



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

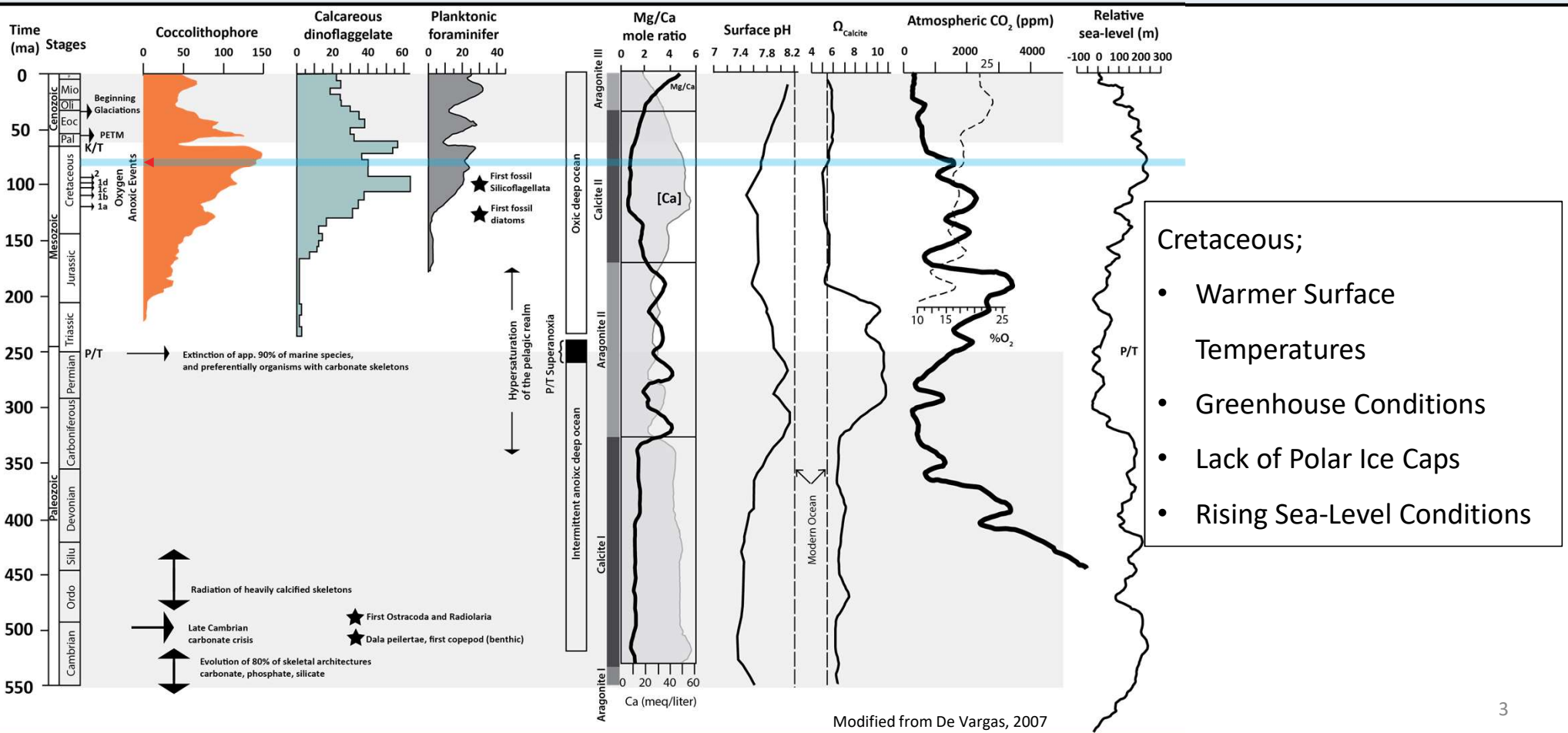
Emre Cankut Kondakci Ph.D. Candidate May 2022

## **GEOCHEMISTRY OF OAE III**

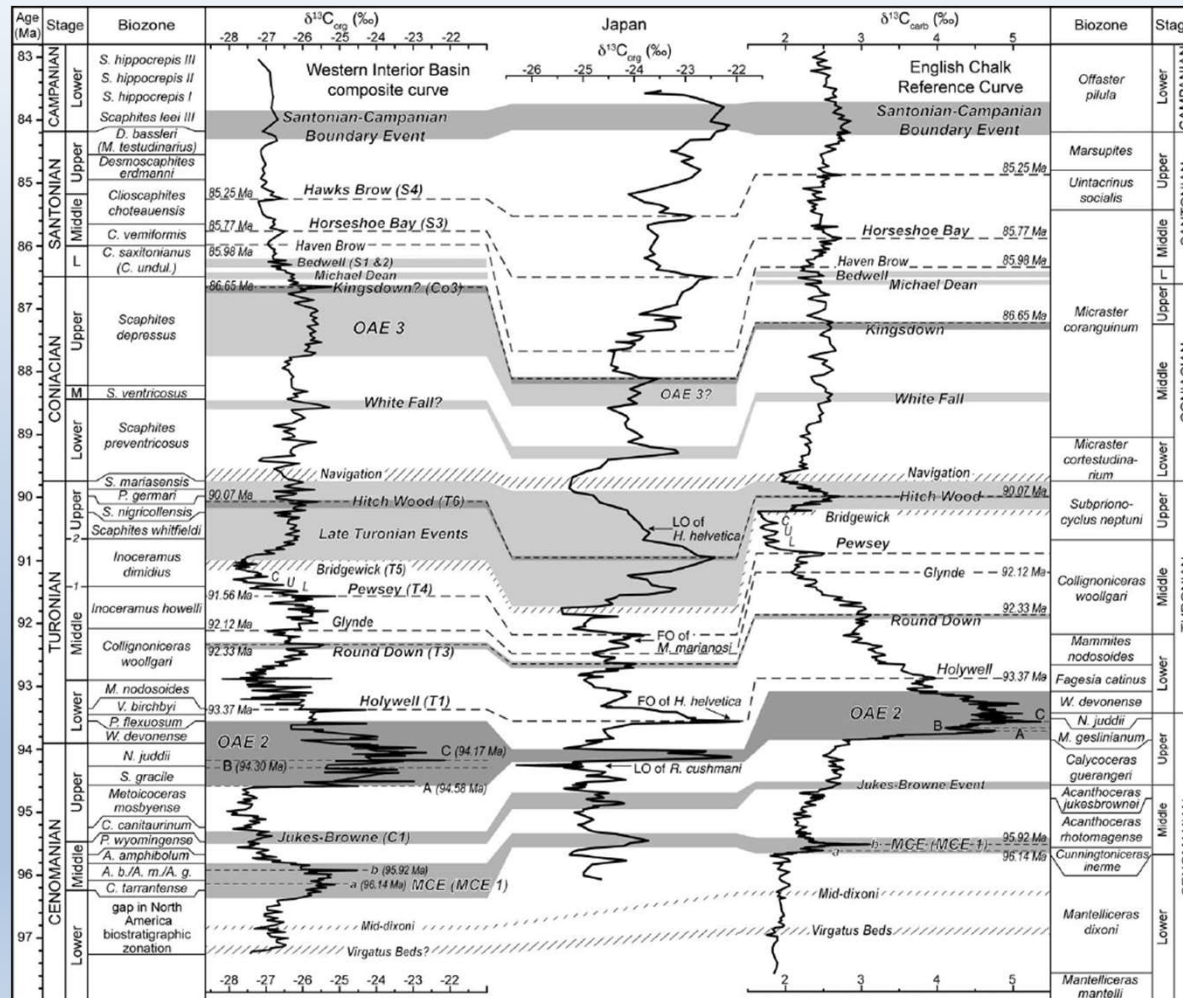
# Outline

- Introduction
- Ocean Anoxic Events
- Paleoredox Conditions During OAE III
- Changes in Organic Matter Composition
- Nutrient Recycling
- Conclusions
- Future Work

