

Modeling Geologic Controls on Hydrocarbon Generation in the Wolfcamp: Integrated Analysis of the Delaware Basin, West Texas



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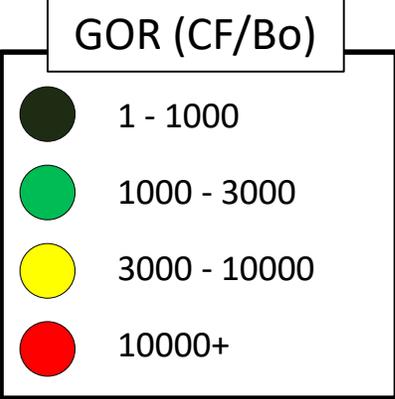
Outline

- Introduction to Delaware Basin
- Building and Calibrating Models
- Results of Models
- Uncertainty Analysis
- Crustal Model
- Conclusions

Introduction

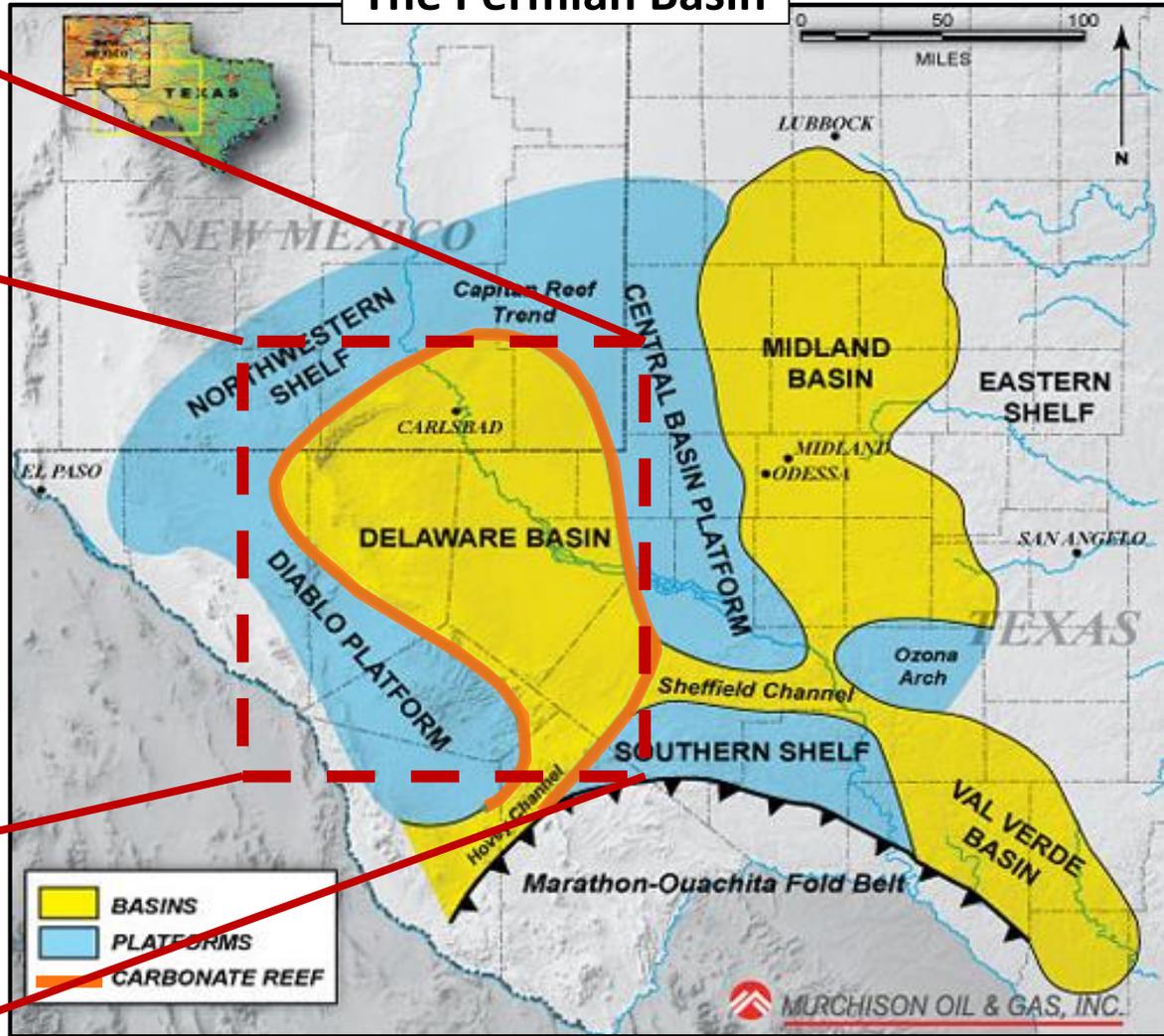
Delaware Basin Gas-Oil-Ratio
Horizontal Wells

High GOR Trend

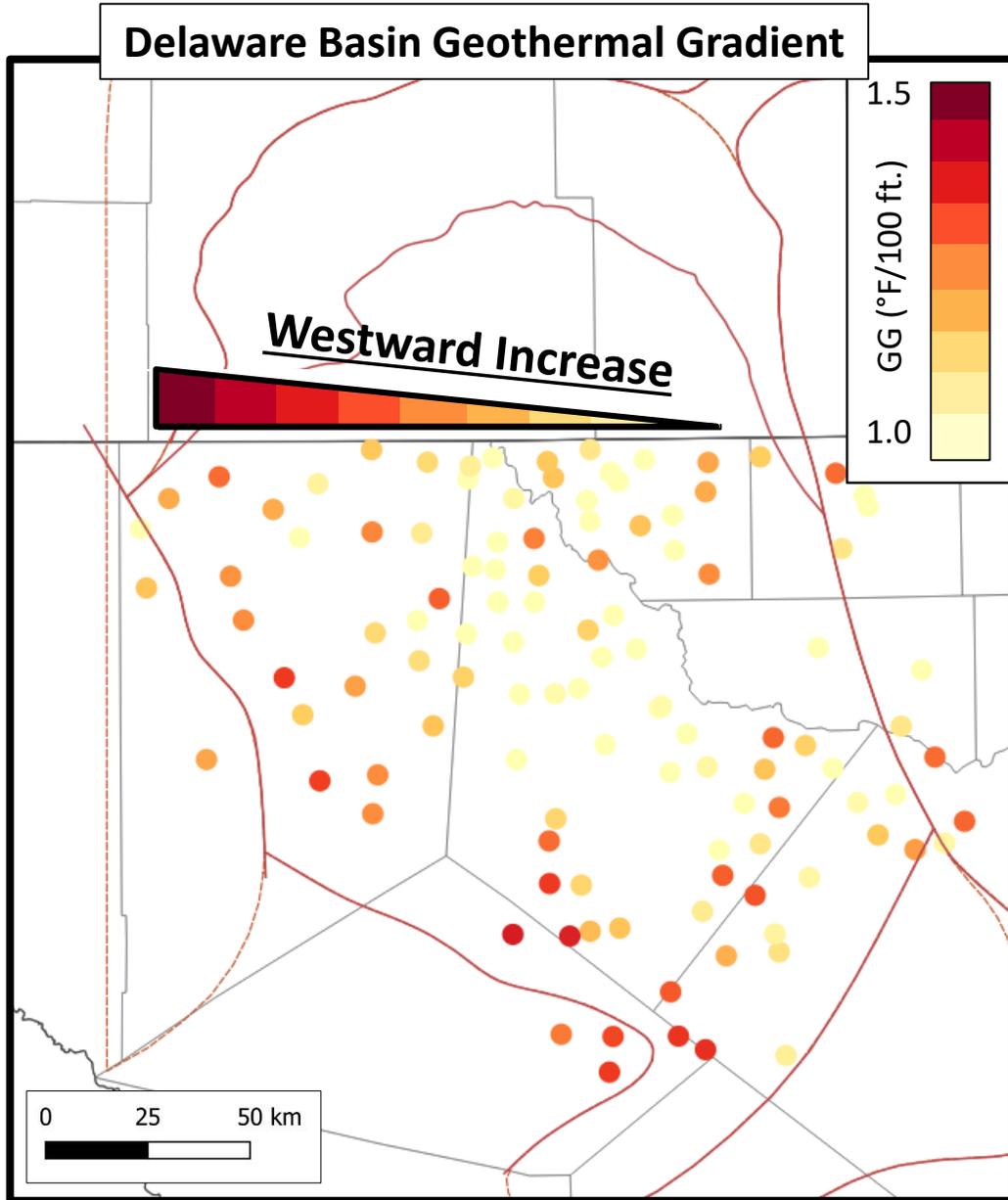


Courtesy of TGS

The Permian Basin



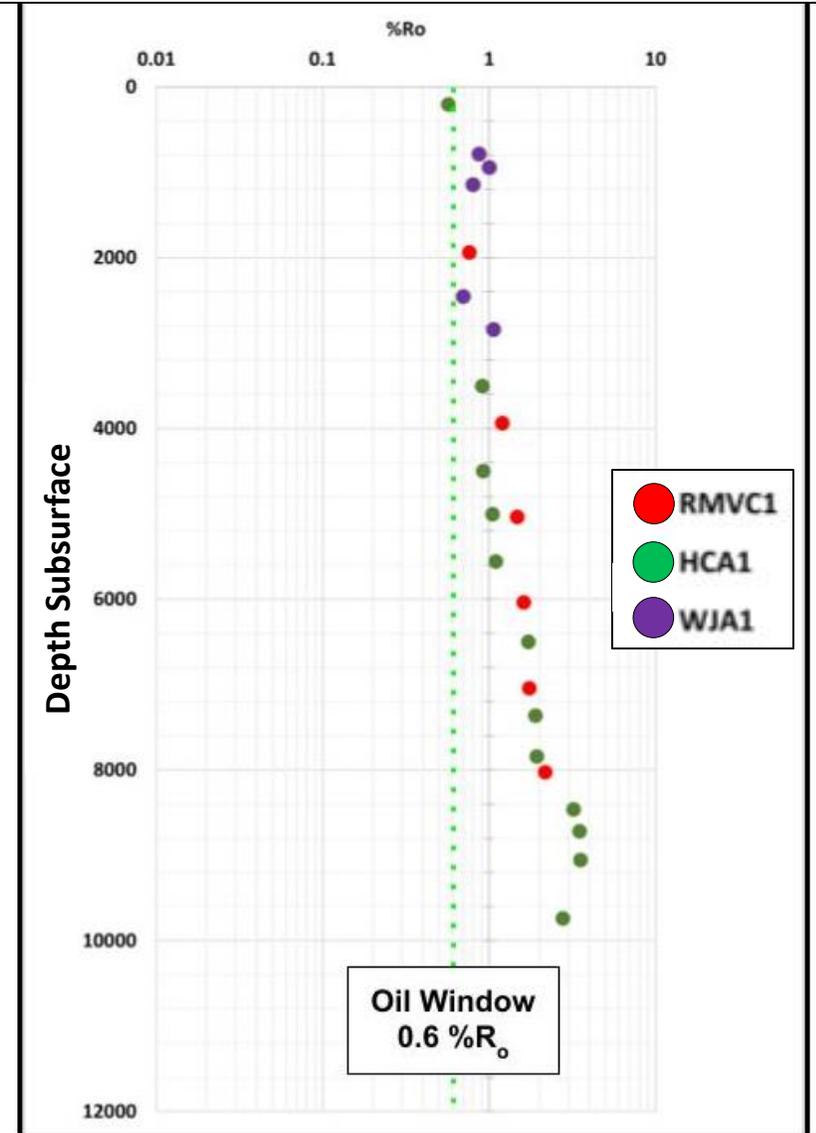
Introduction



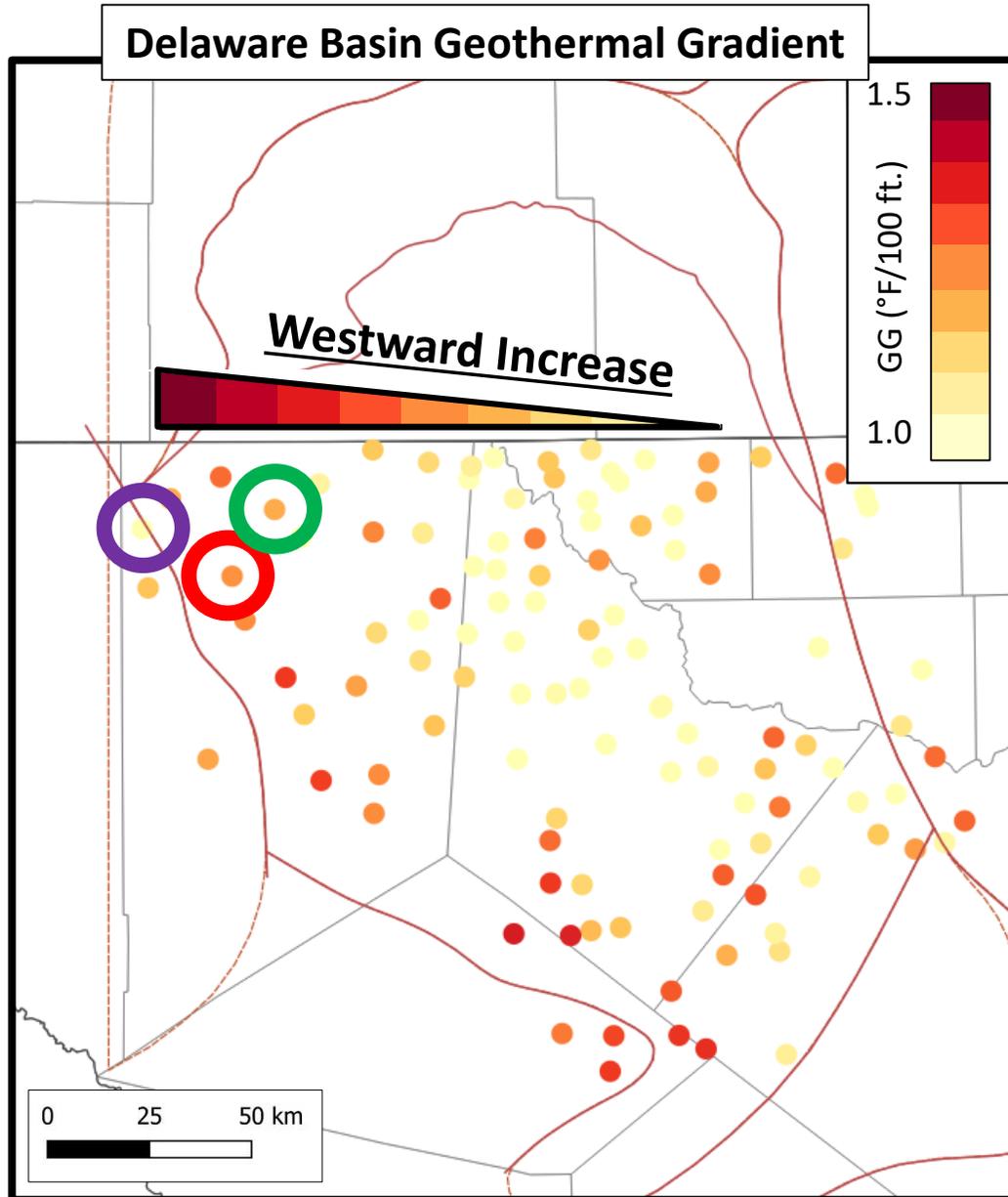
- Higher geothermal gradient in western Delaware
- Oil window close to ground surface in western Delaware
- Implications for production trends

(Pawlewicz et al., 2005)

Western Delaware Basin Vitrinite Reflectance



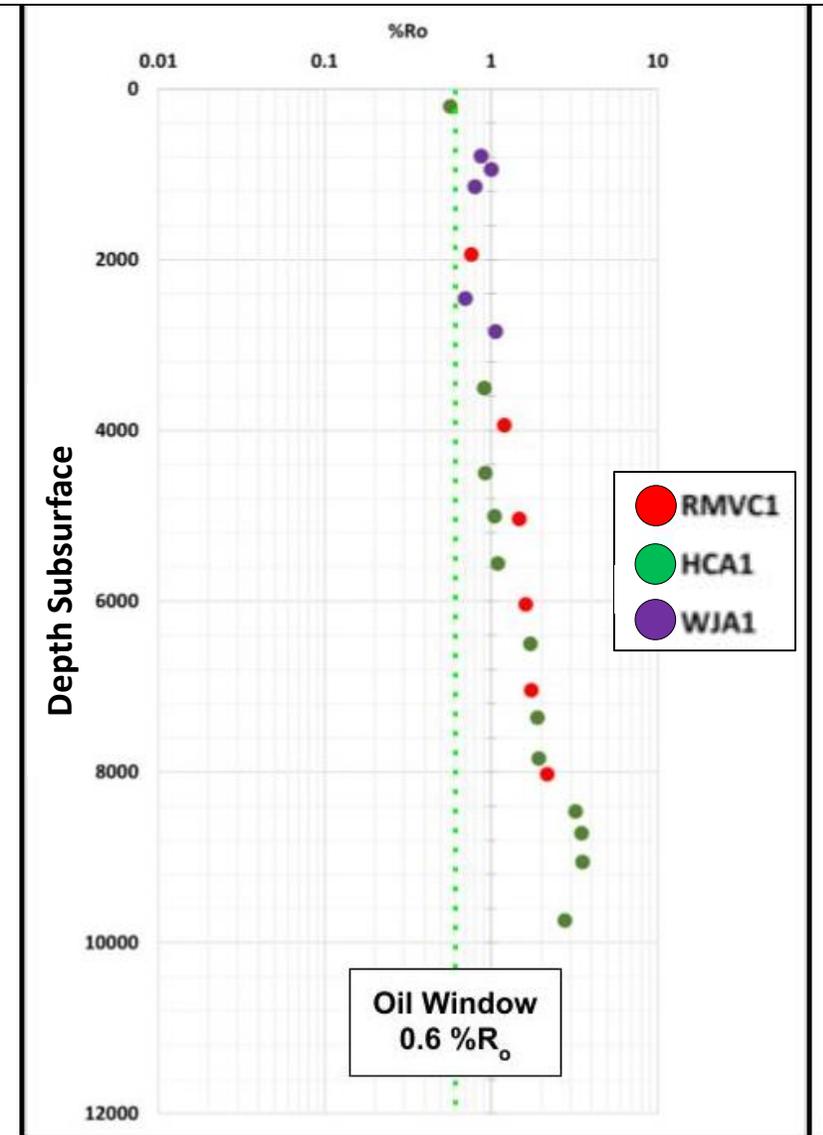
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Western Delaware Basin Vitrinite Reflectance

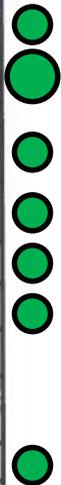


Permian Stratigraphy

Era	System	Series	Ma	Outcrop	Formation	Group
Cenozoic	Quat		1.8			
			5.3			
	Tertiary	Pliocene	33.9		Buck Hill	Big Bend Park
		Eocene & Palaeocene	66.5			Tornillo
Mesozoic	Cretaceous	Upper				Terlingua
						Washita
						Fredericksburg
						Trinity
	Jurassic		145.5			
	Triassic		199.6		Santa Rosa	Dockum
			250.5			
Palaeozoic	Permian	Guadalupian	Ochoan	251	Rustler Salado Castile	
					Bell Canyon	Delaware Mountain
					Cherry Canyon	
					Brushy Canyon	
		Leon	258	Bone Spring		
		Wolfcampian	260			
	Pennsylvanian	Canyon	Cisco	285	Cisco	Cisco
					Canyon	Canyon
			Strawn	295	Strawn	Strawn
			Atoka	306	Atoka	
			Morrow	312	Morrow	Bend
				320		
				320		
Miss	Chester		359	Barnett Mississippian Lm		
				Woodford		
Devonian	Upper-Middle		416			
				Fusselman		
Silurian	Upper		443			
				Montoya	Simpson	
				El Paso	Ellenburger	
Ordovician	Middle					
Lower						
Cam			488.3			
			542			
Precambrian						

Sinclair, 2007

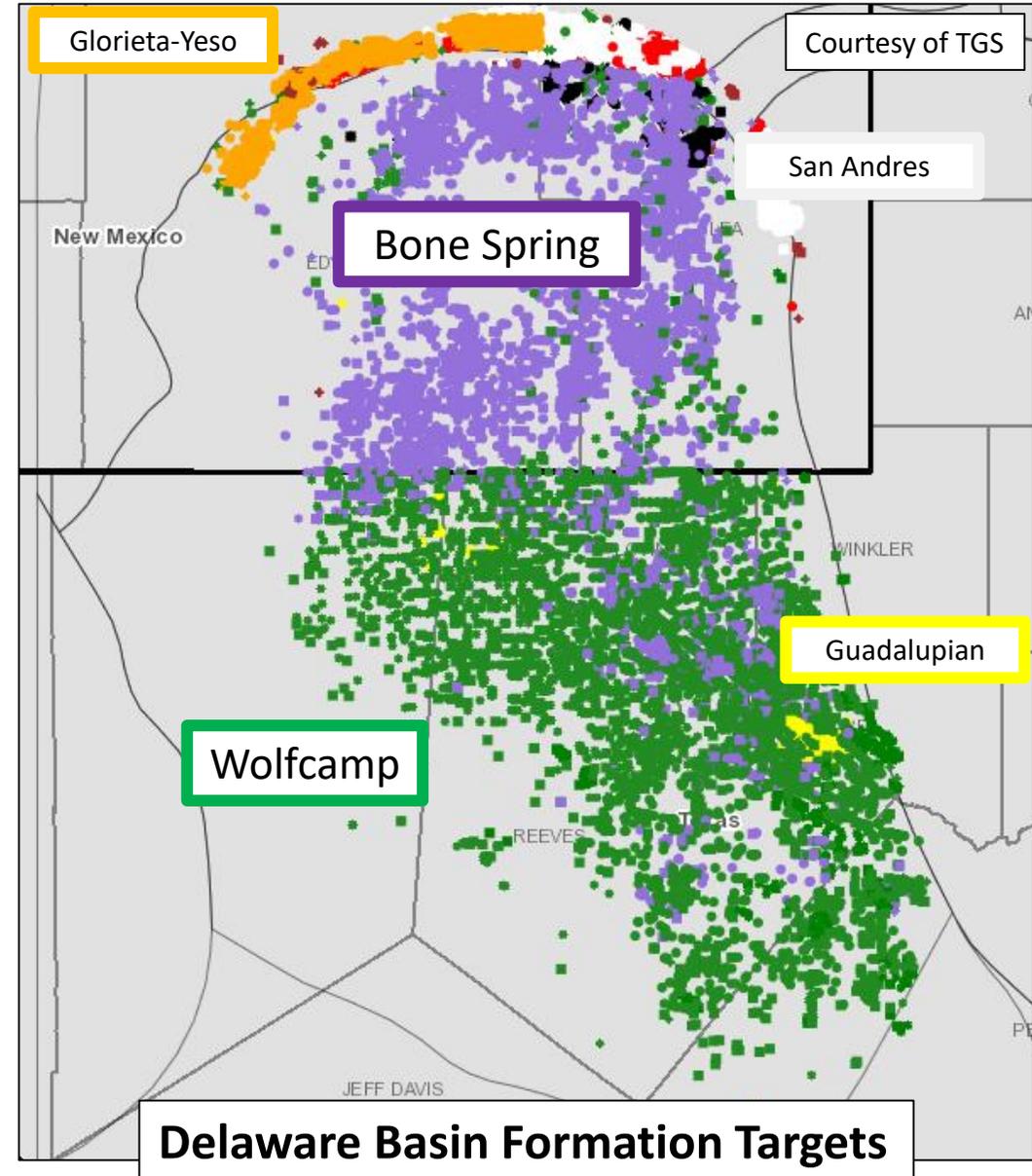
- Multiple Source Rock Intervals
- Conventional production from Guadalupian reservoirs
- Horizontal drilling in basinal Wolfcampian and Leonardian



● **Wolfcamp A and B** most prolific interval

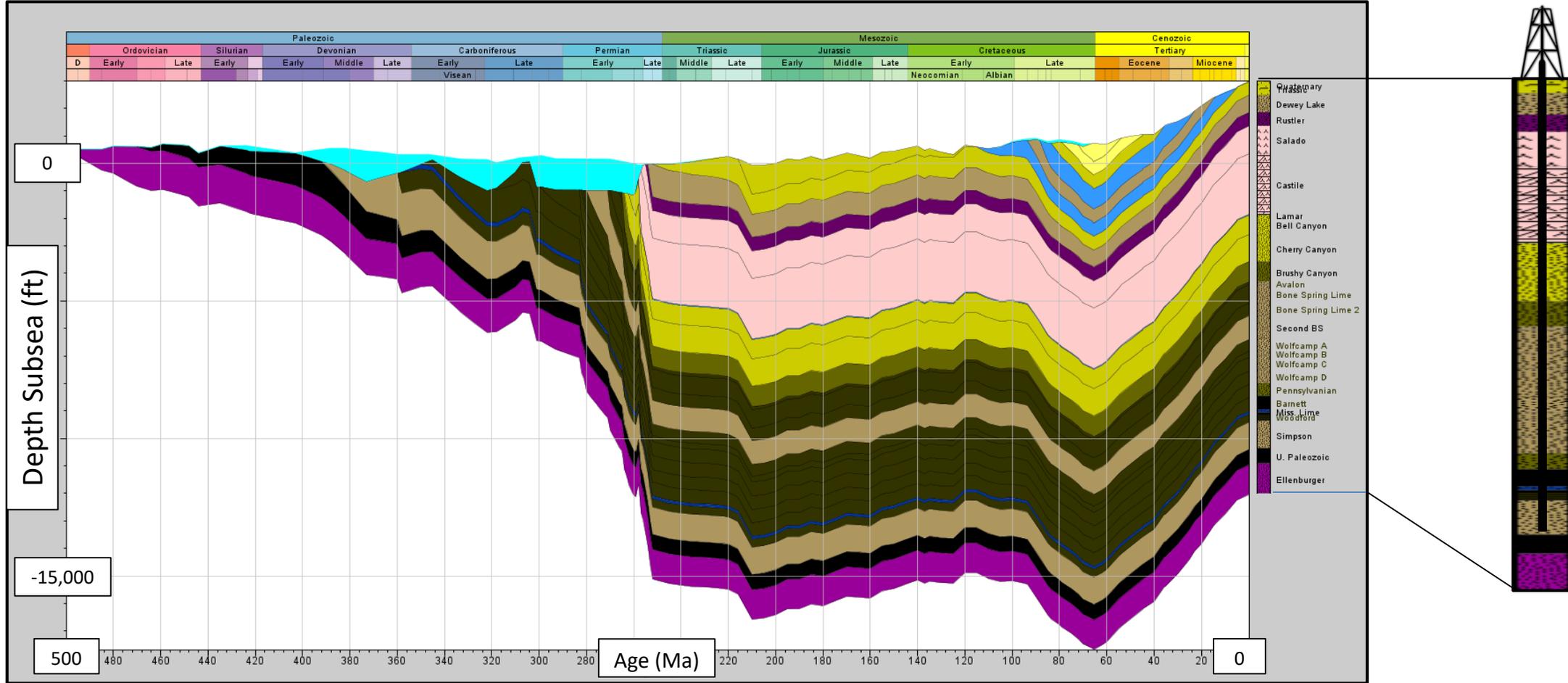
- 1 – 8% TOC (EIA, 2019)
- Type II to type III kerogen (Colburne, 2019)

● Source of Hydrocarbons



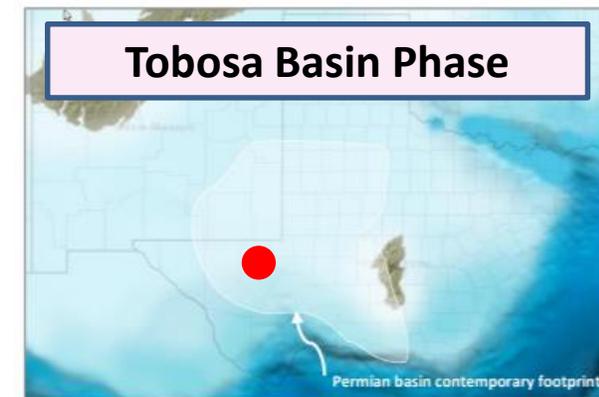
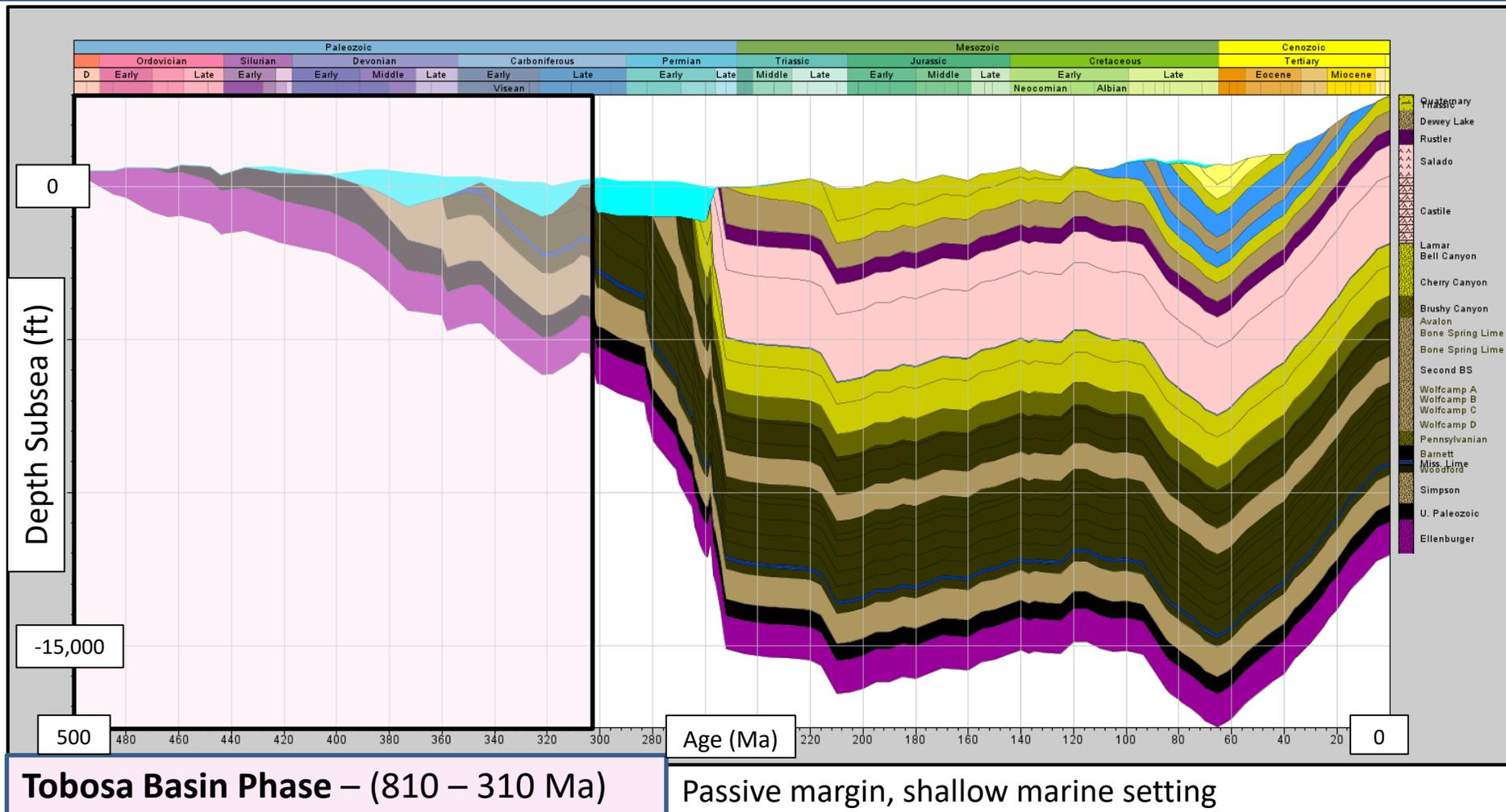
Delaware Basin Formation Targets

