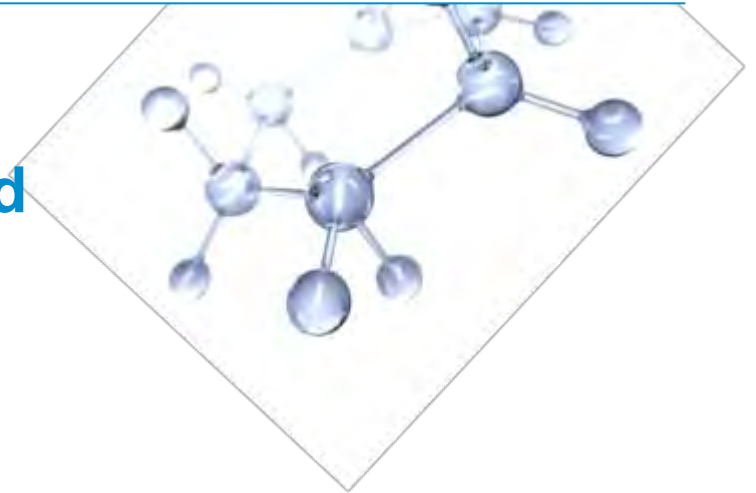


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Taking on the world's toughest energy challenges.™

**Characterization of USGS Core
Repository oil shale core drilled
near the proposed ExxonMobil
RD&D lease**

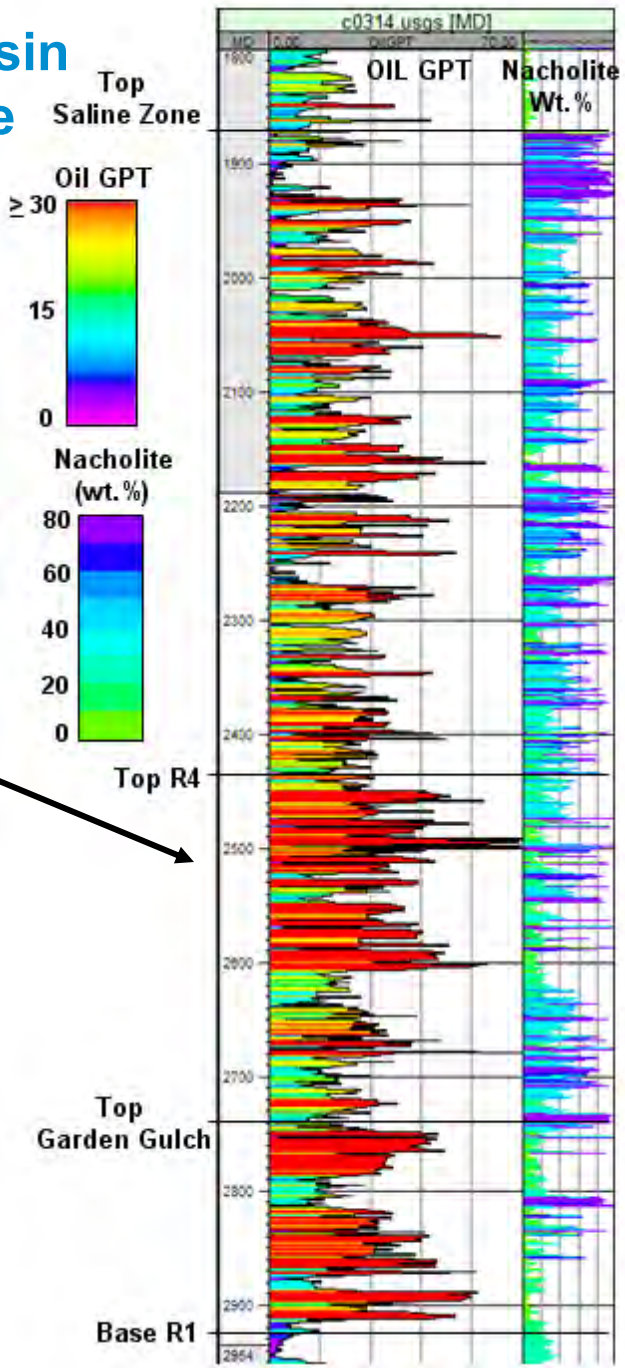
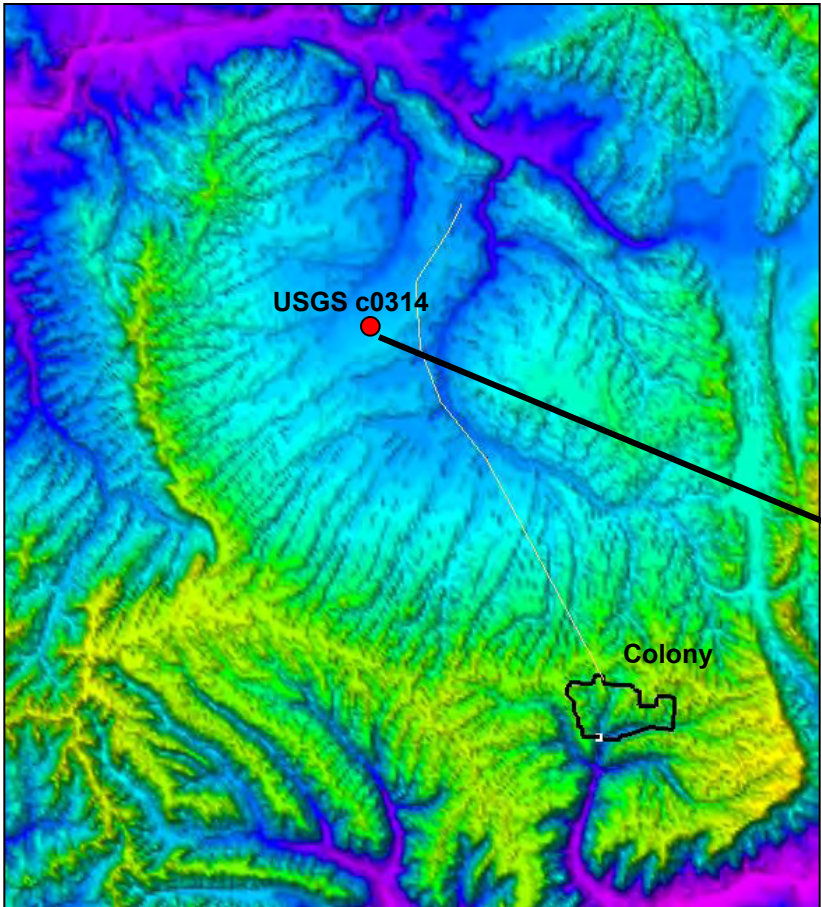


