GEOCHEMISTRY OF OAE III IN THE NIOBRARA FORMATION

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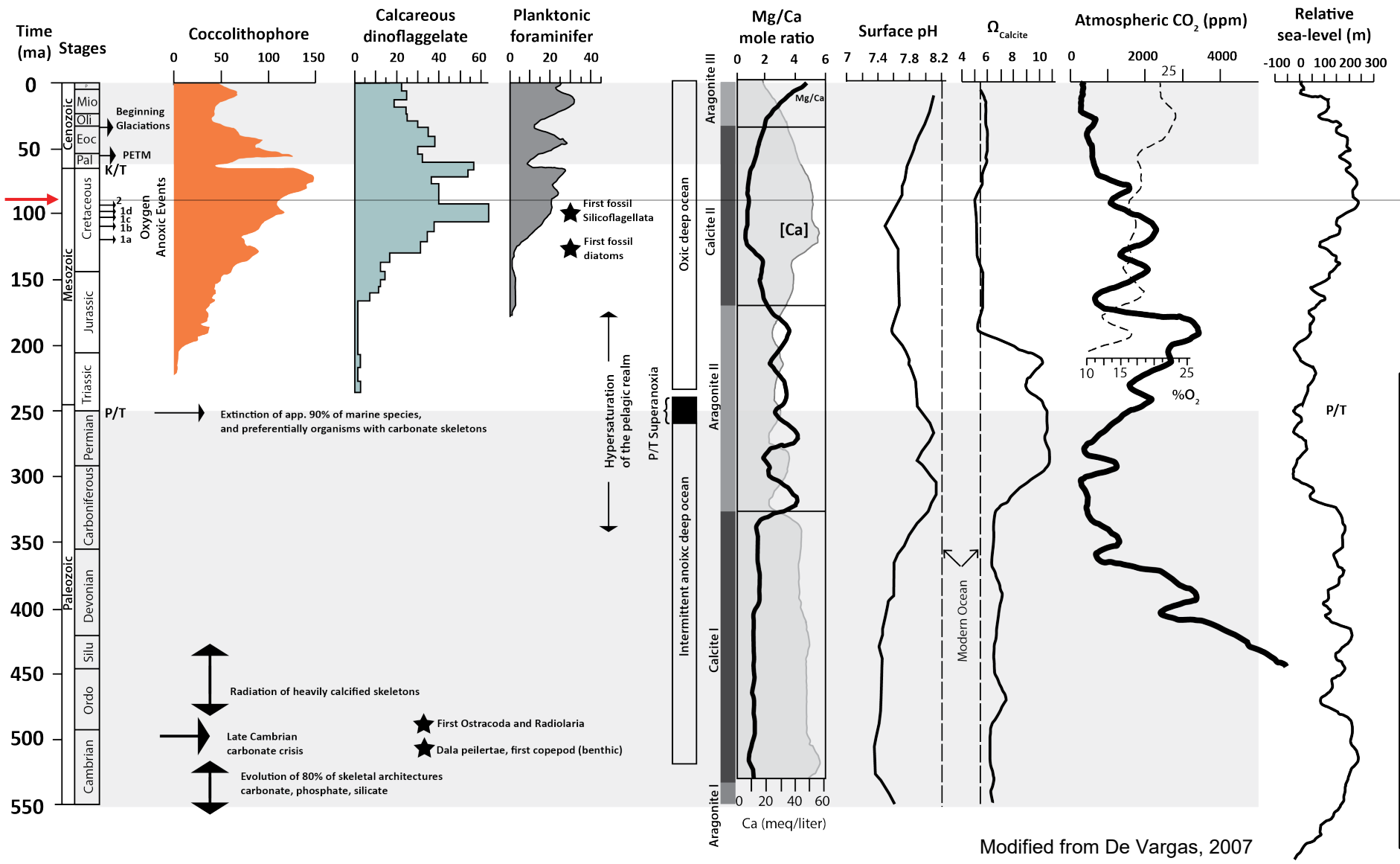
Outline

- Introduction
- Ocean Anoxic Event III
- Geologic Proxies
  - Organic Carbon
  - Elemental Indicators
  - Stable Isotopes
- OAE III in the Western Interior Seaway
- Preliminary Observations
- Future Work