Regional Geology – Burial History

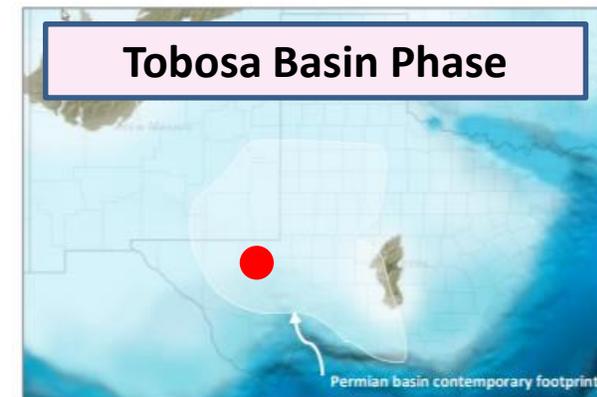
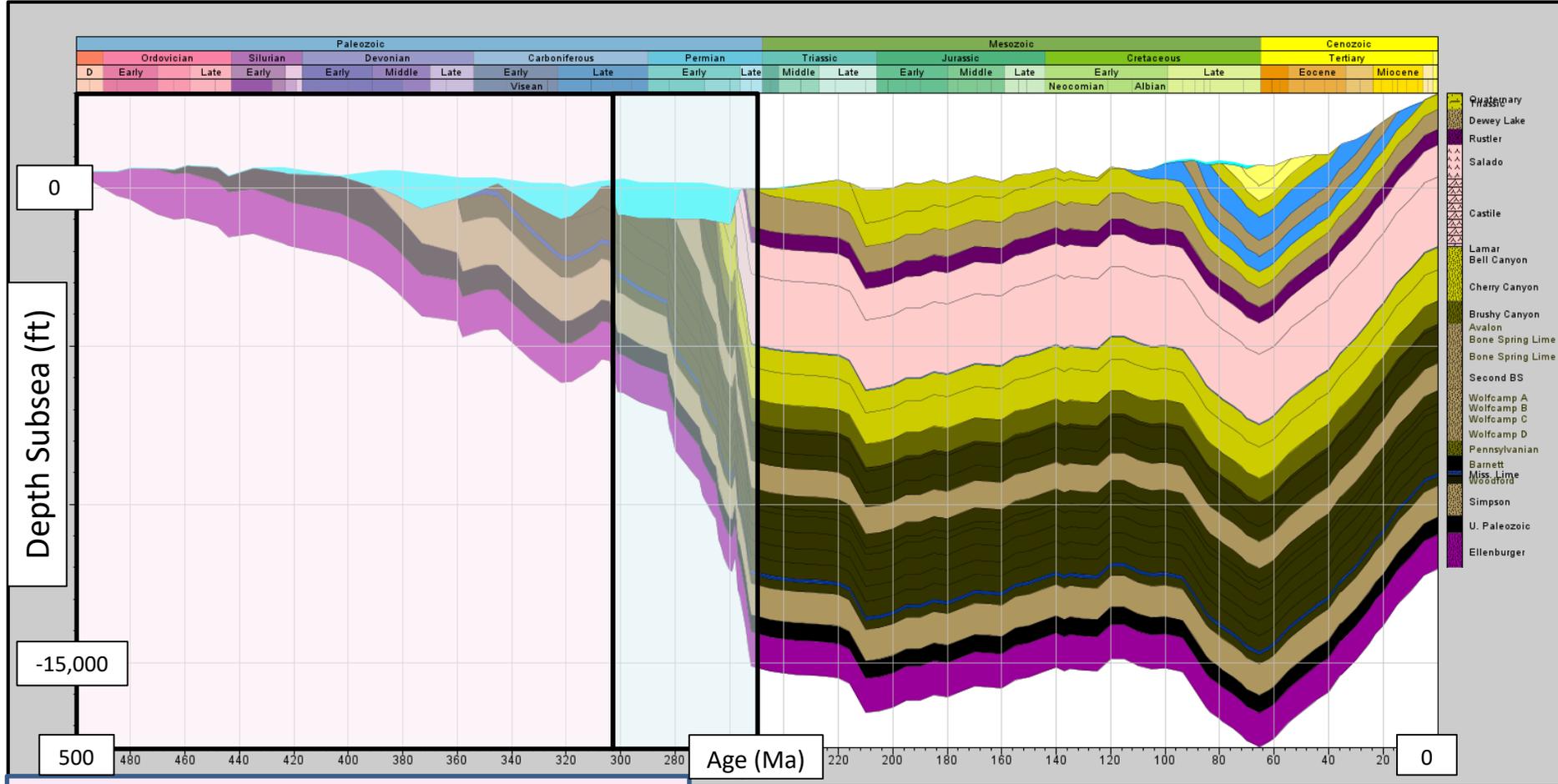


- 1-Dimensional representation of geologic history of the well bore

Regional Geology – Burial History



Regional Geology – Burial History



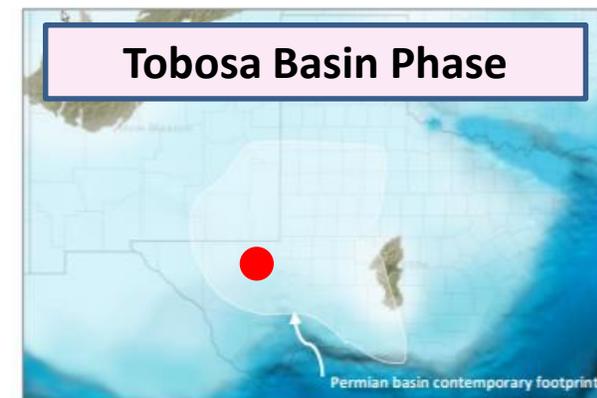
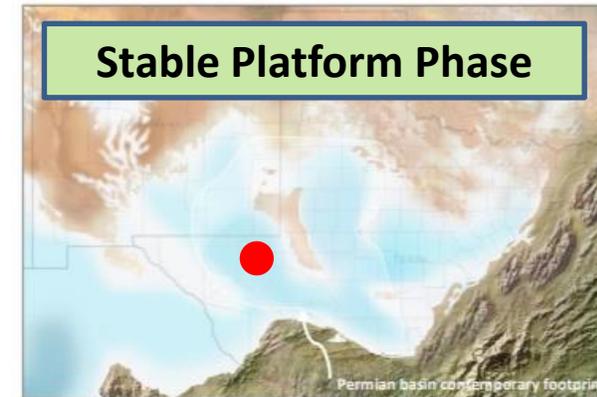
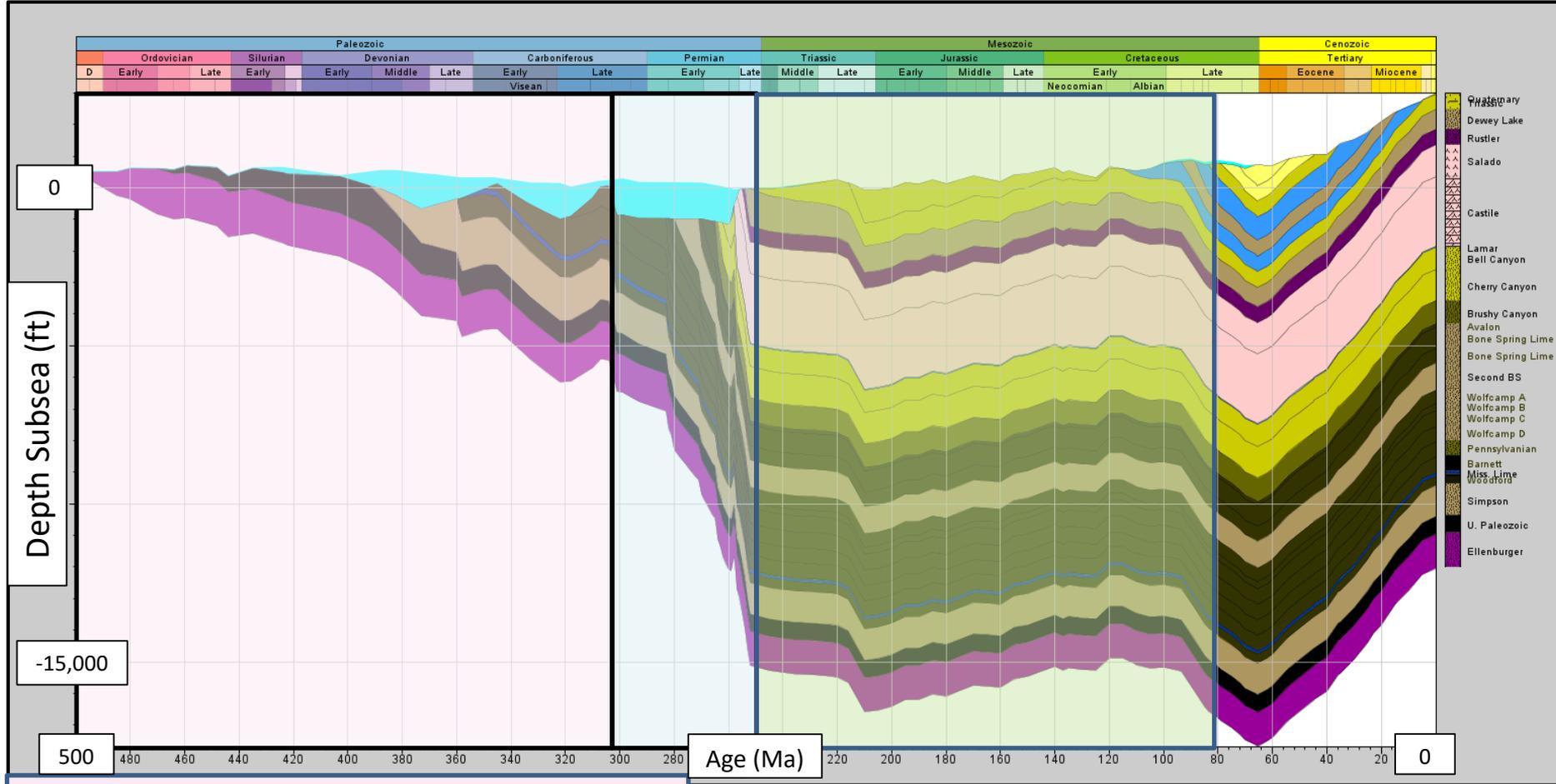
Tobosa Basin Phase – (810 – 310 Ma)

Passive margin, shallow marine setting

Permian Basin Phase – (310 – 250 Ma)

Tectonic collision, basin division

Regional Geology – Burial History



Tobosa Basin Phase – (810 – 310 Ma)

Permian Basin Phase – (310 – 250 Ma)

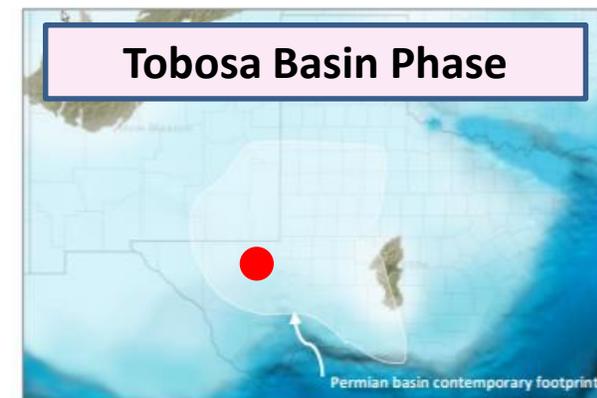
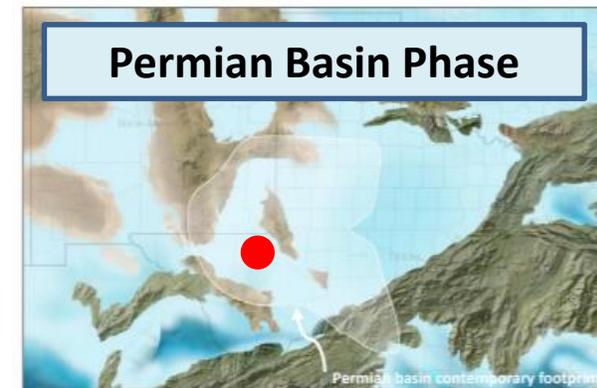
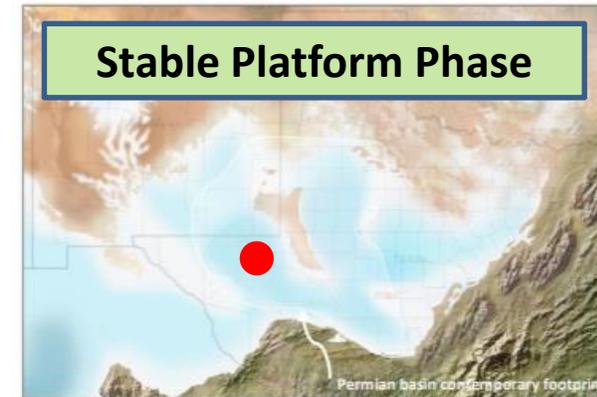
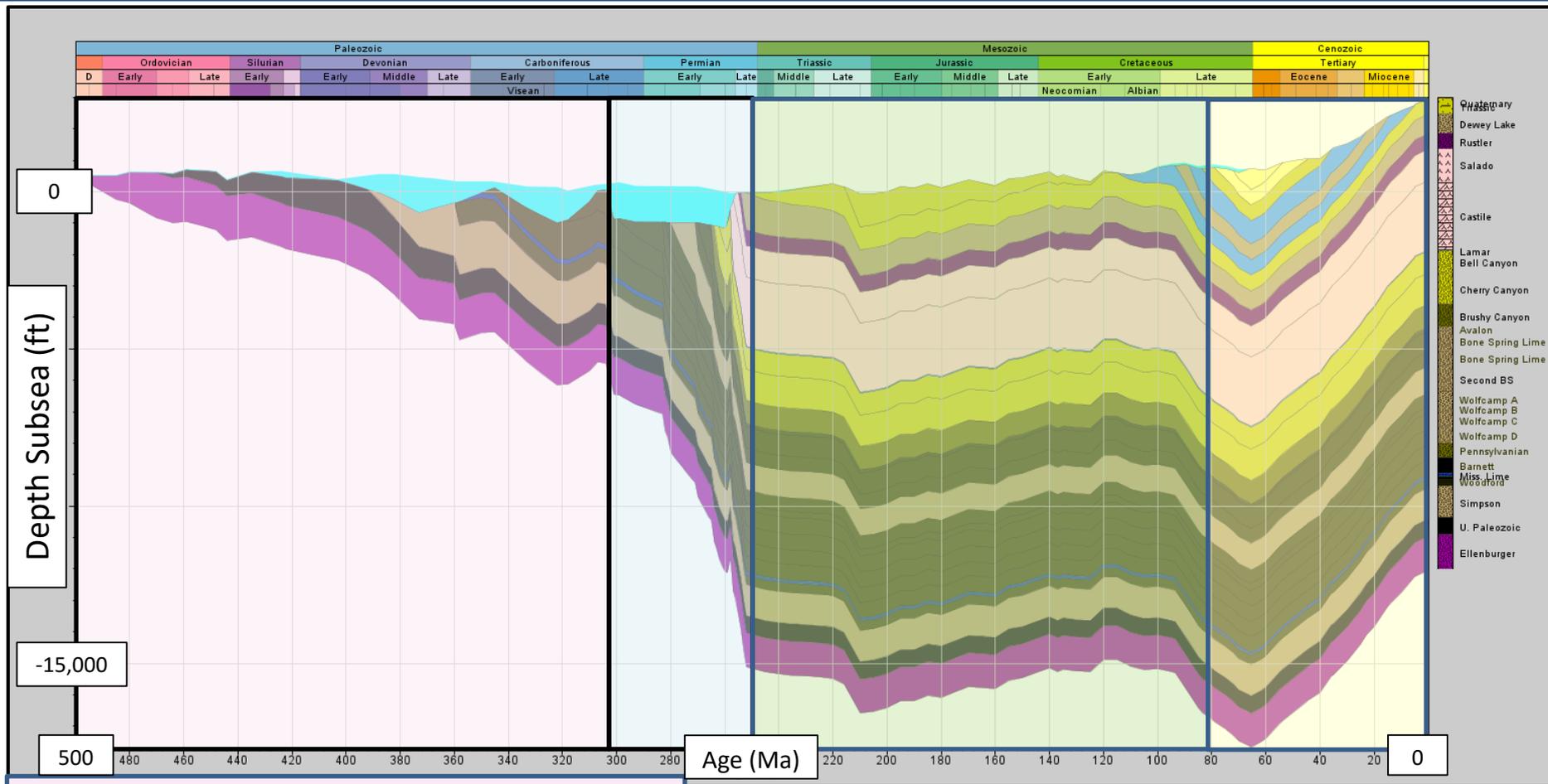
Stable Platform Phase – (250 – 80 Ma)

Passive margin, shallow marine setting

Tectonic collision, basin division

Tectonic quiescence

Regional Geology – Burial History



- Tobosa Basin Phase – (810 – 310 Ma)**
- Permian Basin Phase – (310 – 250 Ma)**
- Stable Platform Phase – (250 – 80 Ma)**
- Cenozoic Uplift Phase – (80 – 0 Ma)**

- Passive margin, shallow marine setting
- Tectonic collision, basin division
- Tectonic quiescence
- Laramide, basin and range tectonics

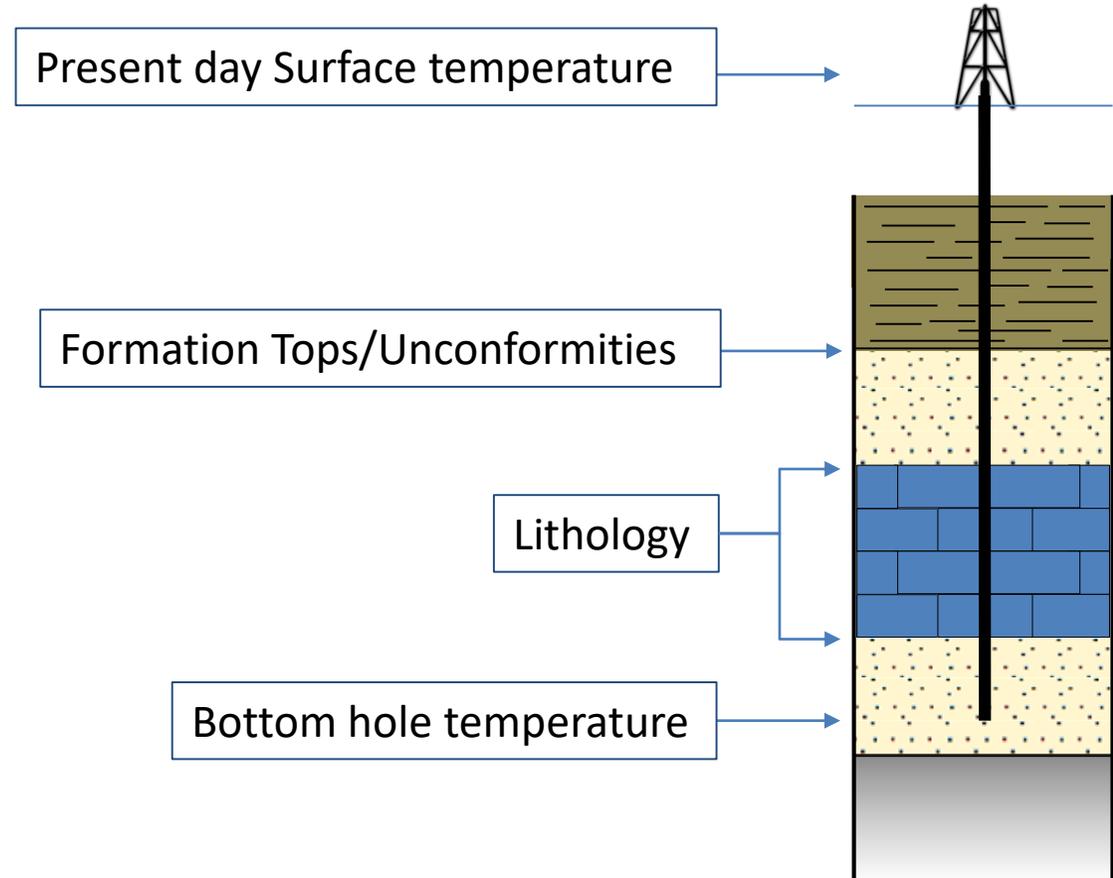
Modified from EIA, 2018

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- Results of Models
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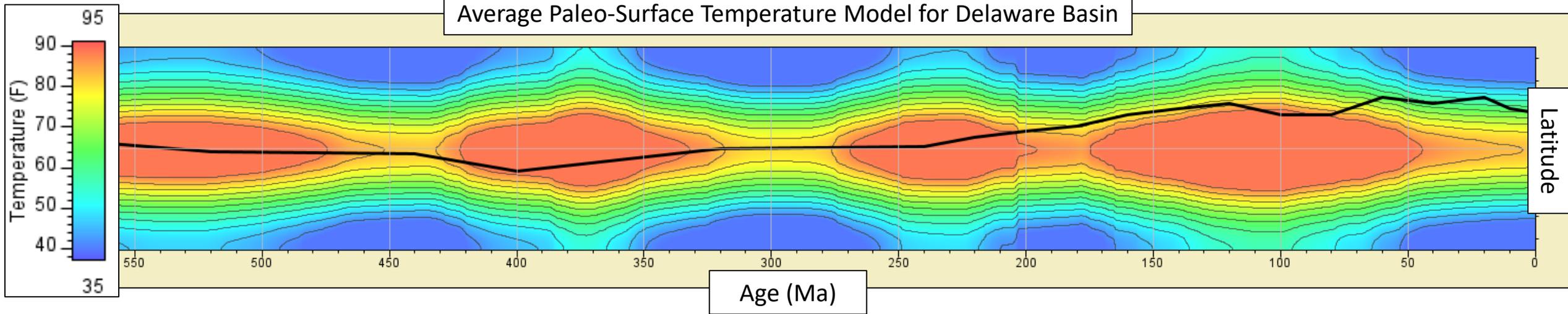
Build the Model - Present Day Geology

- Present day geometry of **geologic surfaces**
- **Ages** of geologic units
- **Lithology**
 - Mudlogs, petrophysical analysis
 - Thermal/mechanical properties
- **Boundary Conditions:**
 - Surface Temperature
 - Basal Heat Flow



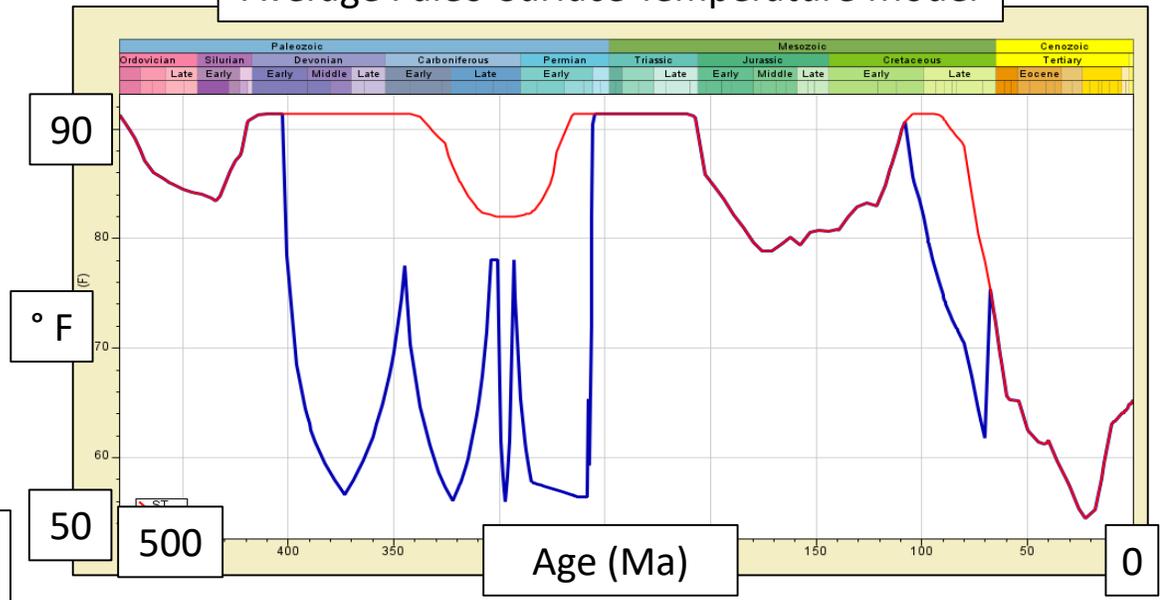
Thermal Model

Average Paleo-Surface Temperature Model for Delaware Basin



- Calculate surface temperature through time as function of paleo-latitude from plate reconstruction
- Used 32° Latitude to represent the Delaware Basin
- Using SWIT accounts for sea-level change

Average Paleo-Surface Temperature Model



Surface Temperature (° F) —
 Sediment-Water Interface Temperature (° F) —

Thermal Calibration

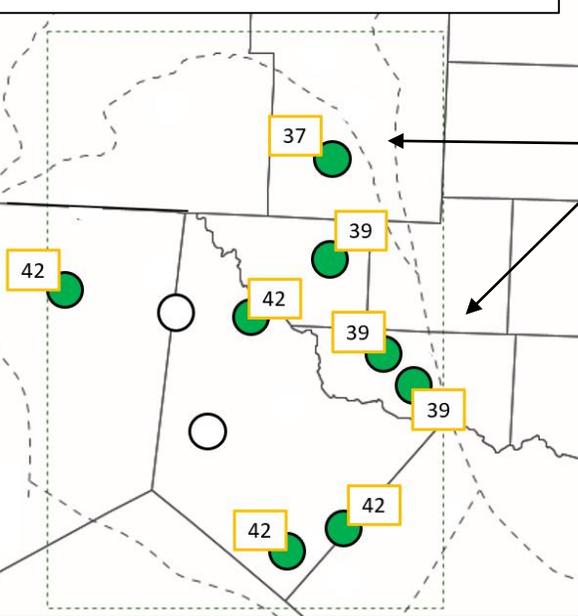
1 Correct Bottom Hole Temperature to equilibrium conditions

- BHT's use time since circulation methods (*Beardsmore and Cull, 2001*)

2 Calculate Heat flow from corrected BHT and lithology

- Heat flow is a function of geothermal gradient and thermal conductivity

Calculated Heat Flux (mW/m^2)