October 18, 2011

Bill Meurer , Jesse Yeakel, Scott Maxwell

Oil Shale in Center of Piceance Basin is Rich and Mineralogically Diverse

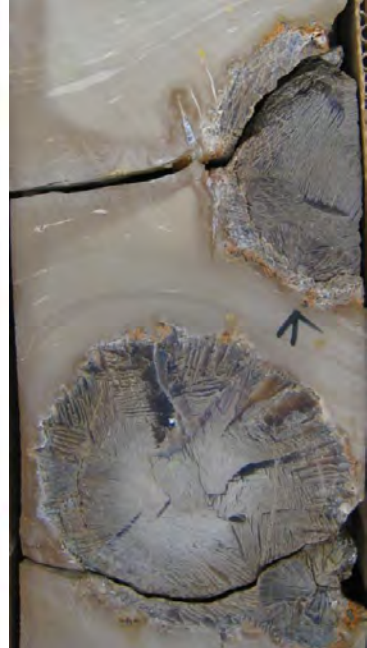
Topography of Piceance Basin



Halite



Nahcolite



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Key Messages



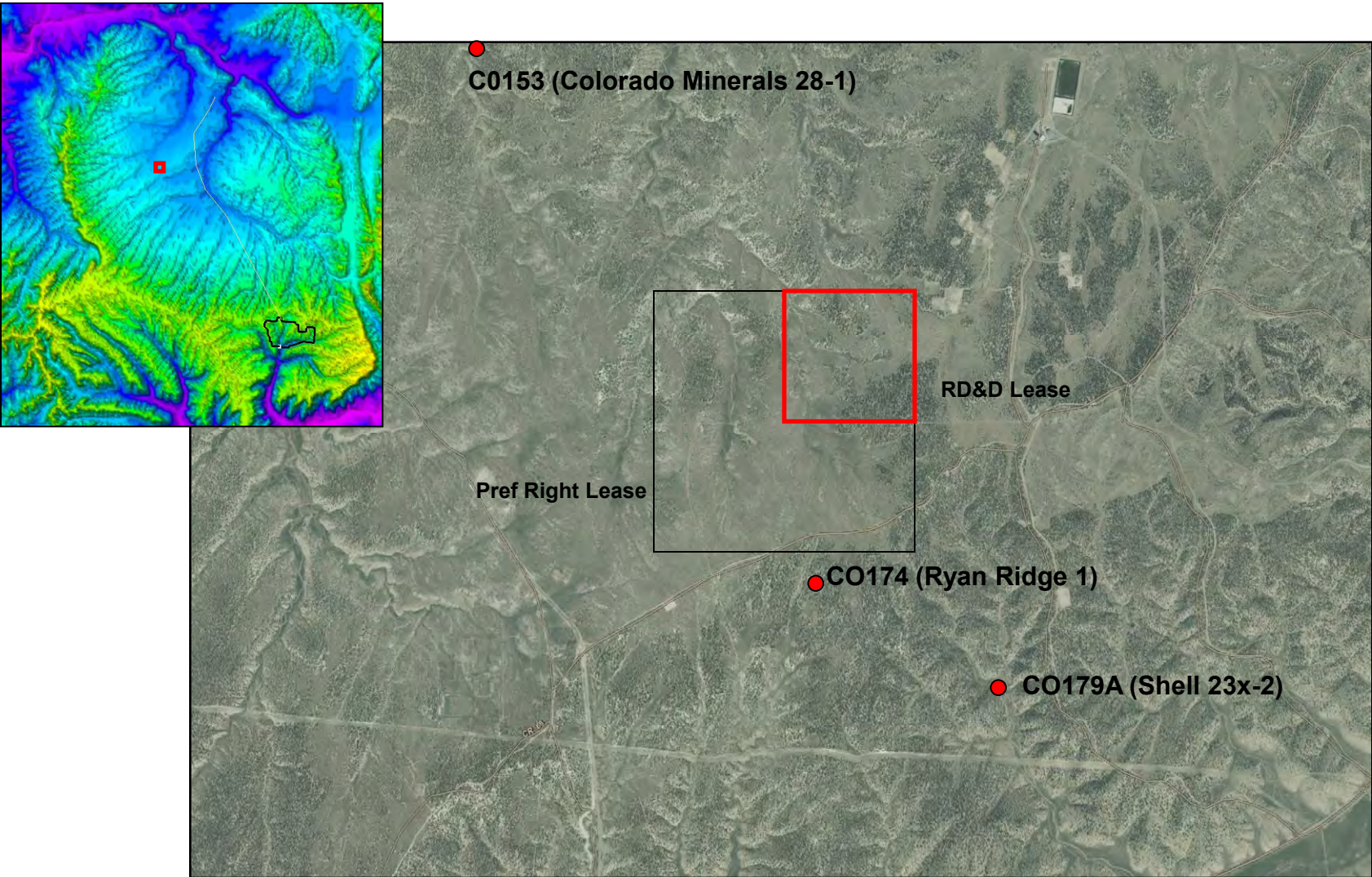
- Establish lithologic packaging and mineralogy in key intervals within the Saline Zone near ExxonMobil's proposed RD&D lease by examining three adjacent USGS cores.
- Mineralogy is important for selecting where (stratigraphically) to position an *in situ* conversion process (guides subsurface engineering).
- Oil shale richness is dependent upon oil shale lamination type
 - e.g., slumped oil shale vs. finely laminated oil shale
- Oil Shale richness and mineralogy are partially correlated
- The thermal conductivity of oil shale is principally governed by the richness - mineralogy plays a modest secondary role.