# Introduction

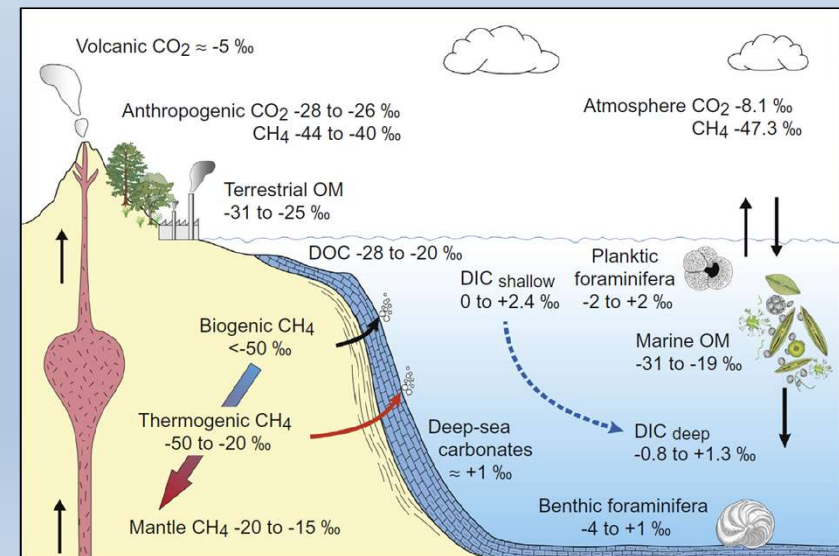


# Ocean Anoxic Events



(Joo and Sageman, 2014)

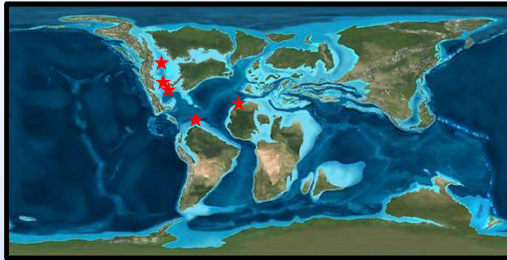
- Stable isotopes can be correlated across continents
- Useful for understanding changes in carbon balance
- Increasing  $\delta^{13}\text{C}$  values indicate increased productivity
- Niobrara Formation involves OAE III



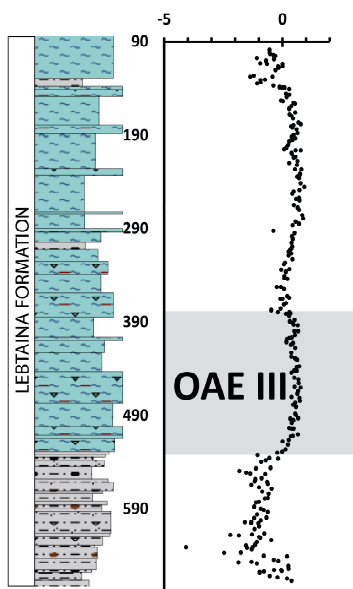
(Mackensen and Schmiedl, 2019)



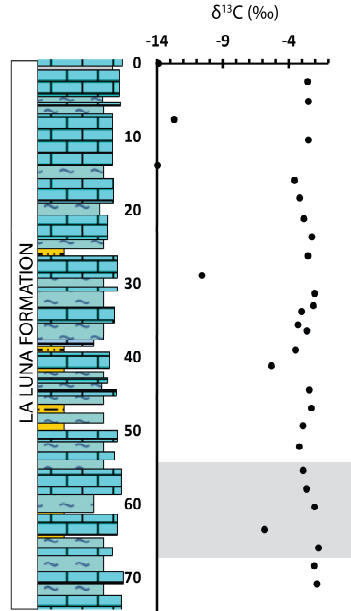
# Ocean Anoxic Event III



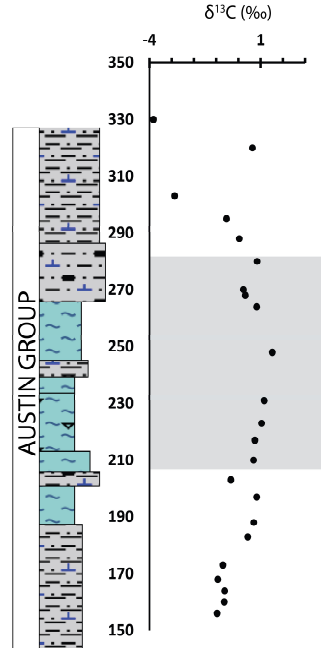
**Morocco**  
**Tarfaya Basin**  
(Aquit, et al. 2016)



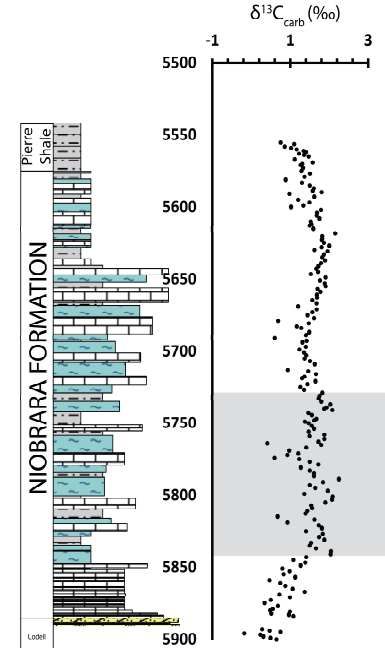
**La Luna Formation**  
**Venezuela**  
(Machado et al. 2016)



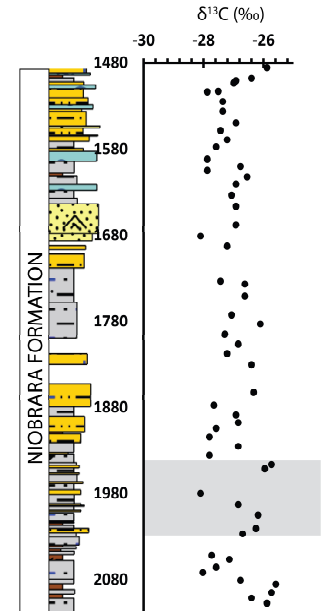
**Austin Chalk**  
**Hot Springs Well**  
(Wehner, 2017)