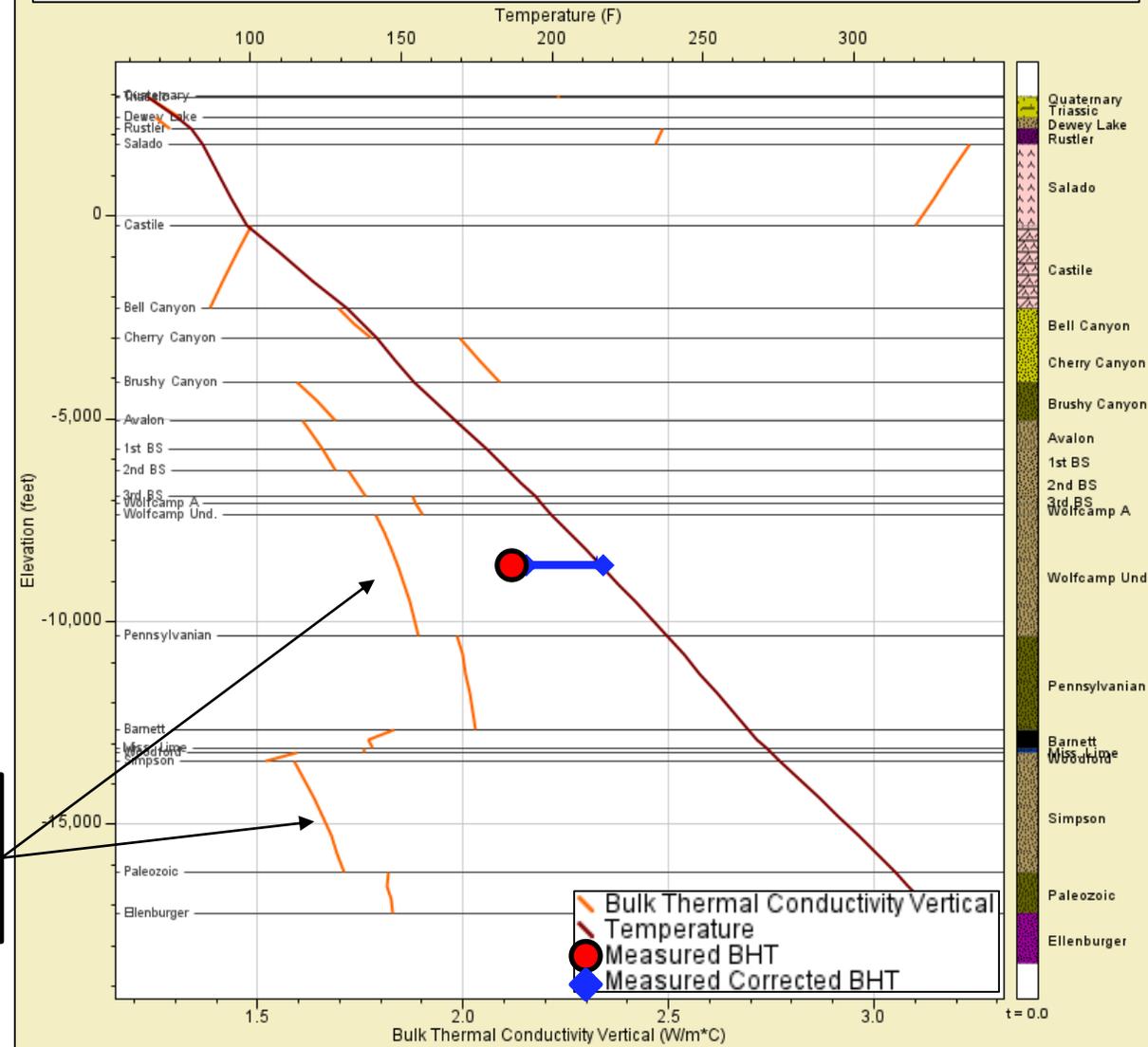


Lowest heat flux on eastern edge of basin, increases west

Variable thermal conductivity based on lithology

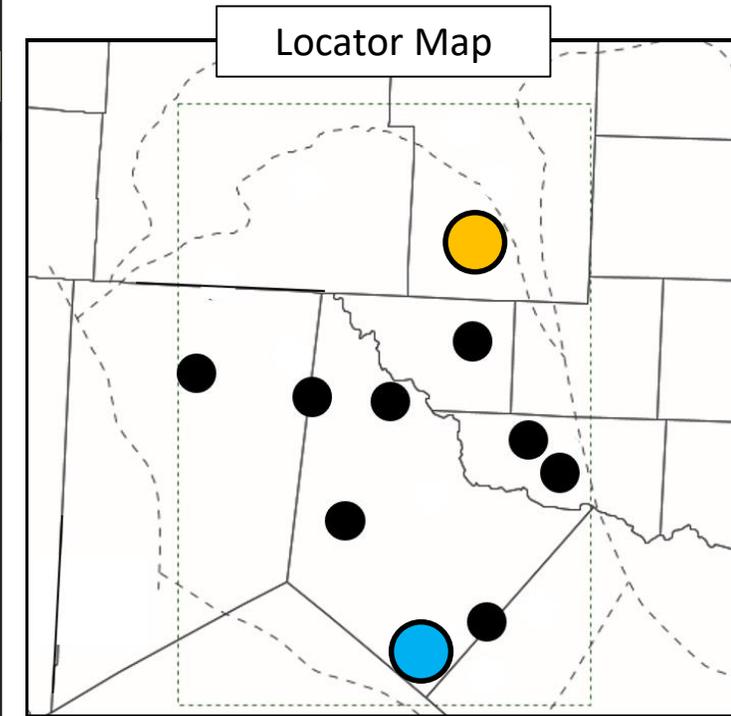
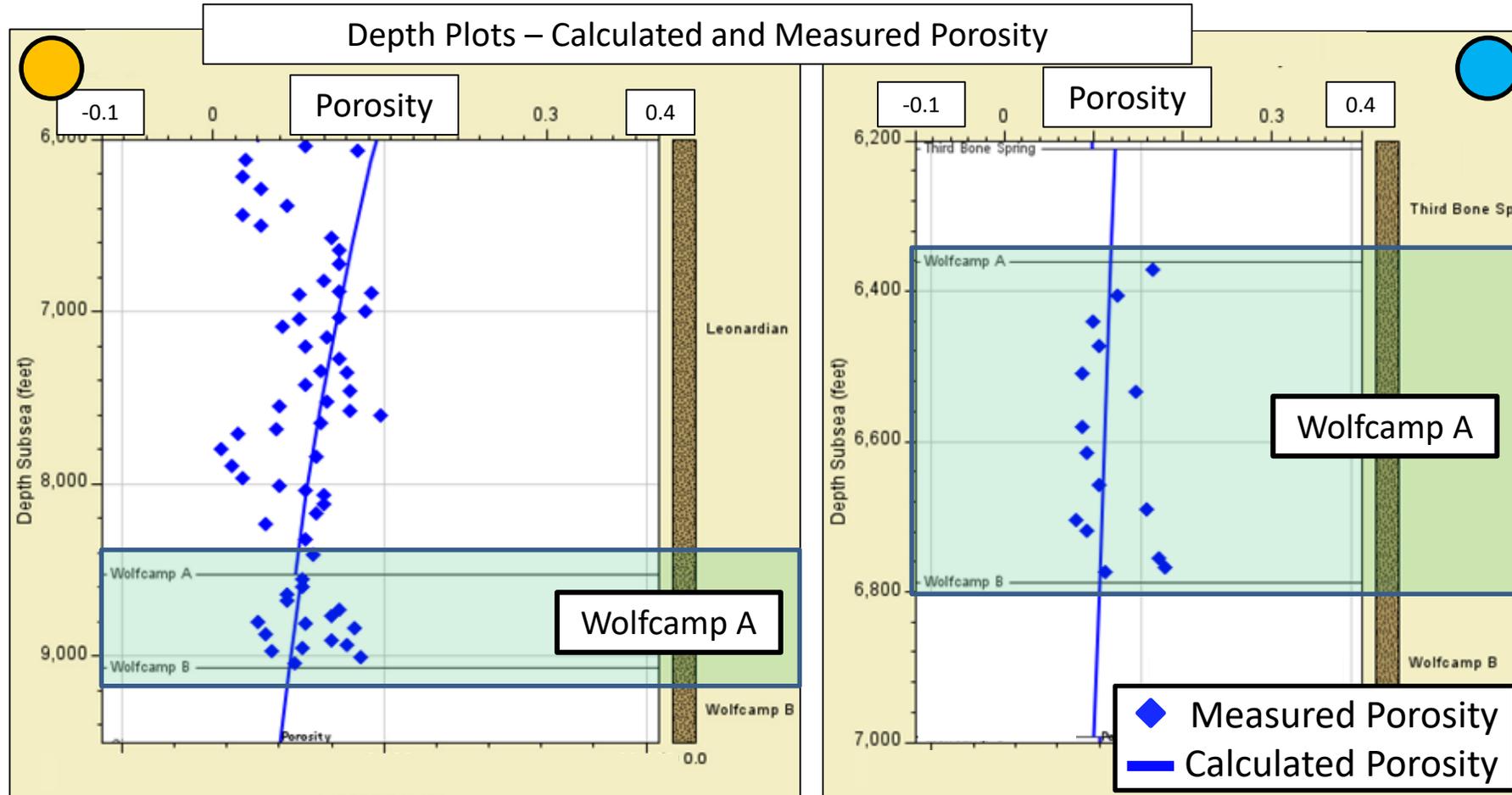
○ No BHT's

Depth Plot – Temperature and Bulk Vertical Thermal Conductivity



Mechanical Calibration

Depth Plots – Calculated and Measured Porosity



*Wells without porosity data used lithology parameters from calibrated wells

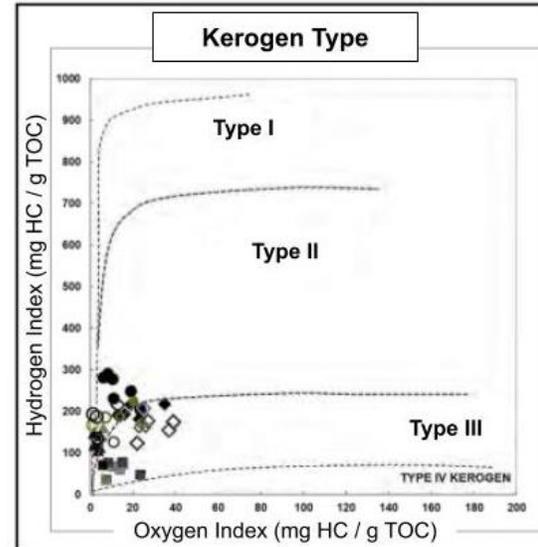
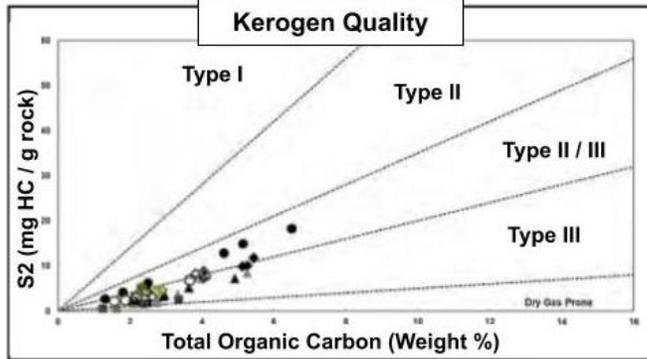
- Match porosity with depth trends to calibrate compaction model using logs, core
- Emphasized accuracy of Leonardian and Guadalupian sections

Geochemical Calibration

Thermal Maturity of Organic Rich Sediments

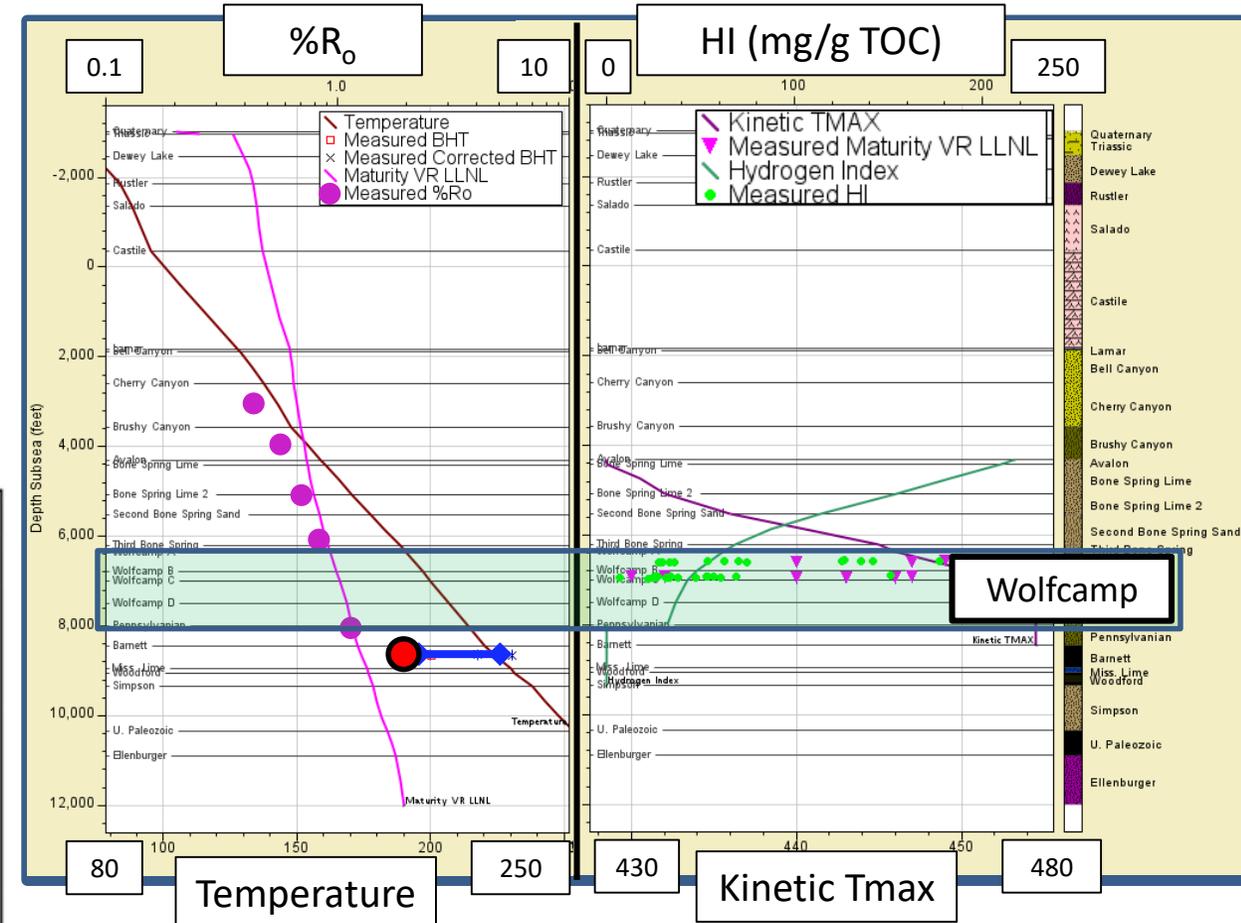
- Maximum temperatures can be derived from geochemical signatures
- Examples of signatures include **Vitrinite Reflectance** and **Rock-Eval**
- **Kerogen type** important for calculating maturity

Wolfcamp Chemical Kinetics (Colburne, 2019)



- Mixed type II-type III kerogen
- 2 – 8% TOC

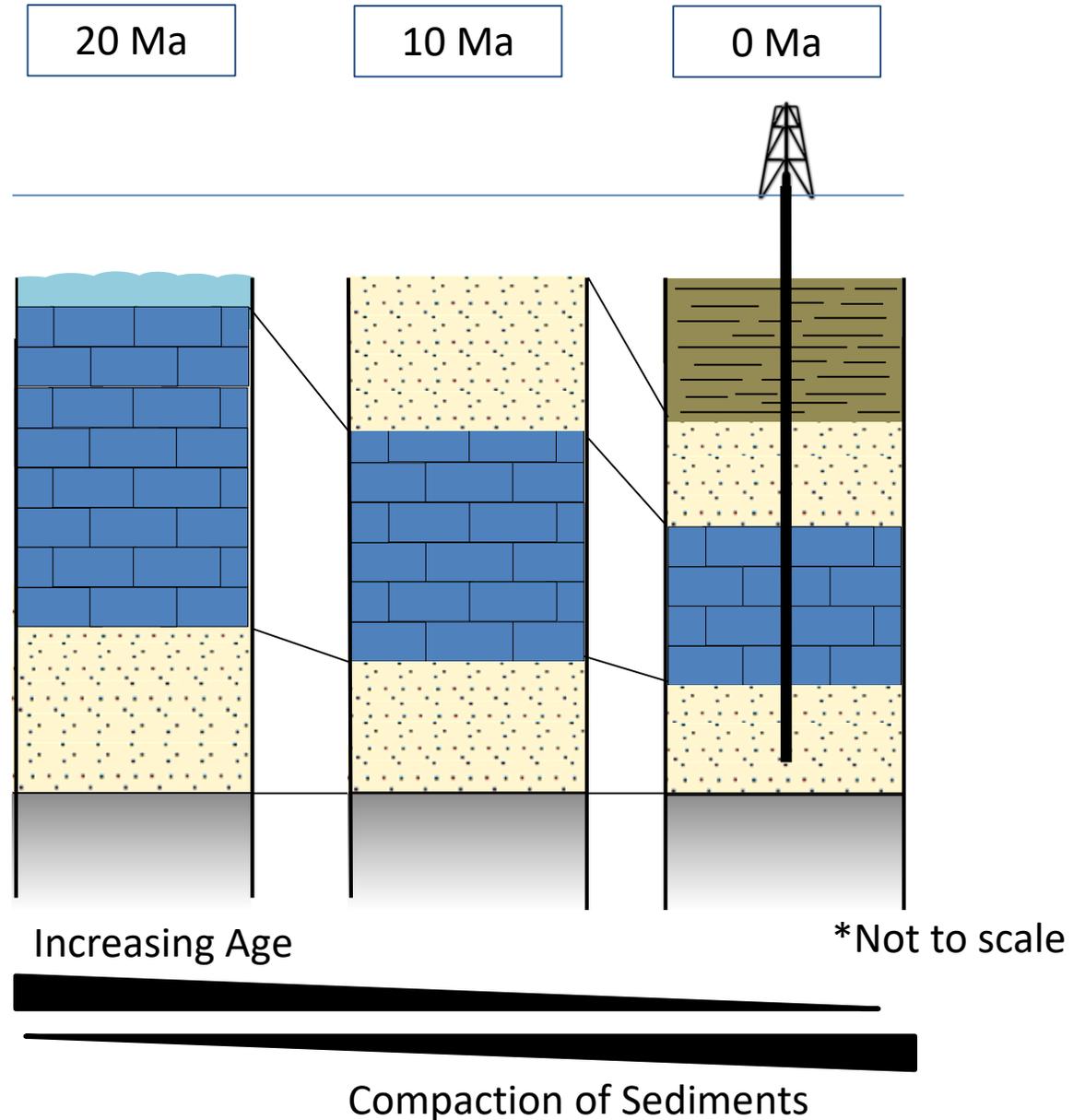
Depth Plots – Modeled %R_o and HI/Tmax



***Modeled curves need to honor measured data**

Backstripping - Tectonic Subsidence

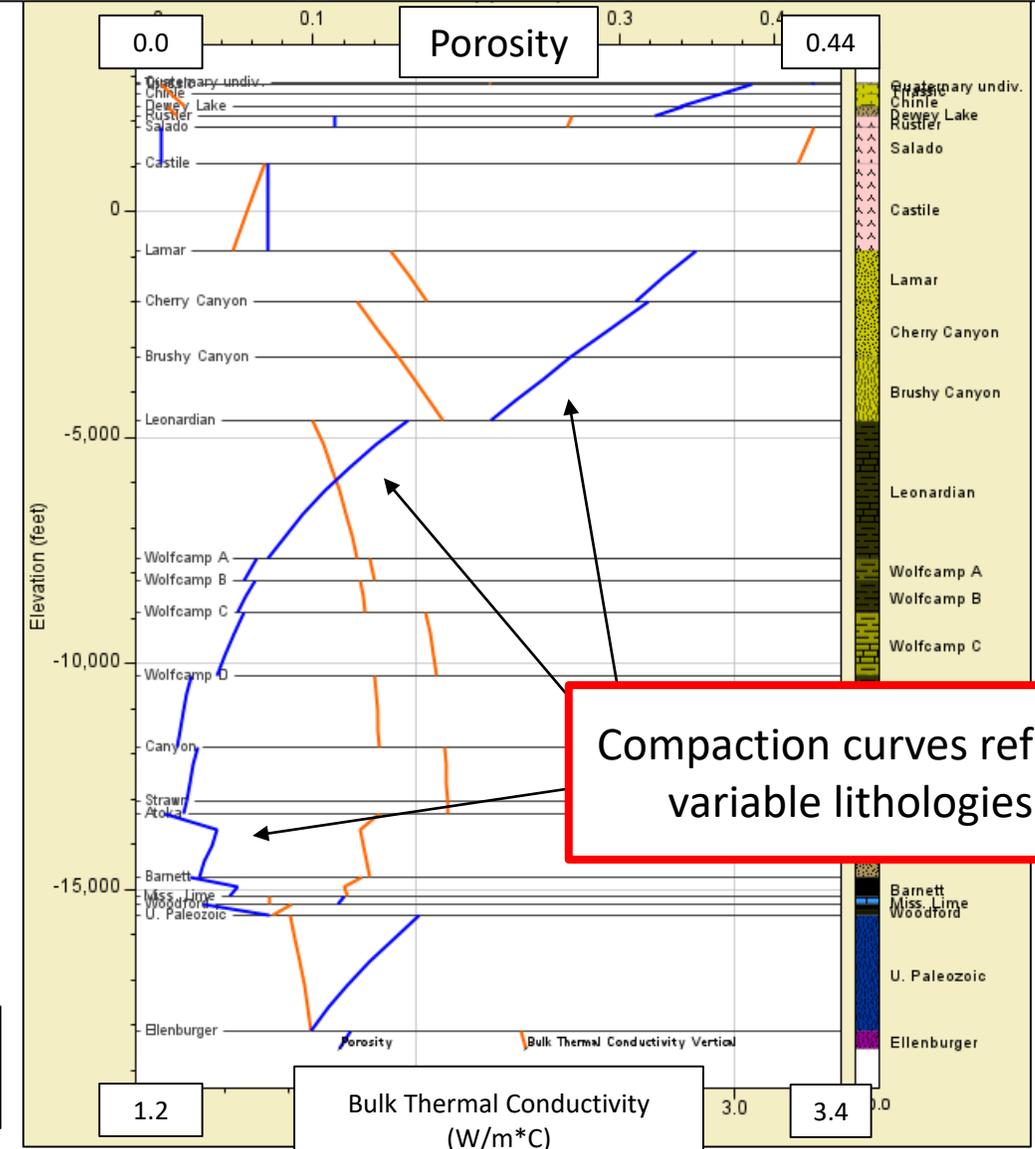
- Quantify **tectonic forces on basin**
 - Begin with present-day conditions and work backward through geologic time
- Remove effects of lithostatic load from stratigraphic column
 - Weight of solid rock (Rock Density)
 - Weight of water column (Sea level)
 - Account for **compaction**
- Plate collision, rifting, flexure affect subsidence



Backstripping - Tectonic Subsidence

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 - Account for **compaction**
- Thermal properties affected by porosity reduction**

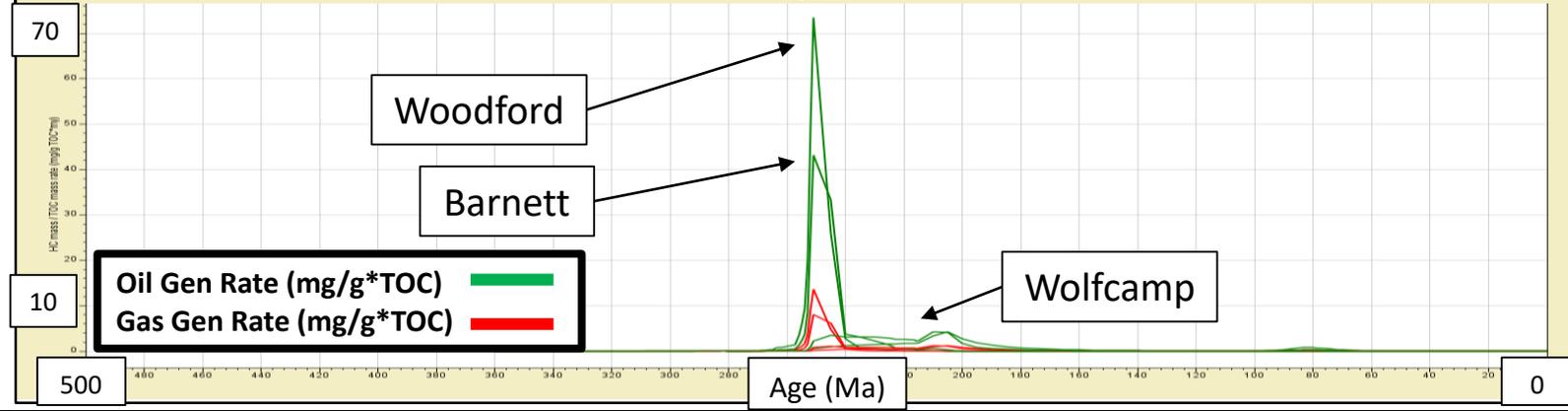
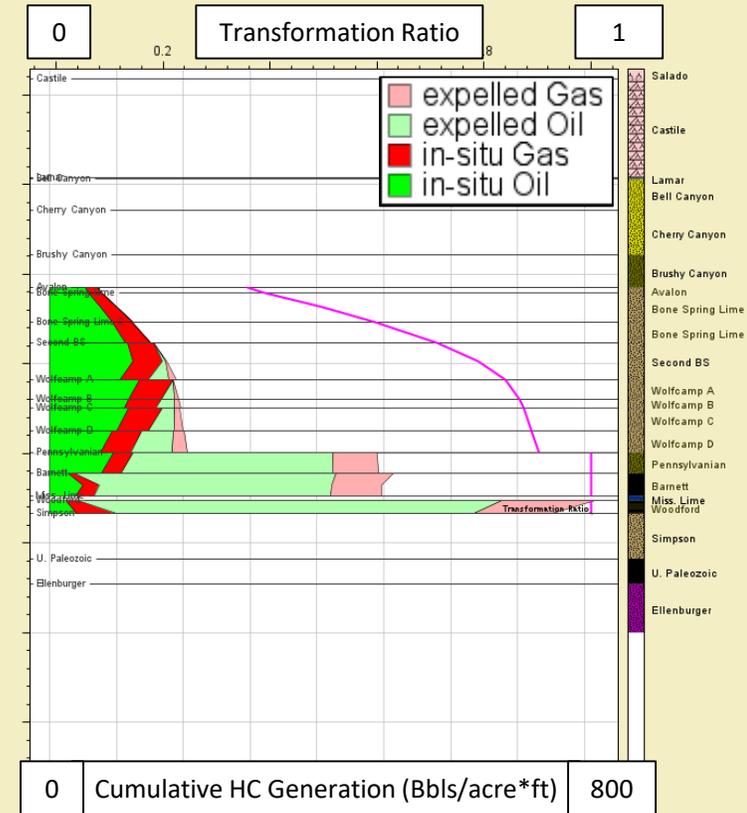
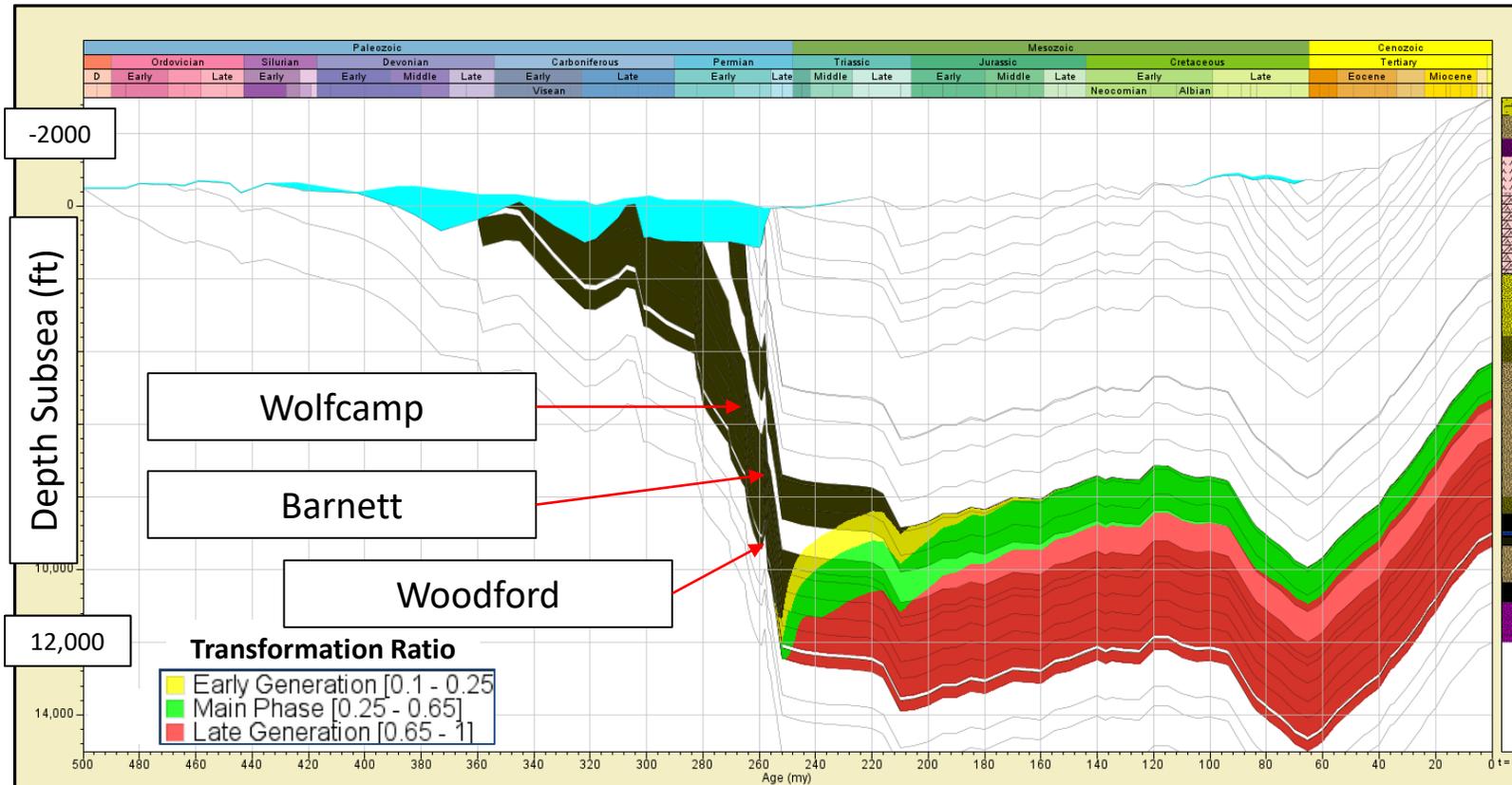
Depth Plot – Porosity and Bulk Vertical Thermal Conductivity