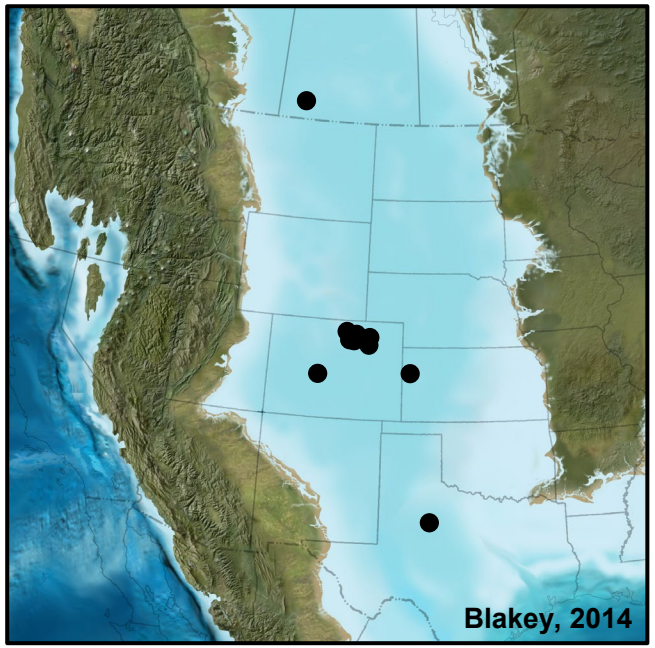
Introduction



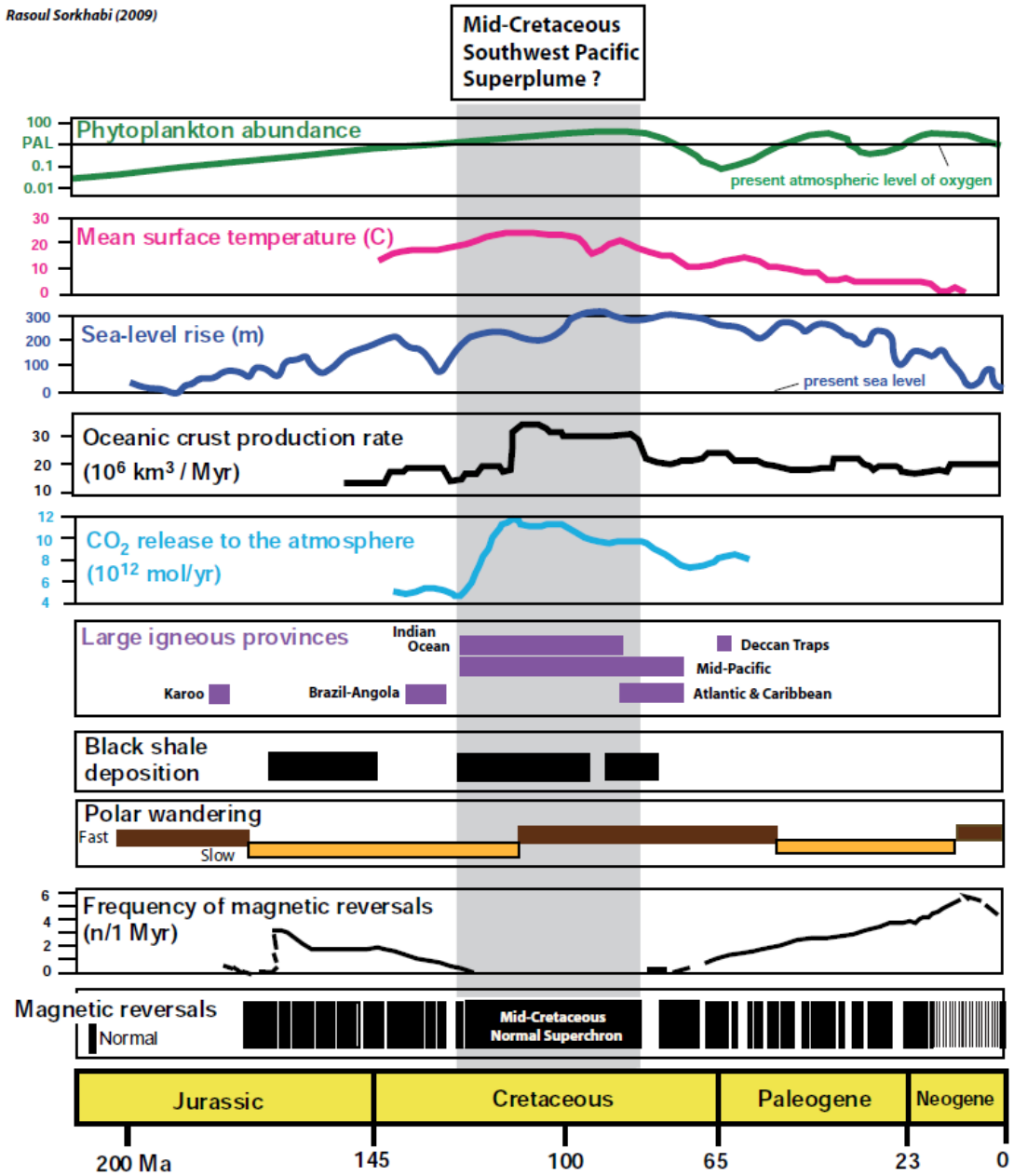
Modified from De Vargas, 2007

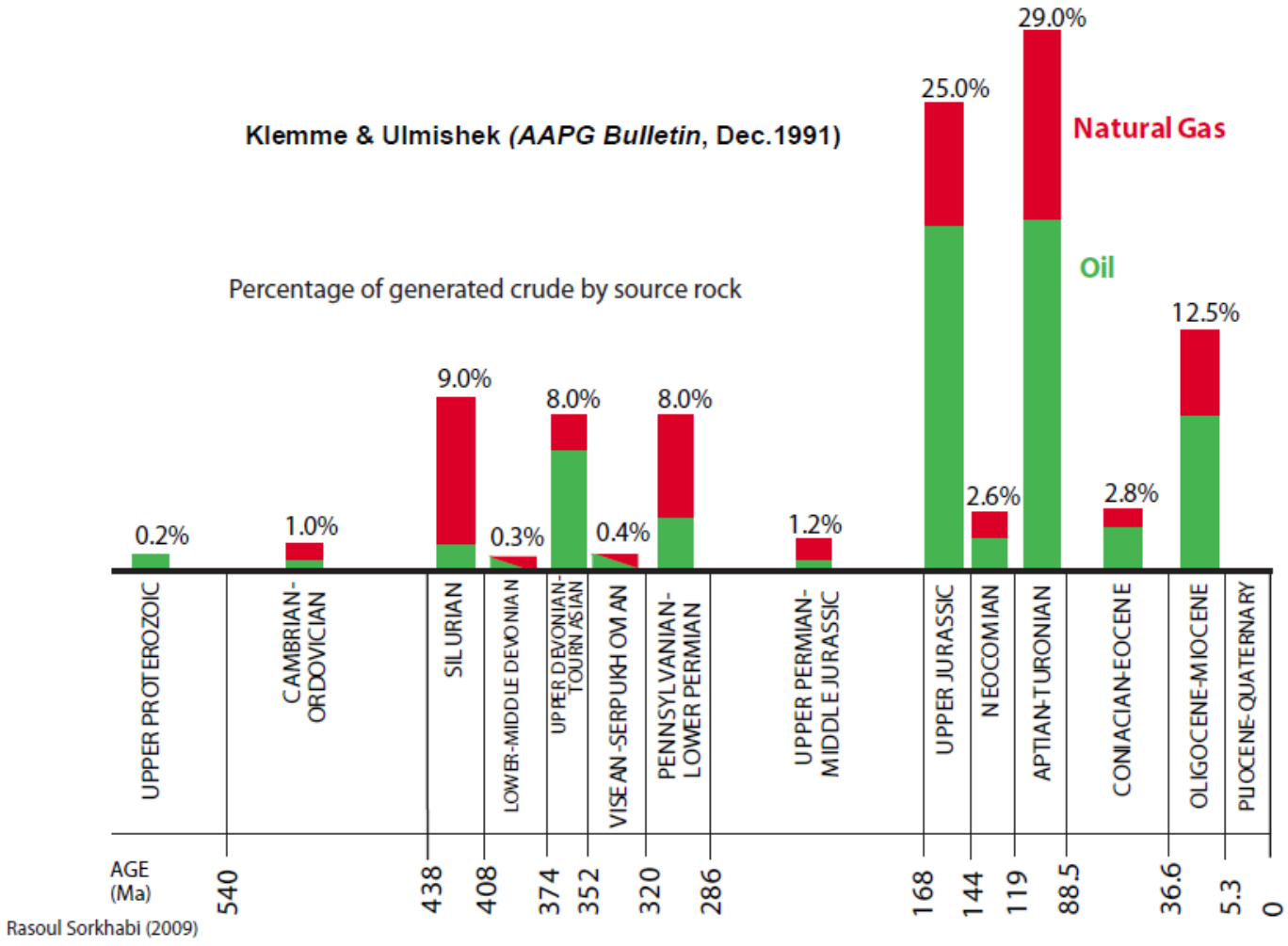
OAE Indicators;

- Trends in Organic Carbon Burial Rates
- Enrichment/Depletion of Elemental Proxies
- Stable Isotopes



Cretaceous Time Period



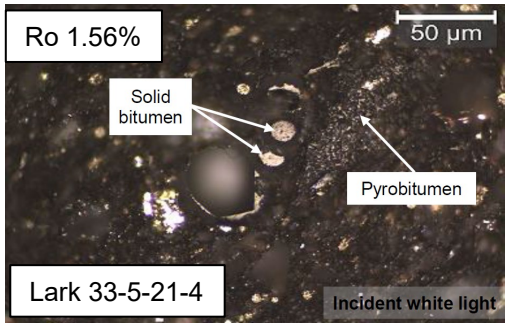


Rasoul Sorkhabi (2009)

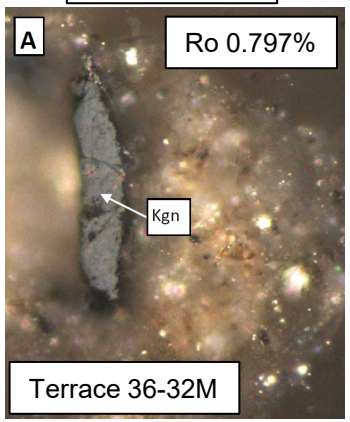
Organic Carbon

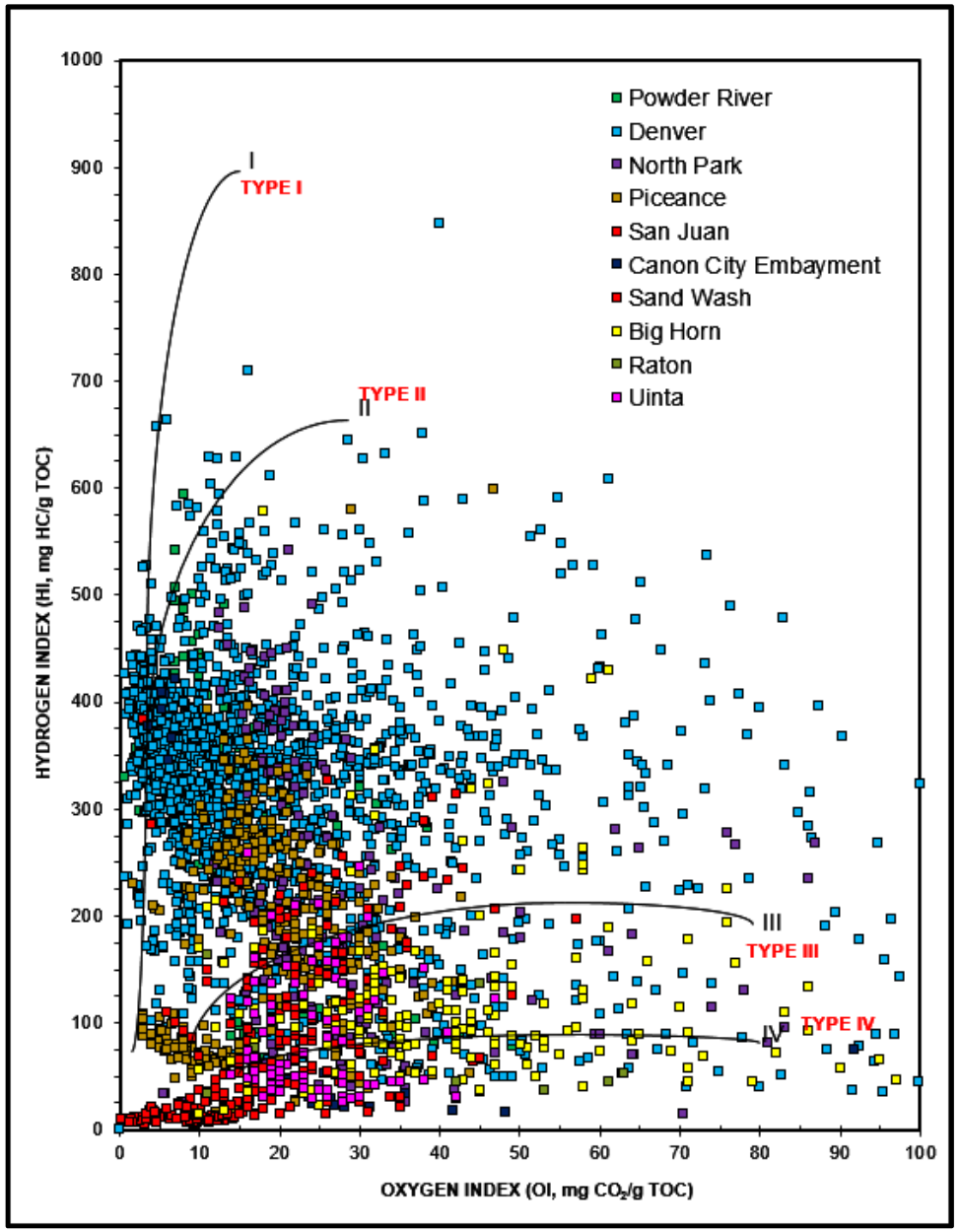
- Kerogen type II to II/III
- Depends on the location in WIS
- Close proximity to Sevier Highlands result in more woody material
- Oil and gas production