Outline

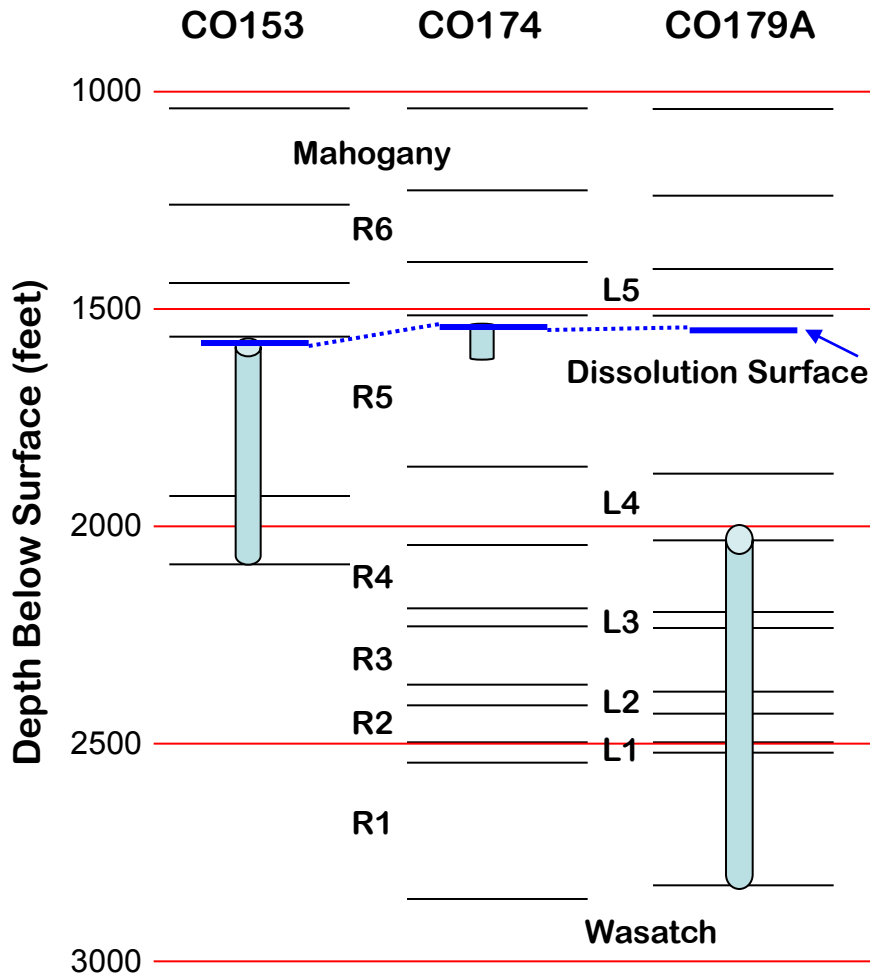


- Proposed RD&D lease location and positions of USGS wells examined
- Mineralogical analysis of the Saline Zone
- Stratigraphic variations in lithology and mineralogy
- Relationship between richness and mineralogy
- Compositional controls on thermal conductivity of oil shale

Location of Proposed RD&D Lease & USGS Well Locations



Stratigraphic Intervals Discussed



(Stratigraphy flattened on top Mahogany CO153.)

- **CO153 and CO179A together provide a composite core of “rich” oil shale through the saline zone.**
- **CO174 allowed thermal conductivity measurements.**

**USGS Core CO153 / B860
Colorado Minerals 28-1
Sec. 28 1S 98W, Rio Blanco Co. CO**

**USGS Core CO174 / E095
Humble Oil Core 1 Ryan Ridge
Sec 3 2S 98W, Rio Blanco Co. CO**

**USGS Core CO179A / CO42
Shell Oil CH 23X-2
Sec. 2 2S 98W, Rio Blanco Co. CO**



Carbonates

Aragonite

Calcite

Dolomite, Fe- Dolomite

Siderite

Magnesite

Evaporites

Halite

Nahcolite (Natrite, Thermonatrite, Thenardite)

Dawsonite (Analcime)

Trona

Terrigenous

Quartz

Microcline (Buddingtonite)

Clay (Illite, Smectite, Mica, Kaolinite)