Outline

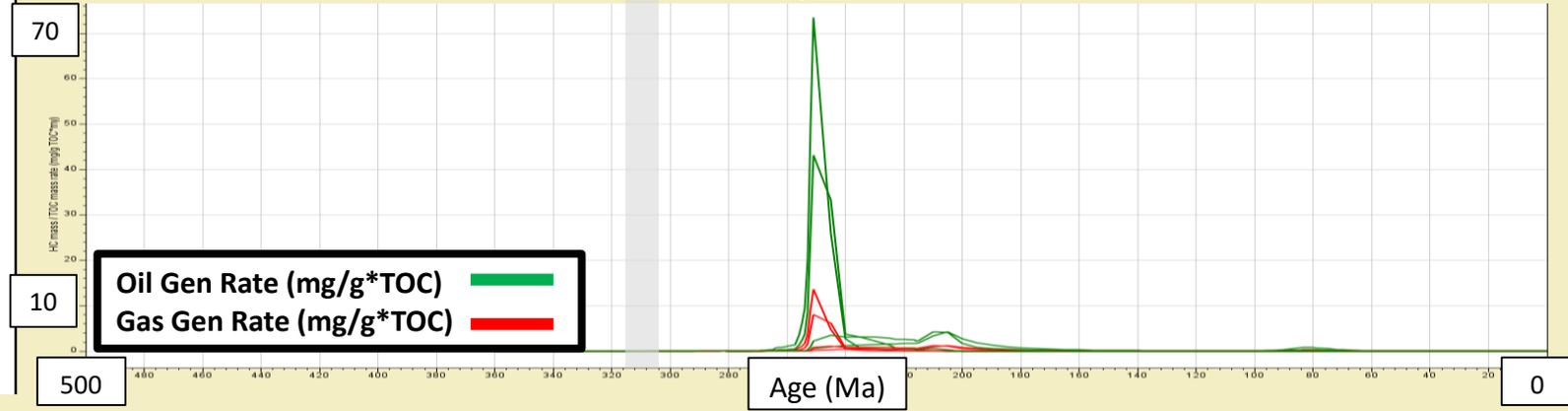
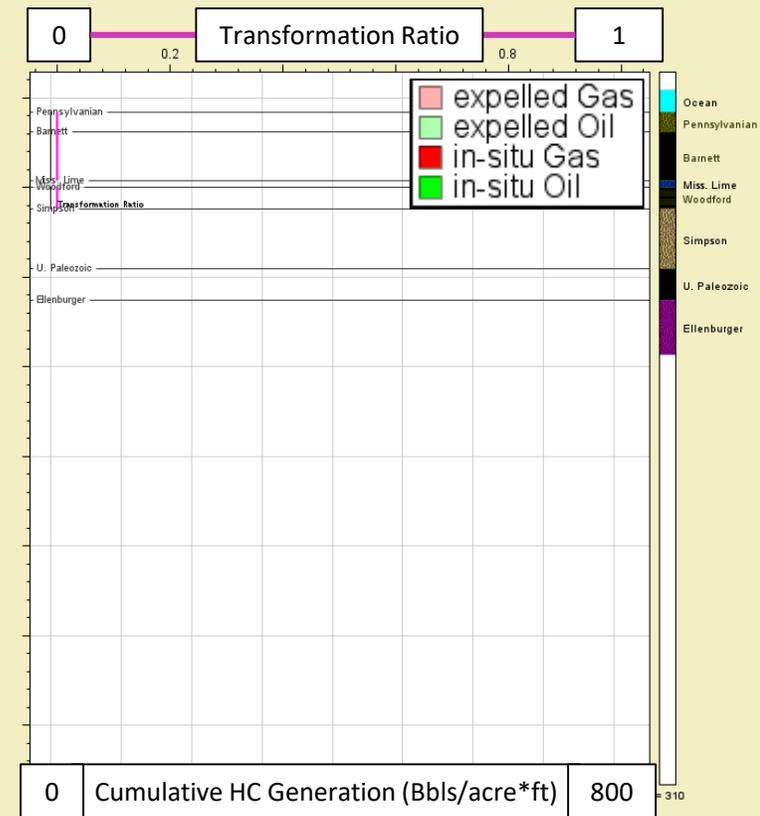
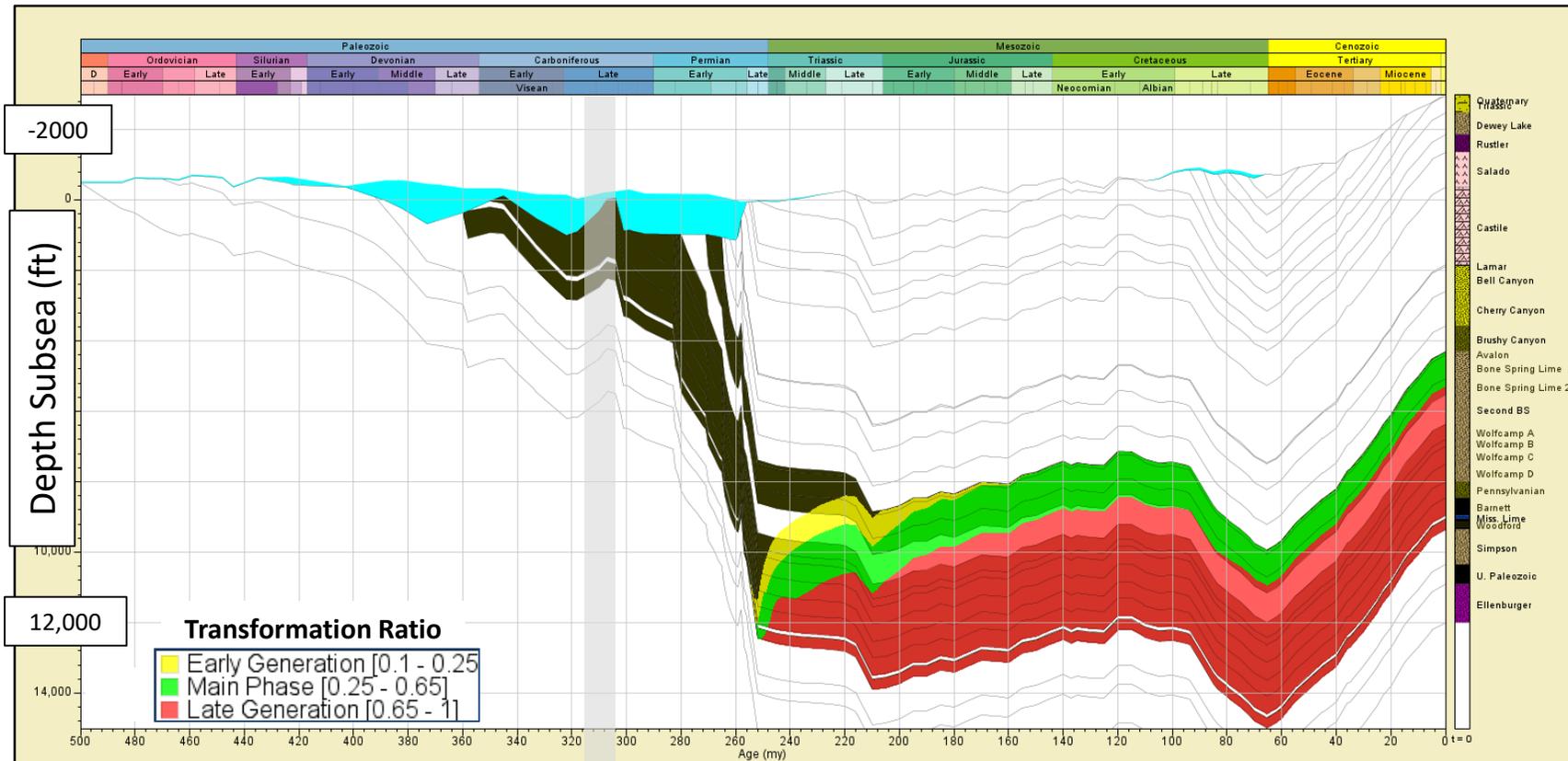
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Source Rock Maturation



- Permo-Triassic Hydrocarbon generation
- Delaware basin geologic reconstruction

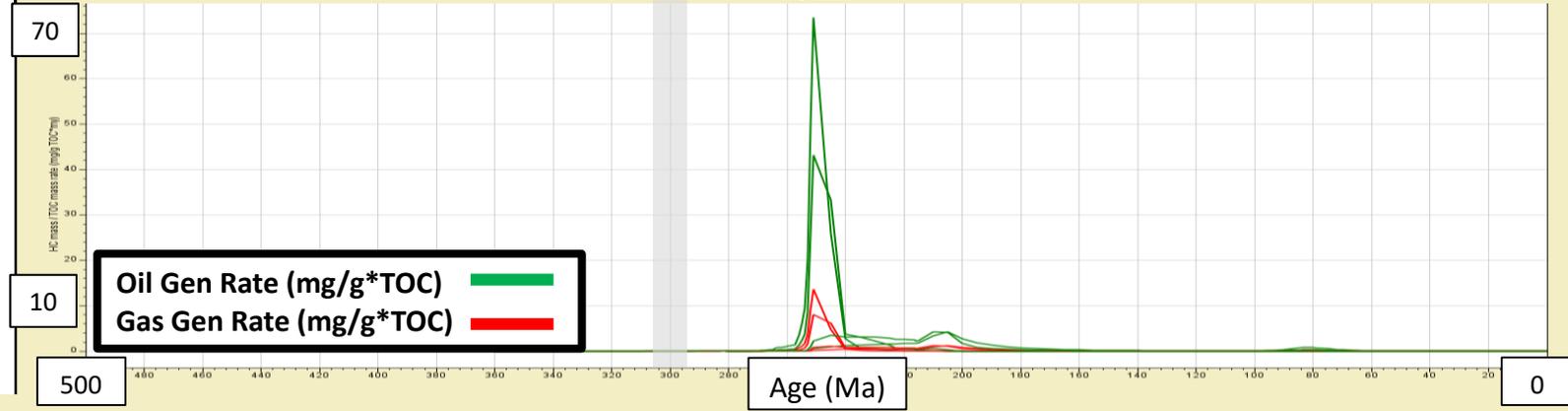
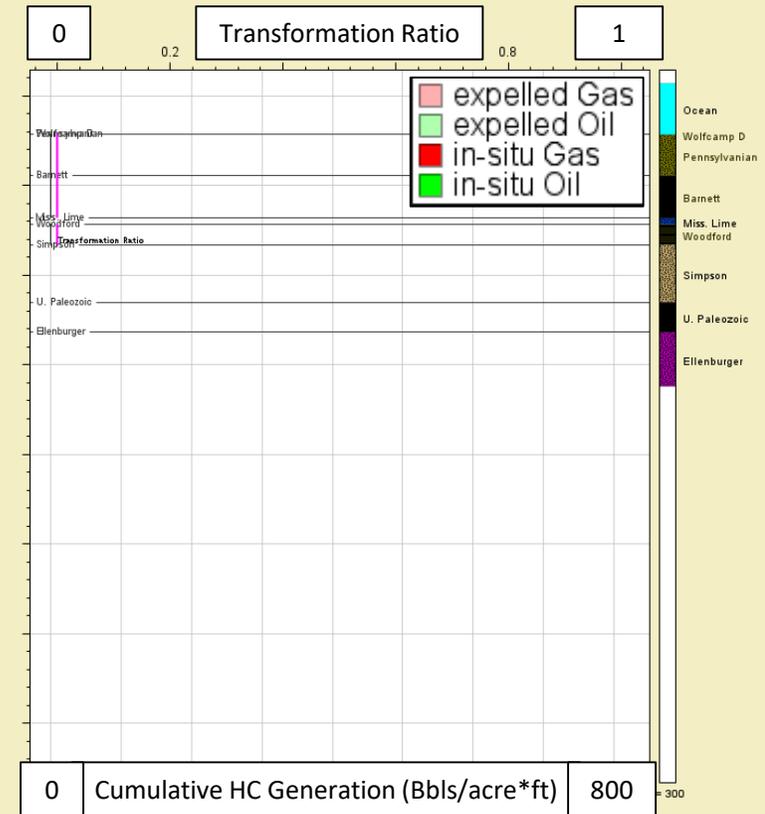
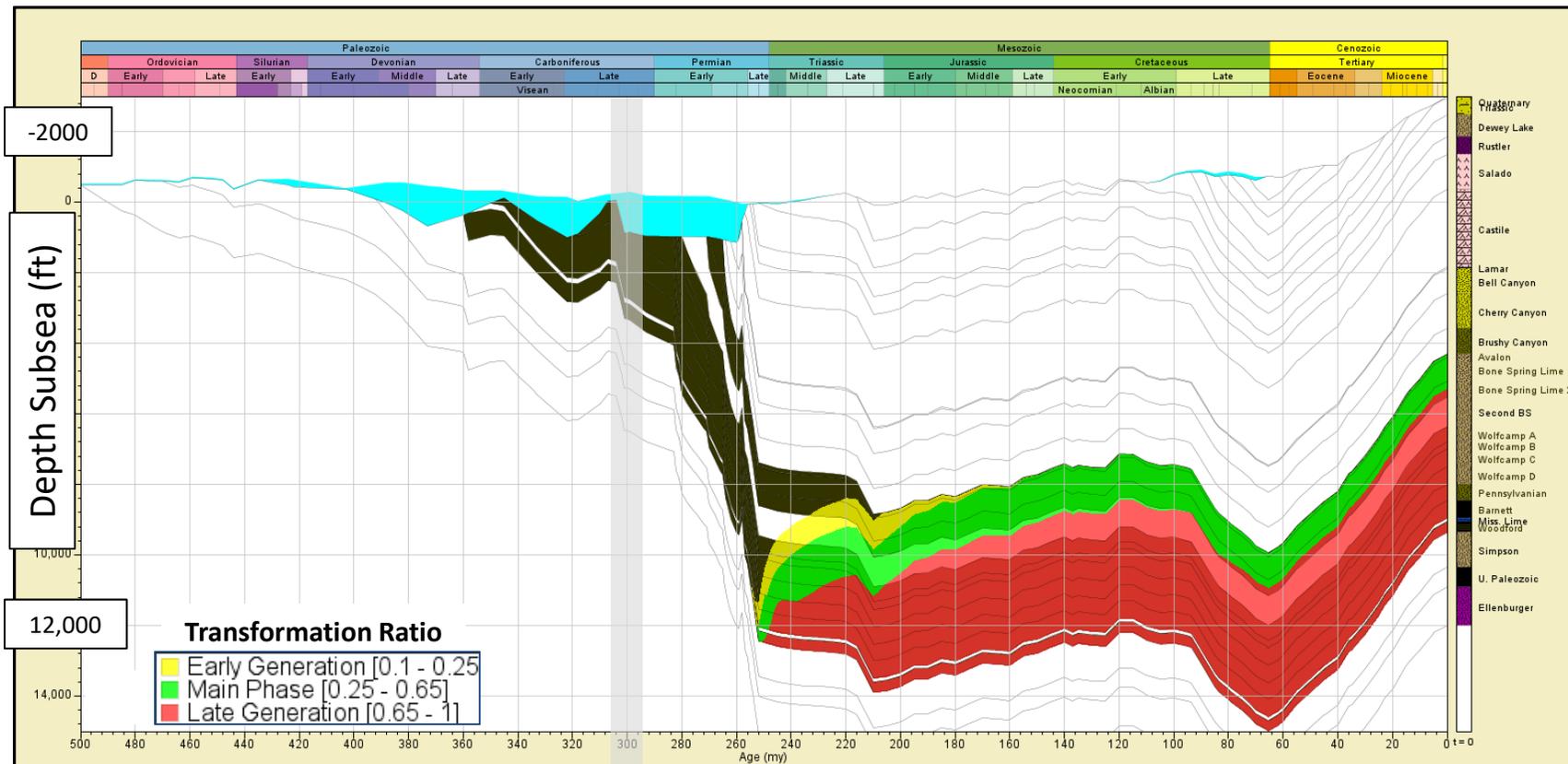
Time lapse of generation