San Juan Basin



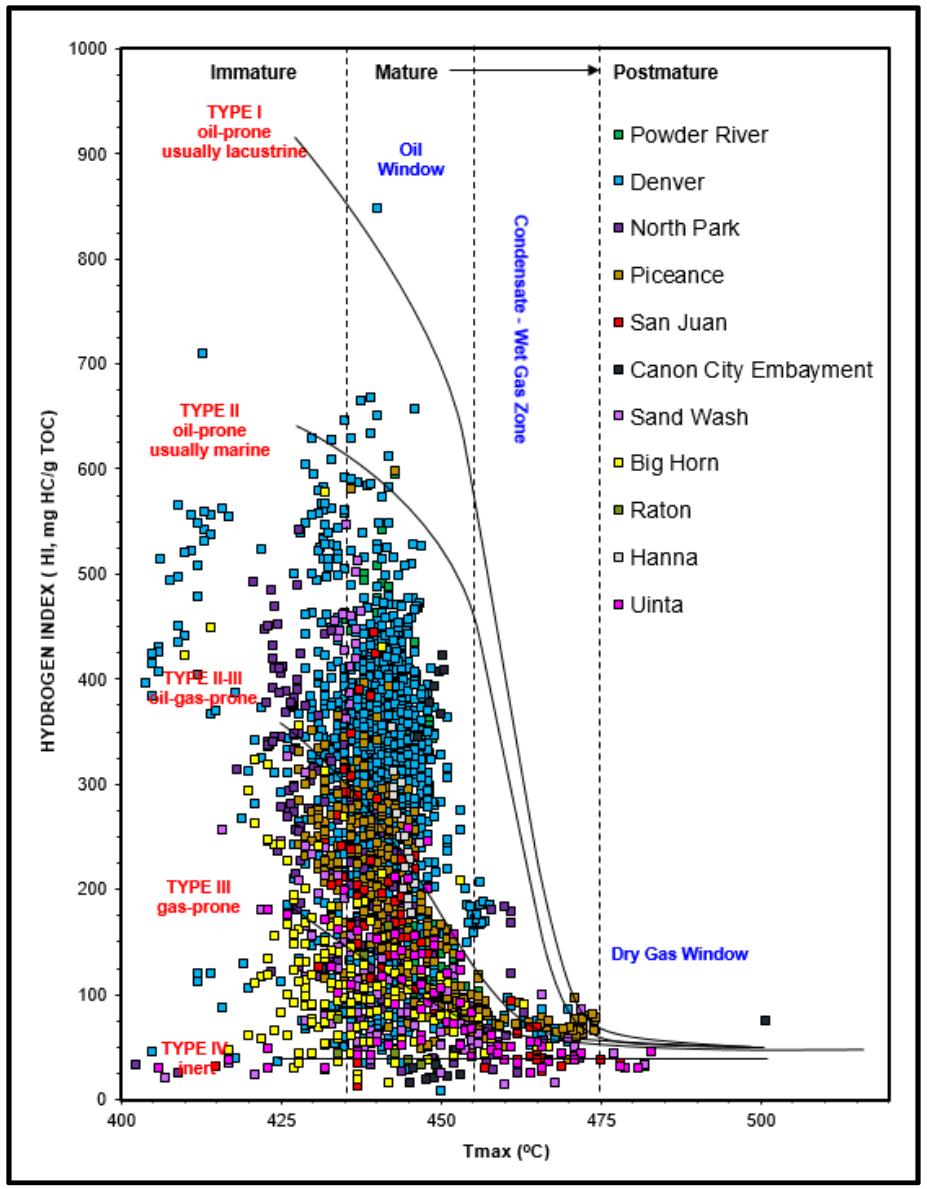
Denver Basin





Data compiled from past studies, USGS, and the literature

Organic Carbon



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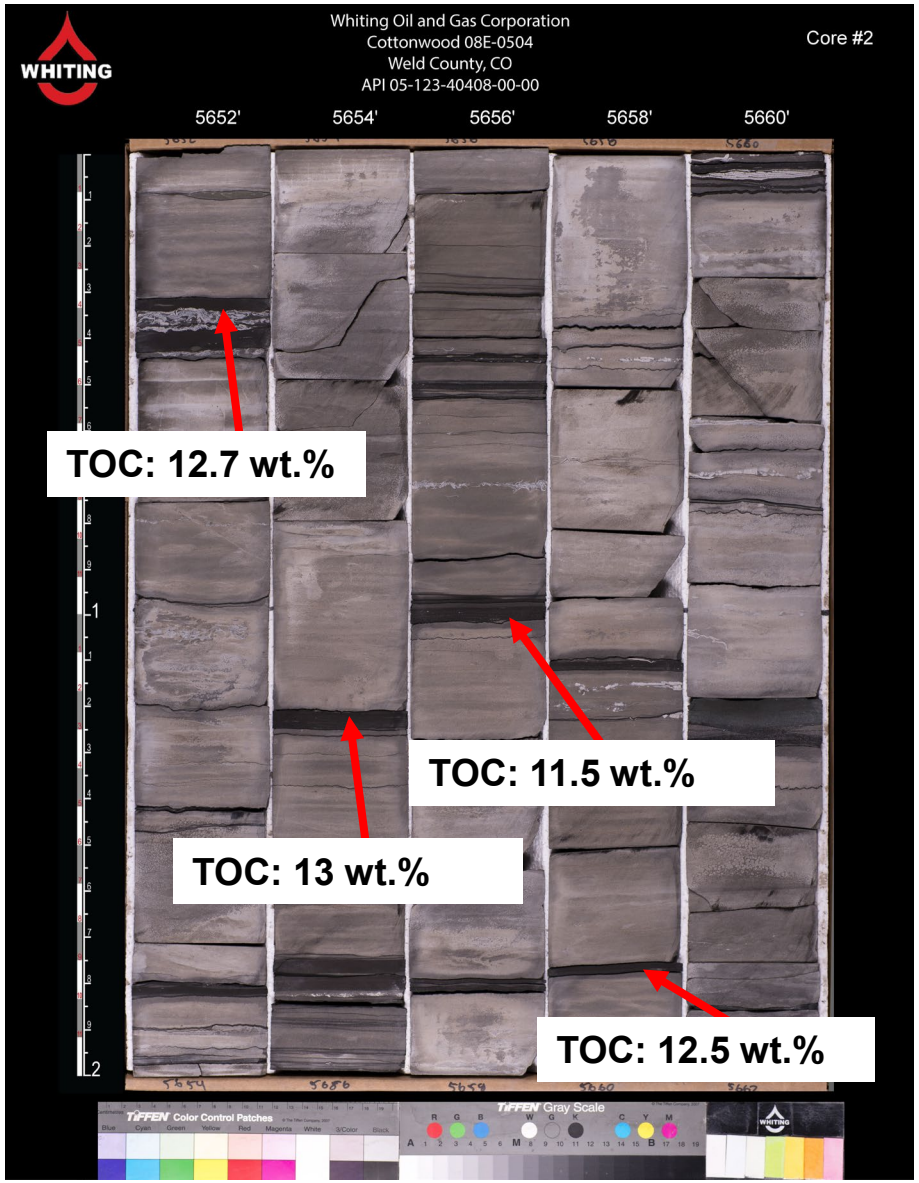
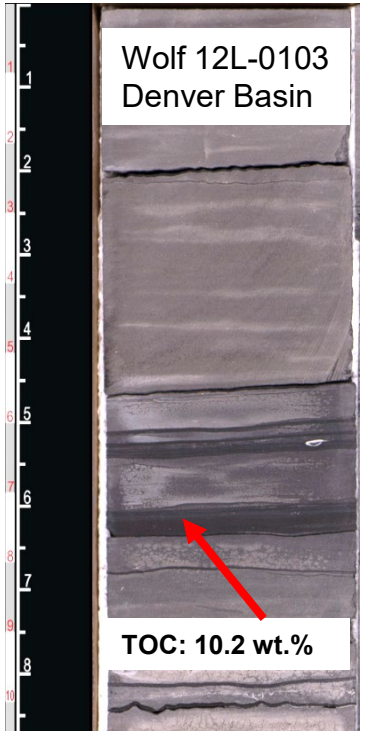