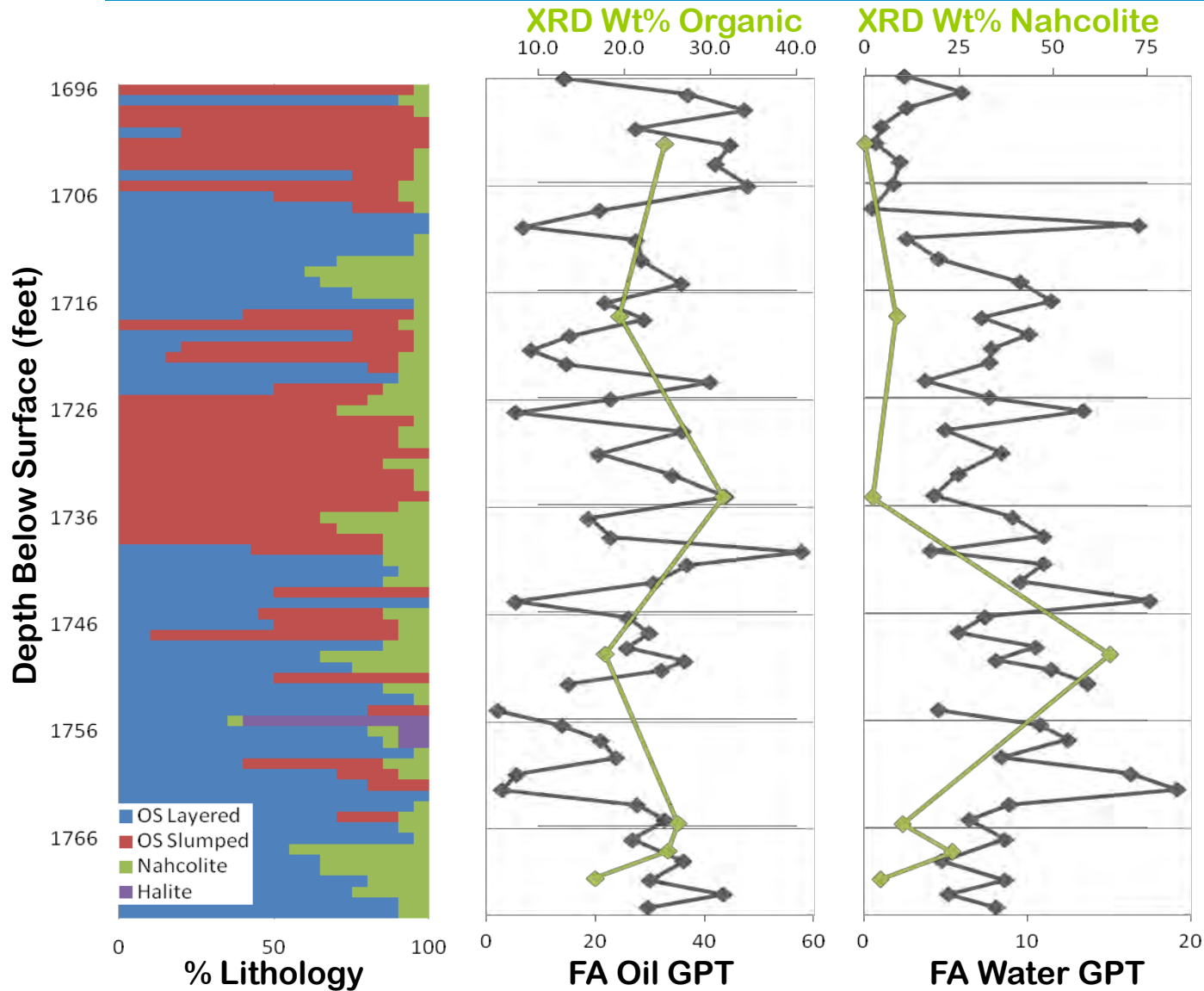
Authogenic

Pyrite, Marcasite

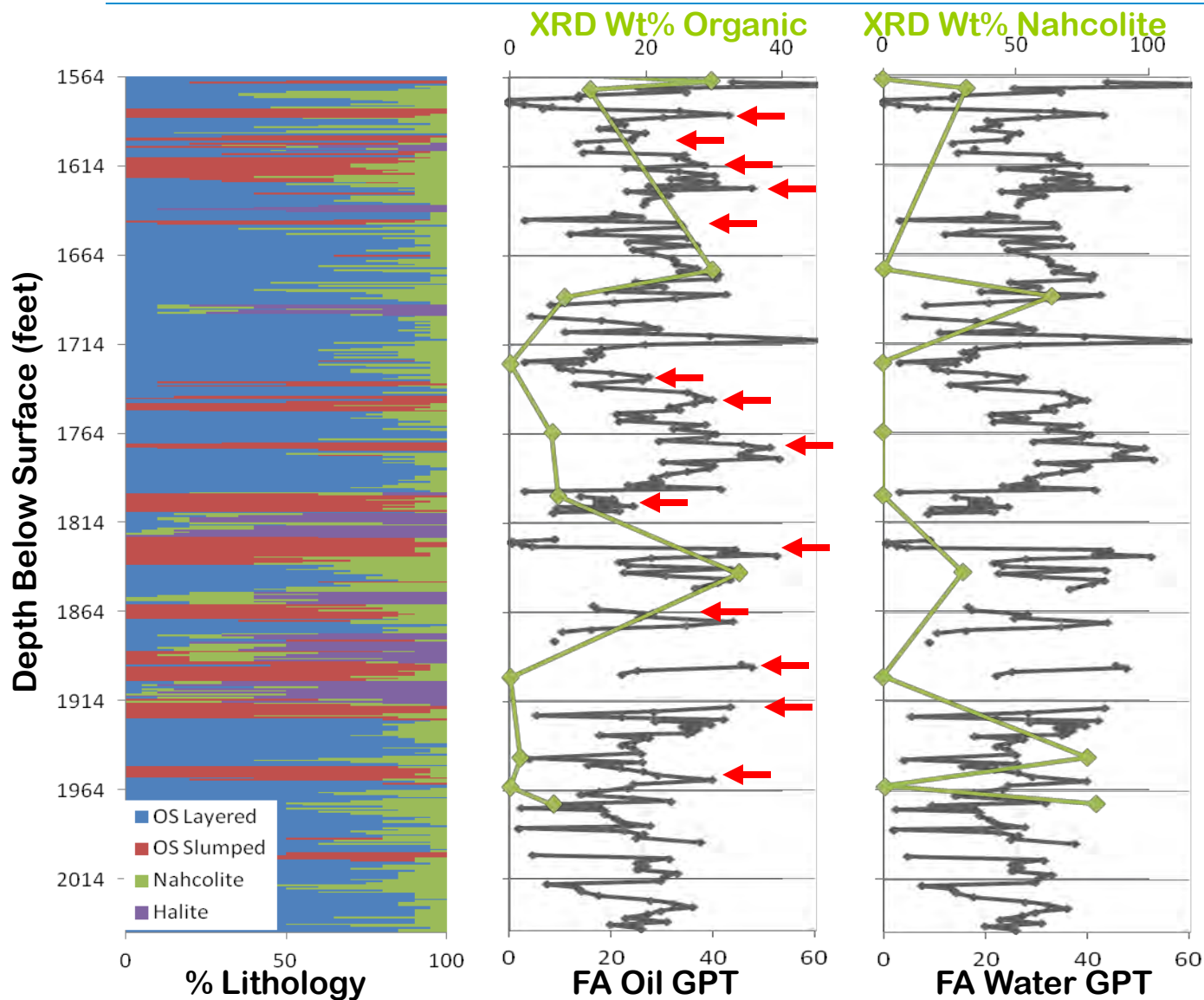
Anatase

Hematite, Ilmenite

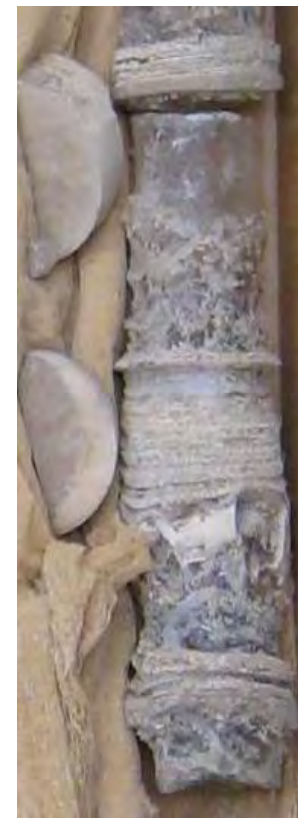
USGS CO174 (Ryan Ridge 1)



