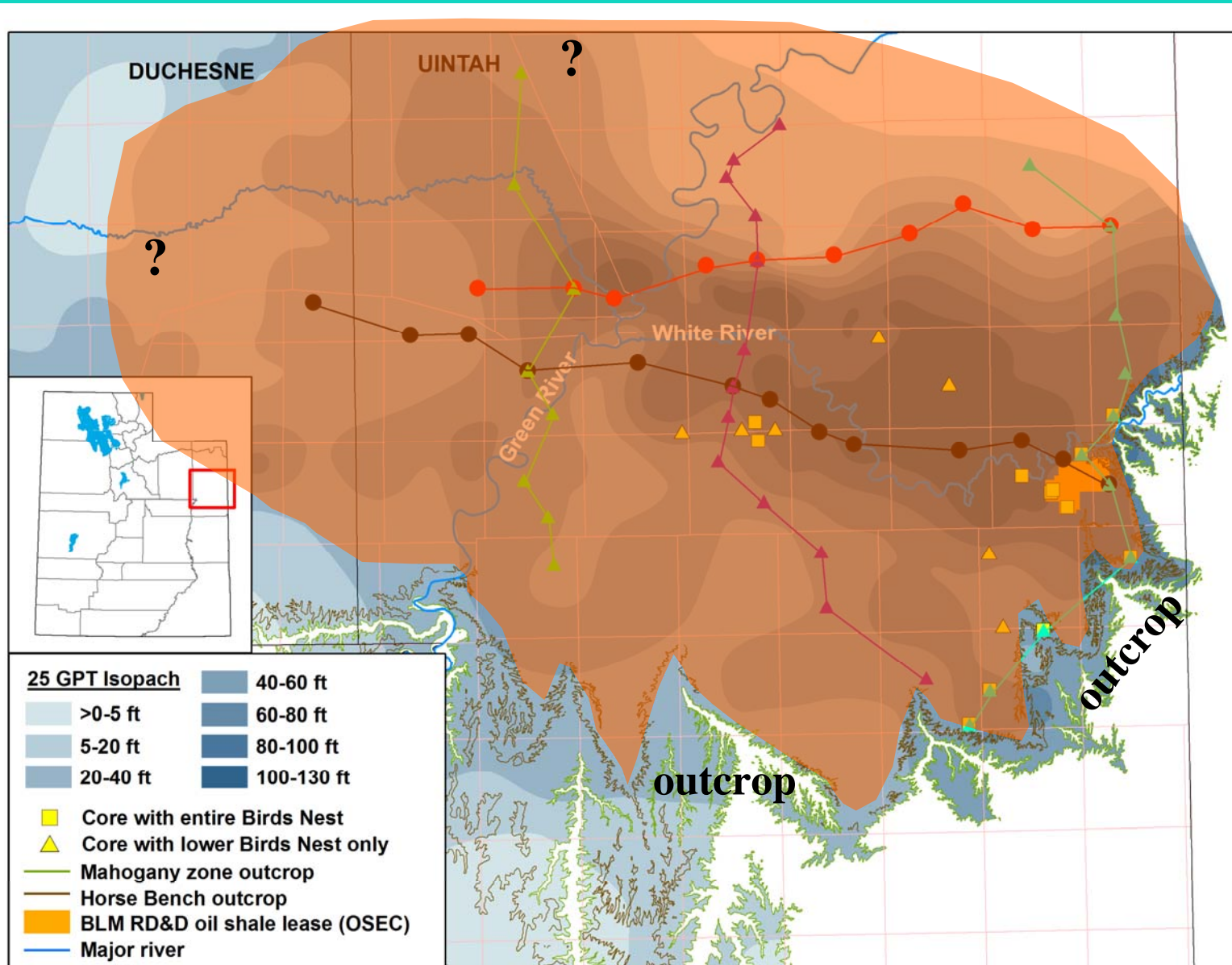
## Earliest Saline Deposition





## Regional Cross Sections

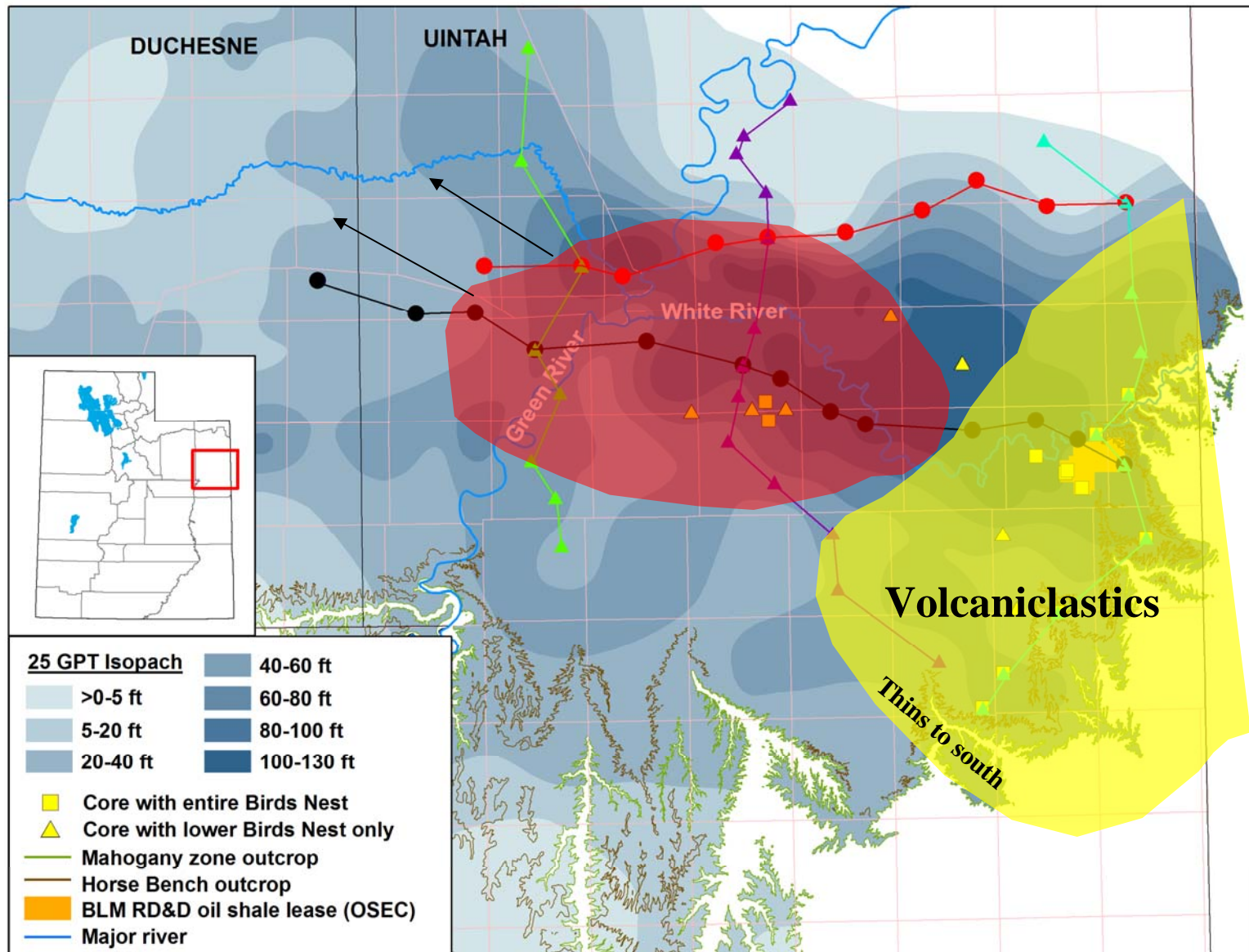
## Middle Saline Deposition





## Regional Cross Sections

## Latest Saline Deposition



# Outline

- Birds Nest aquifer introduction
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- **Relationship with gilsonite veins**

Gilsonite float is very light and may wash far down hill from an outcropping vein.

Weathered gilsonite vein near the surface has a typical "pencilled" fracture structure. This ore generally has a higher melt point and is called "seconds."

Most veins thin gradually upward until they thin to extinction in the upper Uinta or Duchesne River Formations.

The unweathered massive gilsonite generally has a lower melt point and is called "select."

Sandstone walls of a vein are very firm and in clean contact with the gilsonite, with very little penetration.

Typical gilsonite vein reaches its maximum width in the vicinity of the Uinta-Green River formational contact.