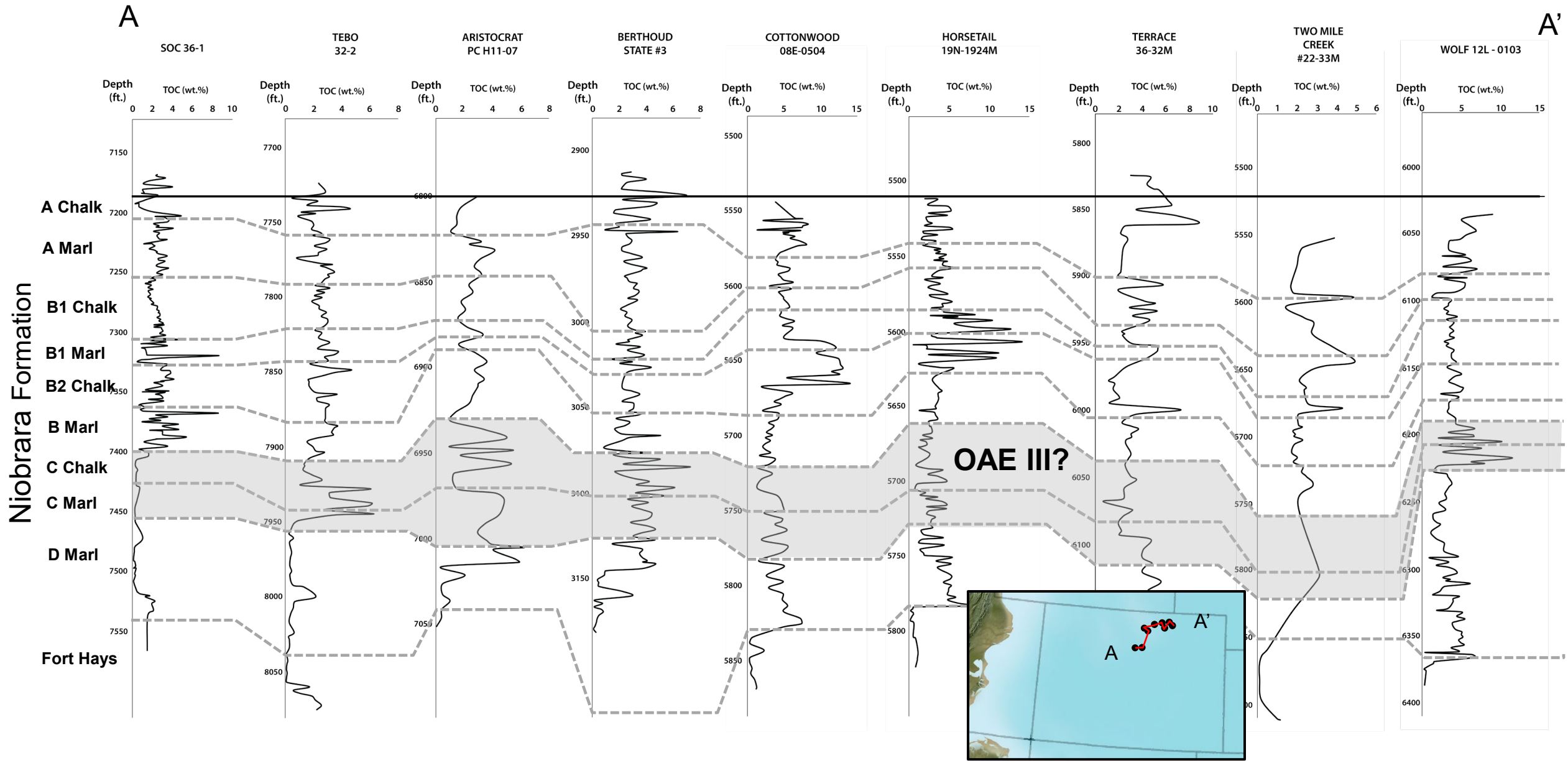


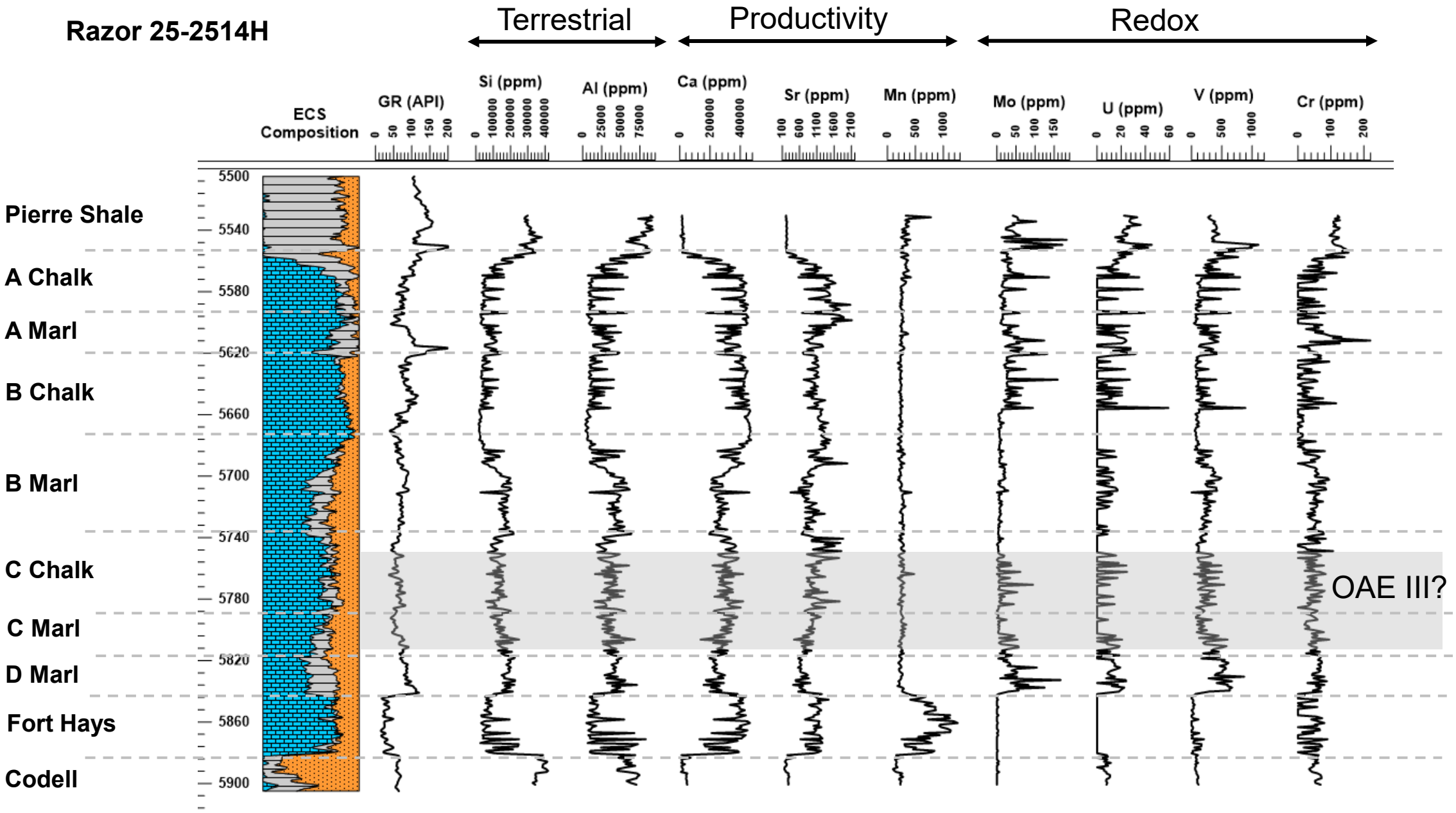
- High organic content
- Above 10 wt.%
- Wet vs. dry climates? High organic productivity in stratified water columns
- OM is preserved
- Decreased oxygen content