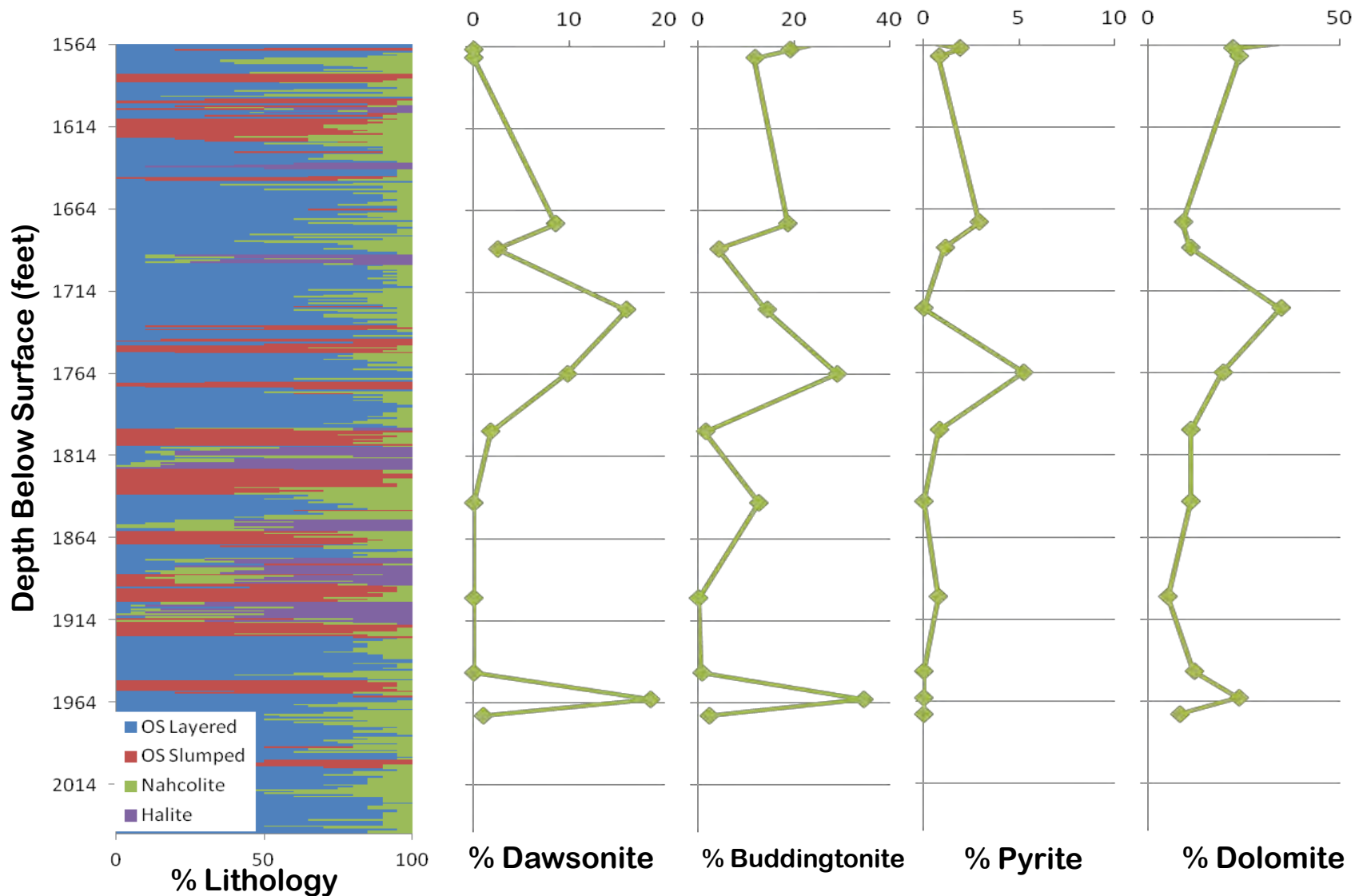
USGS CO153 (Colorado Minerals 28-1)



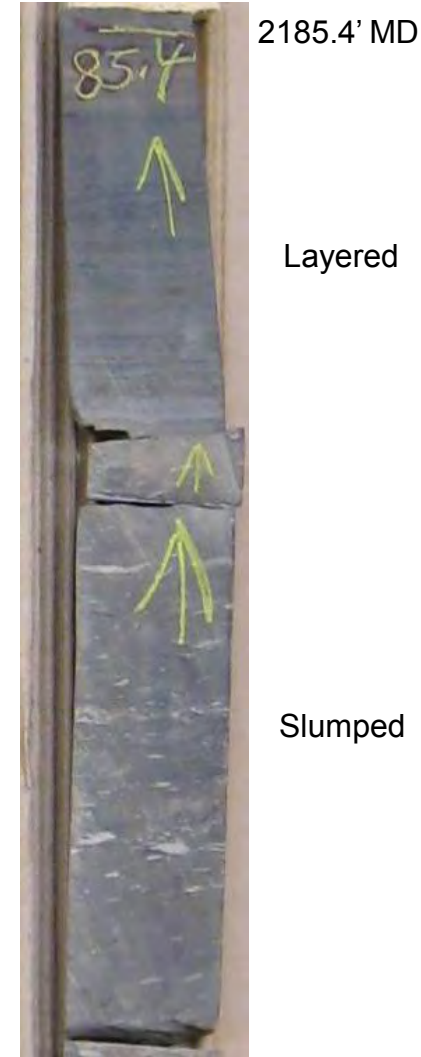
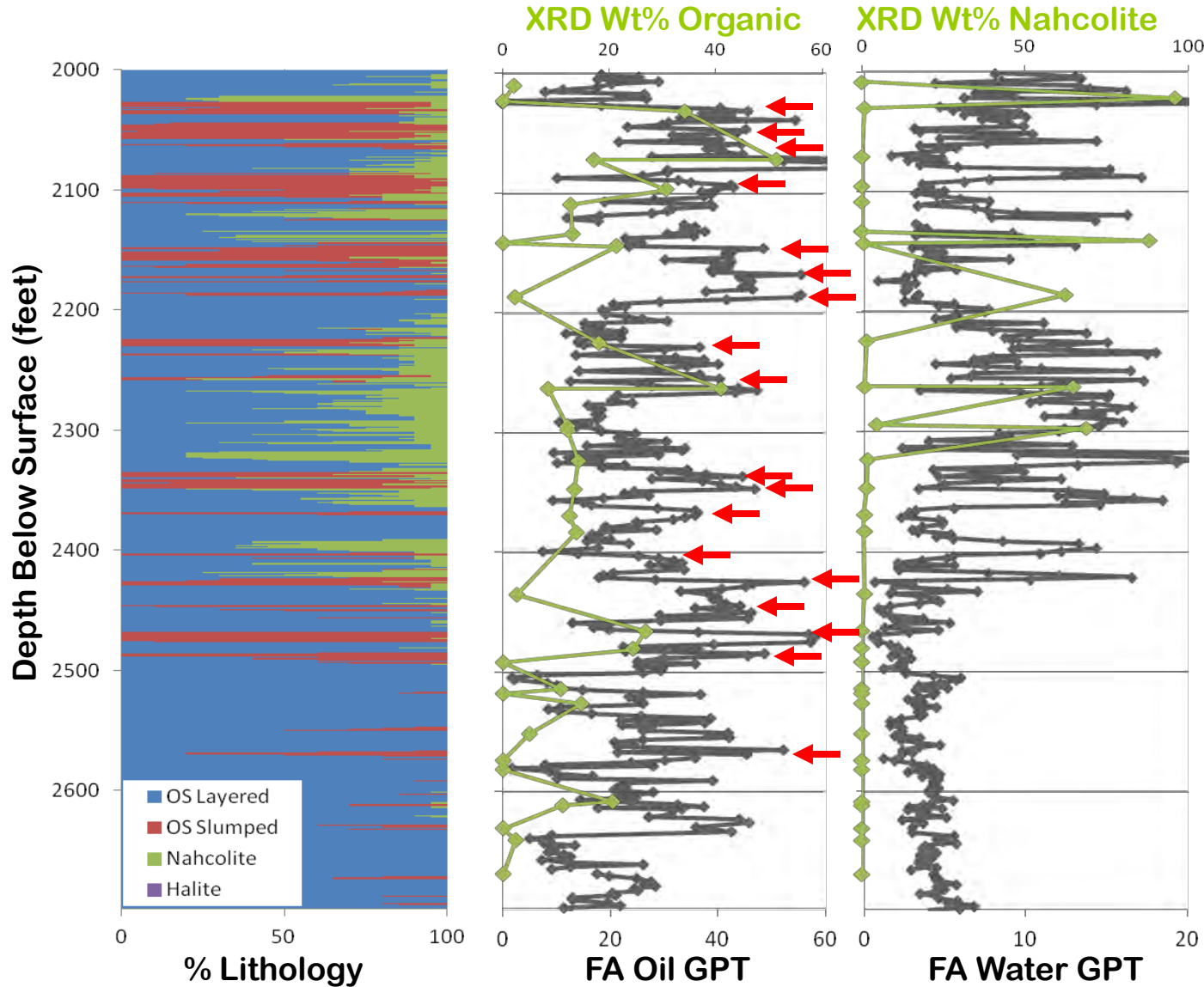
Halite at 1882' MD