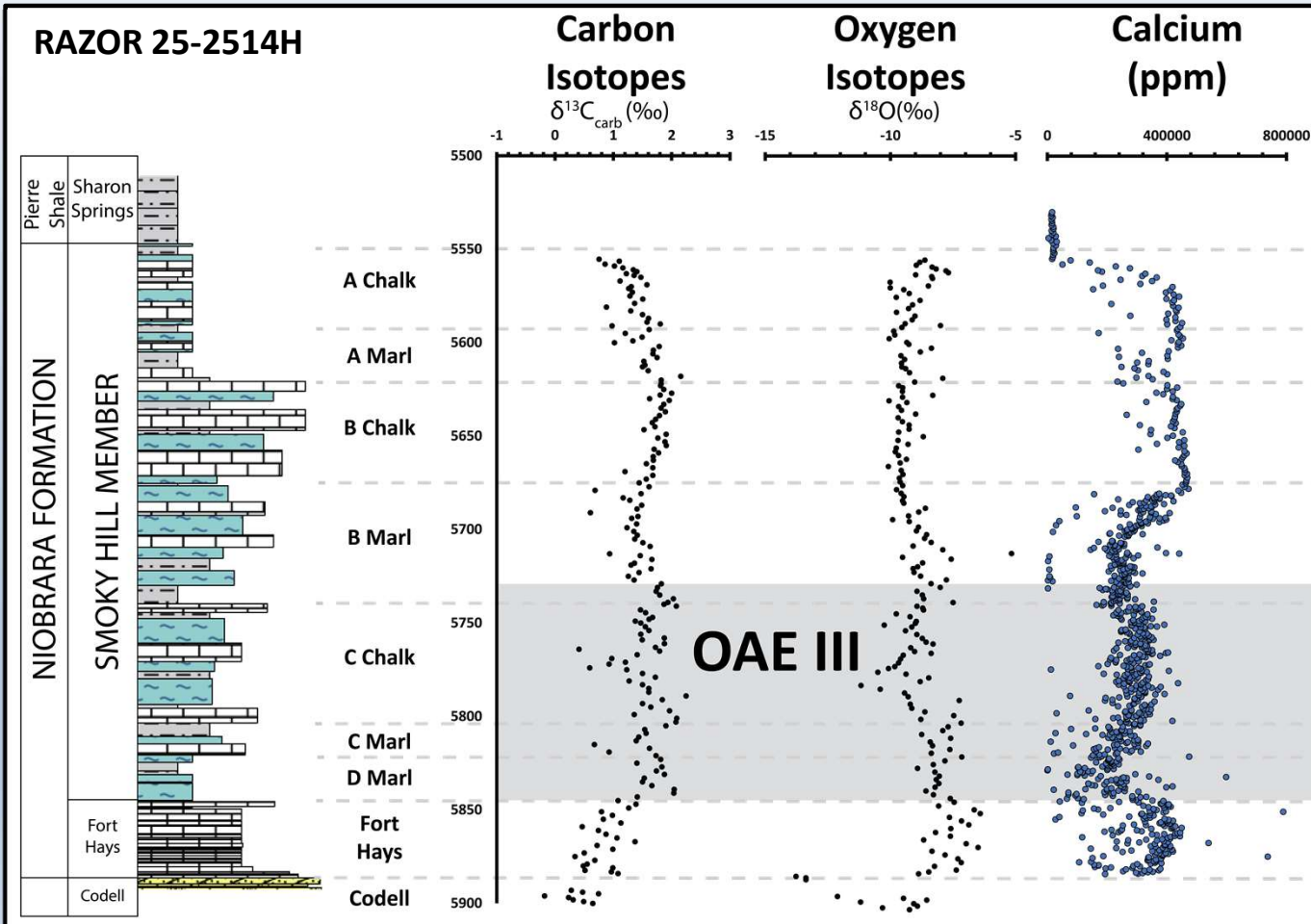
**Razor 25-2514H**  
**Denver Basin**  
(This study)