Organic Rich Units in the WIS



Elemental Proxies



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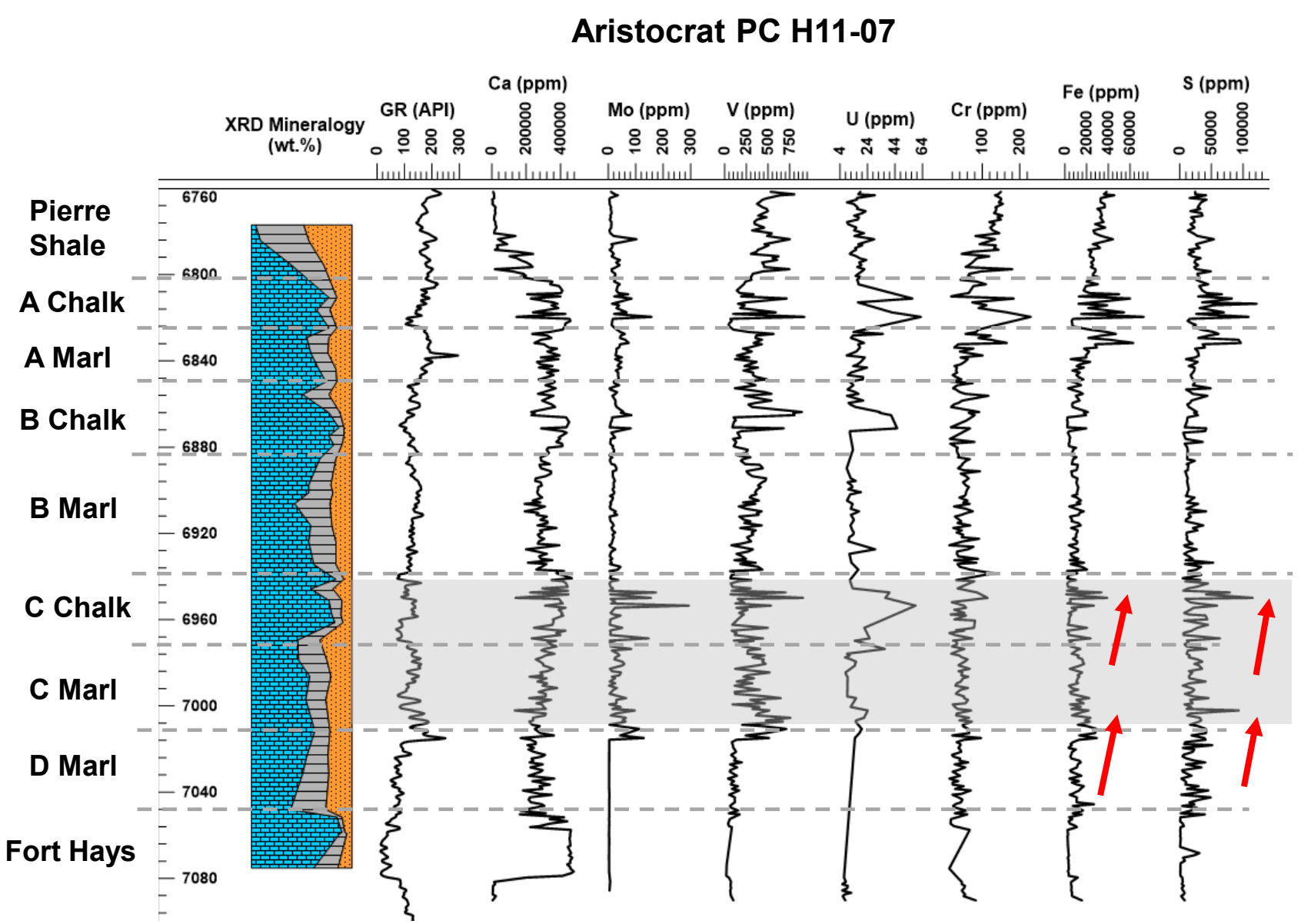
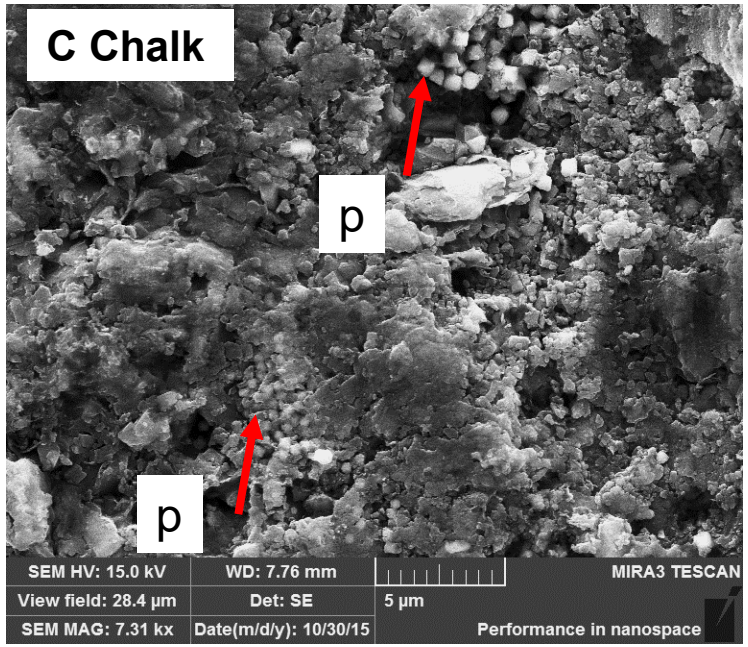
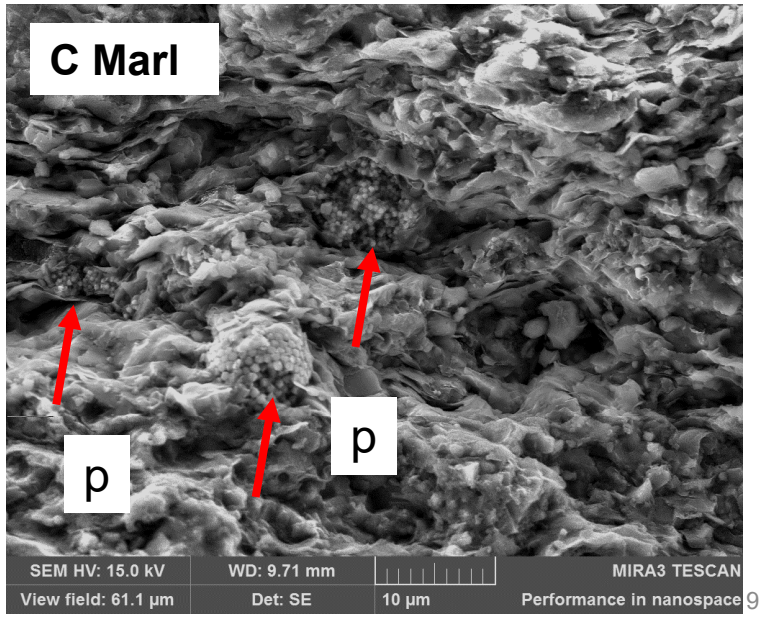
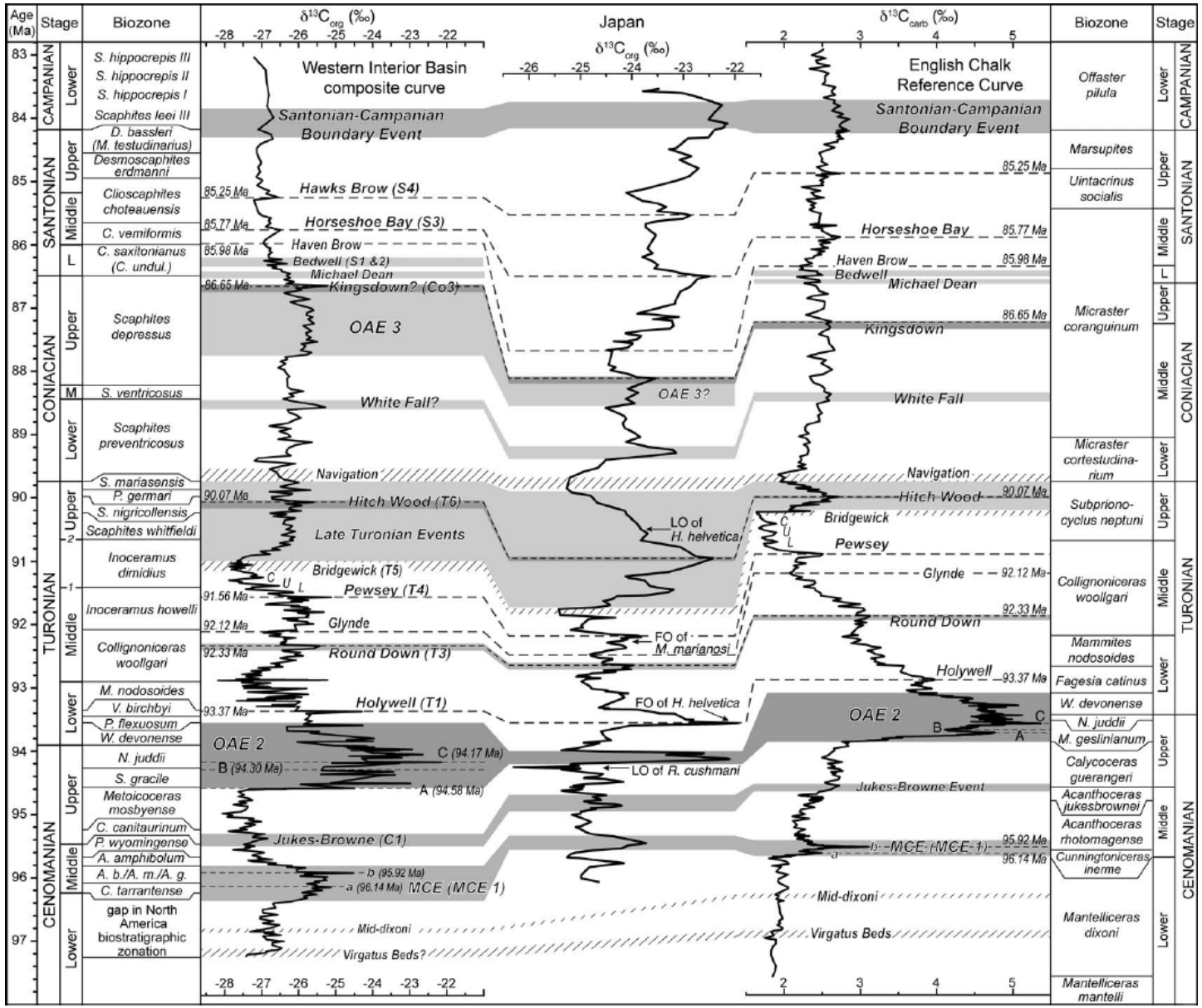