Uinta Formation

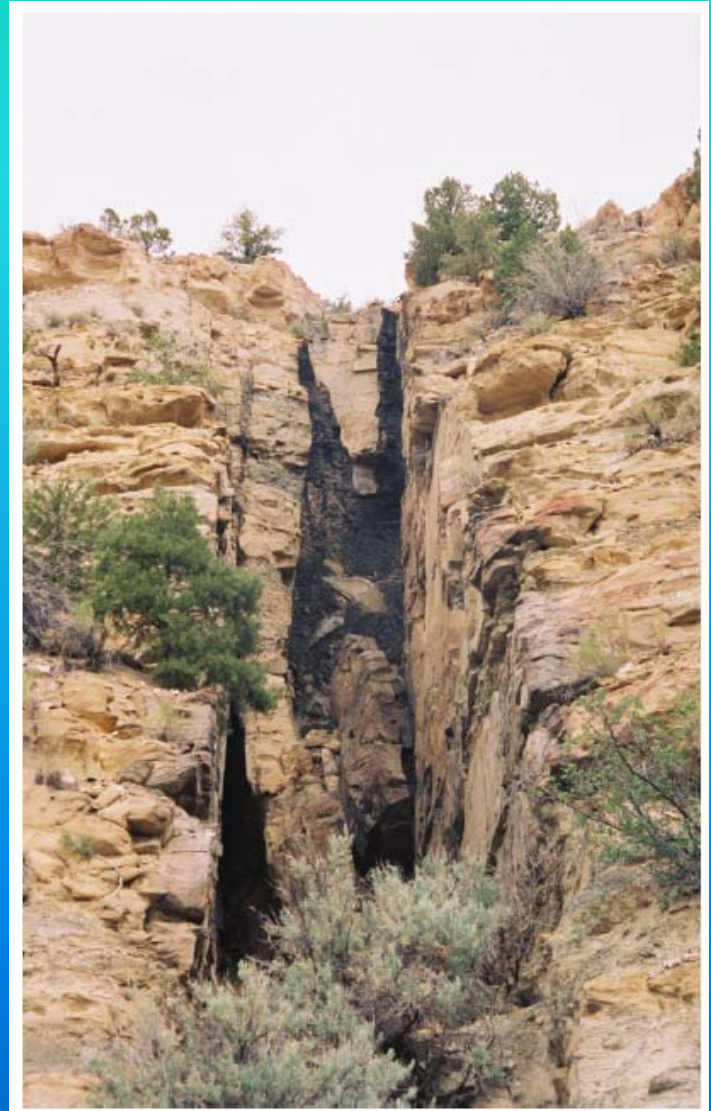
Green River Formation

Debris tends to collect at the bottom of a vein where it begins to split upon entering the shale beds, making clean mining at this level difficult.

oil-shale

Most veins have their "roots" in the rich oil-shale beds of the Green River Formation. A few veins extend downward into the underlying Wasatch Formation.