**Nexen Hatton**  
**12-19-013-28W3**  
**Canada**  
(Diaz, 2017)

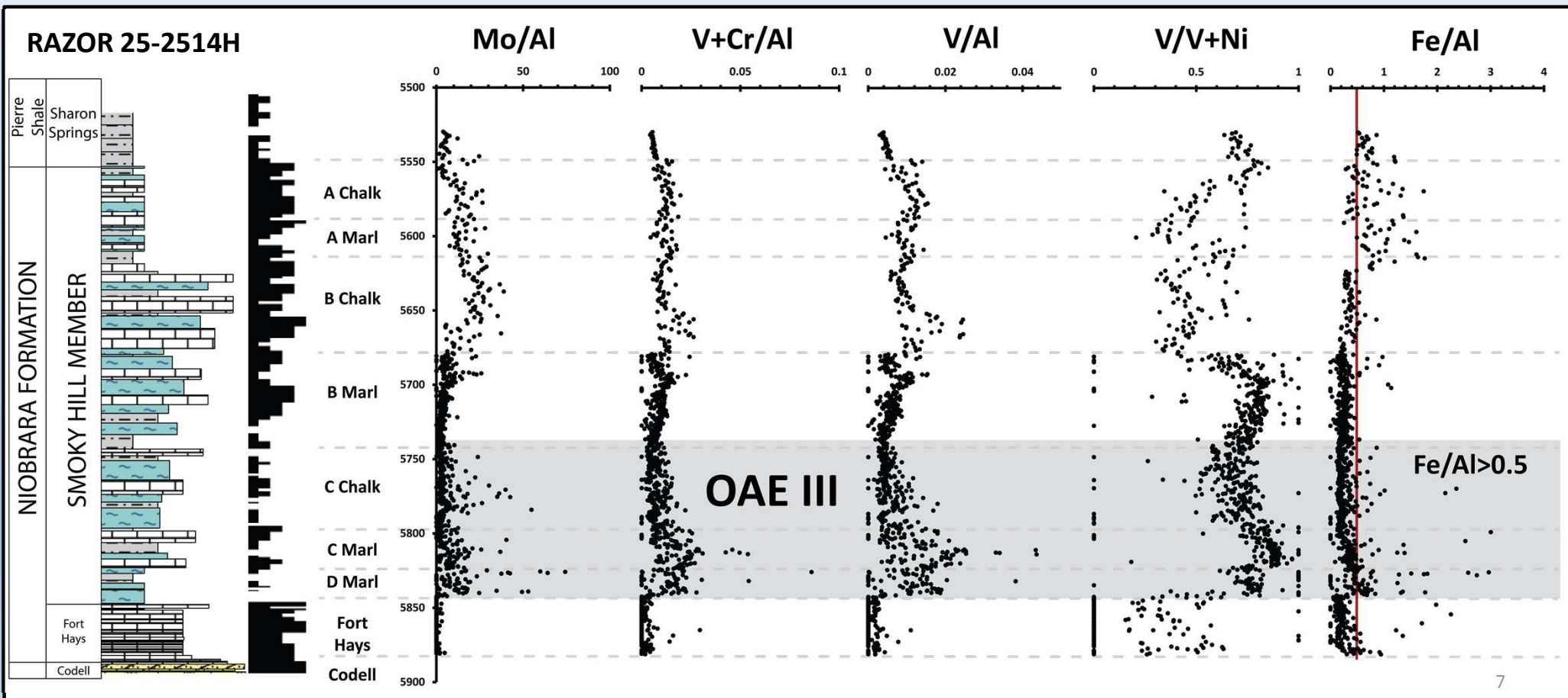


# Ocean Anoxic Event III

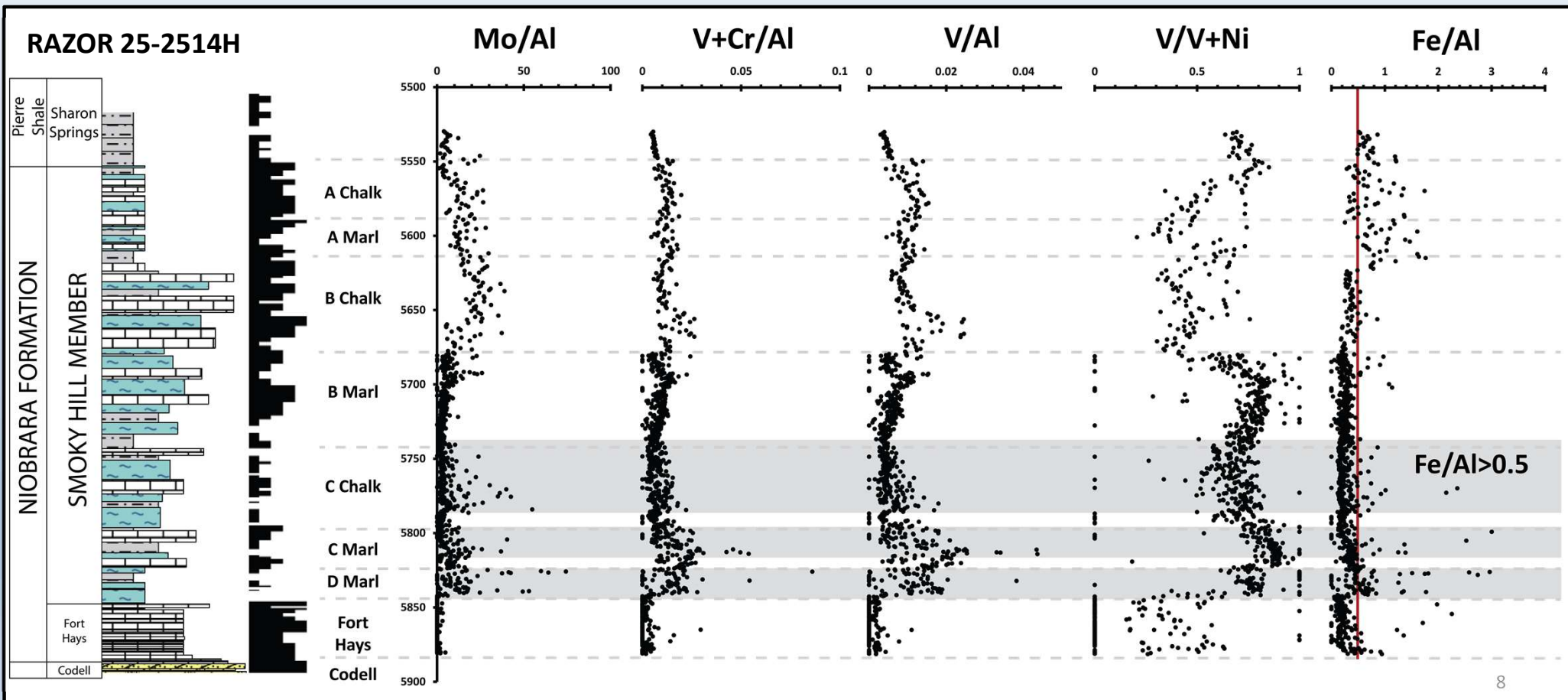


- Positive values and positive trend in stable carbon isotopes
- Stable isotopes indicate initial cooling climate
- Climate warms up during OAE III

# Paleoredox Conditions During OAE III



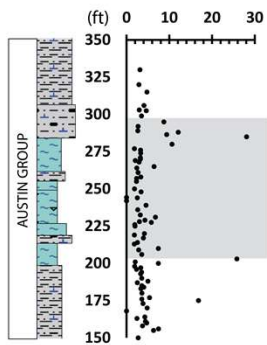
# Paleoredox Conditions During OAE III



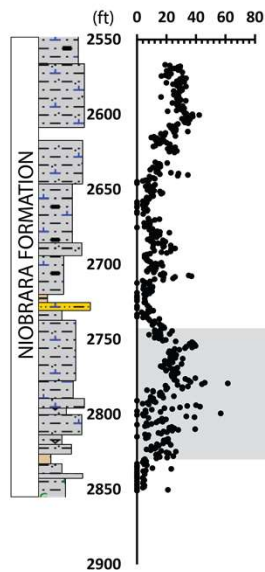


# Paleoredox Conditions During OAE III

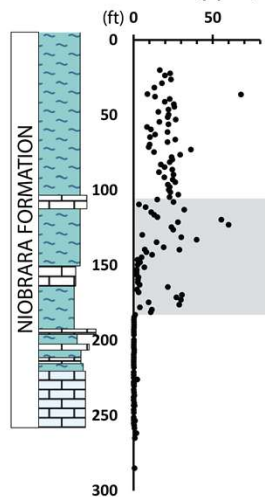
(Wehner, 2017)  
Hot Springs  
Austin Chalk  
Mo (ppm)



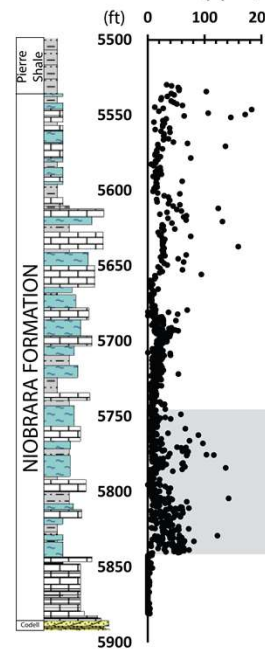
(Nelson, 2019)  
Greer 34-1  
San Juan Basin  
Mo (ppm)



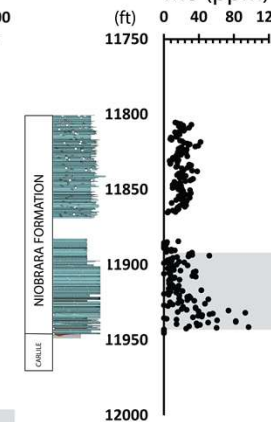
(Tessin, 2016)  
USGS Portland #1  
Canon City Embayment  
Mo (ppm)



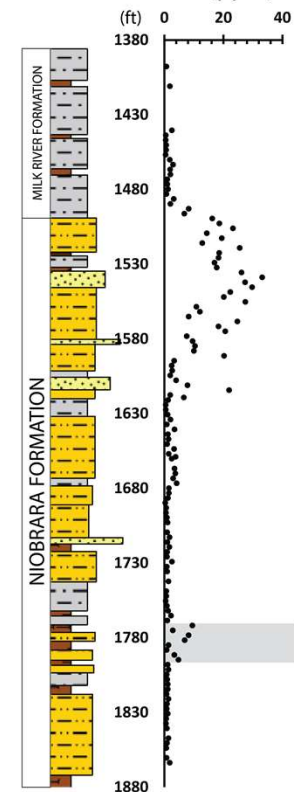
Razor 25-2514H  
Denver Basin  
Mo (ppm)