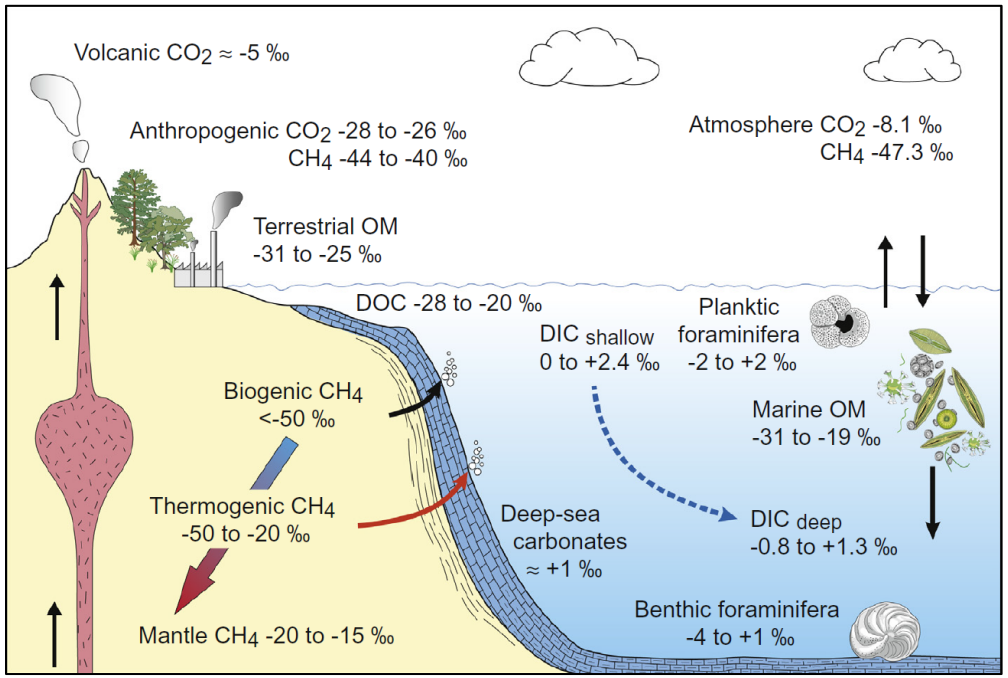


Stable Isotopes



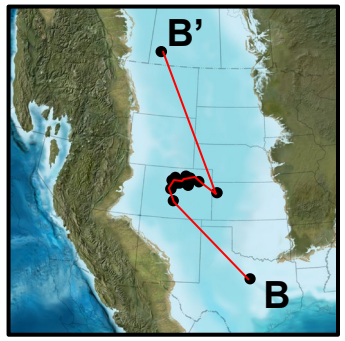
(Joo and Sageman, 2014)

- Stable isotopes can be correlated across continents
- Useful for understanding changes in carbon balance
- Increasing δ13C values indicate increased productivity
- Niobrara Formation involves OAE 3

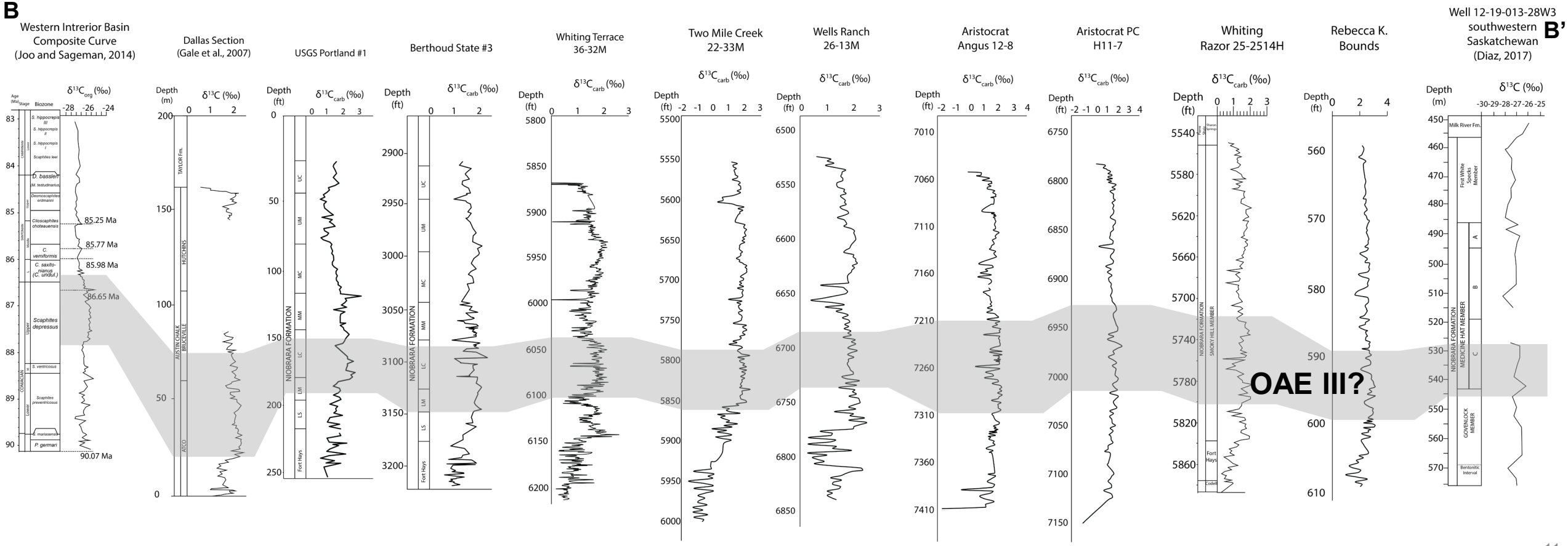


(Mackensen and Schmiedl, 2019)