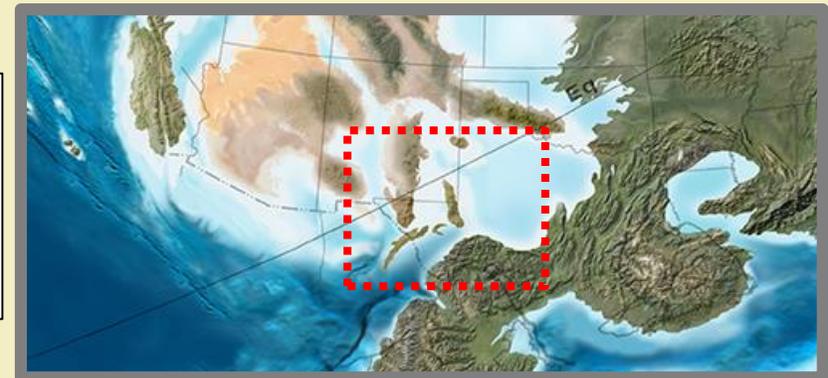
Paleogeography



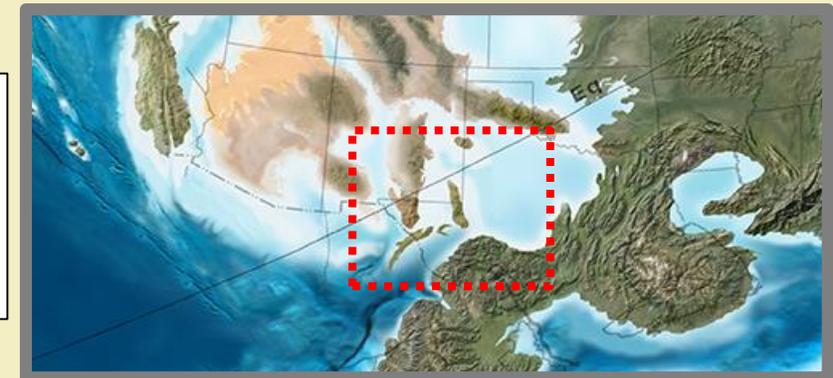
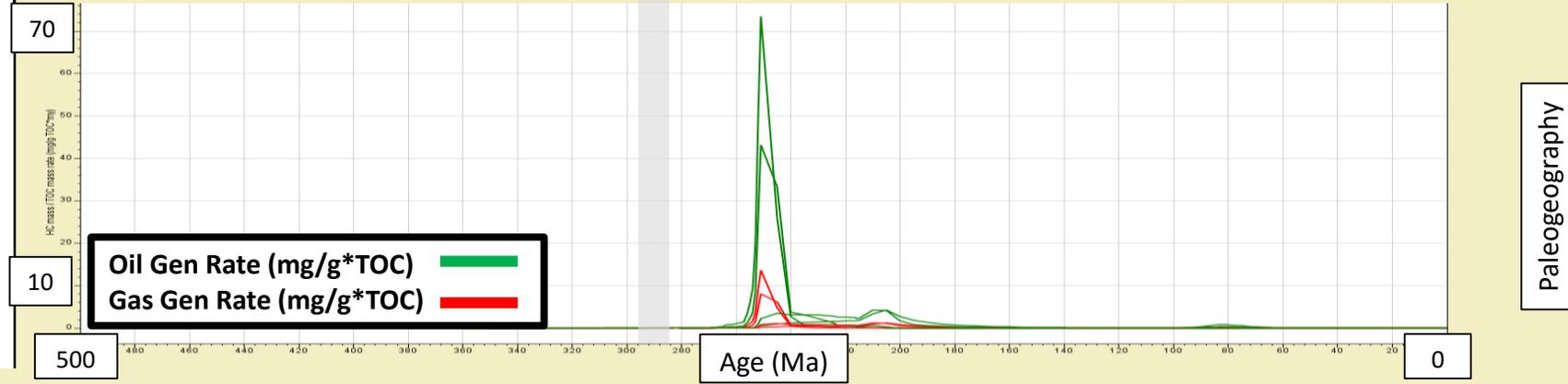
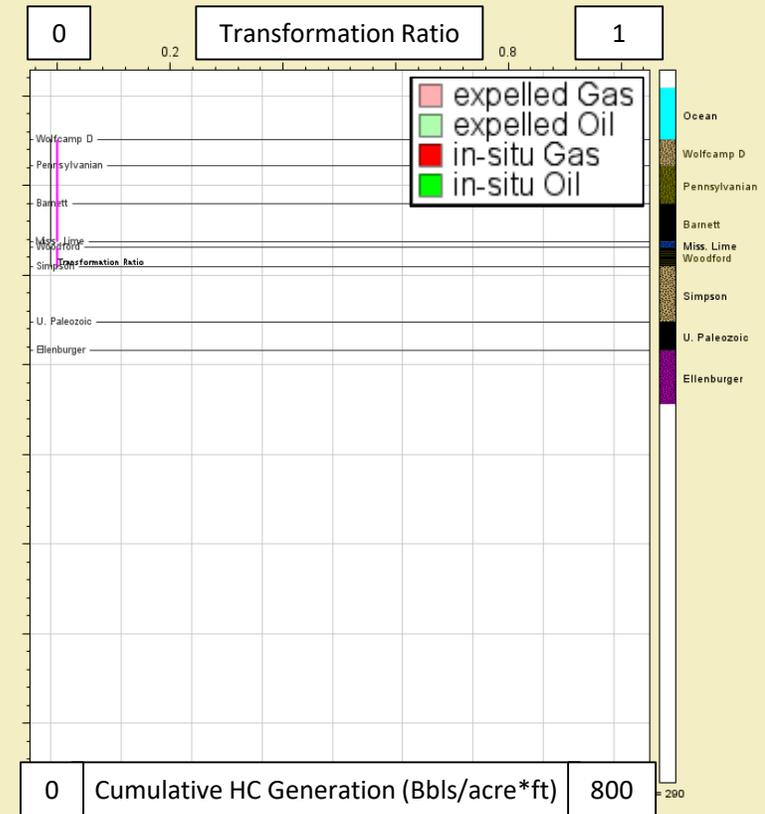
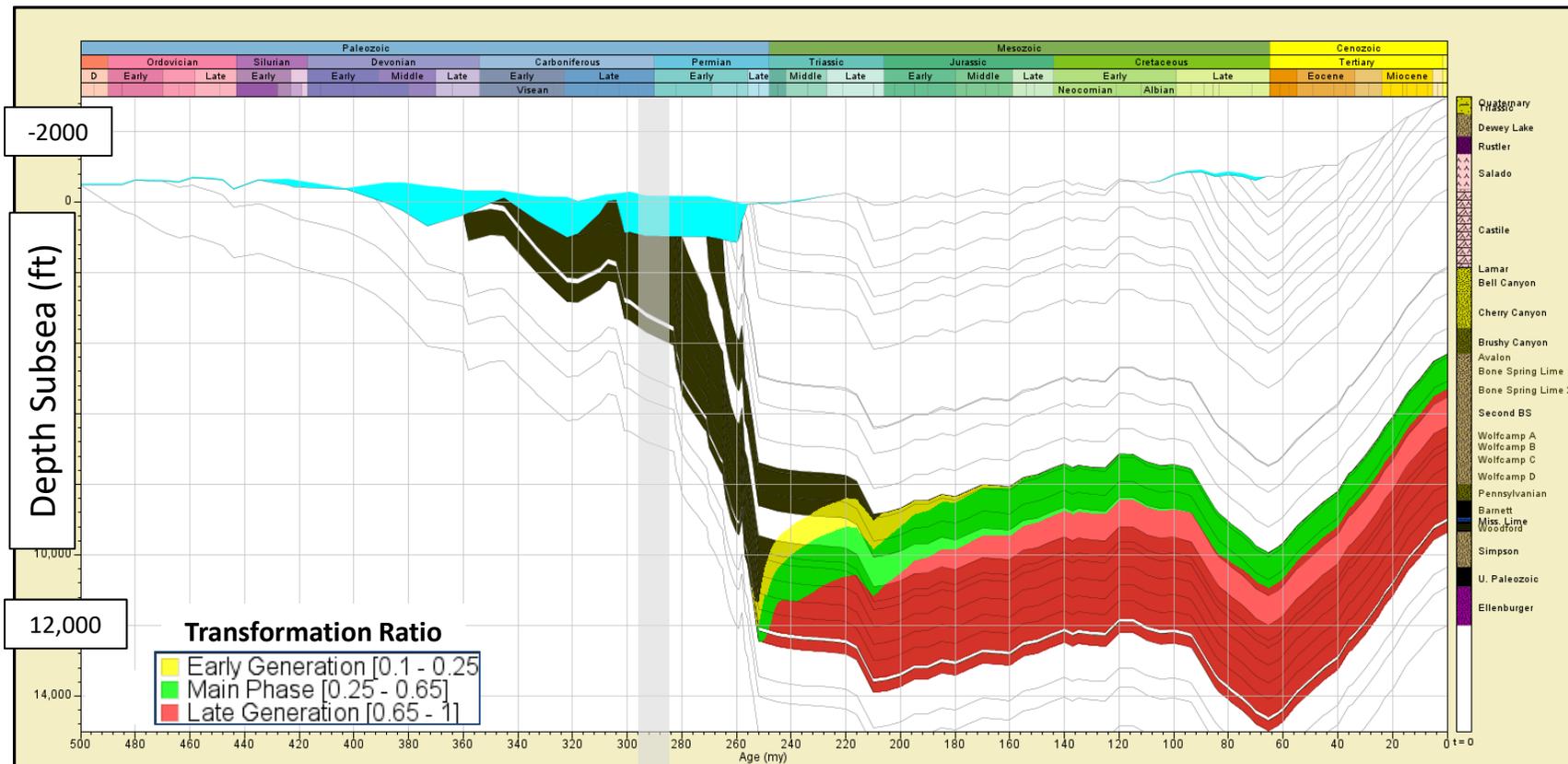
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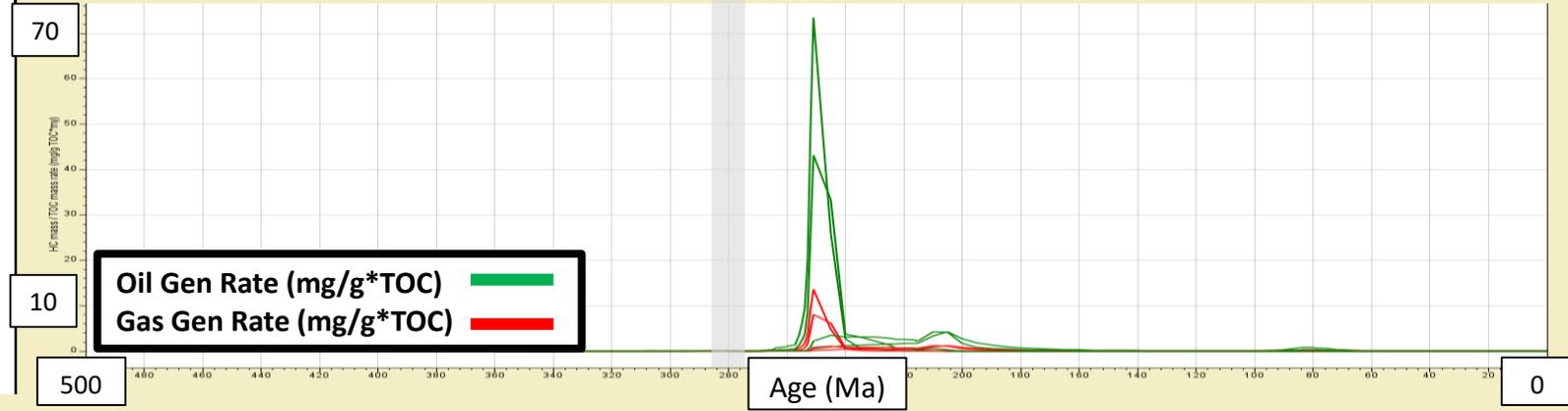
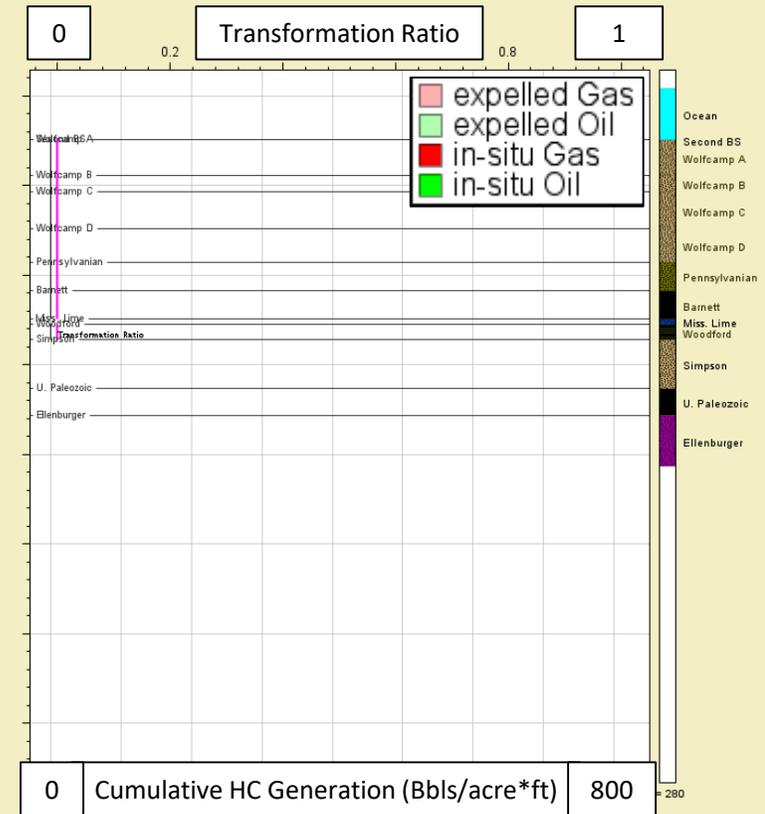
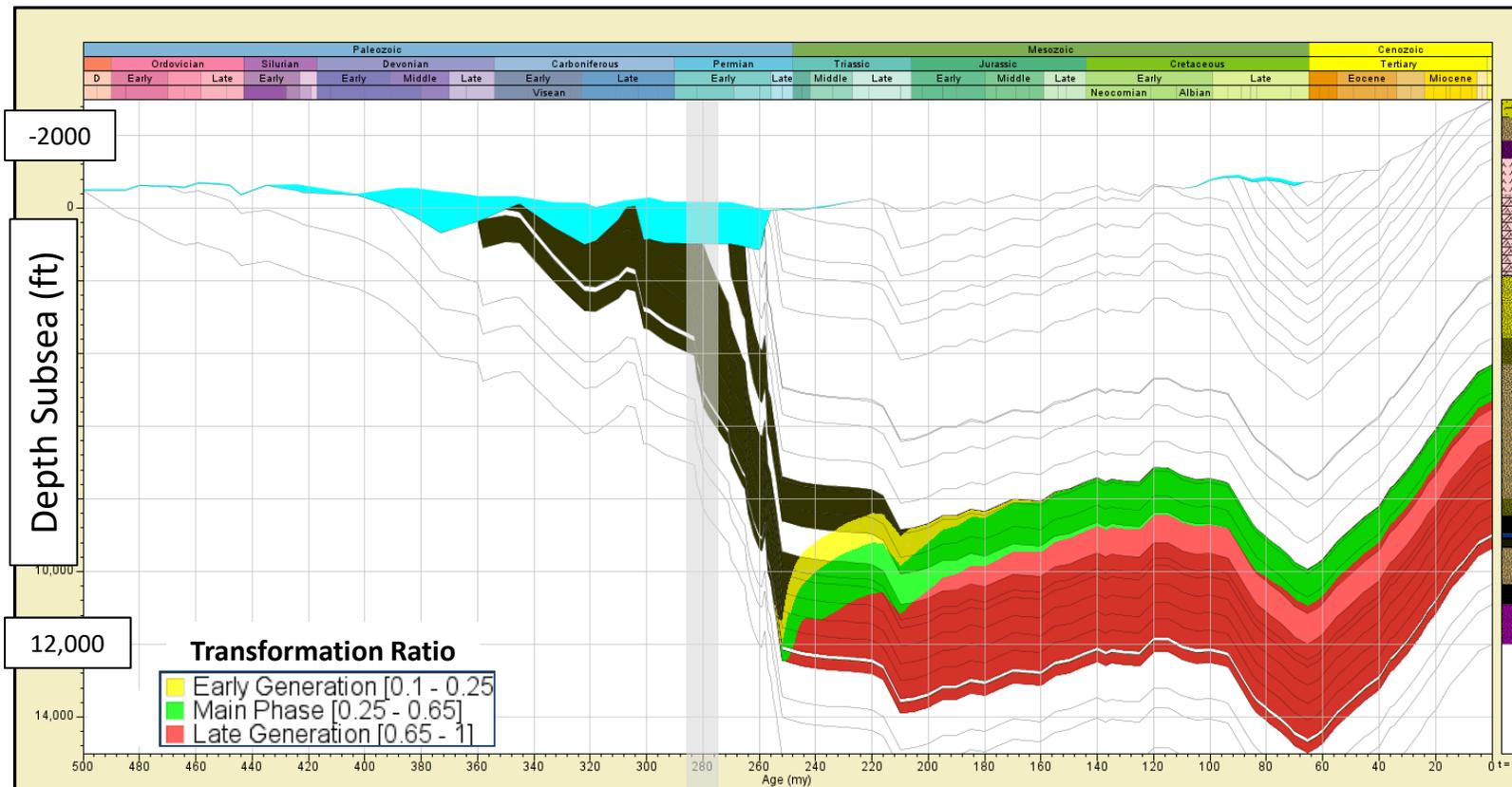
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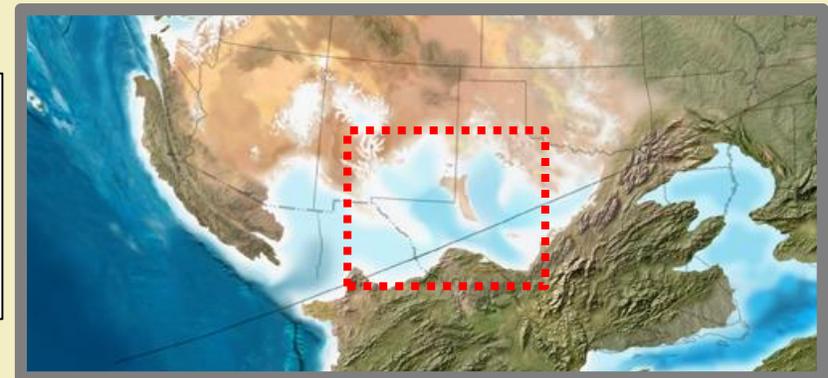
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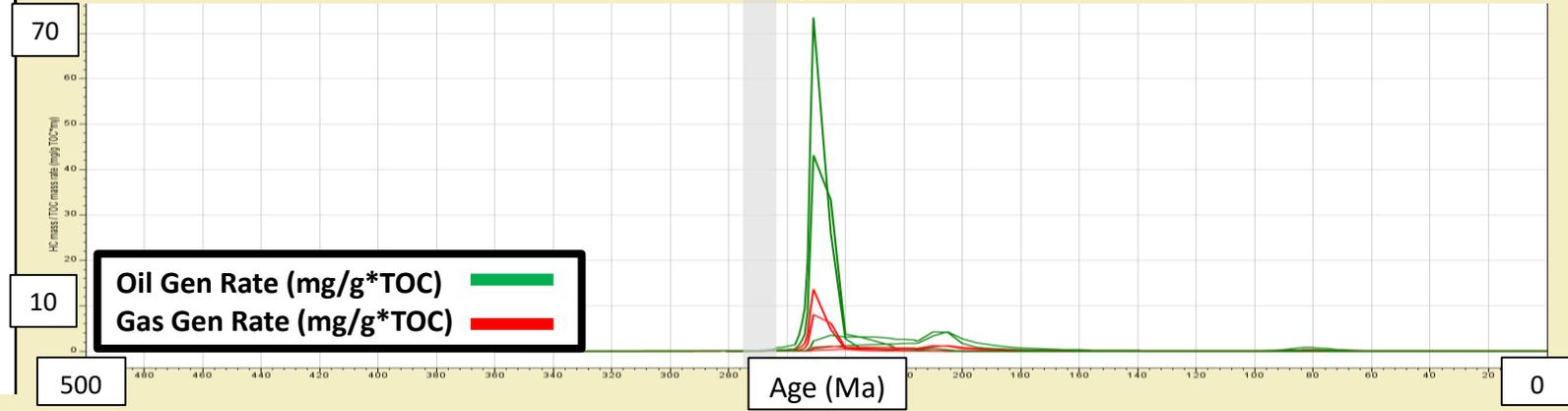
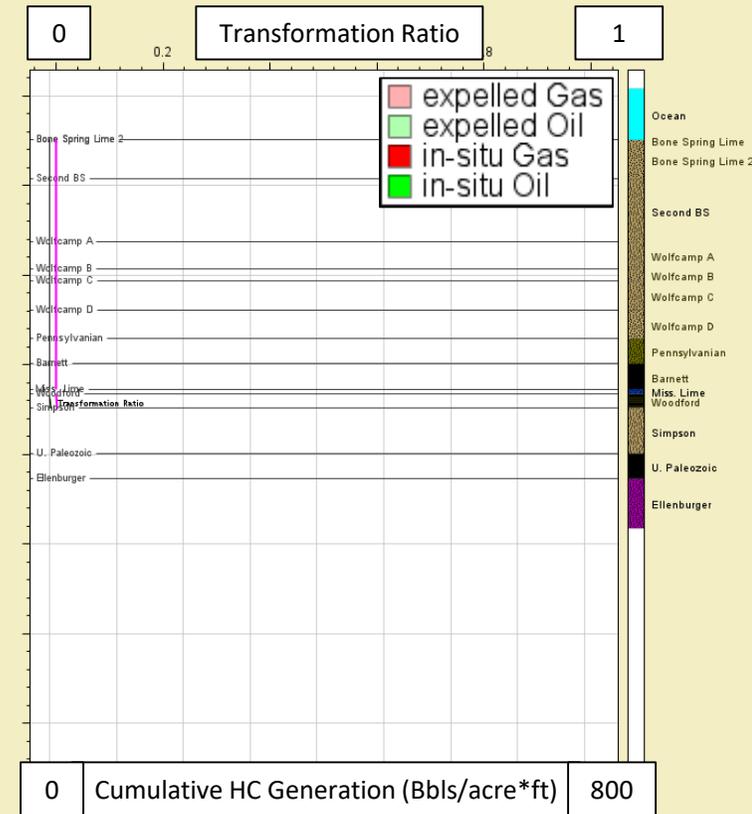
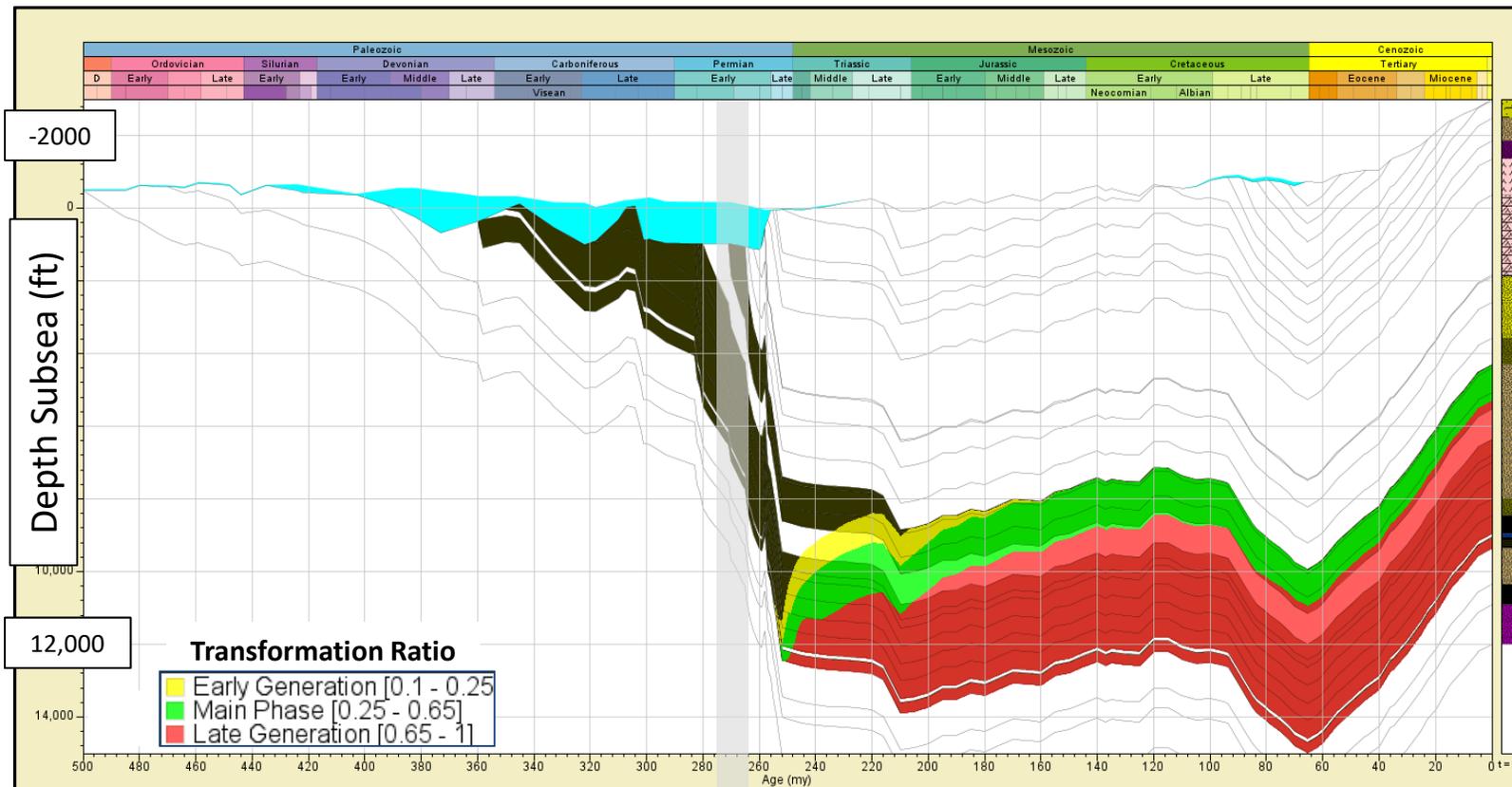
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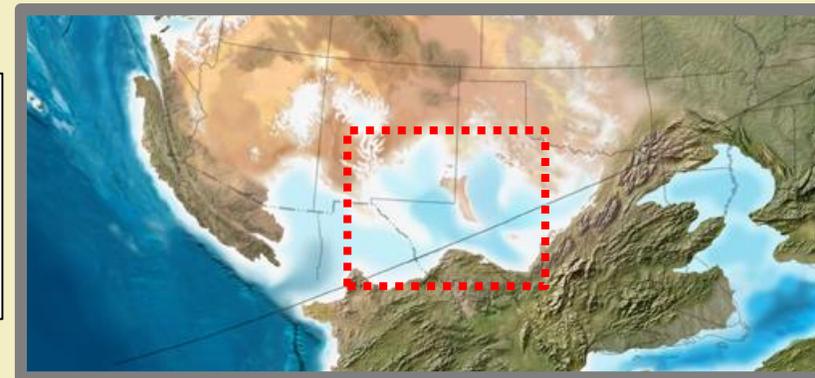
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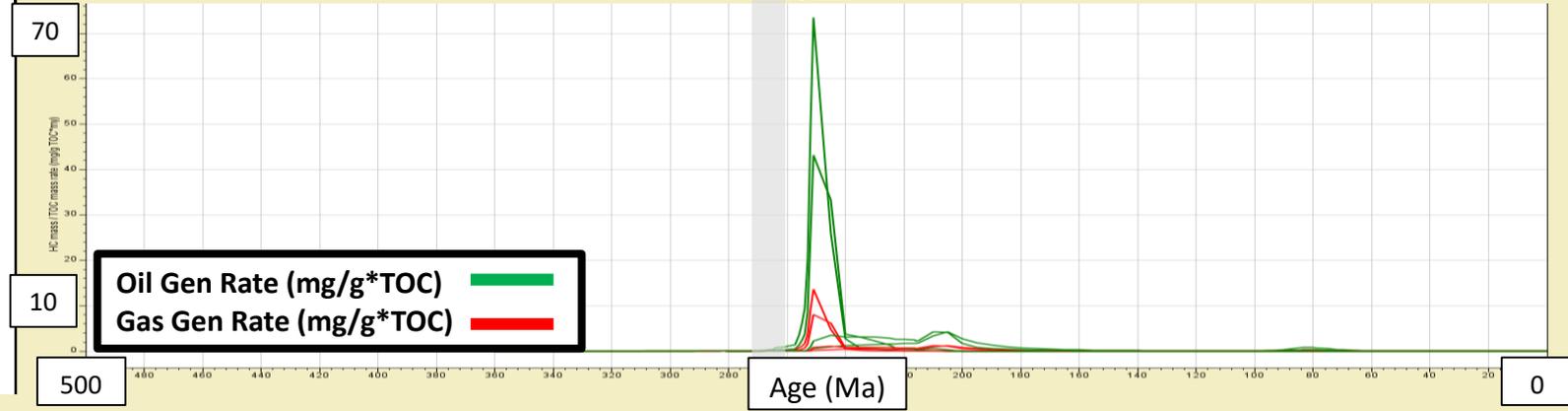
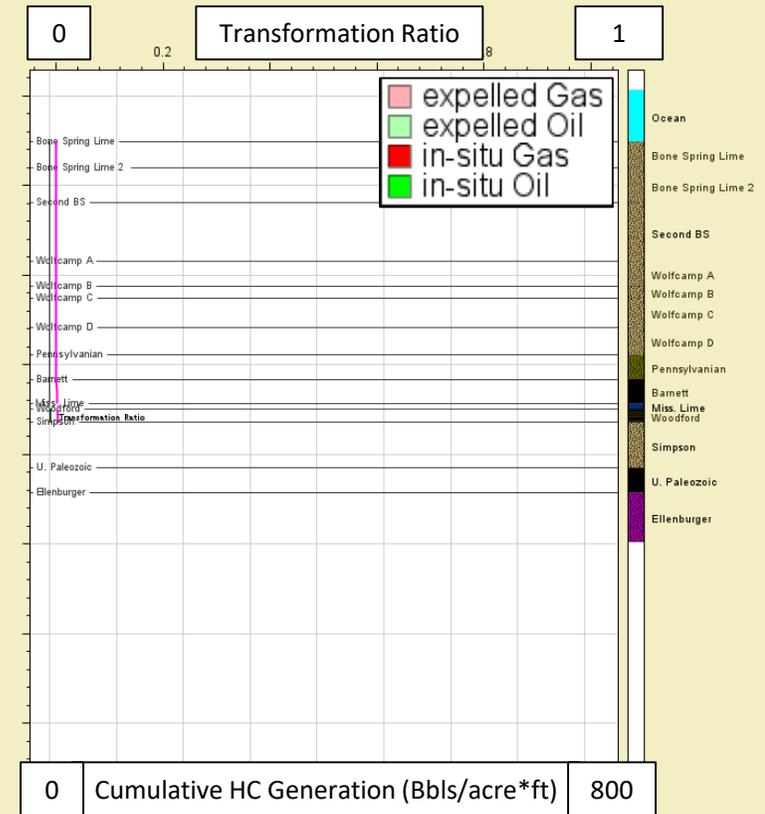
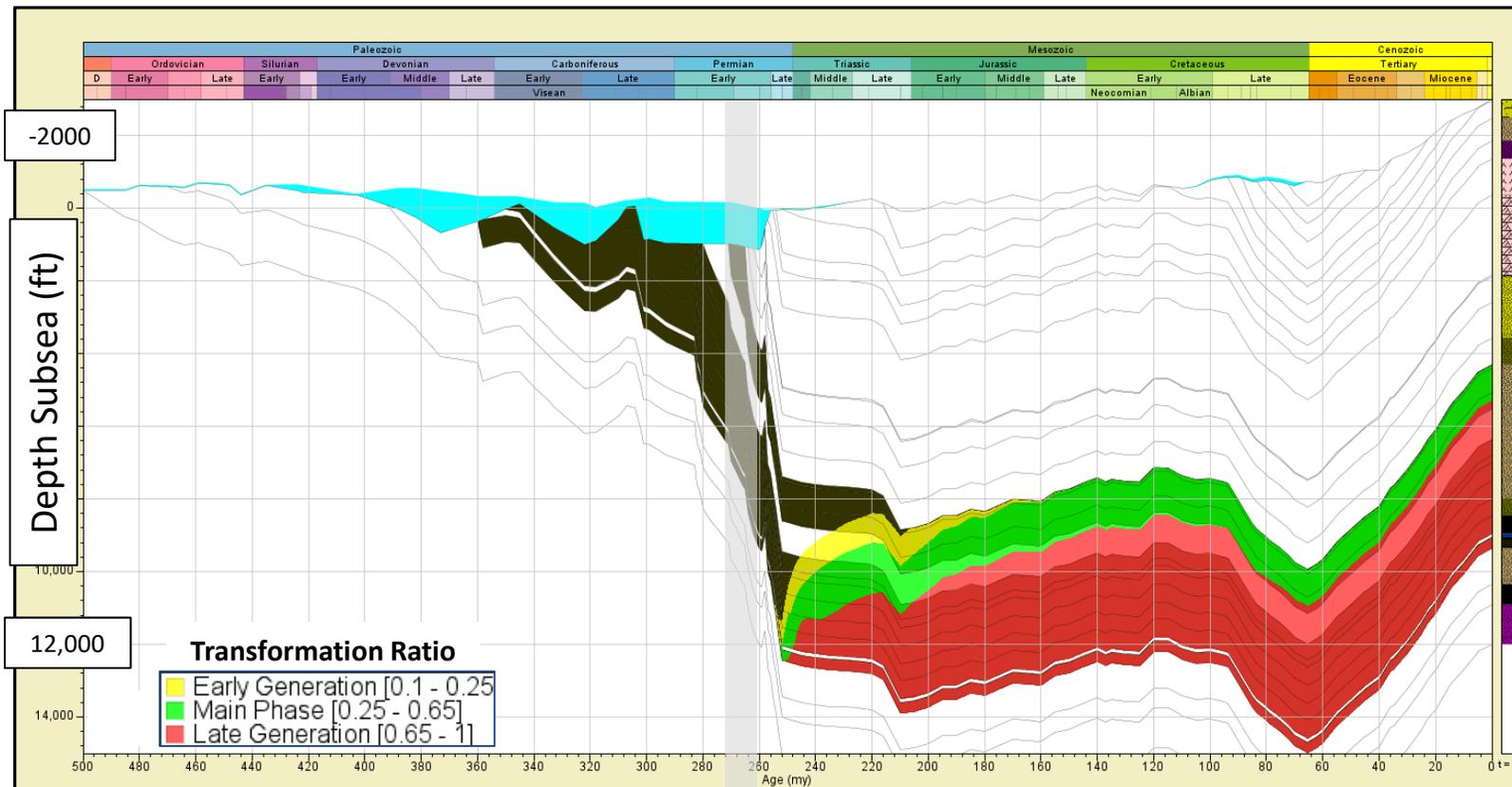
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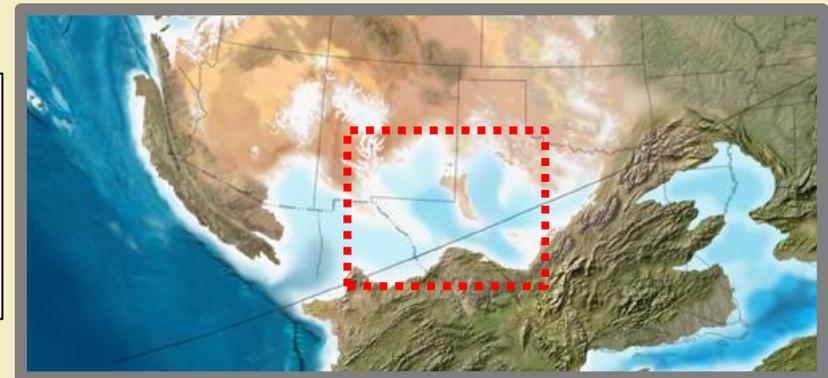
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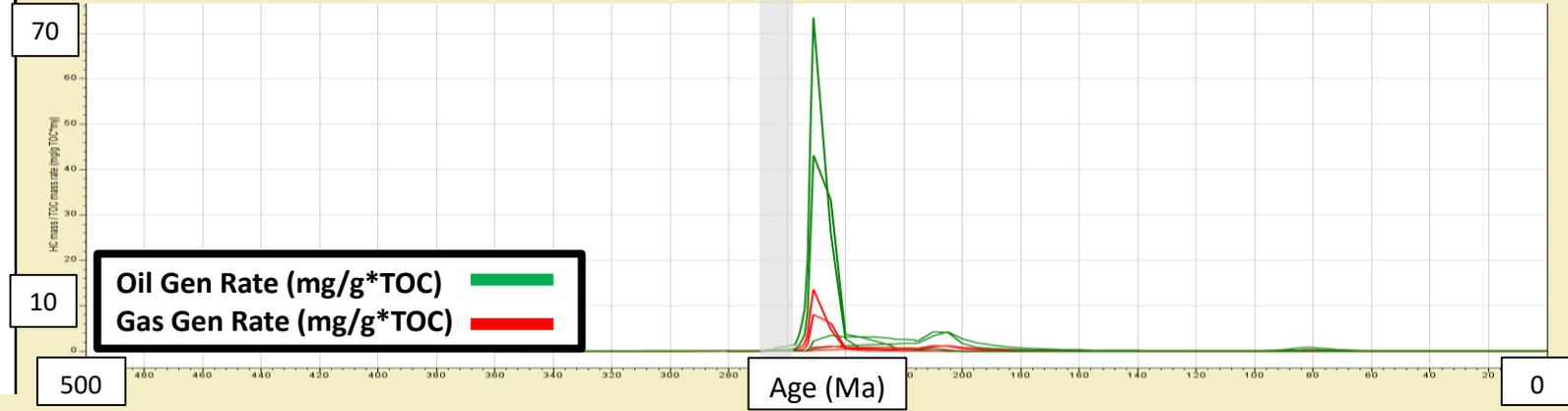
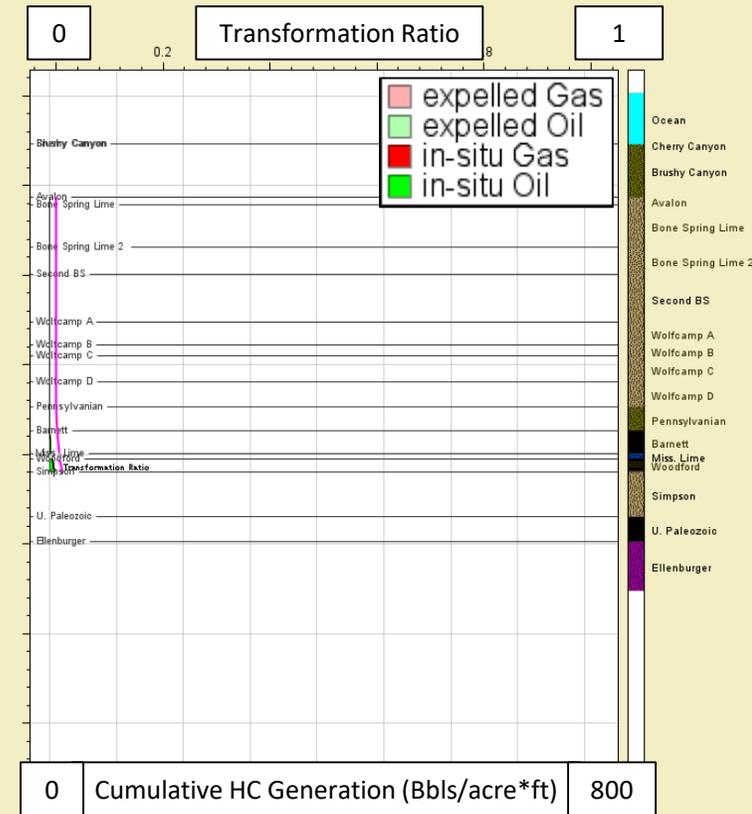
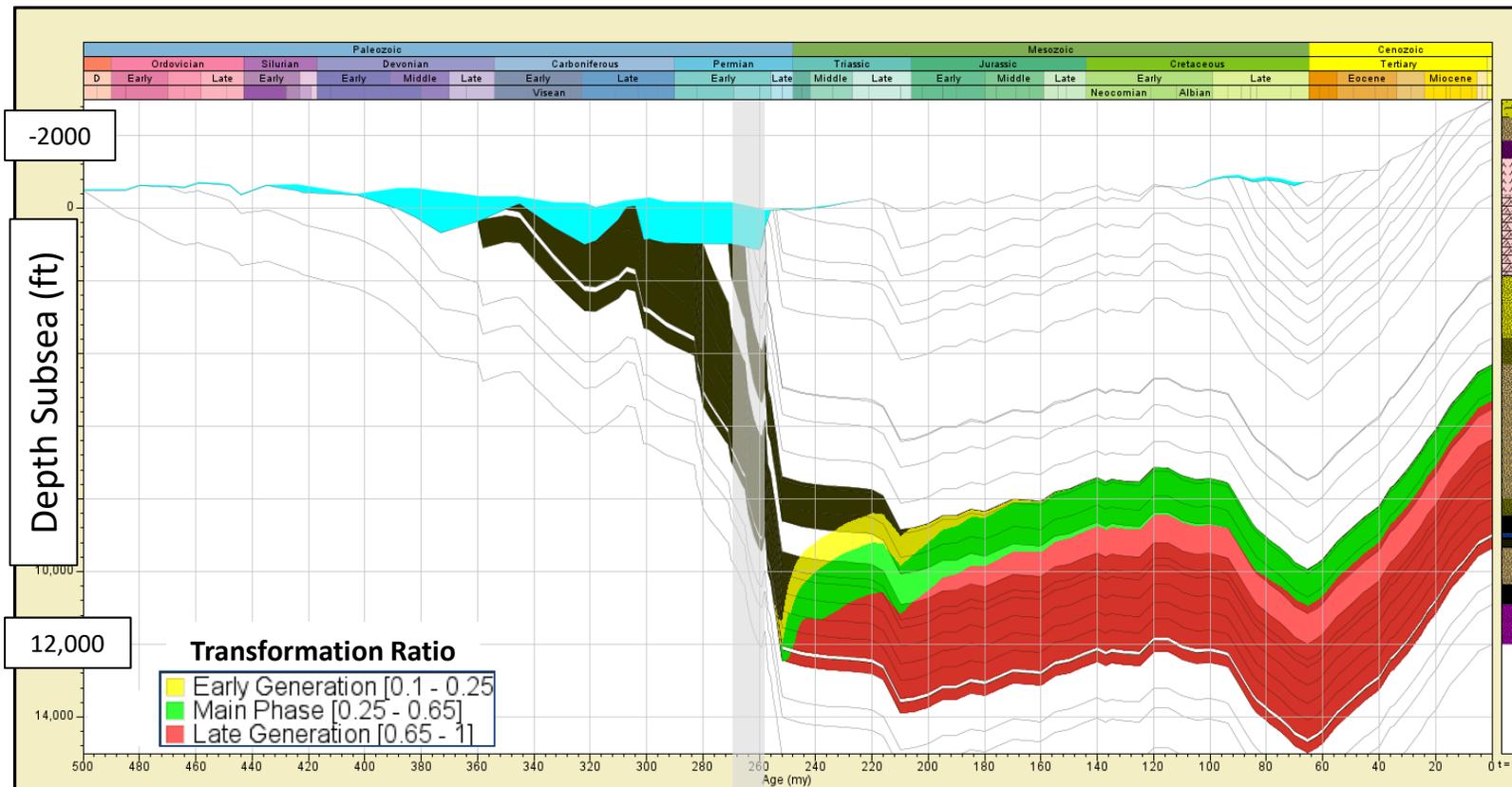
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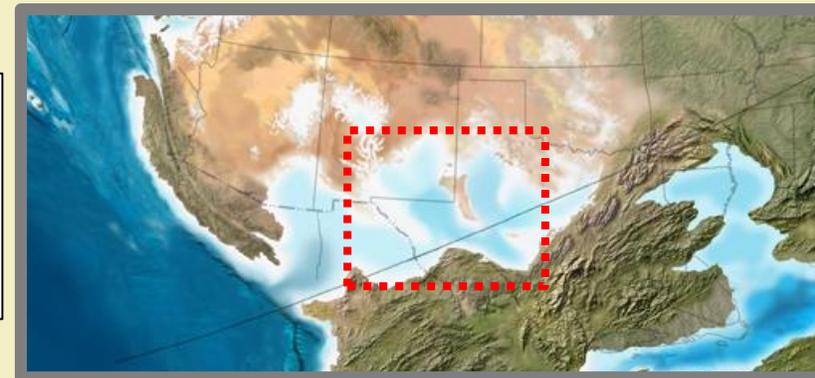
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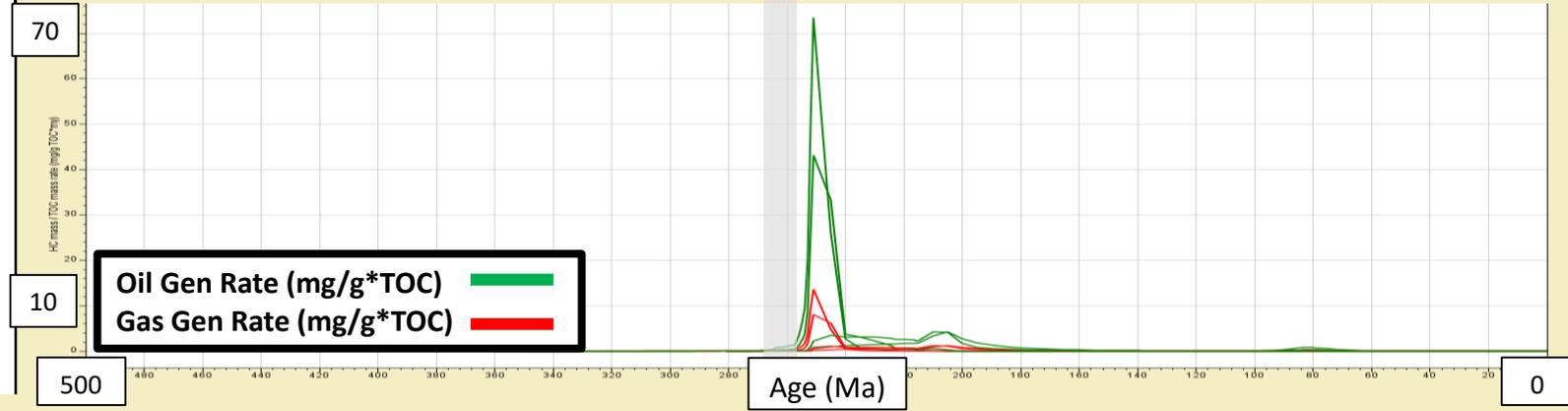
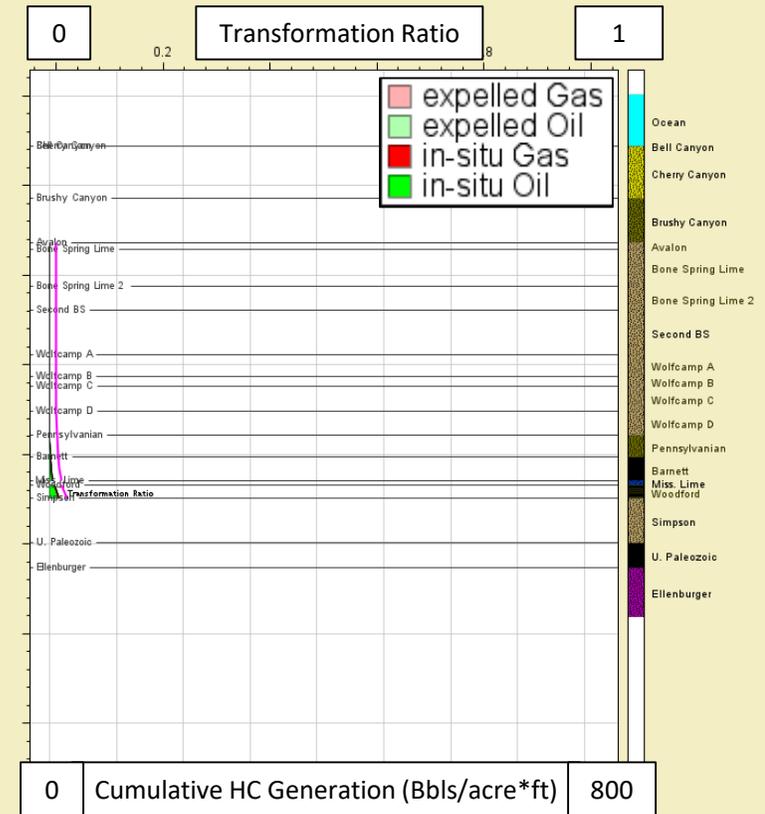
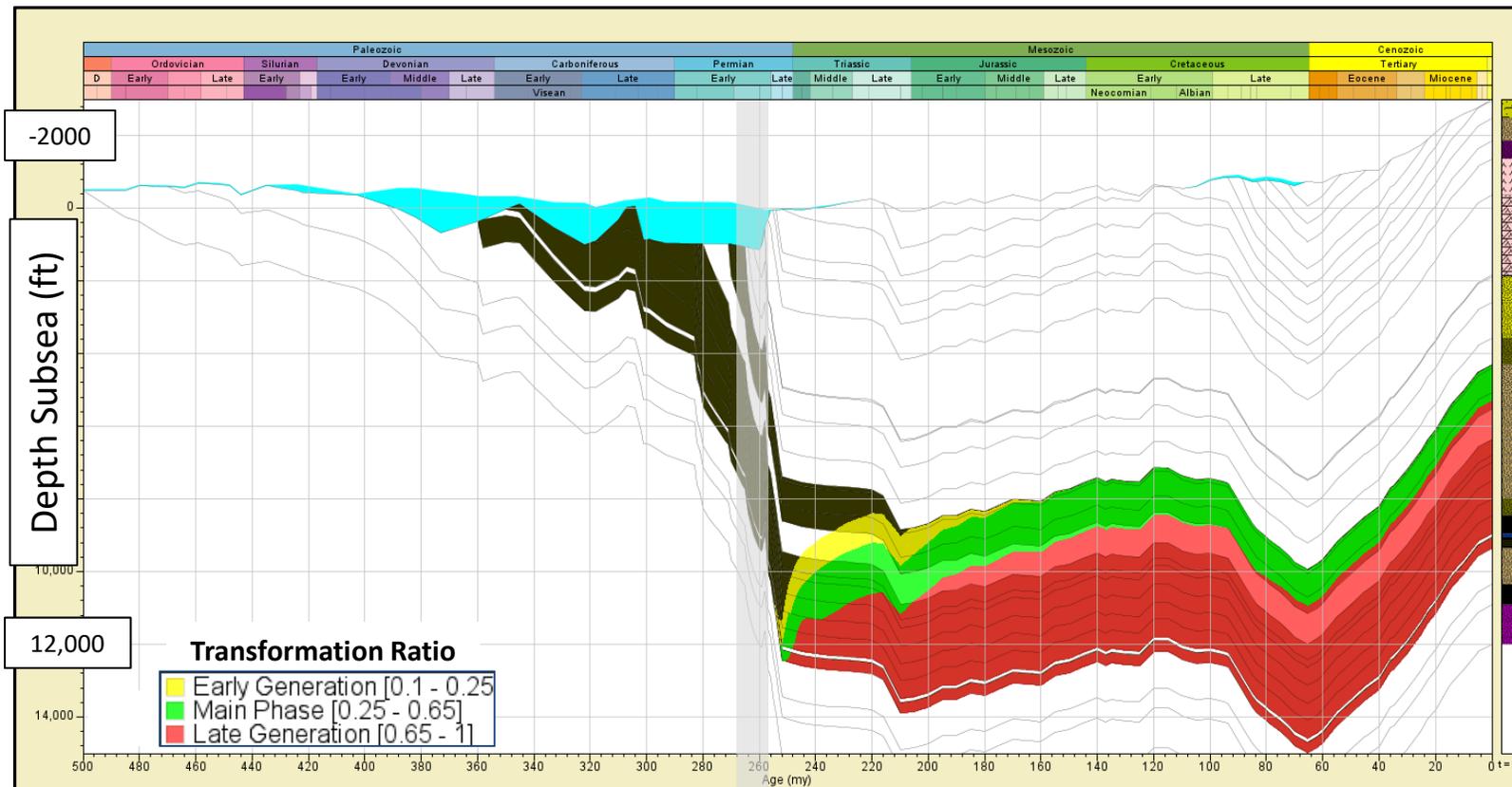
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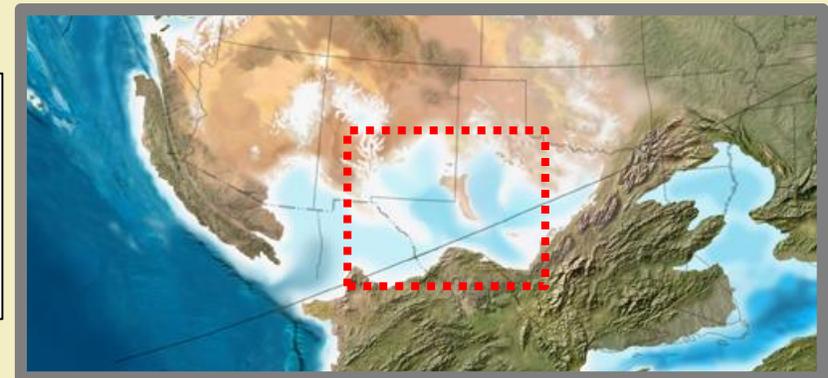
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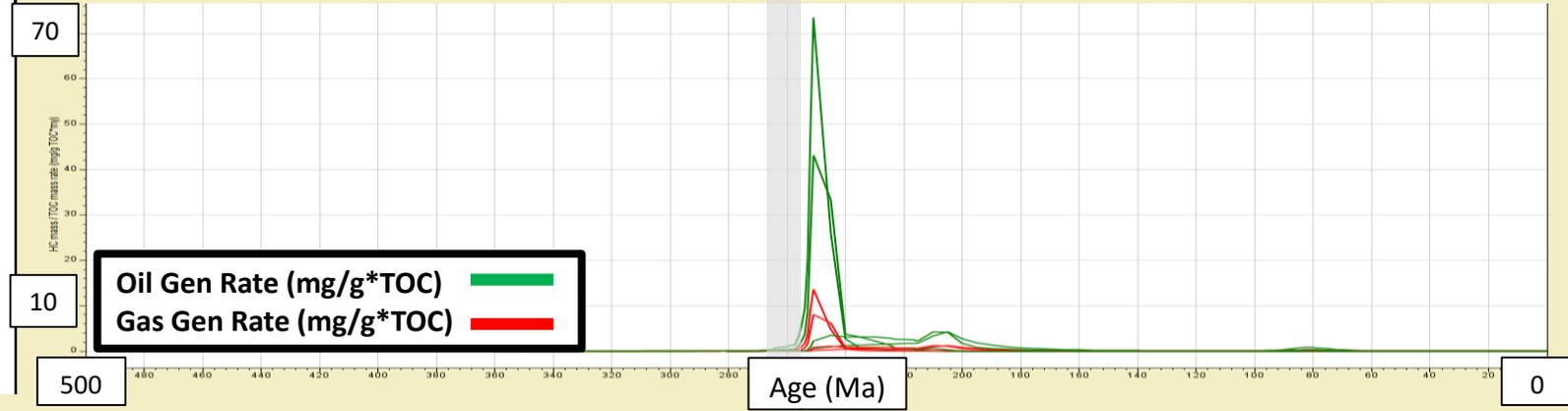
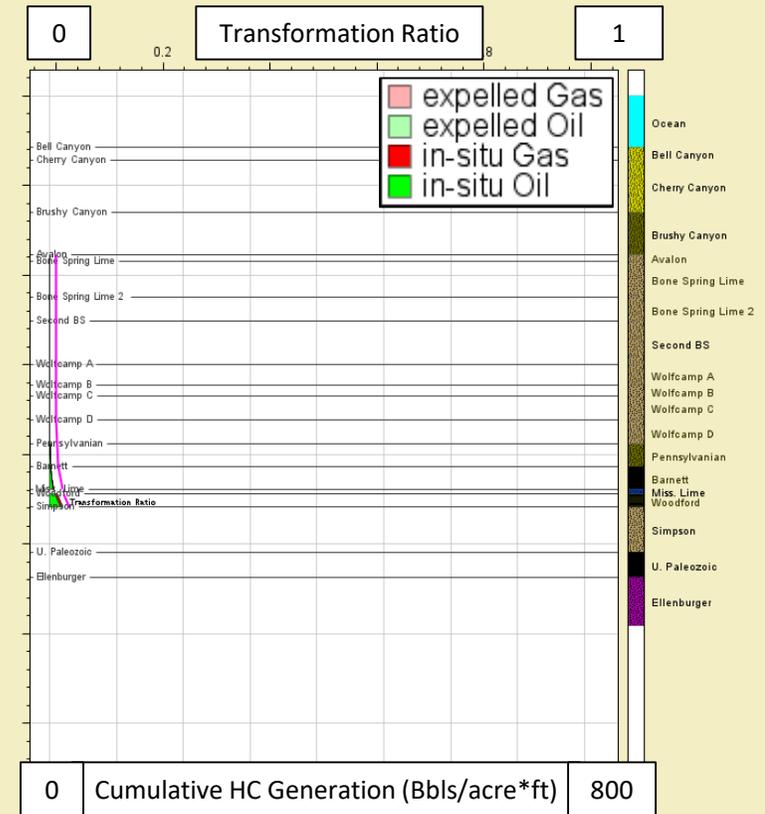
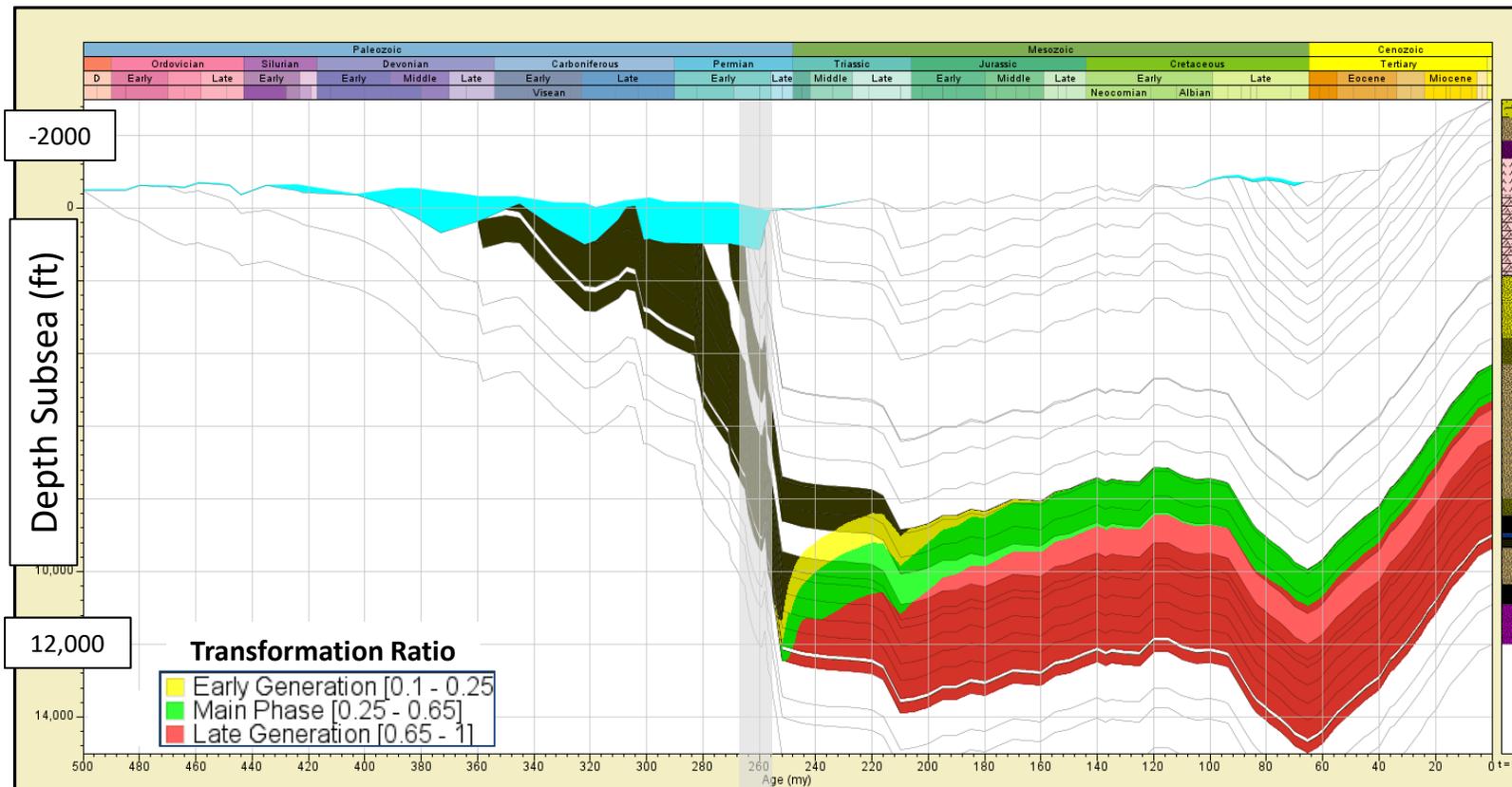
Time lapse of generation