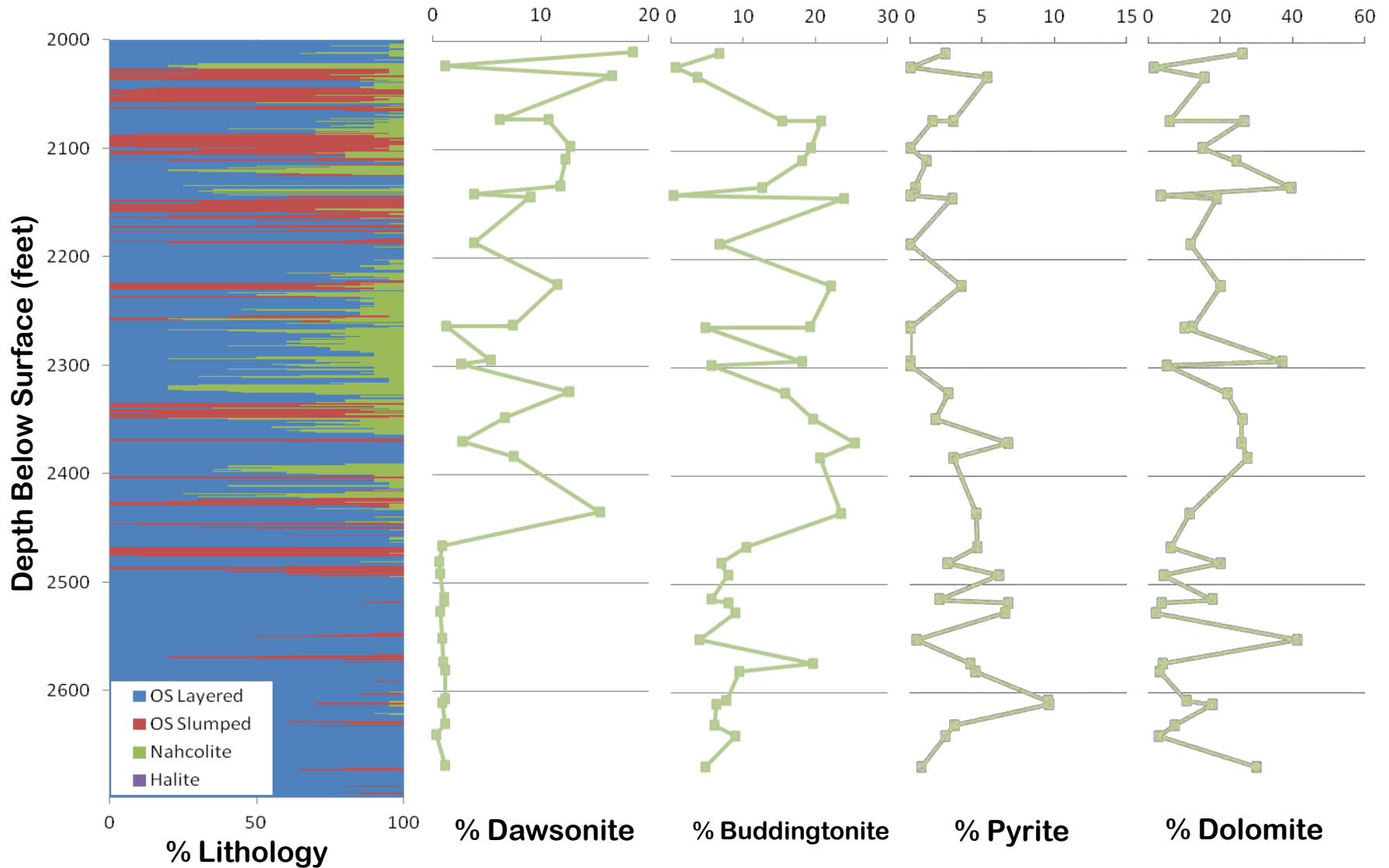
USGS CO153 (Colorado Minerals 28-1)