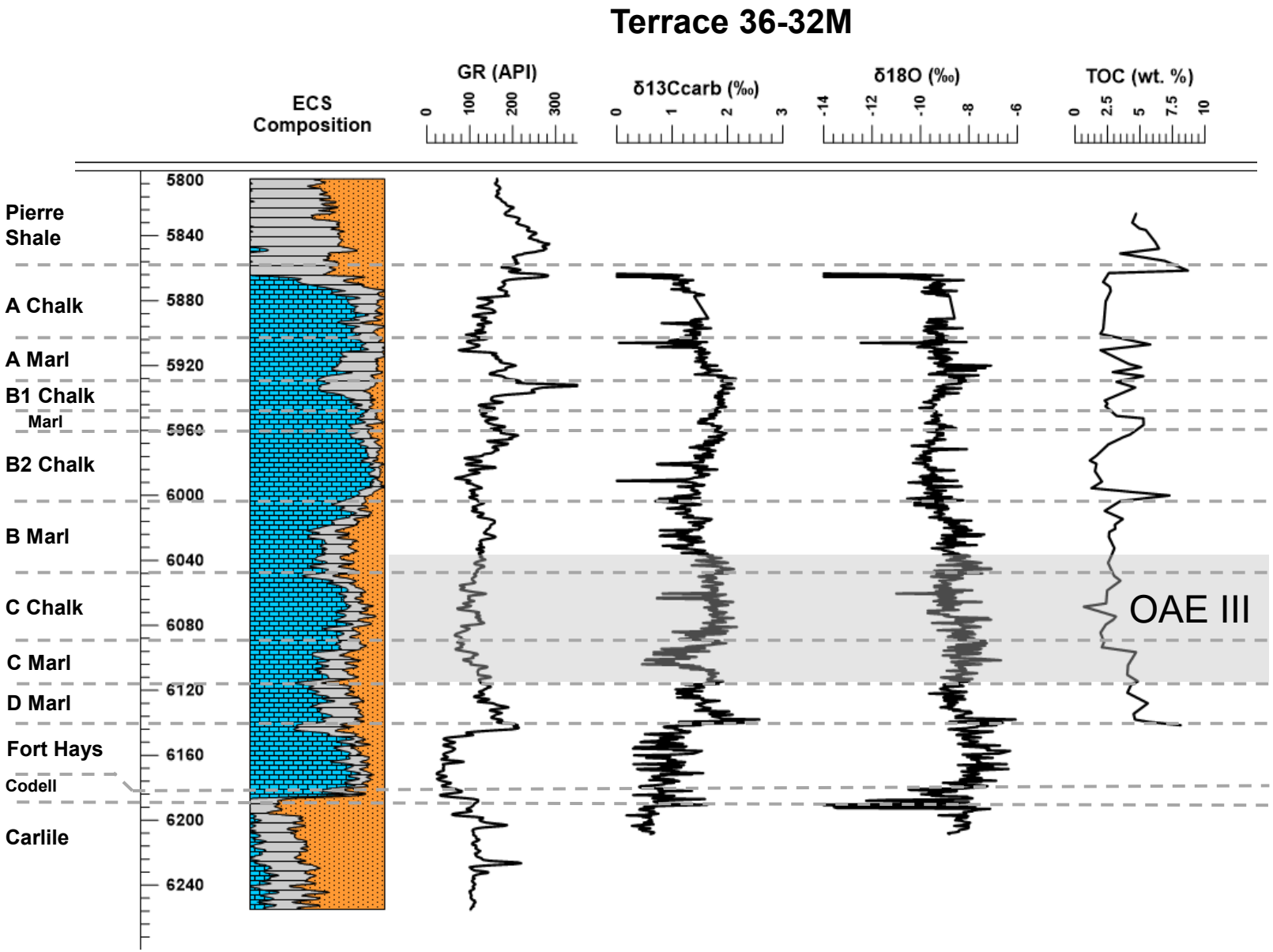
Stable Carbon Isotopes

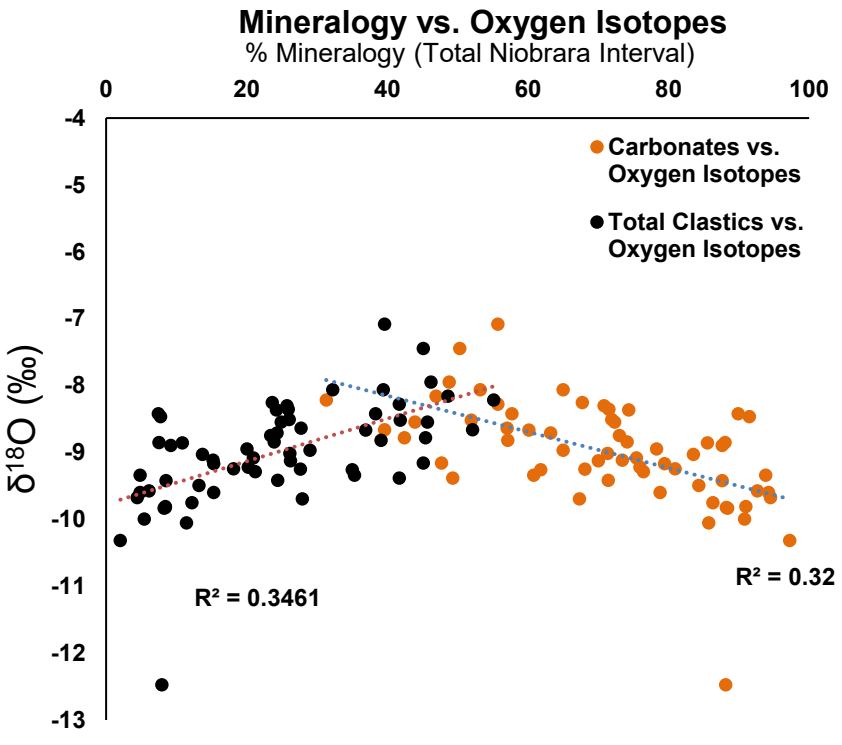


Stable Carbon Isotope Correlation from Western Interior Seaway



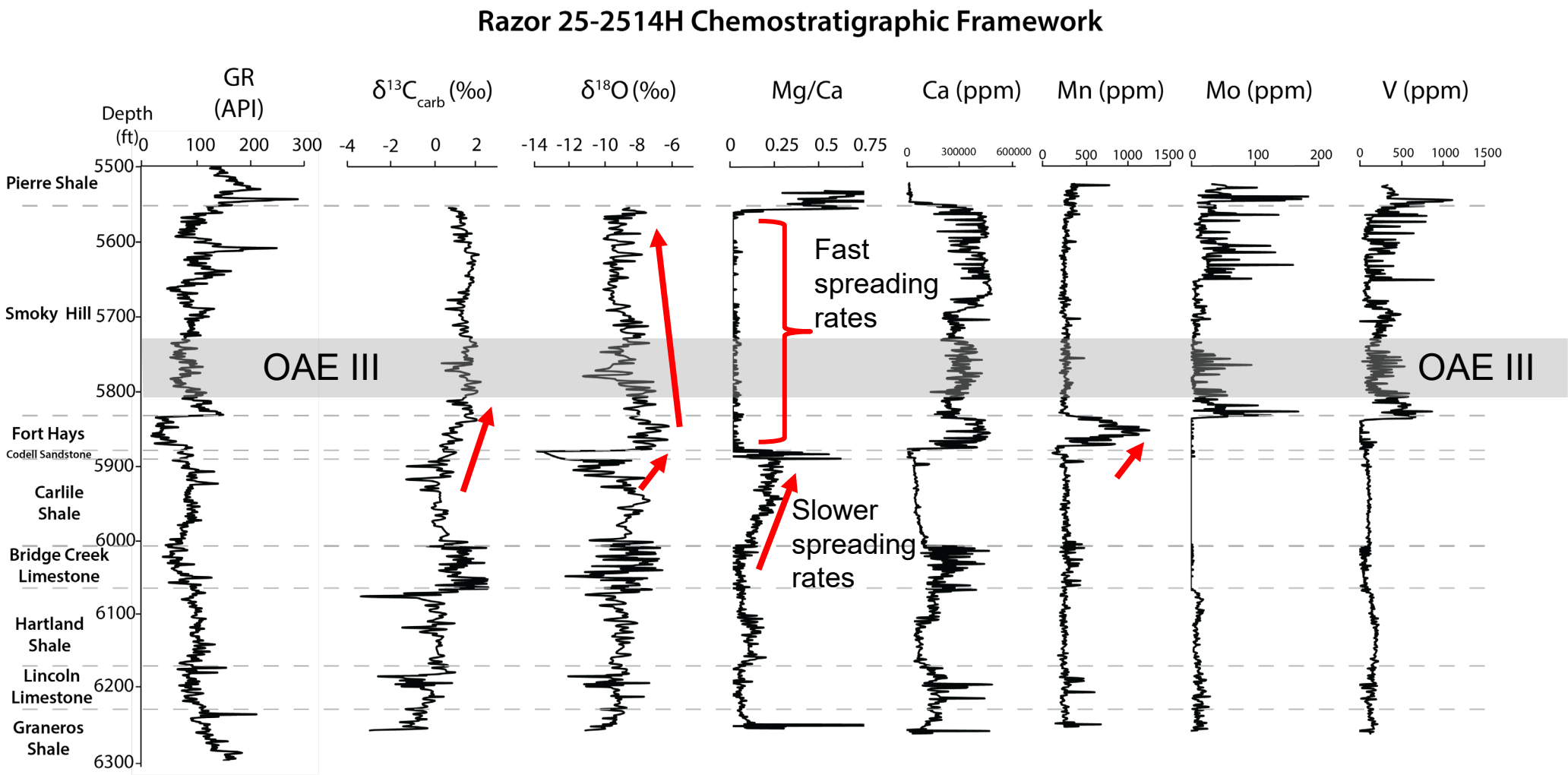
Mineralogy and Oxygen Isotopes





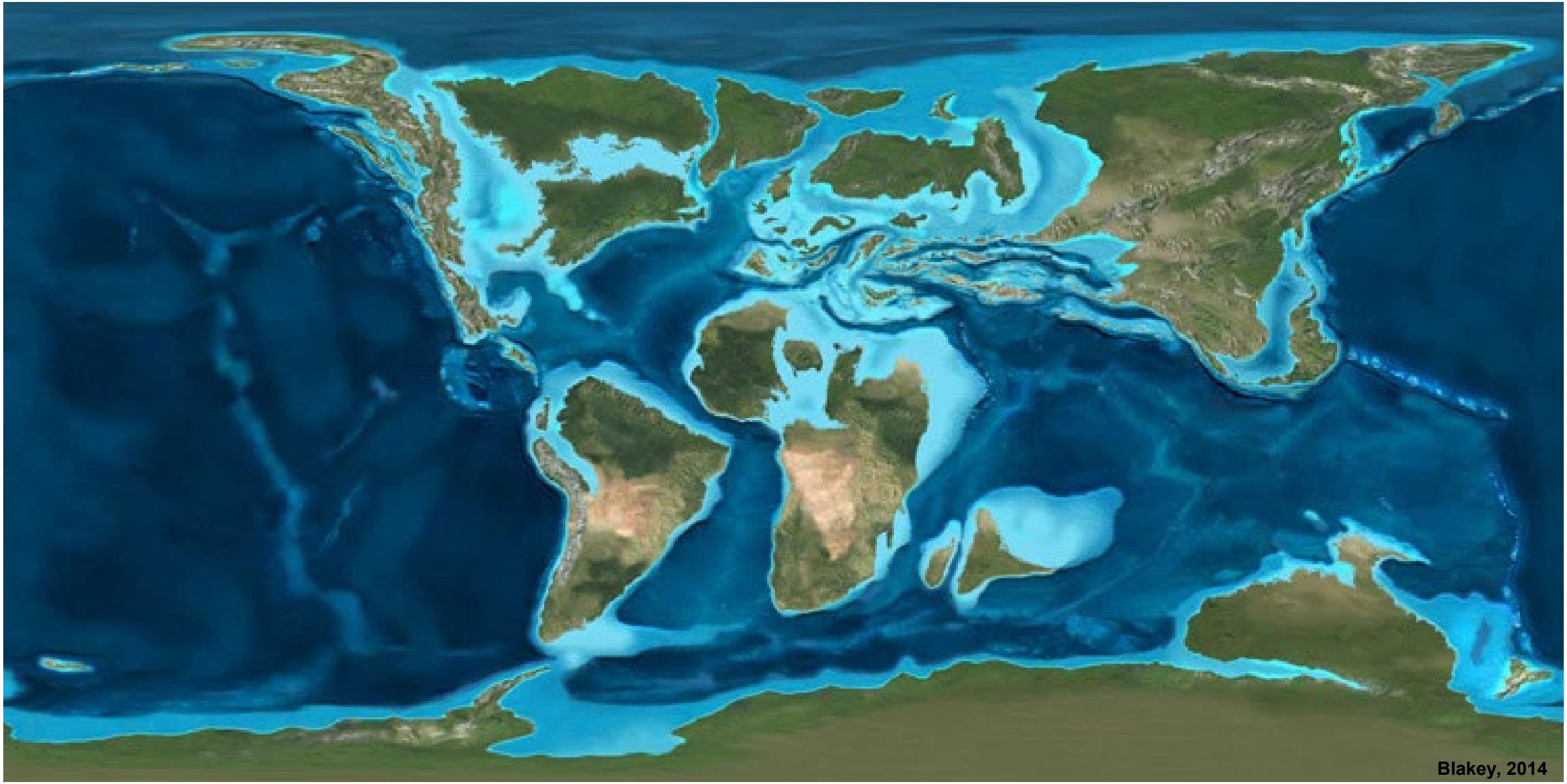
- Increasing carbonate content displays higher O^{16} enrichment relative to O^{18}
- Nature of clastic input relates to climate

Chemostratigraphy and Climate

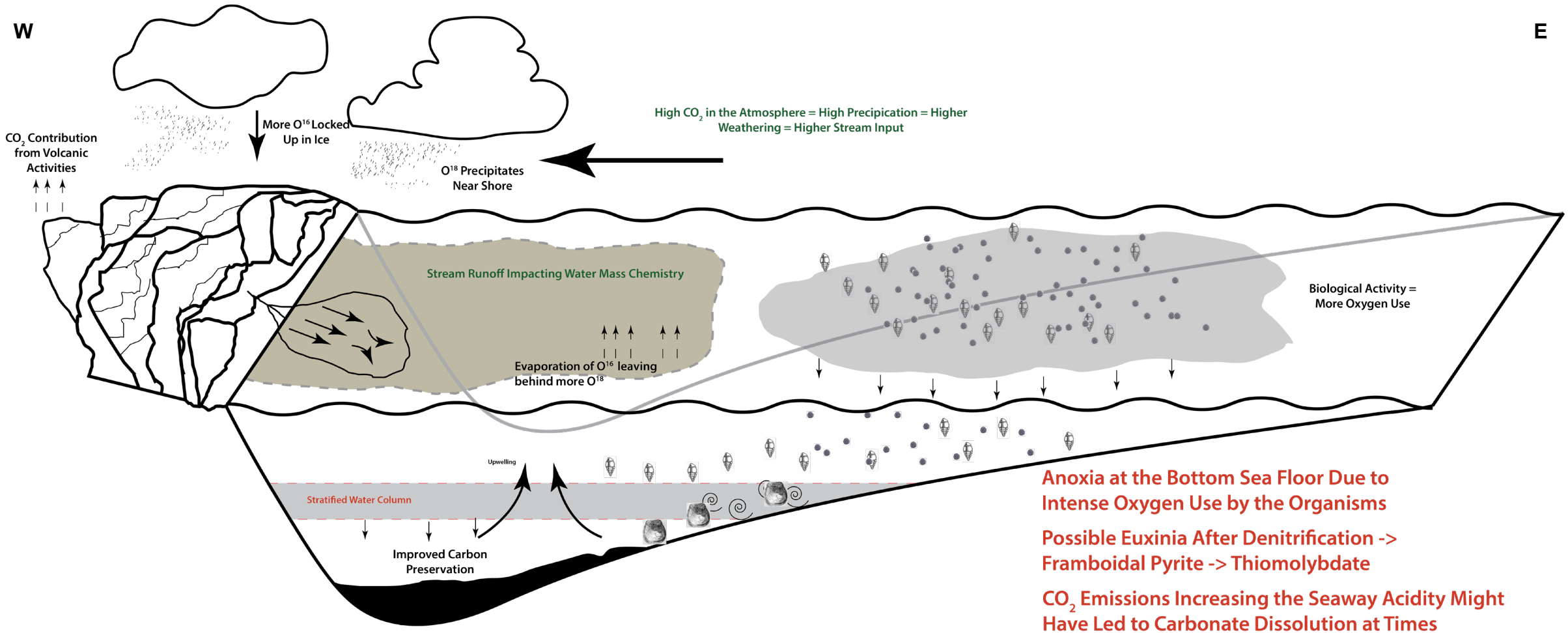


- Faster spreading rates at the Niobrara indicate stronger MOR action
- Increasing Carbon isotopes indicate better preservation of carbon
- Onset of Niobrara deposition display drastic shift in Oxygen Isotope Values
- Niobrara Formation is colder than older units
- Initial cooling might be due to CO_2 emissions
- More CO_2 impacted weathering rates
- OAE III might be a result of increased stream runoff during cooling
- After OAE, climate warms

Chalk Deposition



Climate During OAE III



Anoxia at the Bottom Sea Floor Due to Intense Oxygen Use by the Organisms

Possible Euxinia After Denitrification -> Framboidal Pyrite -> Thiomolybdate

CO_2 Emissions Increasing the Seaway Acidity Might Have Led to Carbonate Dissolution at Times

Increased Precipitation Rates -> Increasing Weathering -> OAE

Preliminary Observations

- OAE III displays better carbon preservation
- Redox sensitive elements display enrichment during OAE III
- Stable isotopes indicate climatic variations prior to and during the of deposition of Niobrara
- Increasing Mg/Ca ratios indicating fast spreading rates with the onset of Niobrara Deposition
- Higher seafloor spreading likely causing transgression leading to saline Tethyan water influx
- CO_2 emissions at the time might have a role in widespread global chalk deposition ($CO_2 + H_2O$)
- Niobrara Formation displays cooler climate than older stratigraphic units
- After OAE III cooling trend shifts to warming
- Influence of climatic changes might have influenced weathering rates – more nutrient input
- Overall OAE III might have occurred as a response to structural deformation and subsequent climate change leading to high photic zone productivity followed by anoxia

Future Work

- Increase data resolution for Chemostratigraphy
  - Higher resolution XRF
  - Stable isotopes Sr, Rb, Os, Cr
- Identify biostratigraphic units
  - Paleobiologic/Paleoenvironmental indications
- Astrocycles based on statistical methods
  - Multitaper Method
  - EHA
  - Is there a shift in orbital action at the onset of the Niobrara Formation deposition?

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