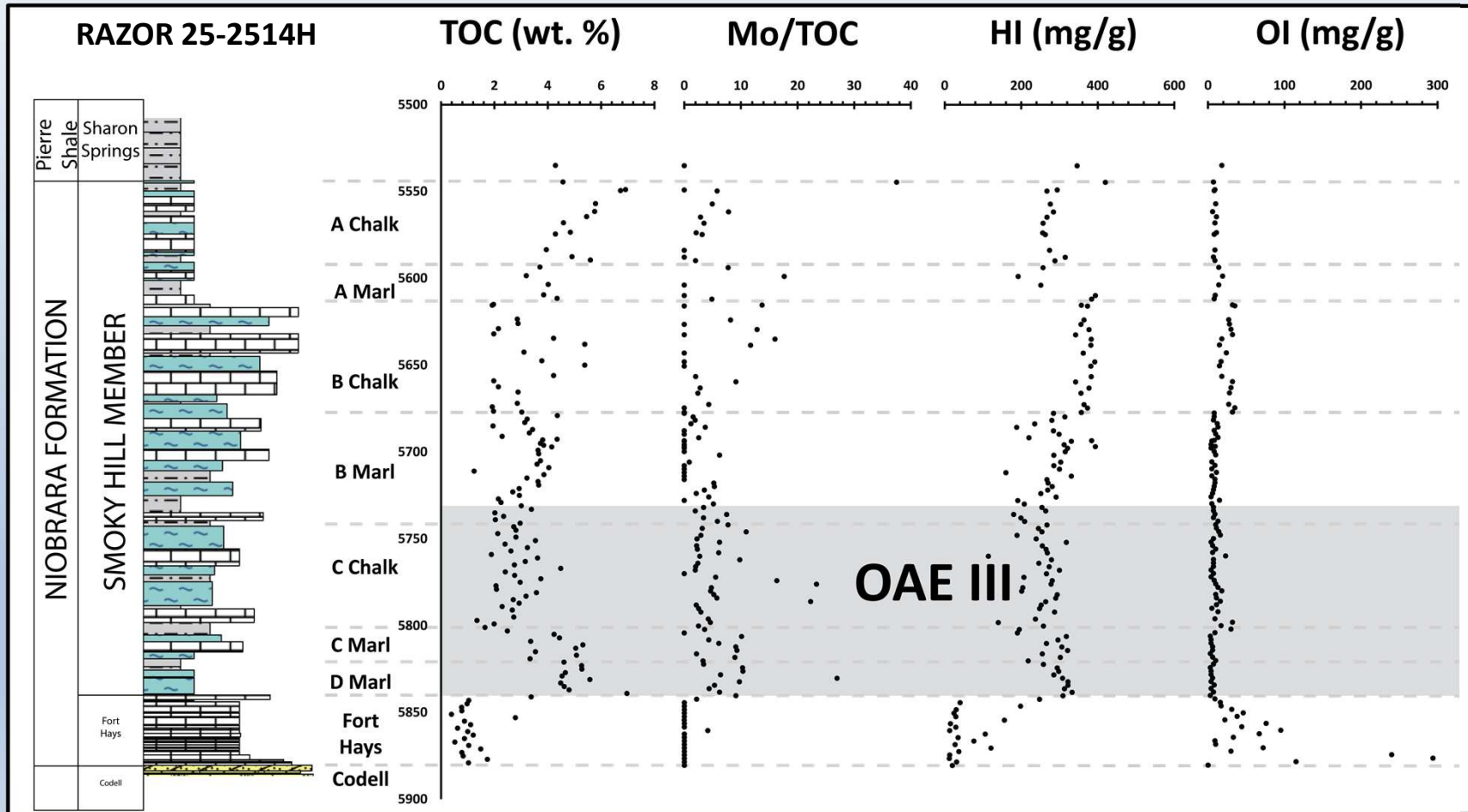
Ponderosa 44-17 &  
Buffalo 14FH  
Powder River Basin  
Composite  
Mo (ppm)



(Tessin, 2016)  
16-4-22-15W4  
Canadian Section  
Mo (ppm)