## Gilsonite Veins

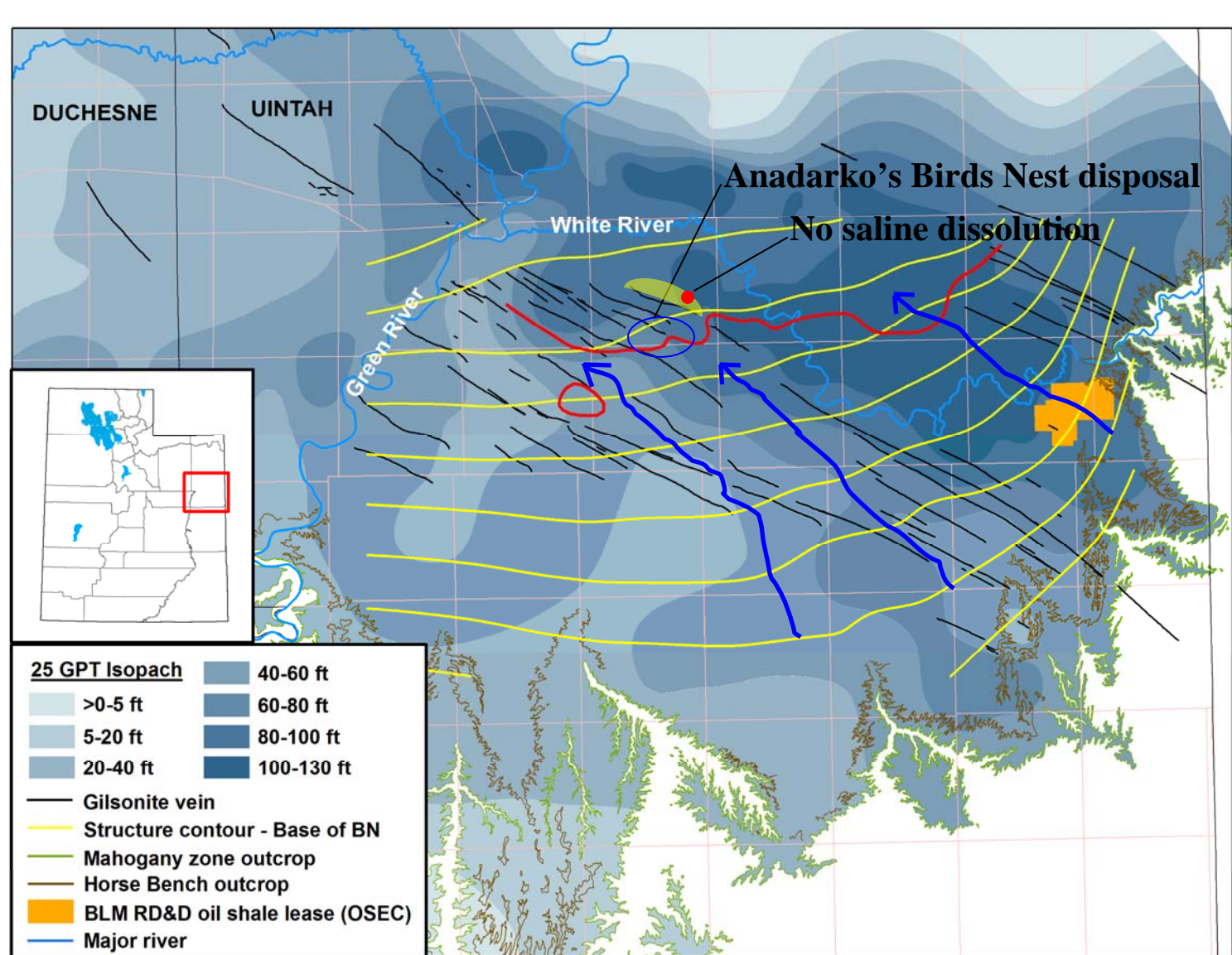


**Birds  
Nest  
Aquifer**

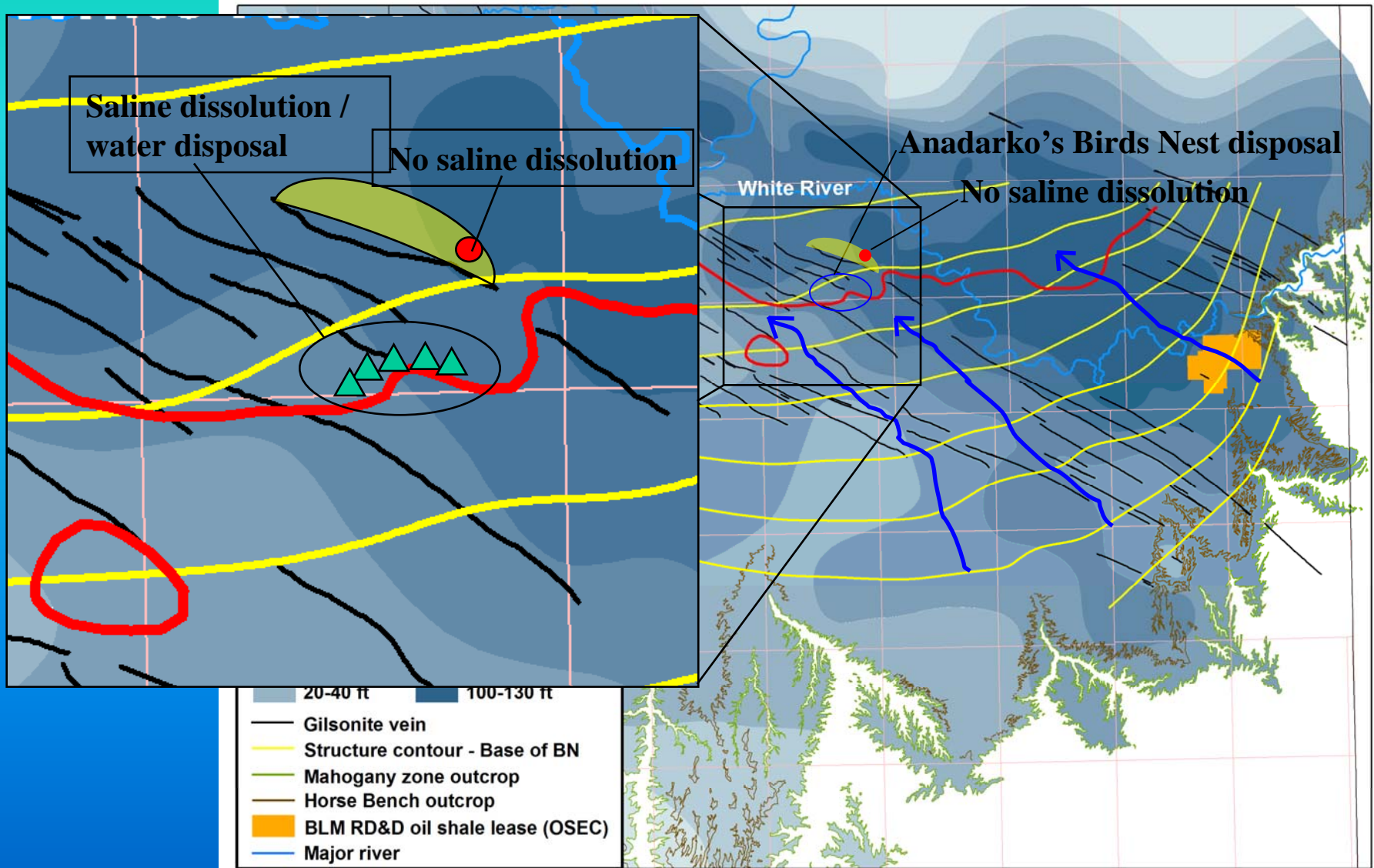
Figure 6. Cross section of a typical gilsonite vein (from Eldridge, 1901).