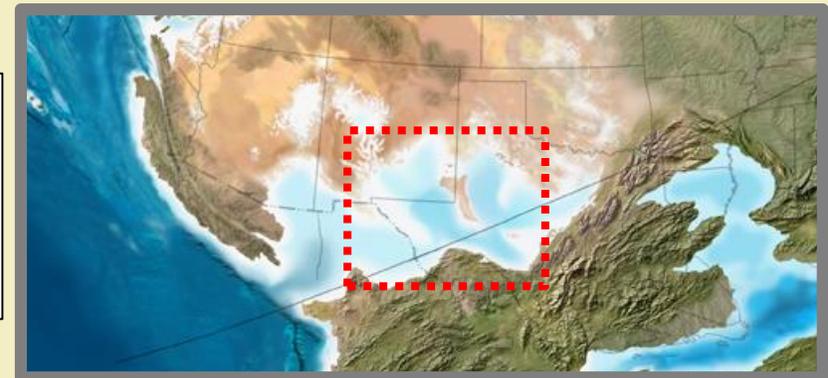
Paleogeography



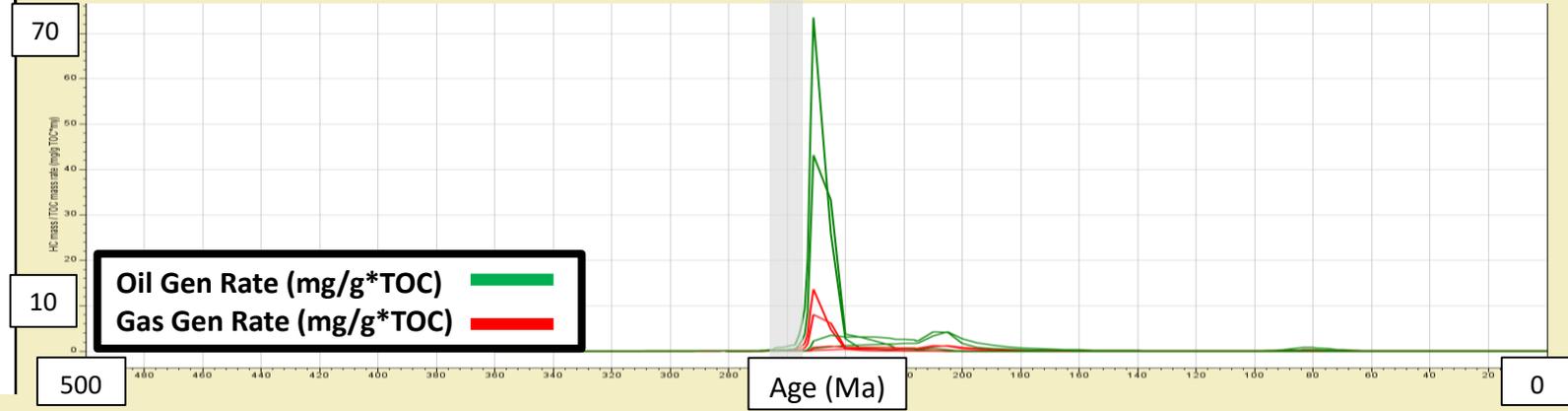
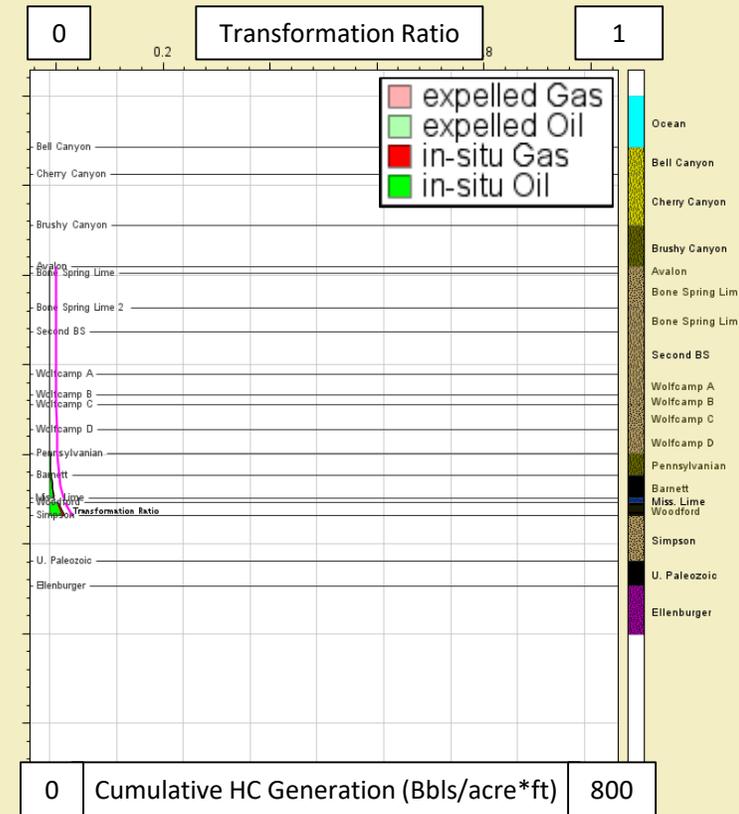
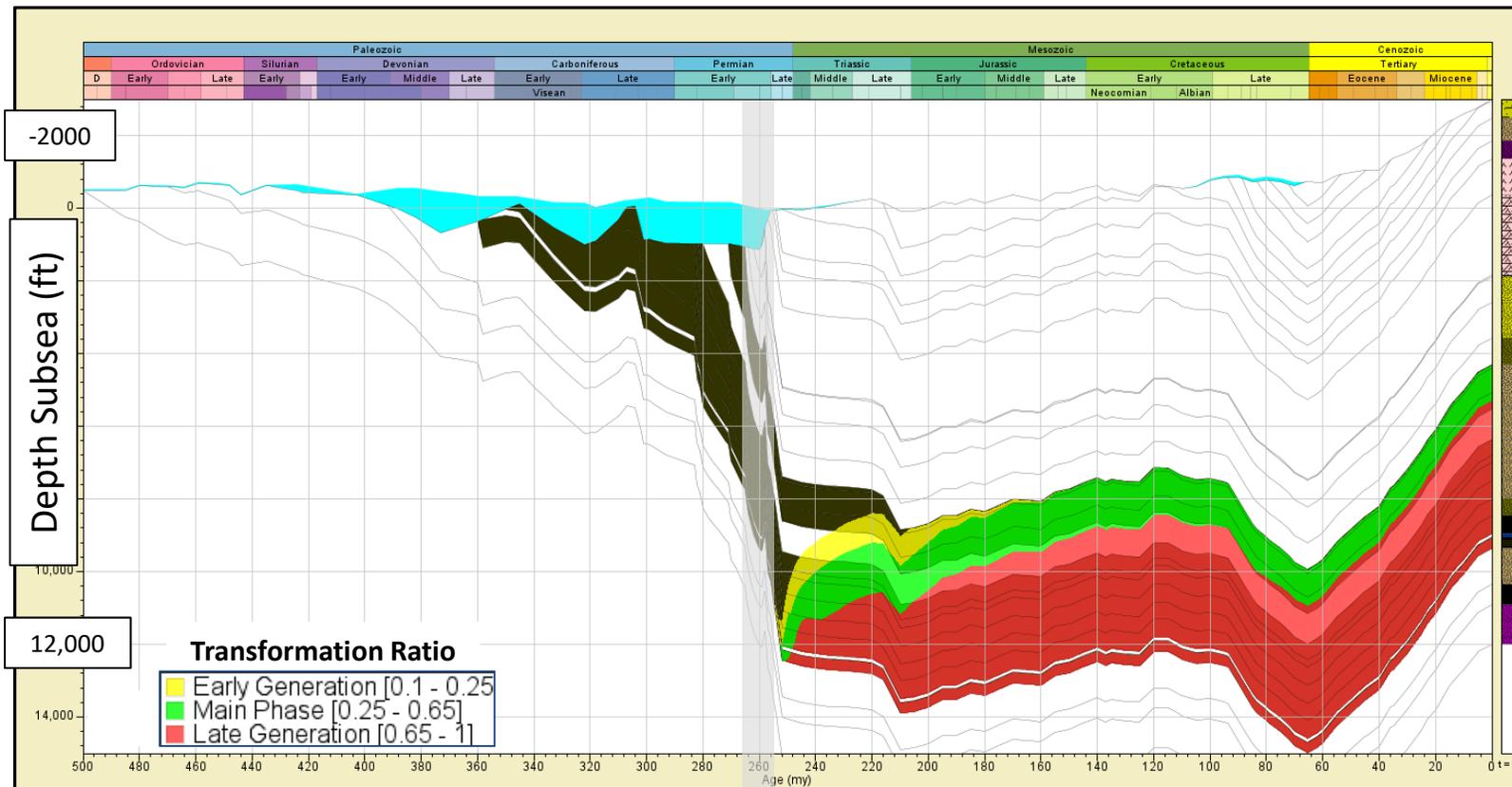
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Paleogeography



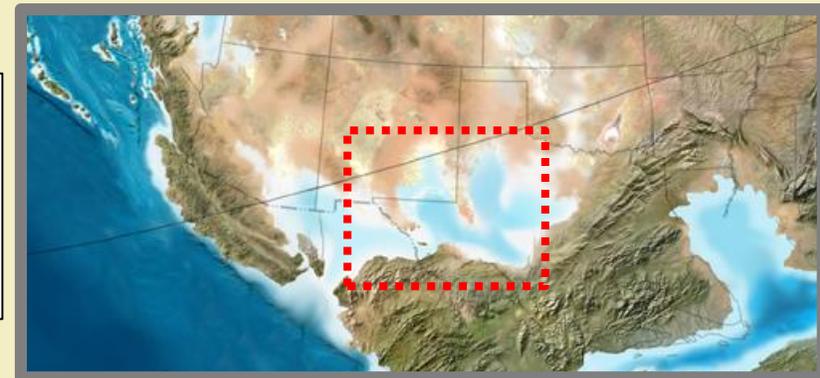
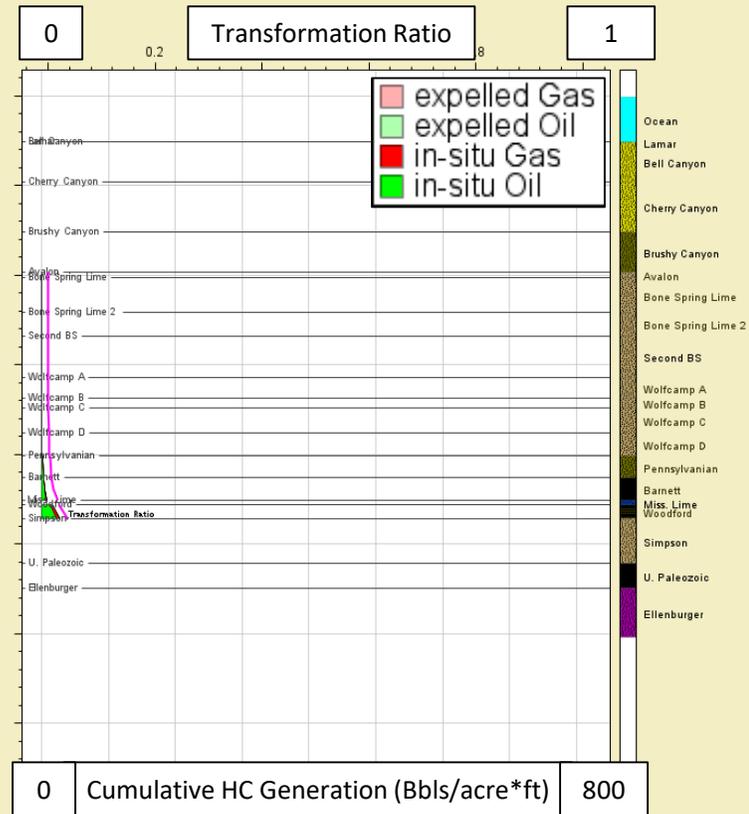
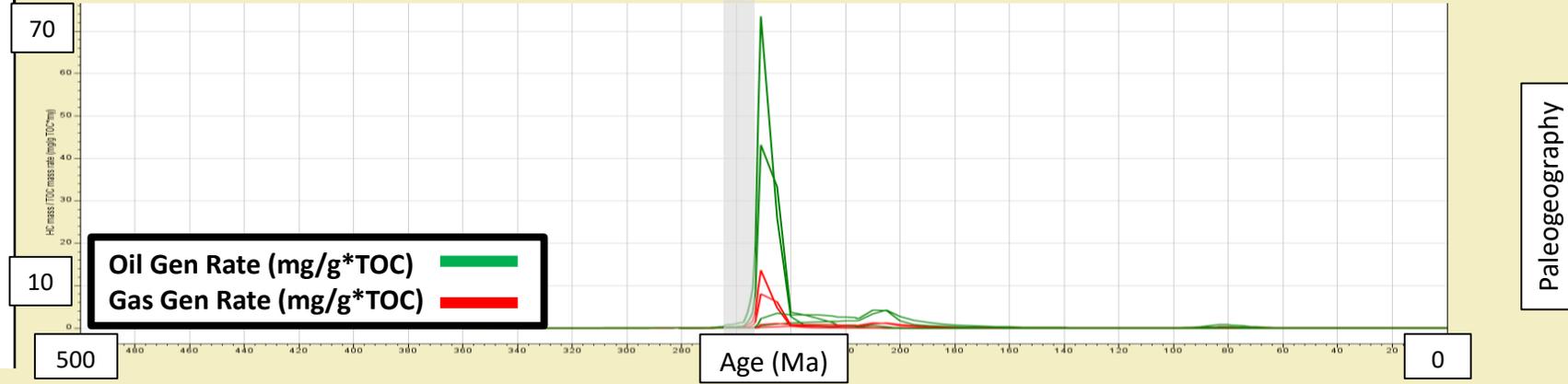
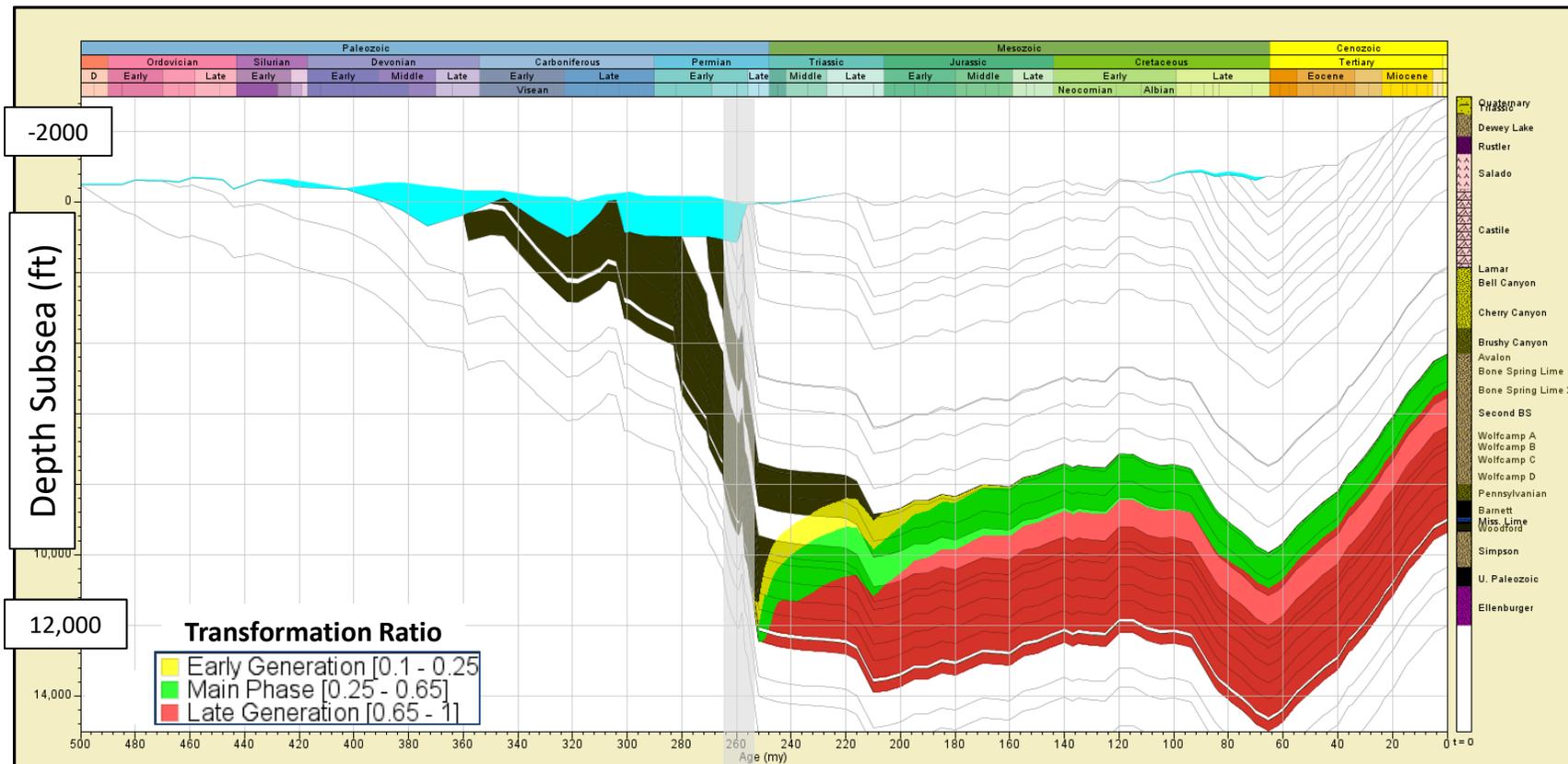
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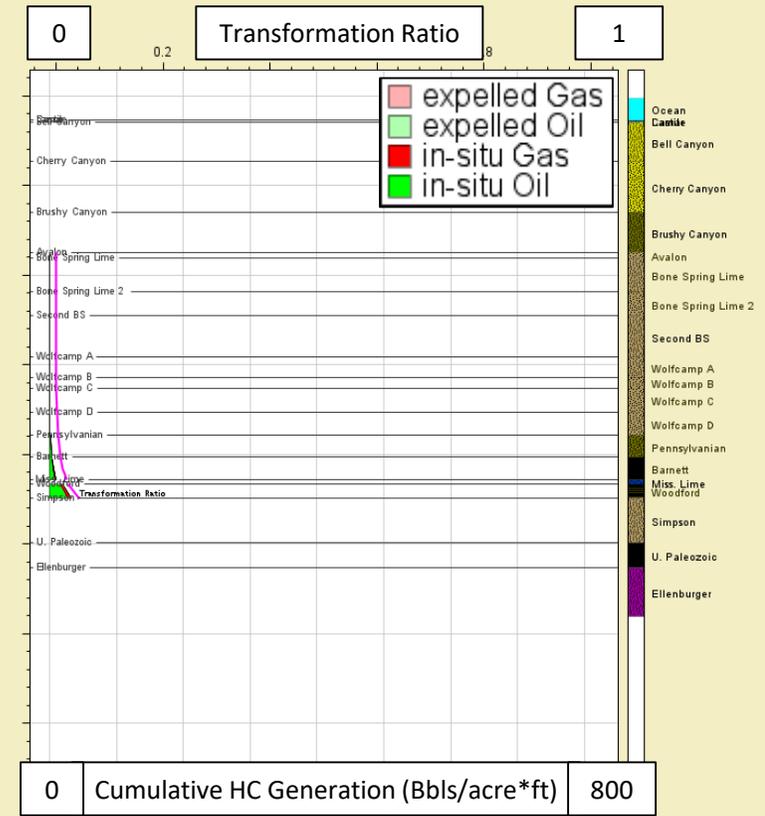
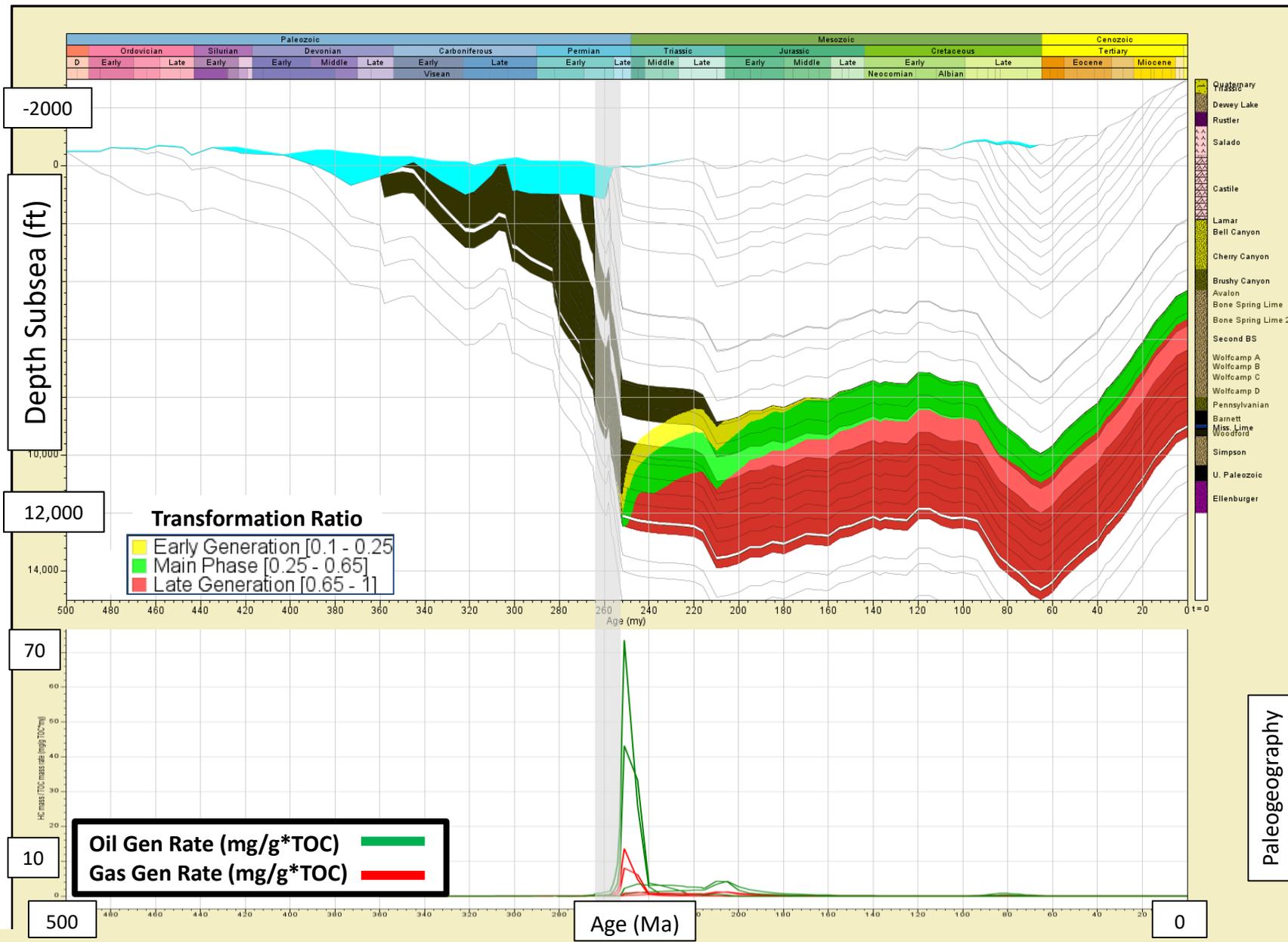
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Time lapse of generation