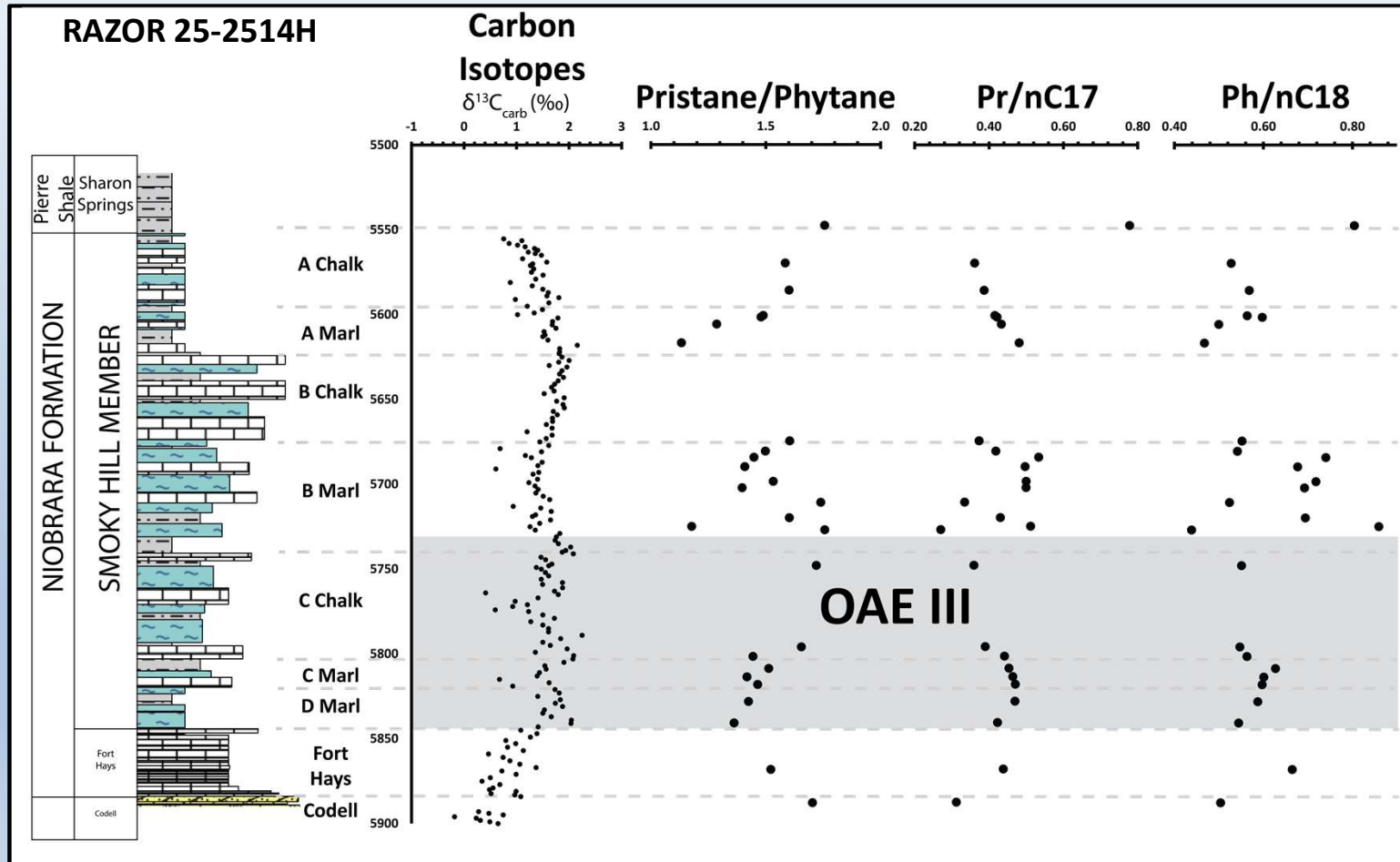


# Organic Matter Composition Change





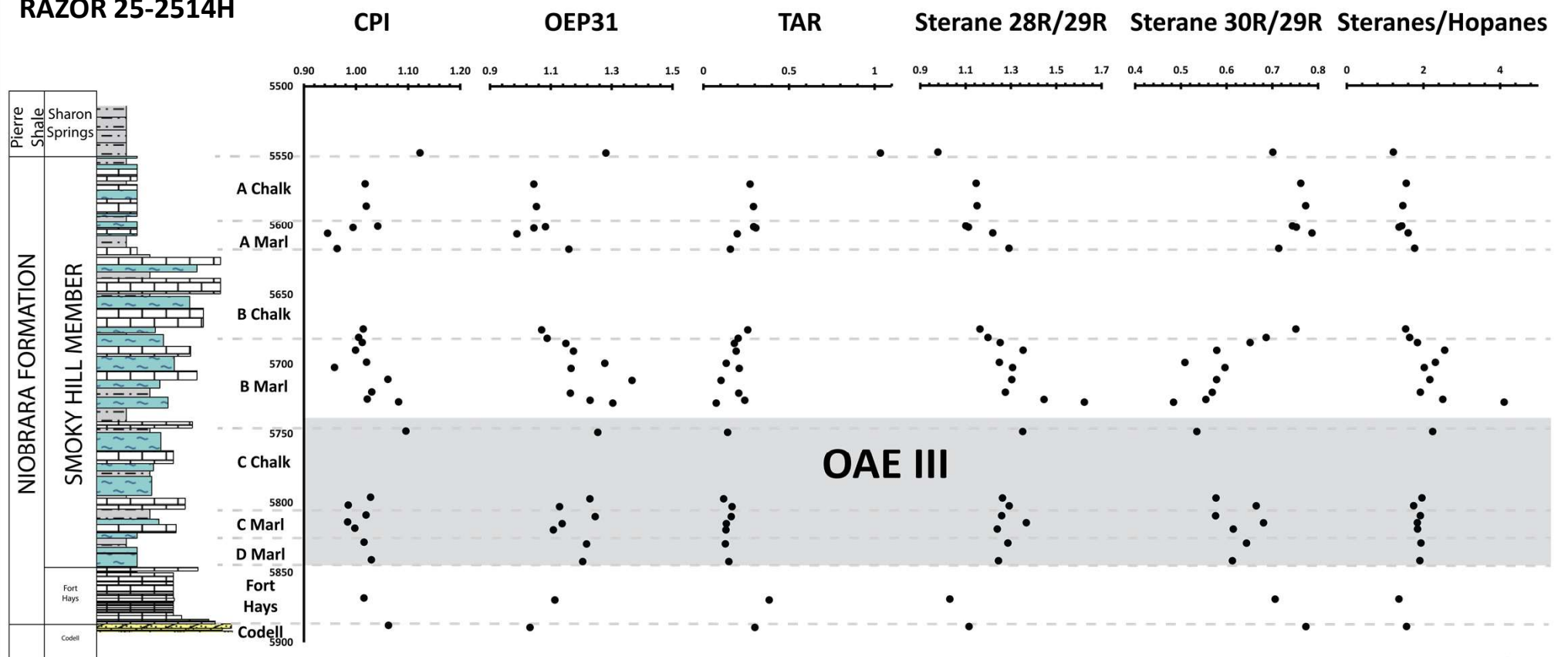
# Organic Matter Composition Change



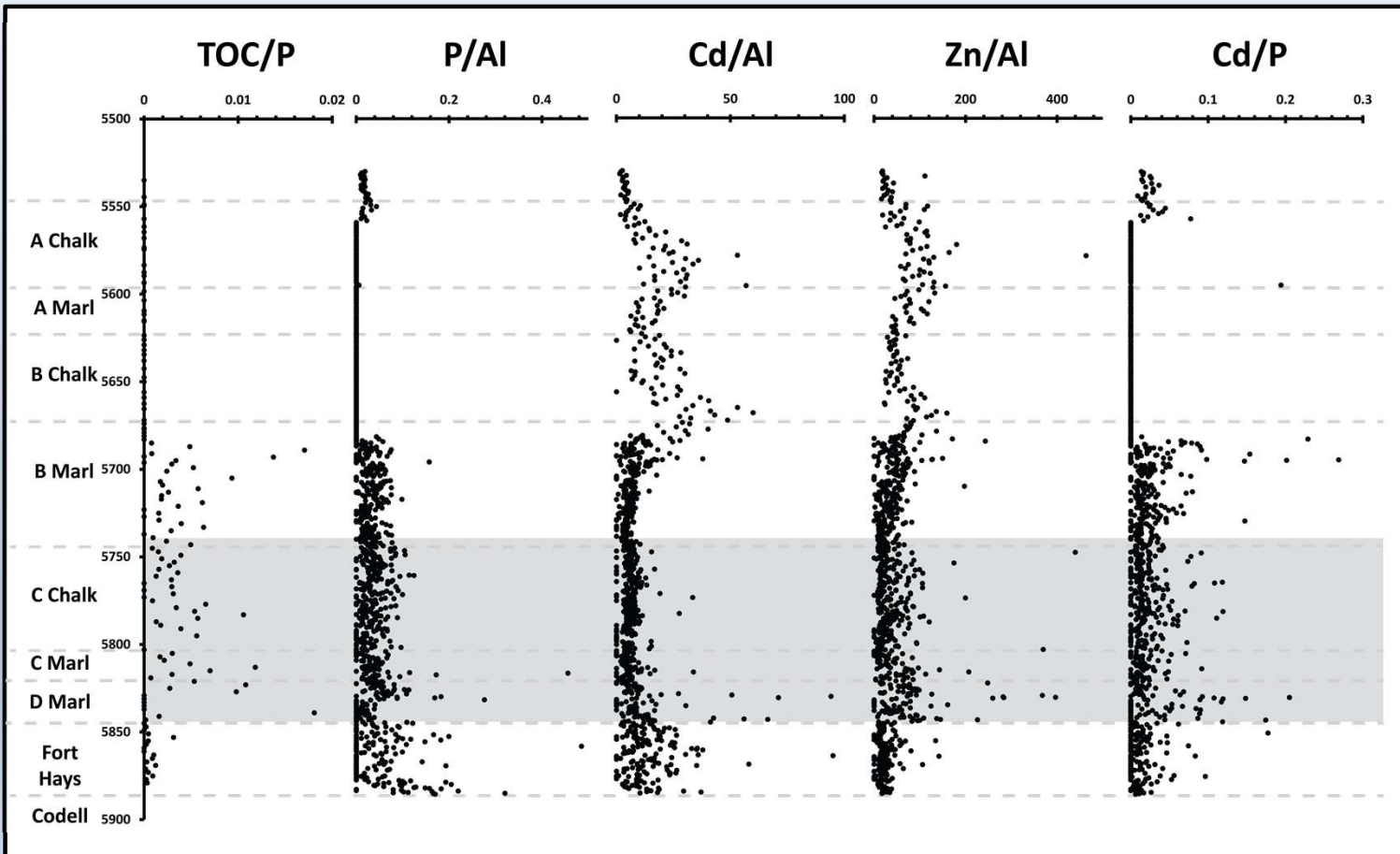
- Pr/Ph indicate oxygen depletion
- Pr/Ph not a reliable indicator
- OM composition changed
- More algae influence