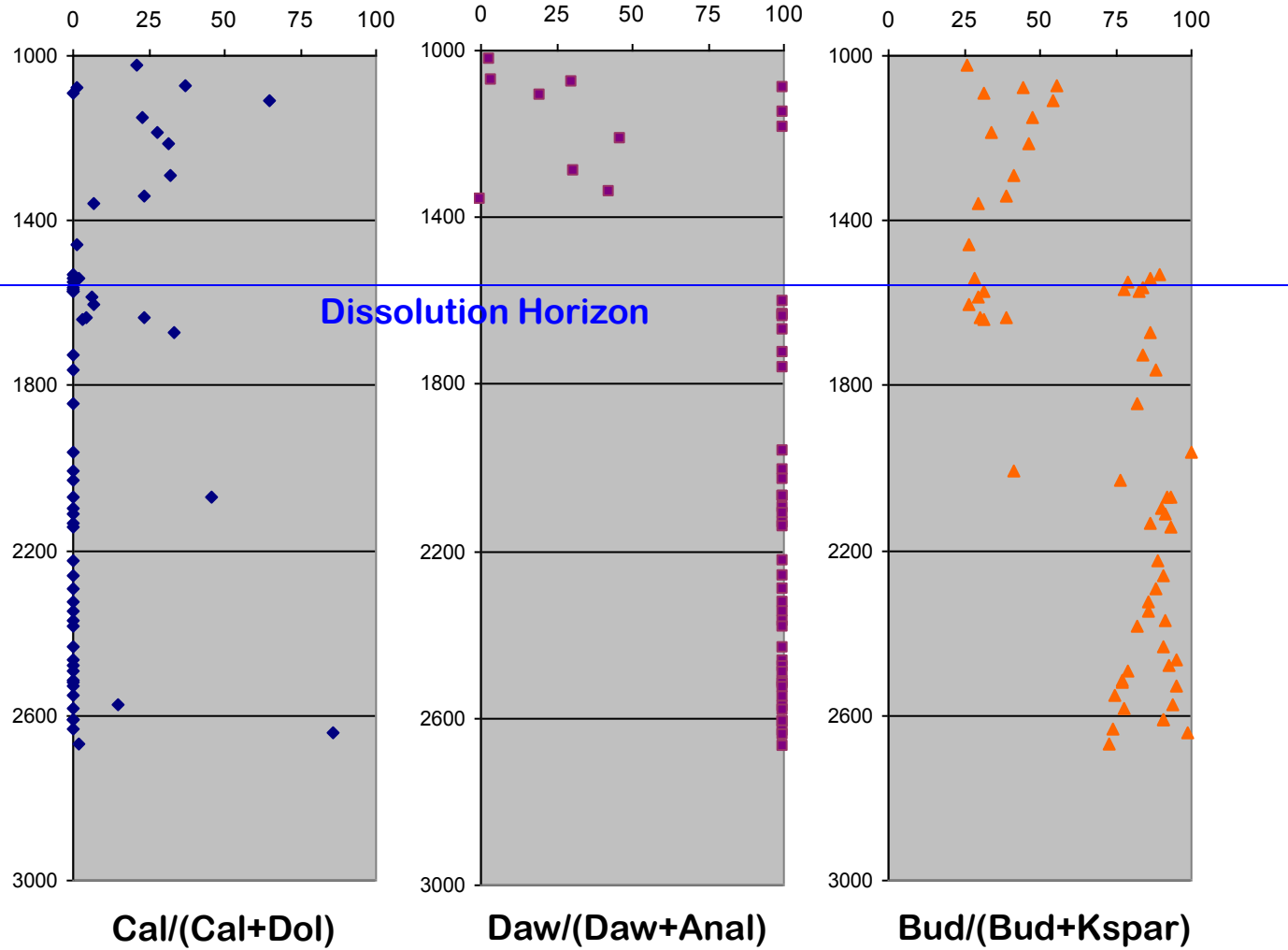
USGS CO179A (Shell 23X-2)



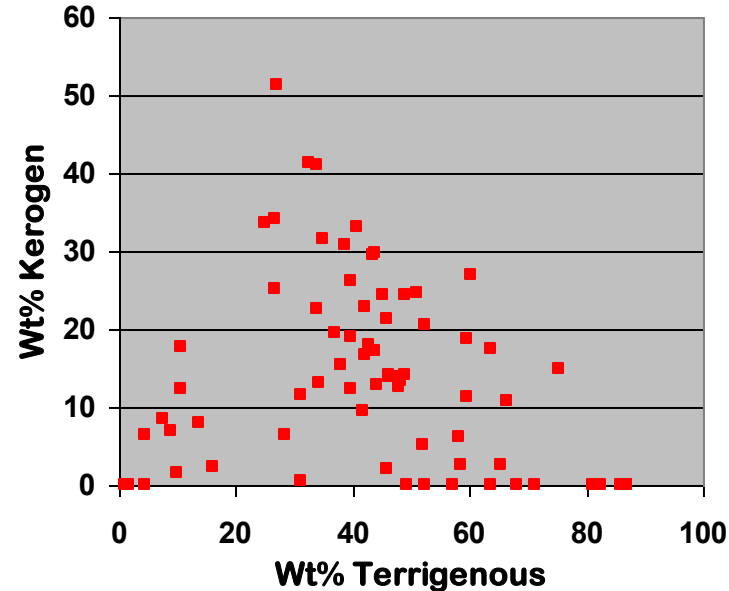
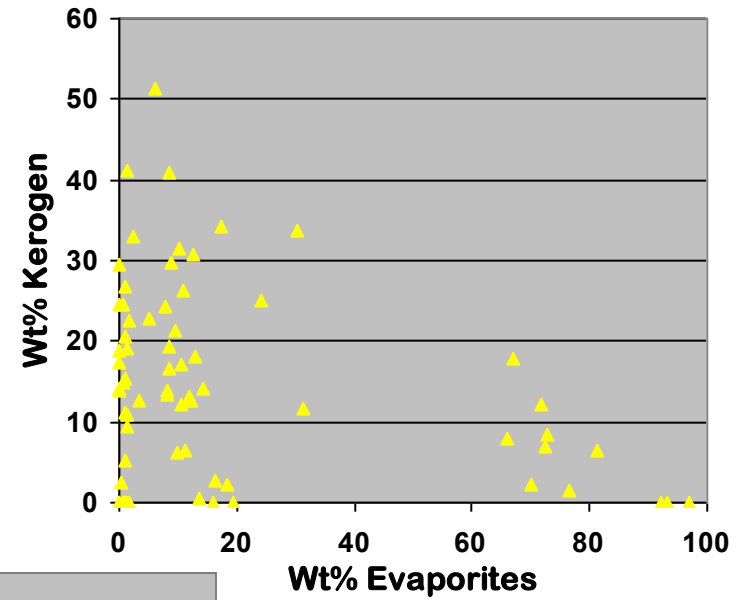
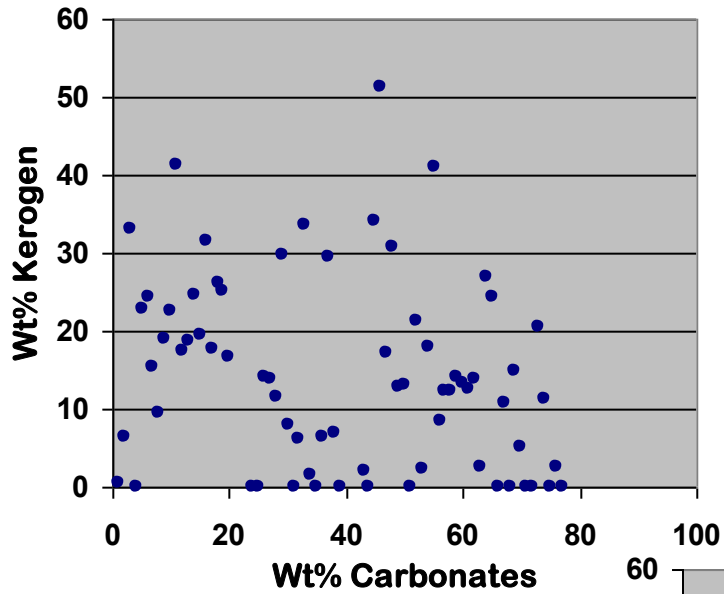
USGS CO179A (Shell 23X-2)