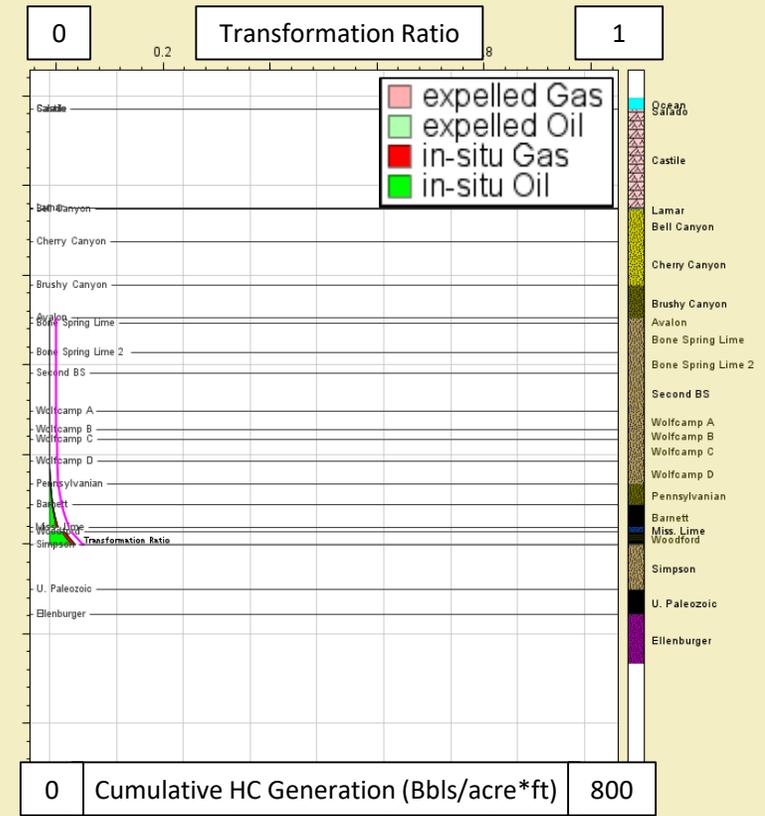
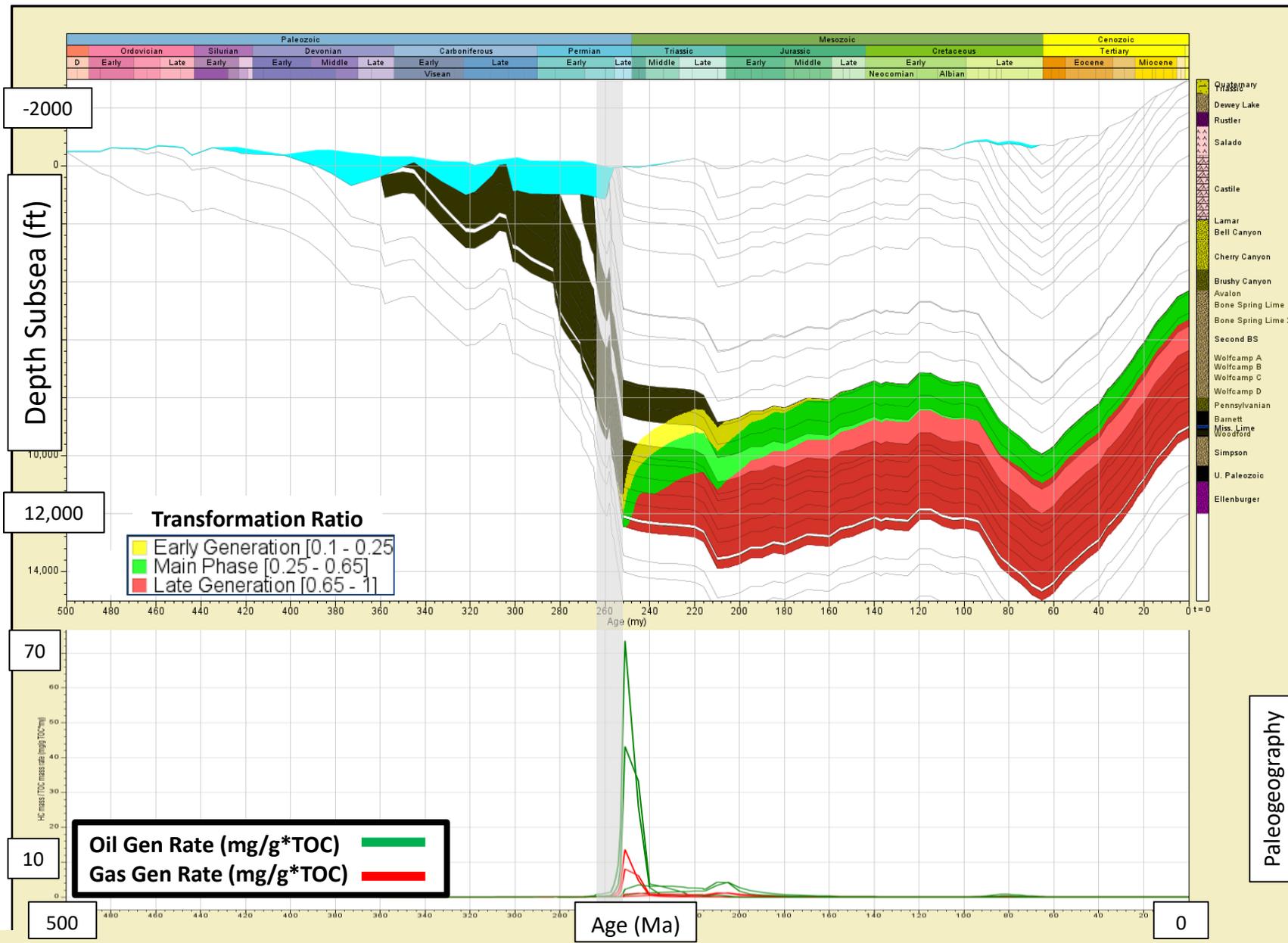
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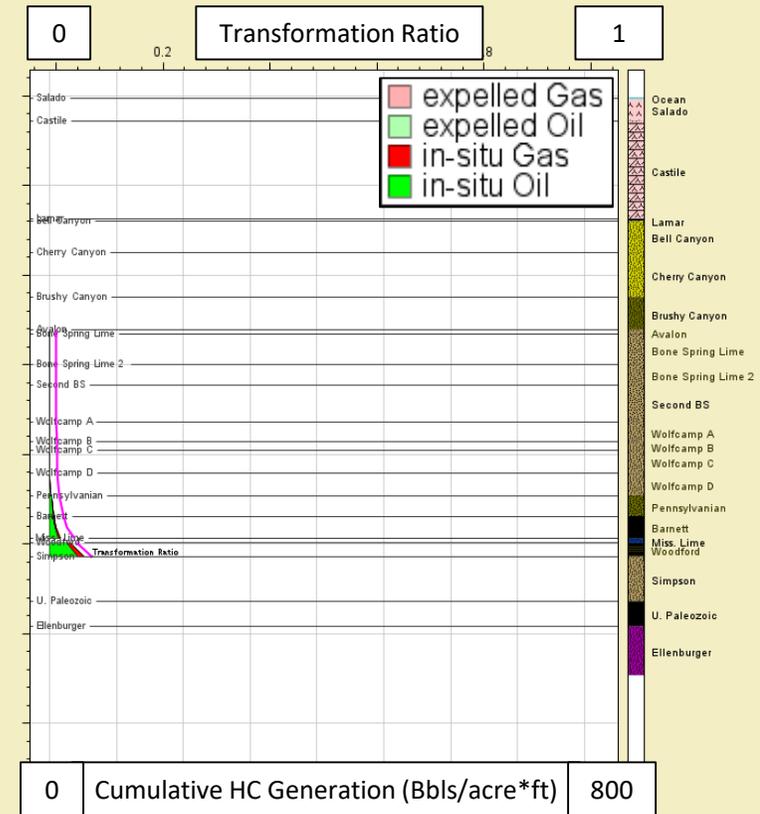
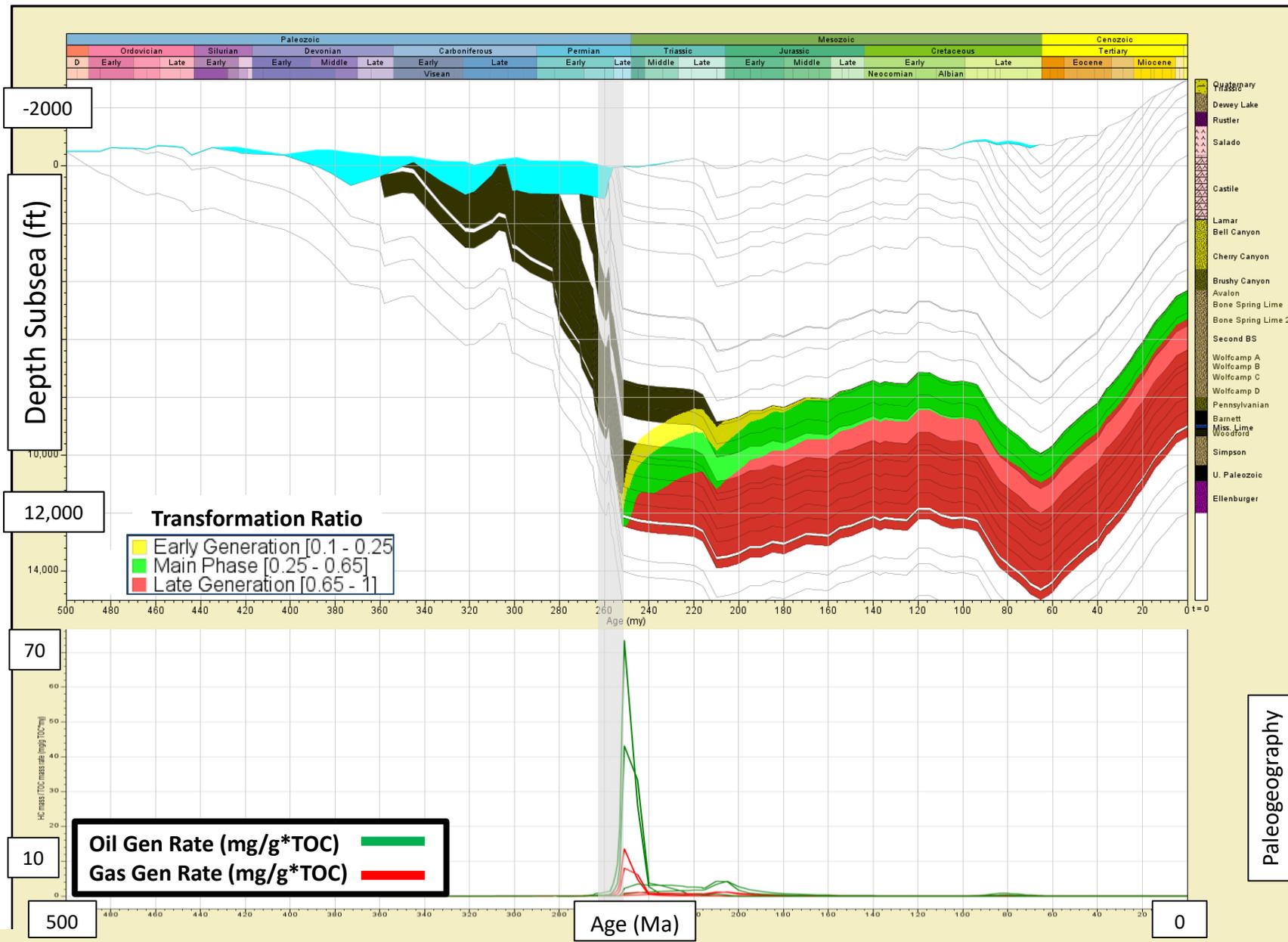
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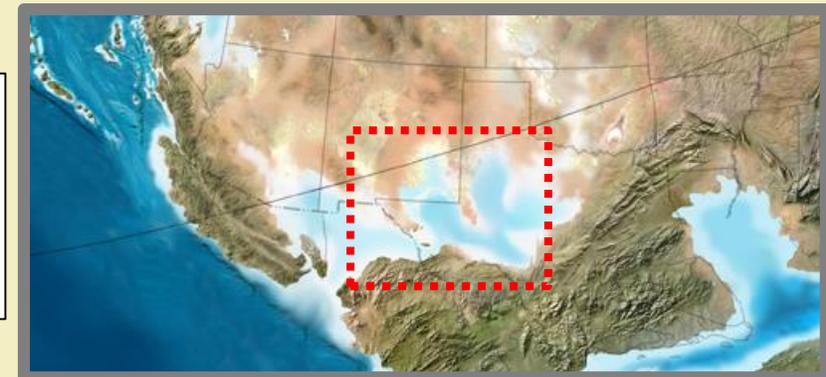
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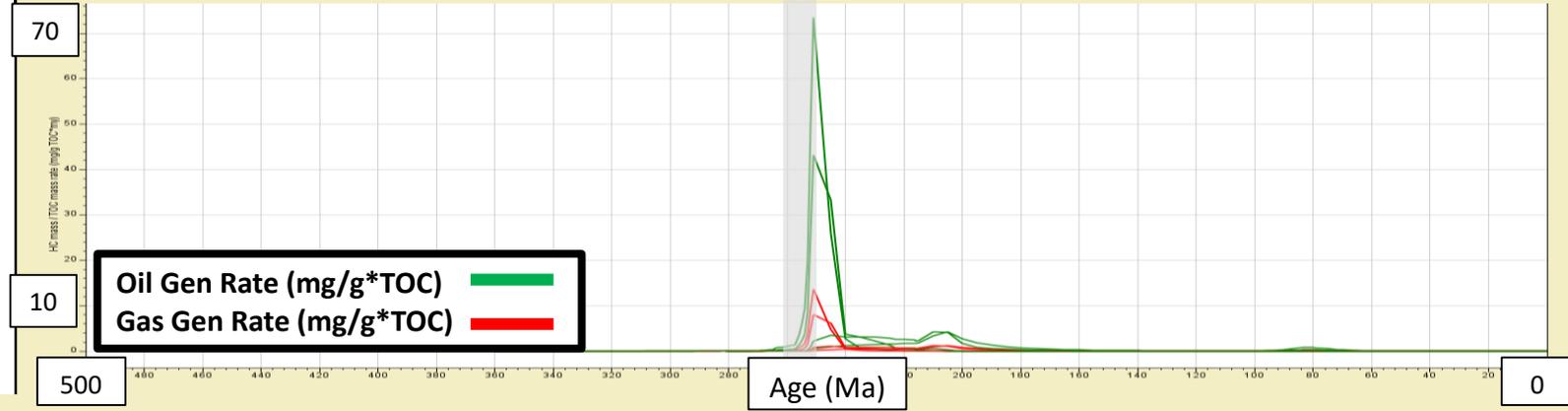
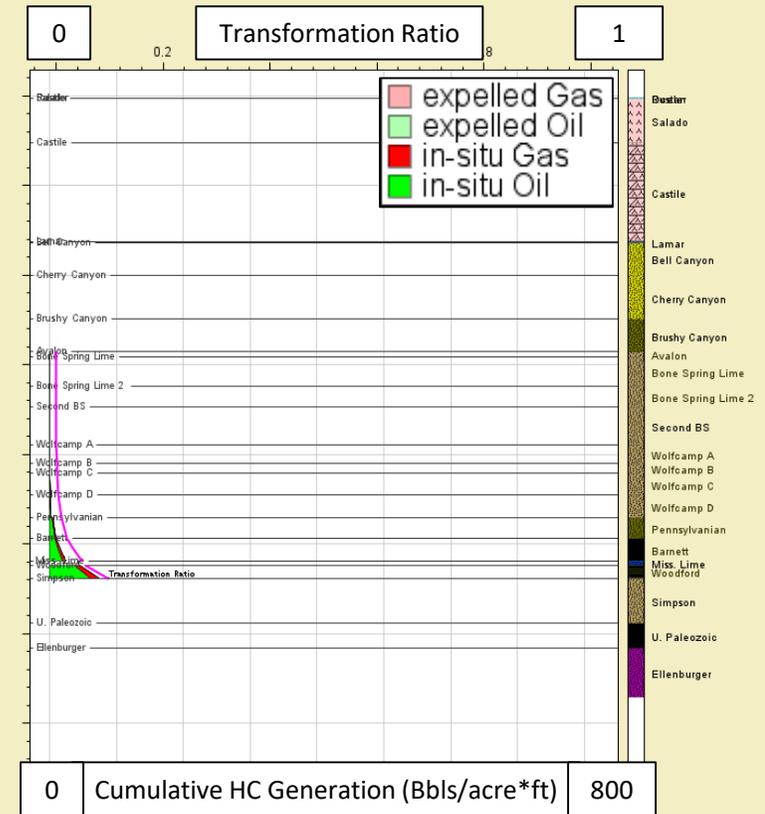
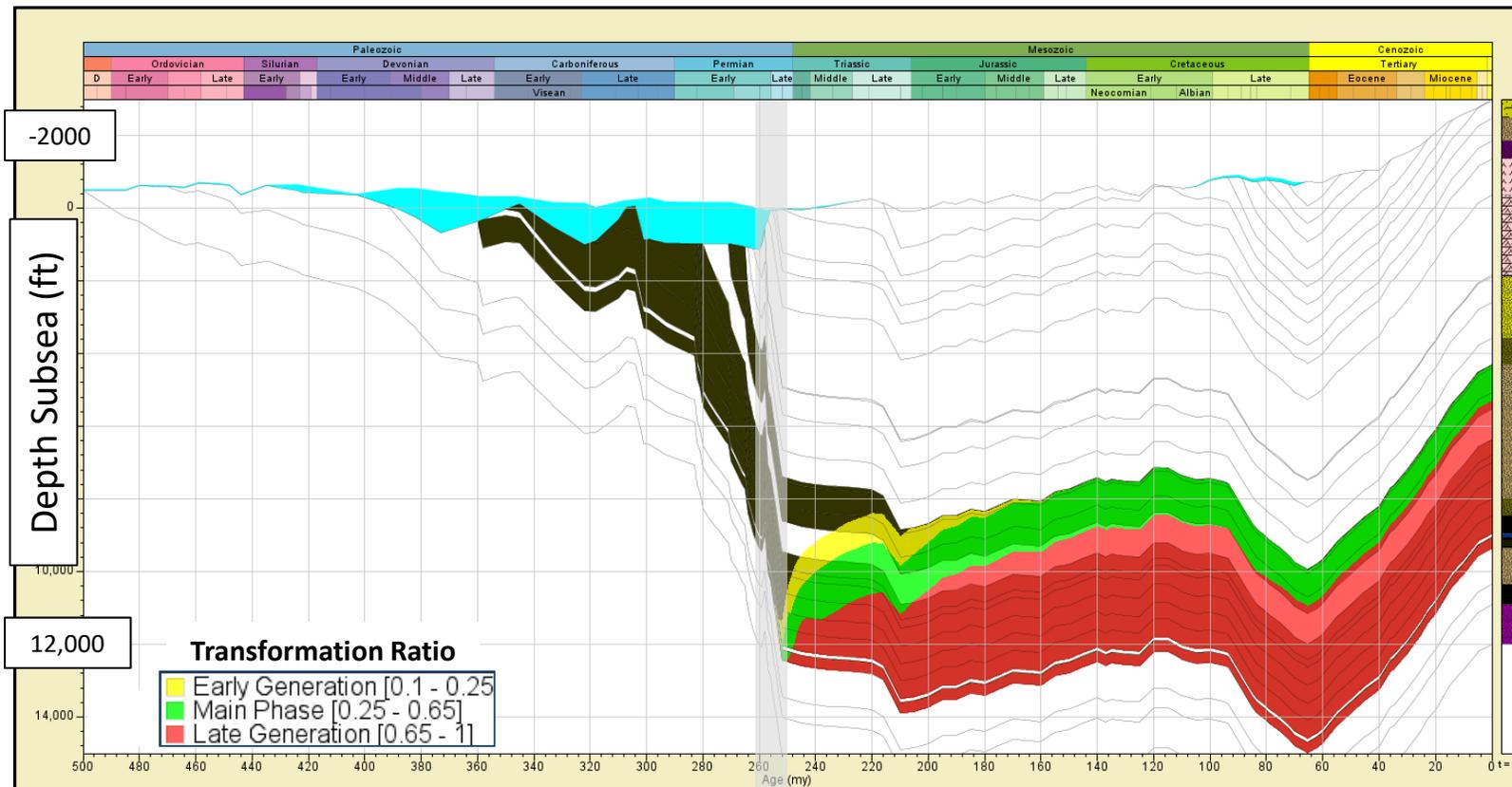
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Paleogeography