# Organic Matter Composition Change

**RAZOR 25-2514H**

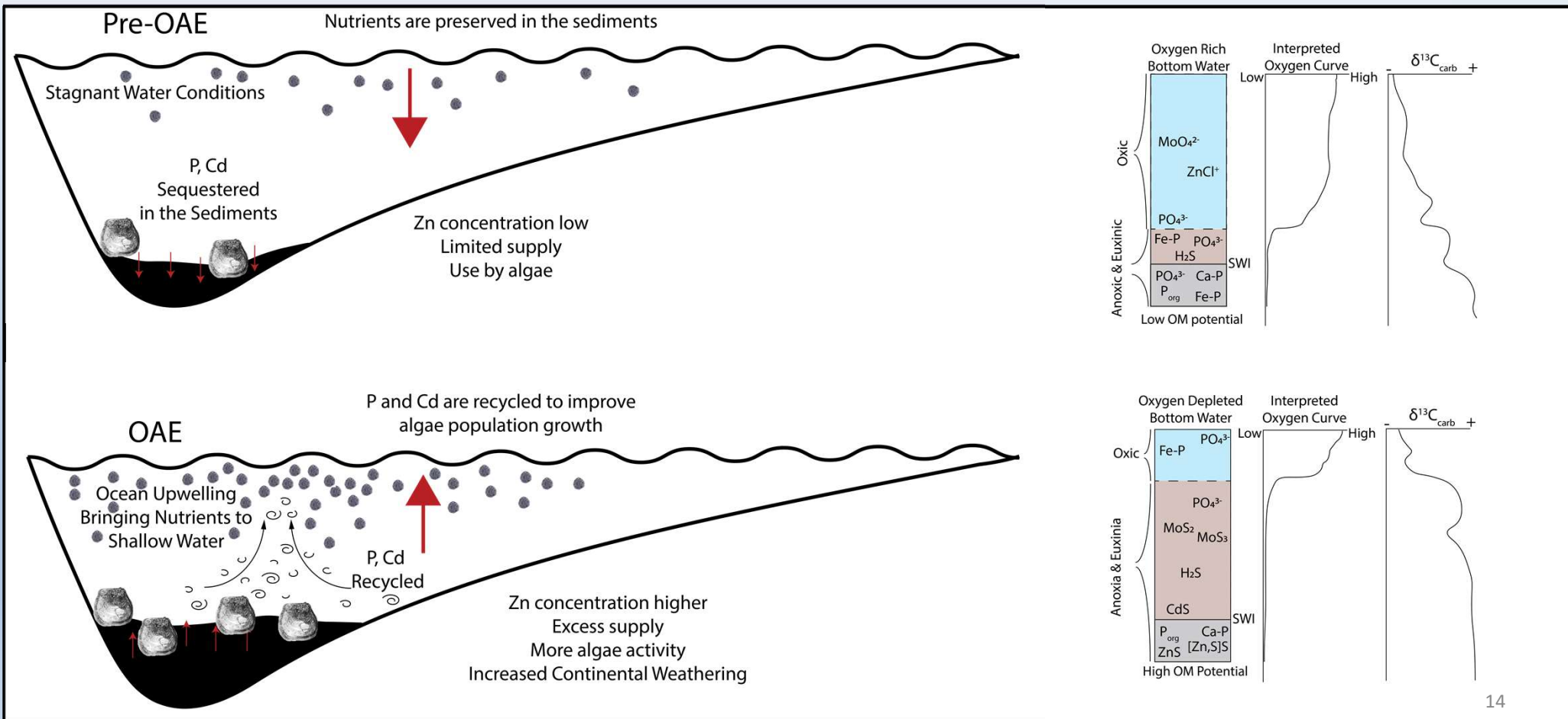


# Nature of Nutrient Recycling



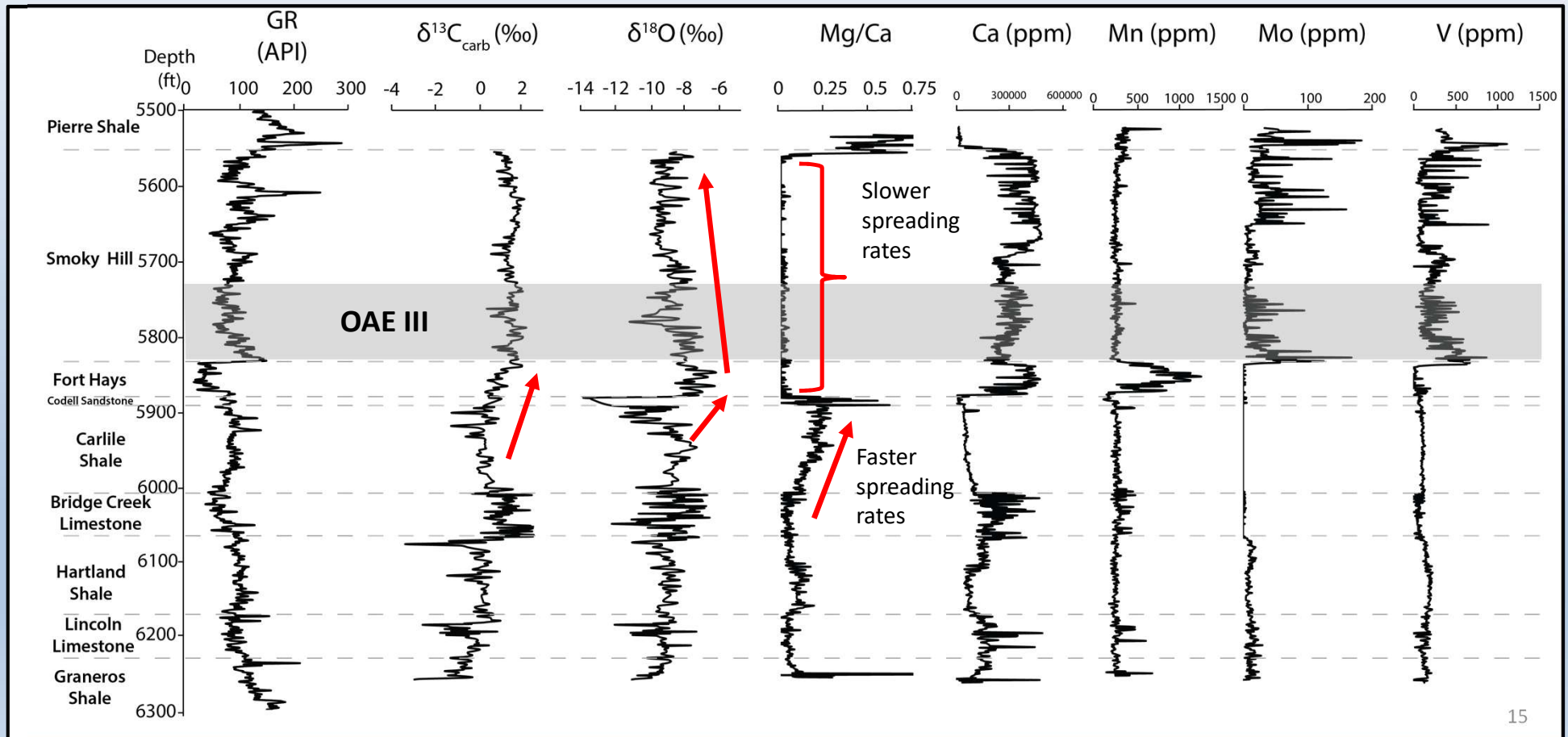
- P and Cd loss/retention
- Nutrients leave pore waters
- Continuous nutrient recycling = Increased Surface Production
- P associated with redox
- Cd nutrient-like behavior
- Pre-OAE Ph, Eh, and Salinity
- Zn increase – Algal population increase and increased rates of continental weathering
- ZnS or [Zn, Fe]S

# Nature of Nutrient Recycling



# Geochemistry of OAE III

## Razor 25-2514H Chemostratigraphic Framework



# Conclusions

- OAE III is better accentuated in WIS
- Stable carbon isotopes used for correlation
- Oxidizing conditions prevalent before OAE III in WIS
- WIS becomes oxygen depleted during OAE III
- Mo trend correlate across WIS but with varying intensities
- OAE III is shorter in duration in Canada
- OM composition changes during OAE III, more algal OM contribution is observed based on SRA parameters and biomarkers
- Nutrients are recycled leading to more algae growth
- OAE III in WIS a result of algal population increase after major structural deformation