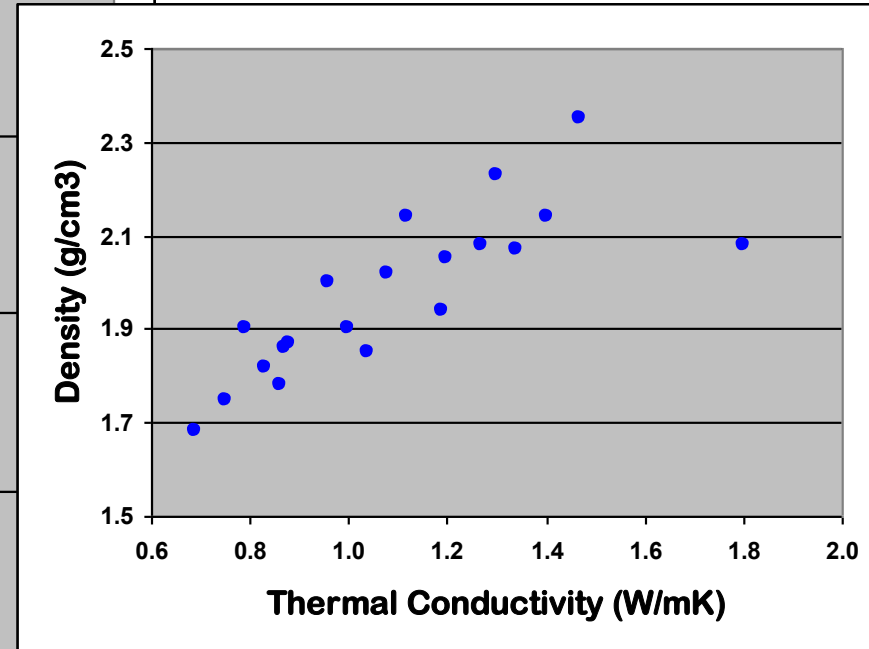
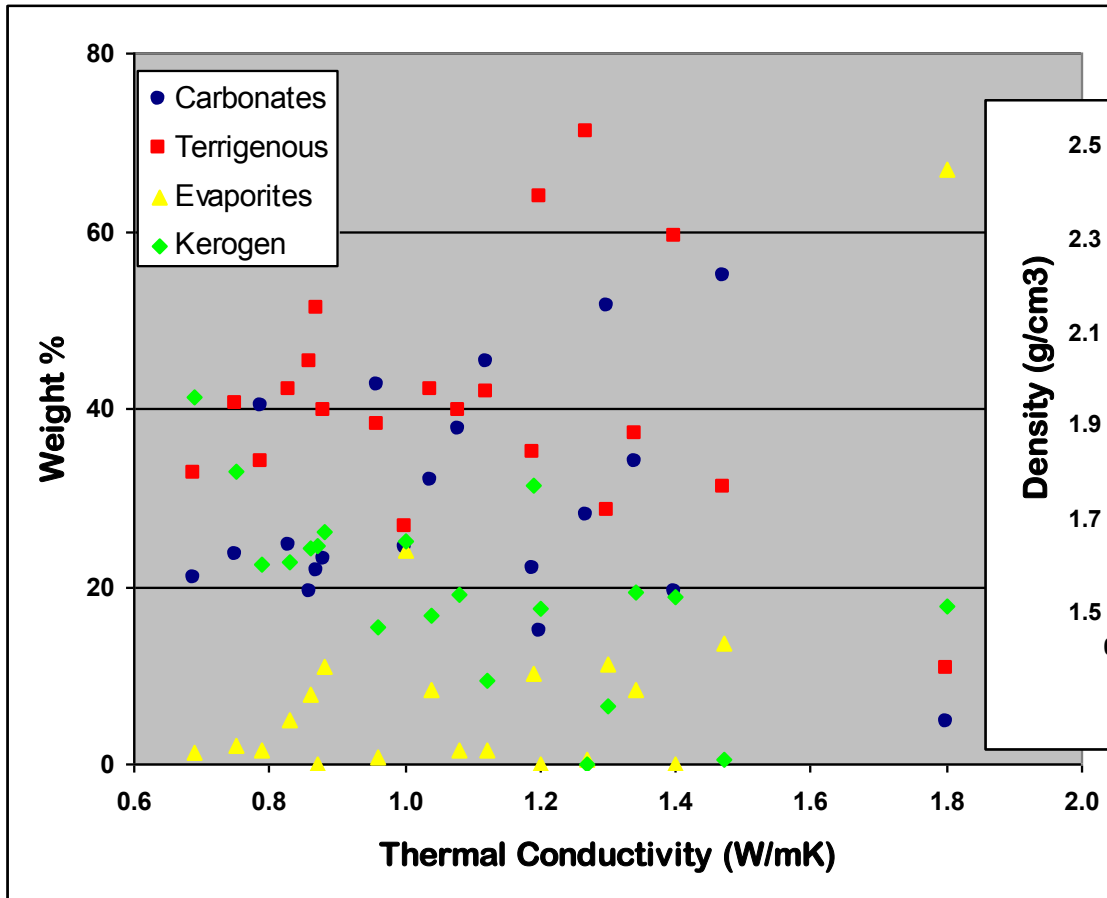
Composite Stratigraphic Variations



Organic Enrichment and Mineralogy



Thermal Conductivity – Compositional Control



Conclusions



- Any subsurface engineering effort should be informed by, and take advantage of, variations in lithology/mineralogy.
- In general, slumped oil shale is richer than surrounding well-laminated oil shale.
- There are significant changes in mineralogy with stratigraphic position. These have corresponding implications for *in situ* conversion processes.
- Thermal conductivity of oil shale can vary substantially and is best correlated with density variations.