# Evidence for gilsonite influencing groundwater



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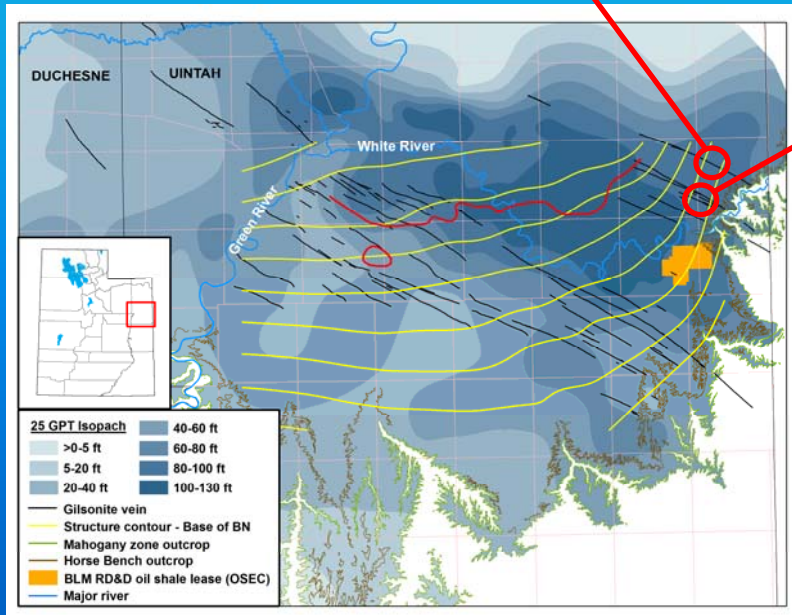
## Bonanza Vein

- Highly fractured gilsonite
- 630 ft depth (Uinta Fm)
- Lots of water infiltration (from wall rock and vein)



## Independent Vein

- “Solid” gilsonite
- 230 ft depth (Uinta Fm)
- Minor water infiltration (from wall rock)





# **Gilsonite vein cross-cutting the Birds Nest aquifer**





# Gilsonite vein cross-cutting the Birds Nest aquifer





# Gilsonite vein cross-cutting the Birds Nest aquifer





# Thoughts and Conclusions

- **The effect of saline water disposal into the Birds Nest aquifer on oil shale development depends on the value of leaner deposits**

- The saline zone in general will likely be bypassed by both mining and in-situ processes
  - Oil shale within the saline zone is lean compared to richer targets below
  - Mining will focus on outcrop sections of rich oil shale below the saline zone
  - In-situ extraction will likely target deposits below the Big-3 bed, ~70 feet below the saline zone
- However, if water can travel vertically through the section via fractures or gilsonite veins, future development could be adversely affected

- **Core descriptions are key to the regional characterization of the Birds Nest aquifer**

- These oil shale cores have only recently become available
- Geophysical logs only recognize the large saline nodules and layers
- To date, UGS has described 11 of 21 cores

# Thoughts and Conclusions

- **Gilsonite veins seem to act as barriers to flow in some areas and pathways for vertical movement of water in others**
  - Depends on the type of gilsonite (solid or fractured)
  - Depends on vein thickness
  - Little information is available on the gilsonite veins found at depth near the center of the basin where active saline water disposal is taking place