# Suggested Future Work

- Trace metal and P isotopes to better understand nutrient recycling
  - P, Cd, Zn
- Biostratigraphic studies
  - Age constraint
  - Basin restriction
- Sr isotopes for continental weathering rates

# MUDTOC Consortium Sponsors

## Fall 2021



### Sponsoring Member Companies



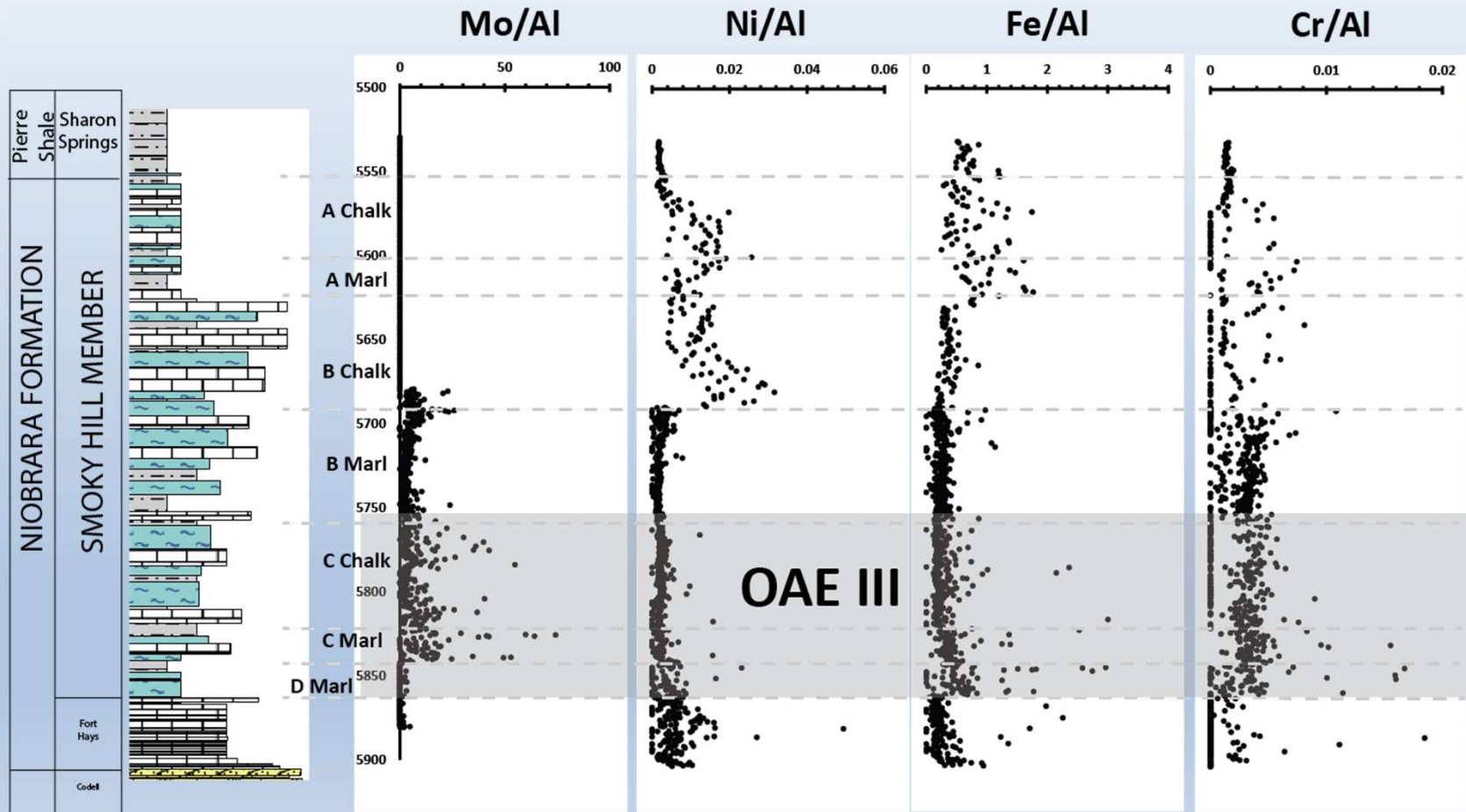
### In-Kind Supporting Companies



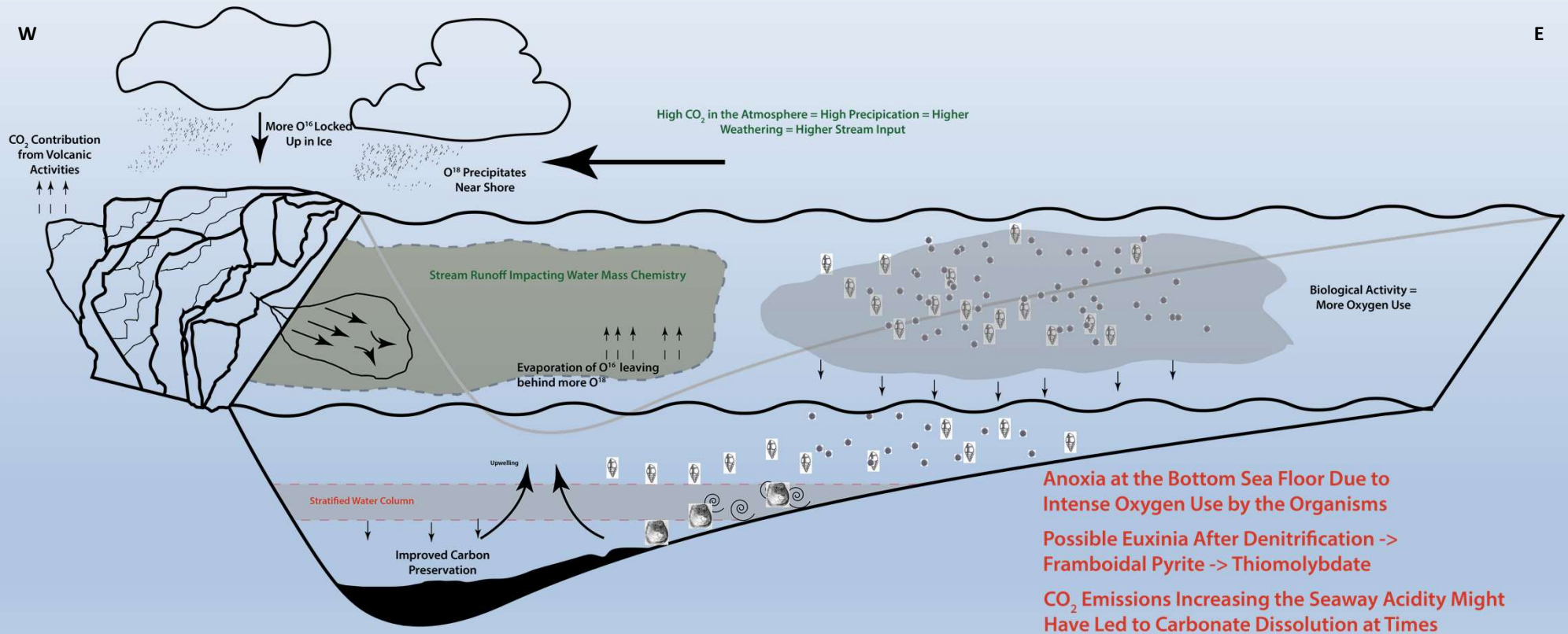
Mike Johnson & Associates



# Paleoredox Conditions During OAE III



# Geochemistry of OAE III



Increased Precipitation Rates -> Increasing Weathering -> OAE