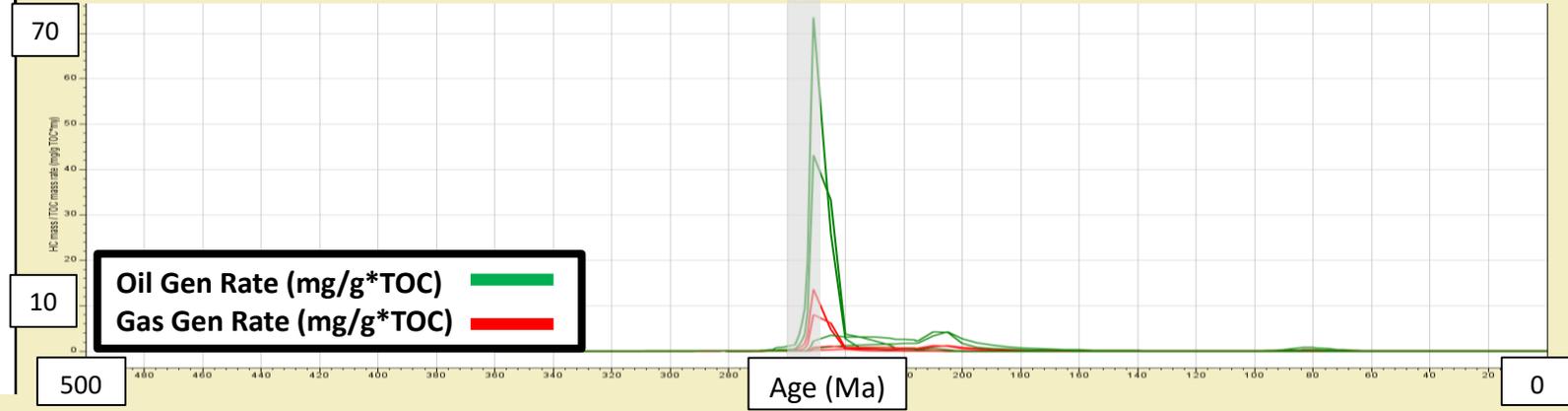
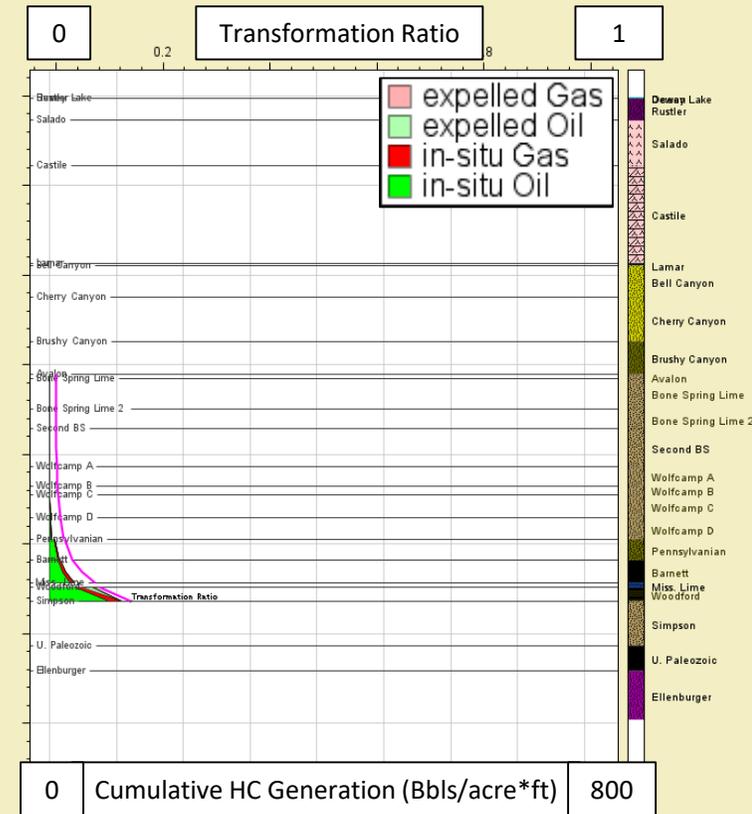
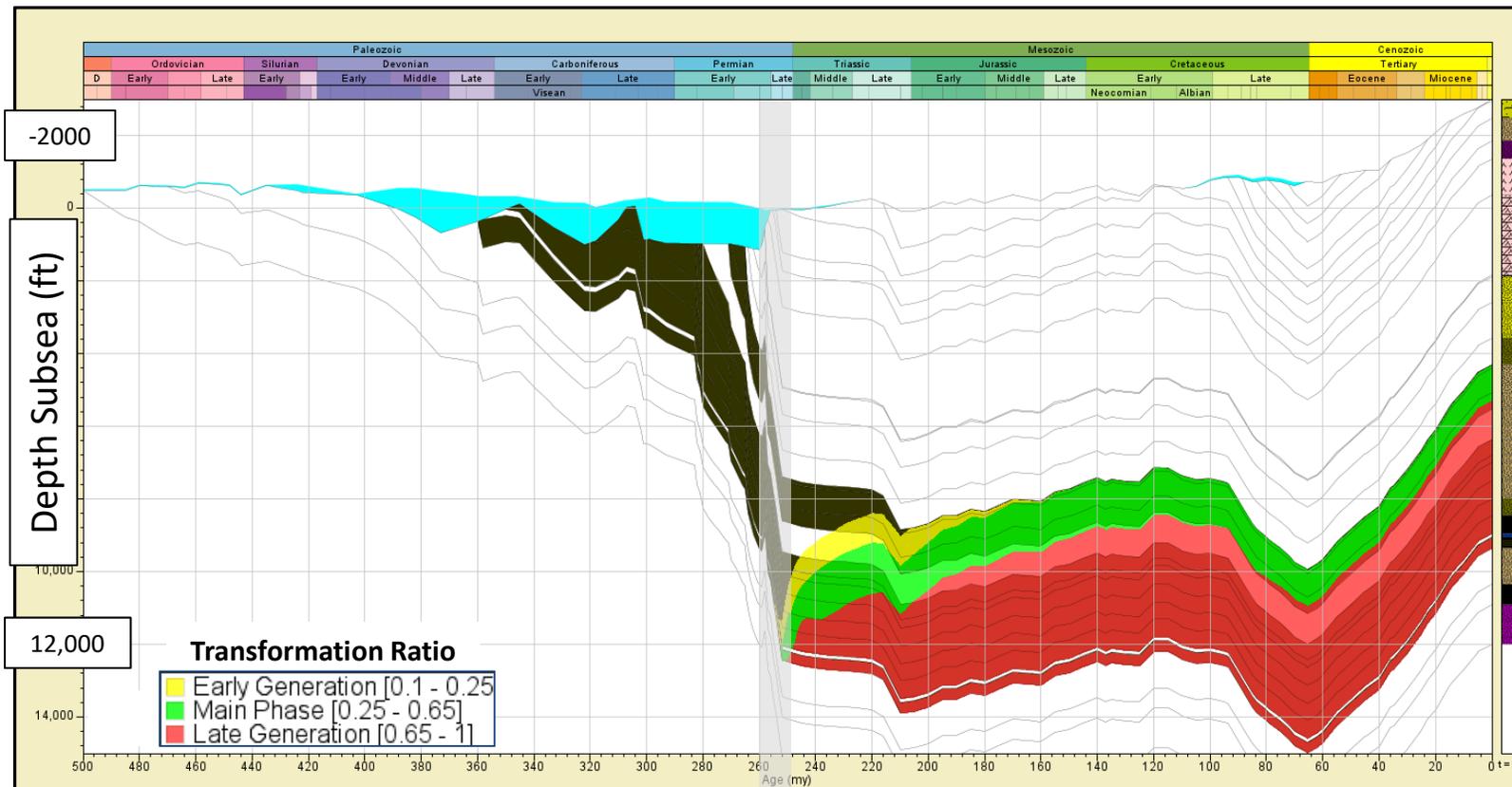
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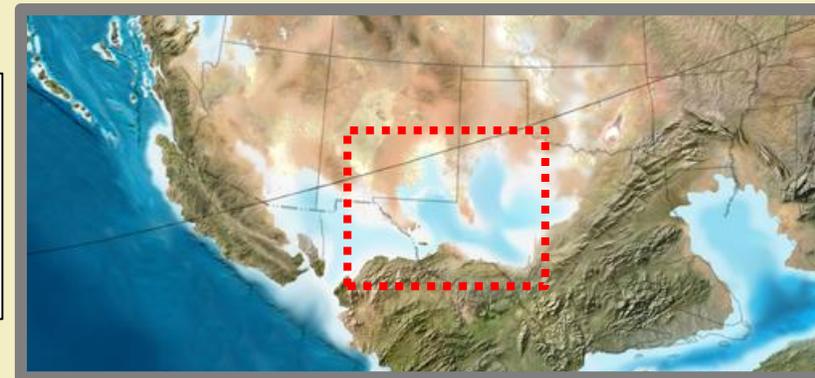
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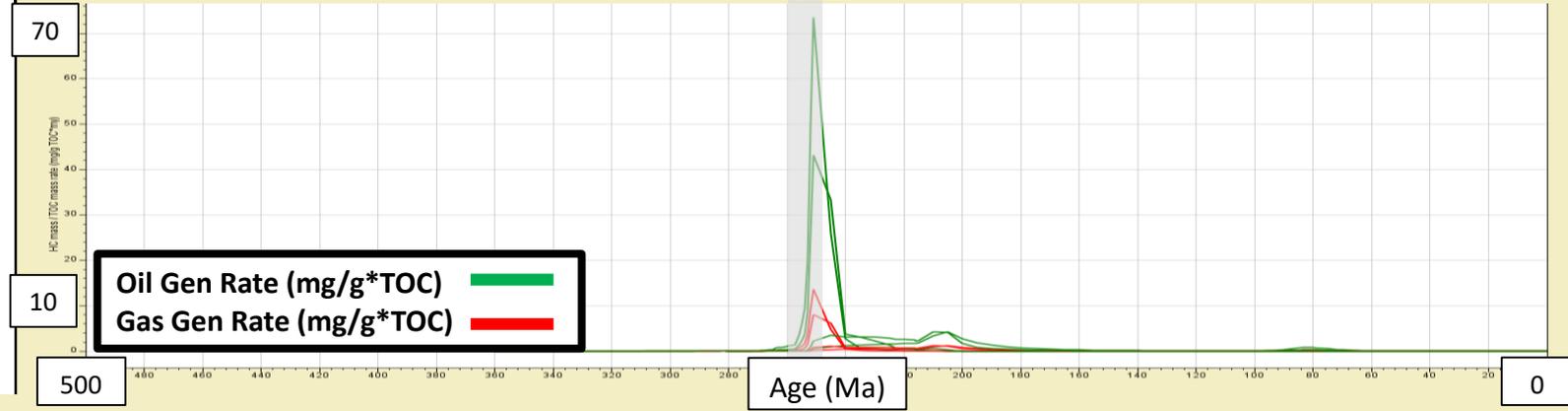
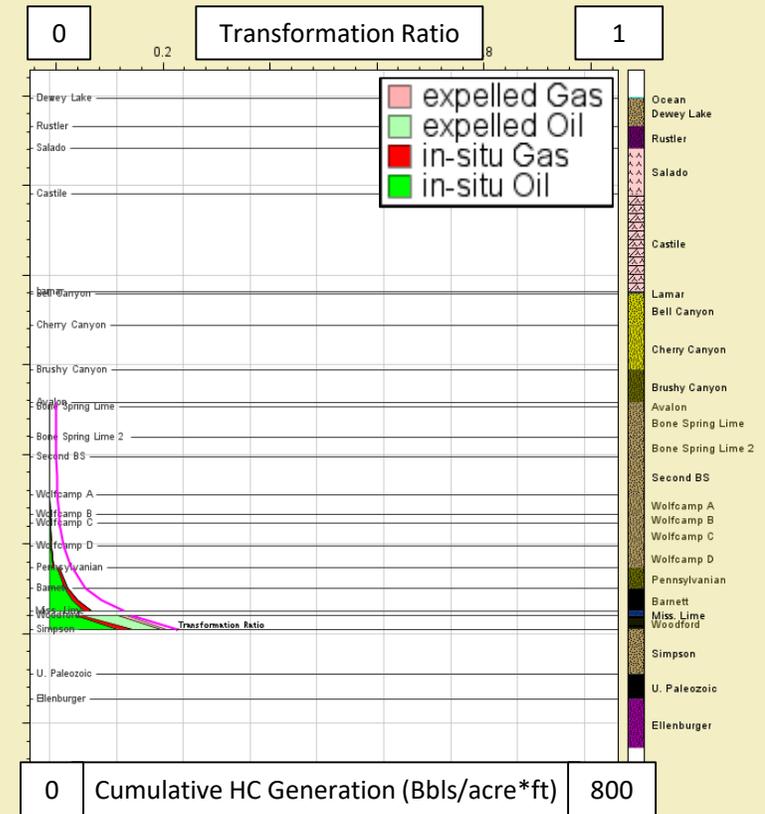
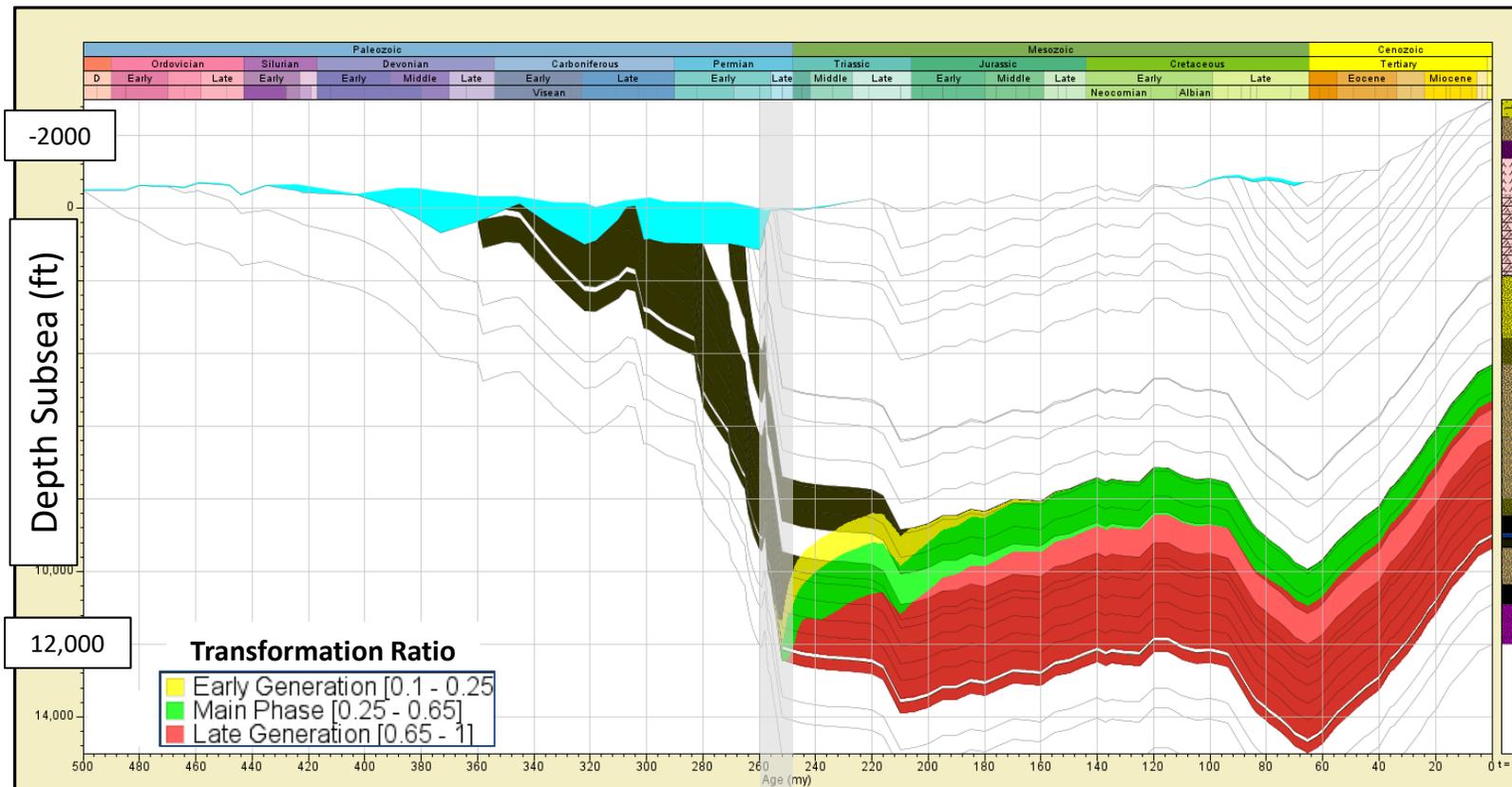
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Paleogeography



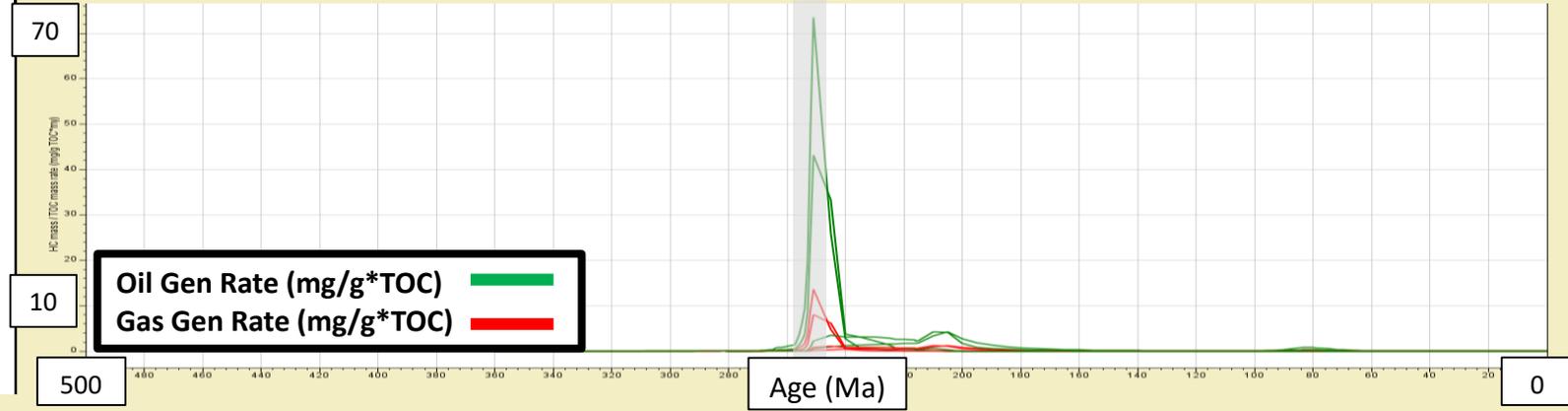
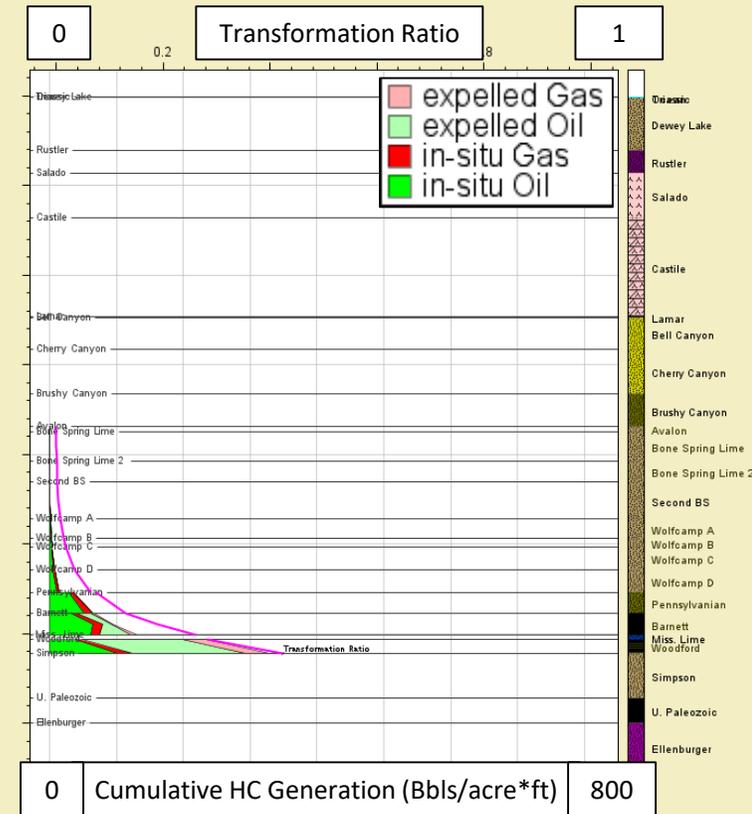
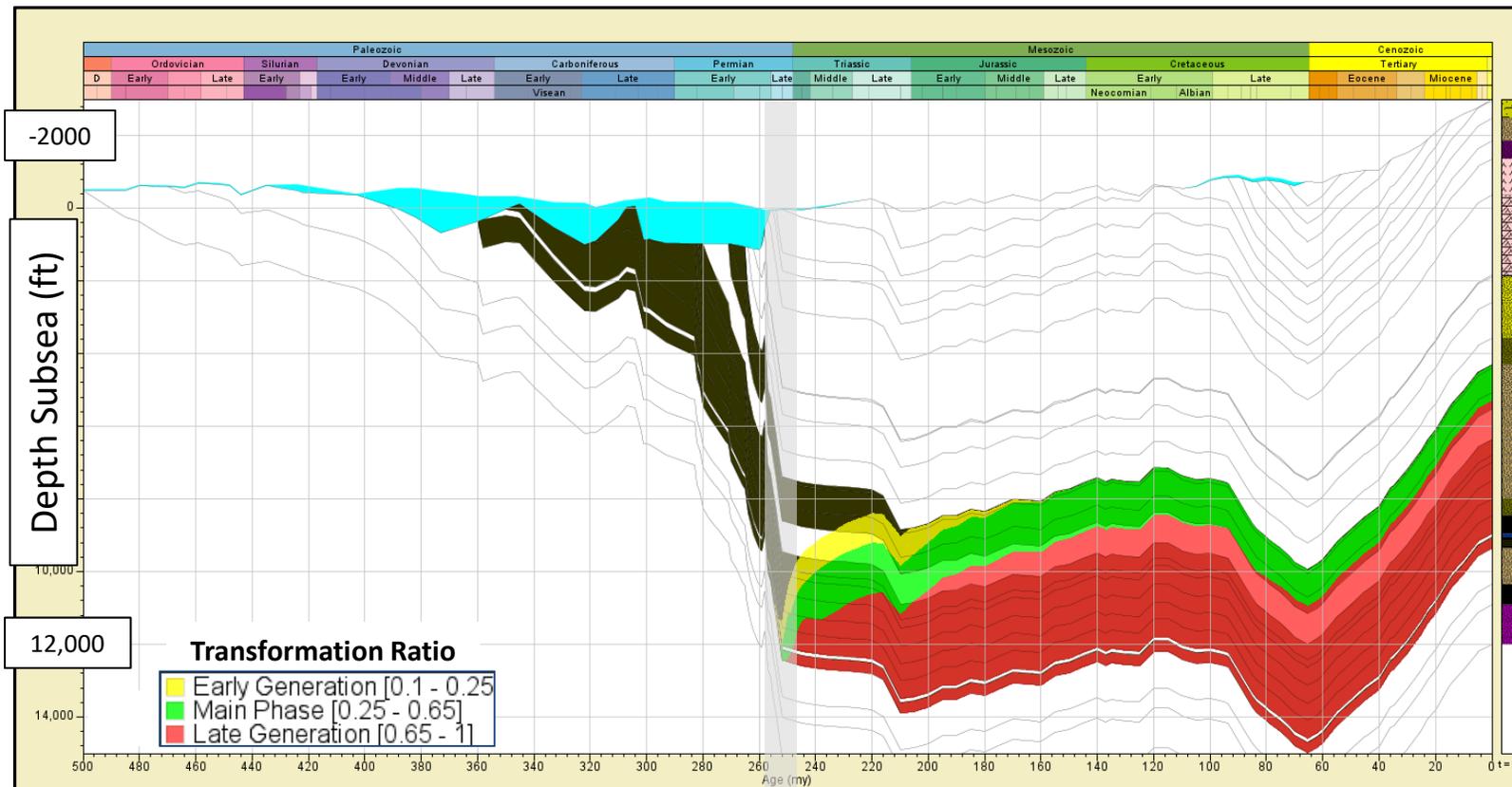
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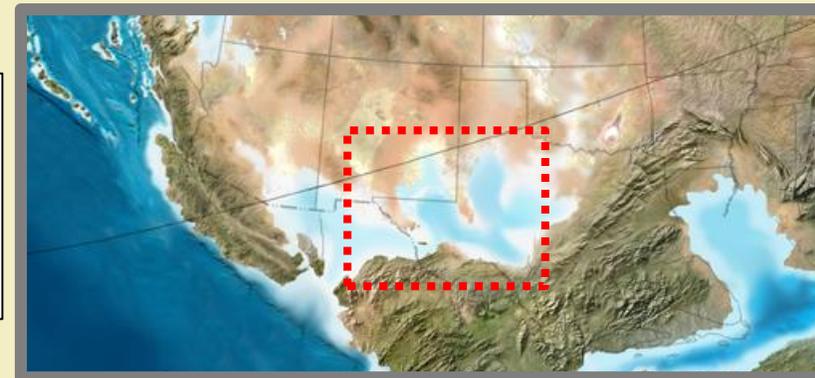
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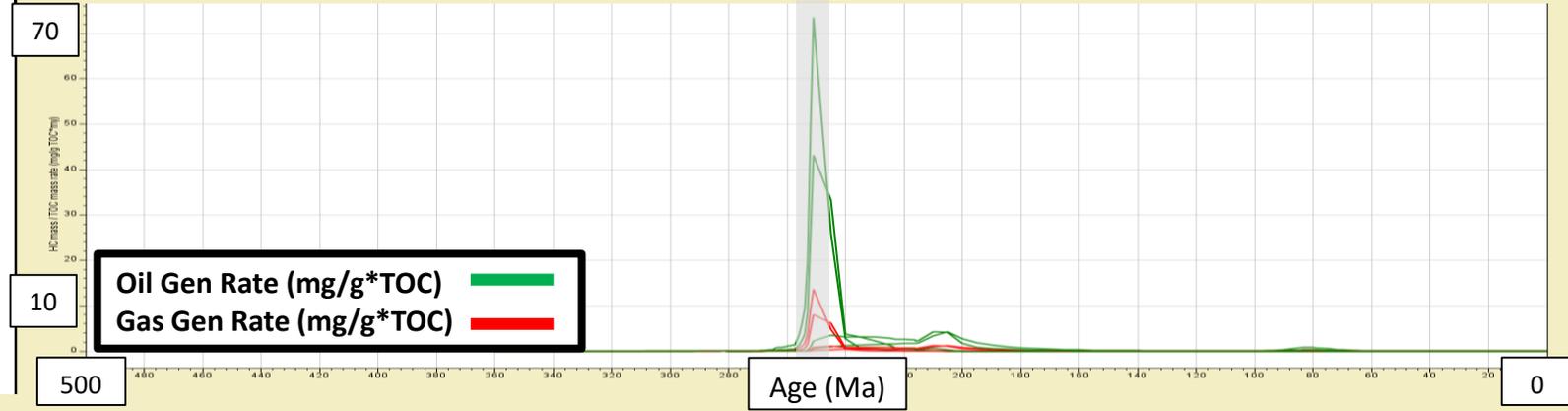
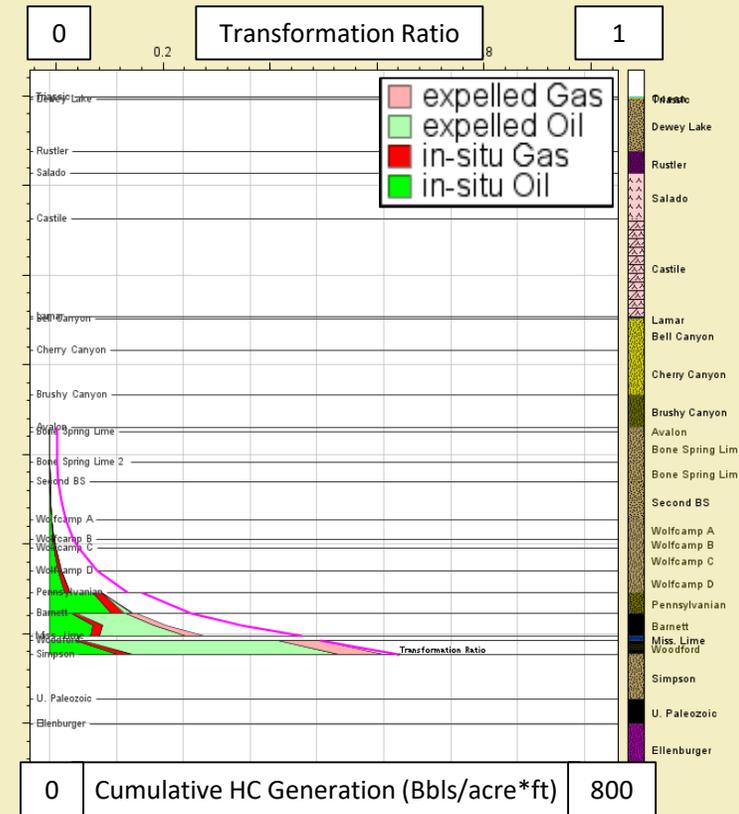
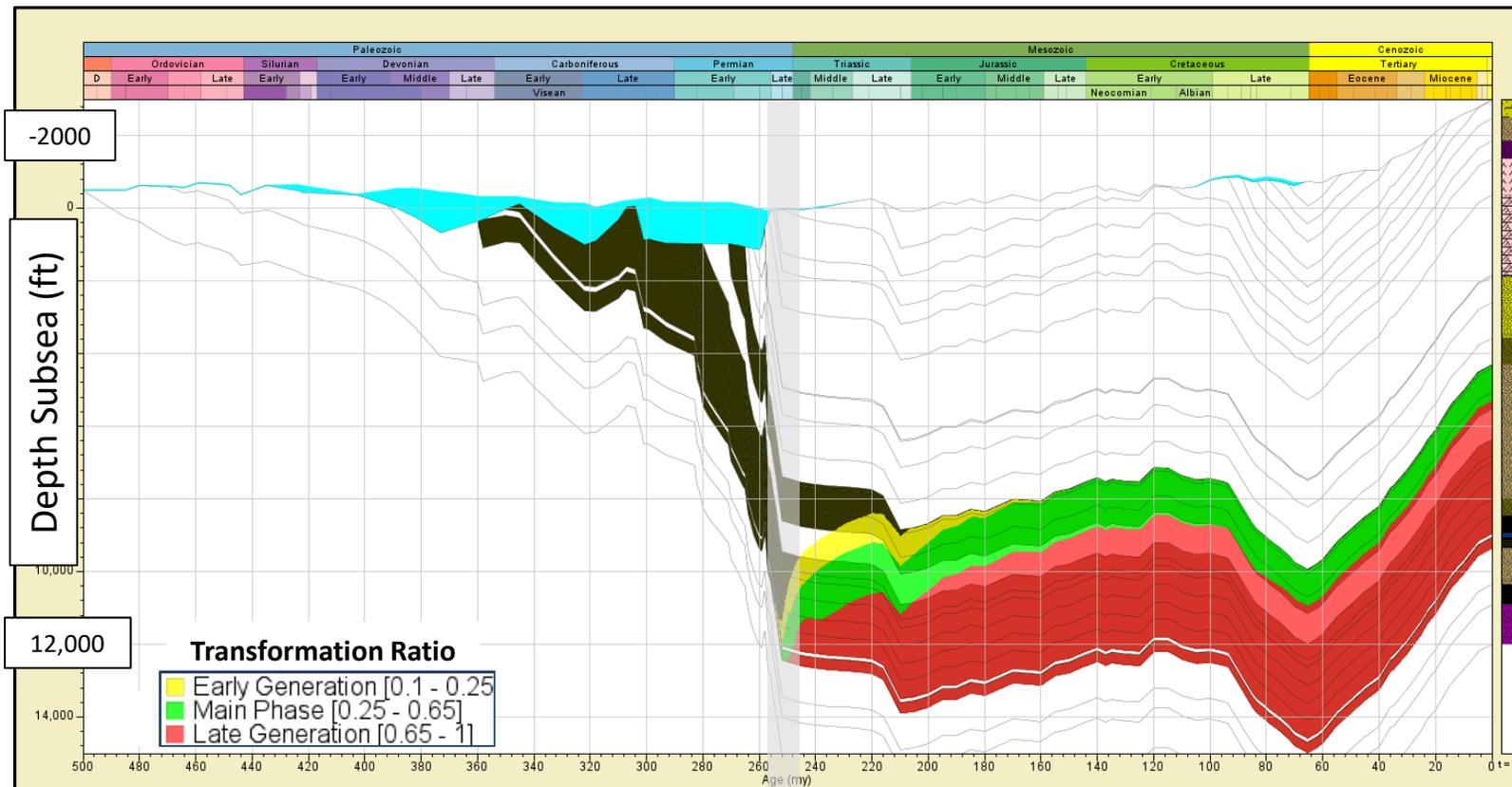
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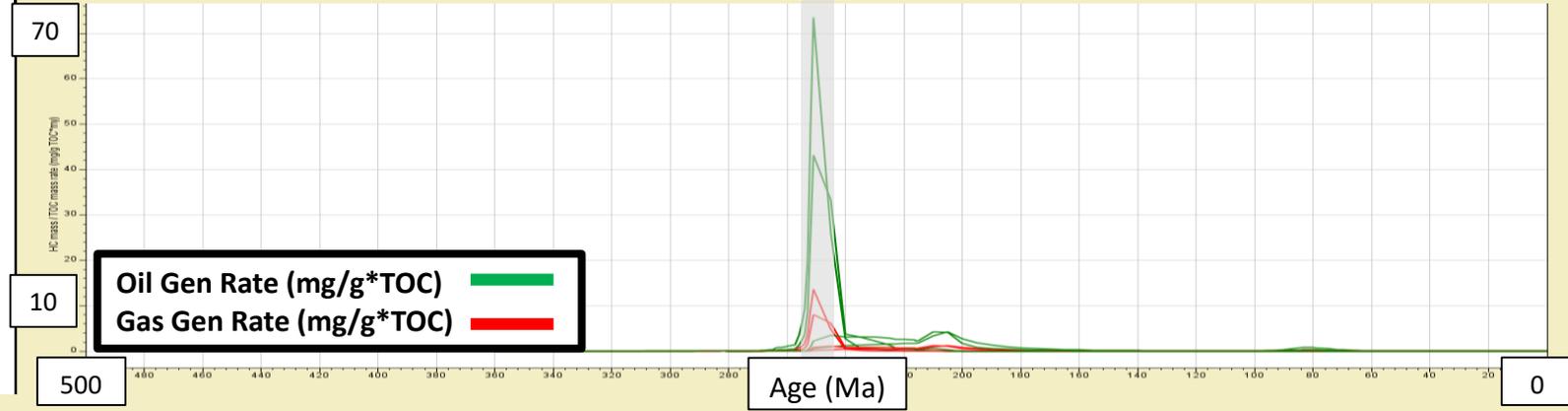
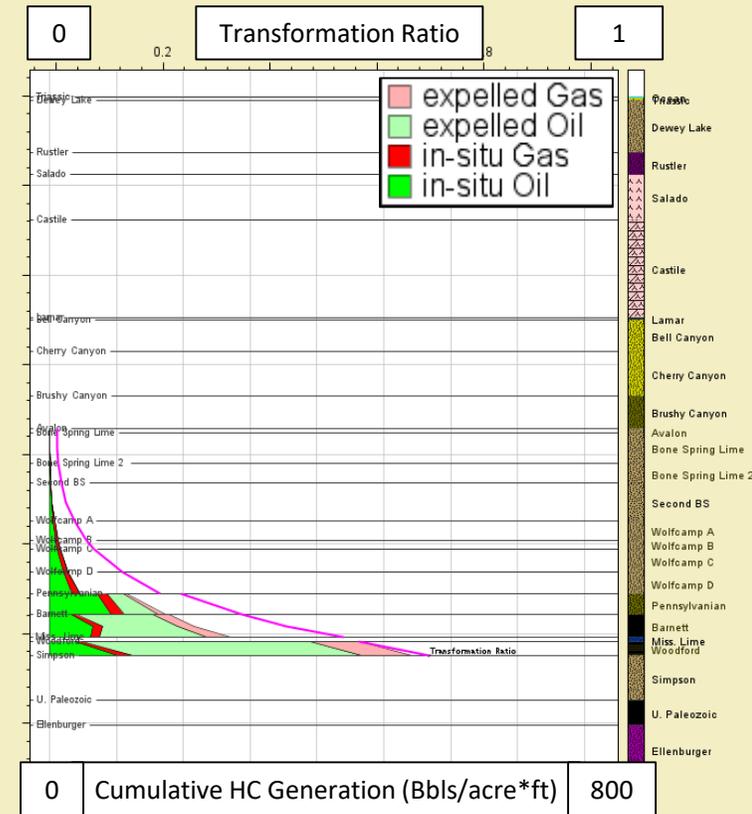
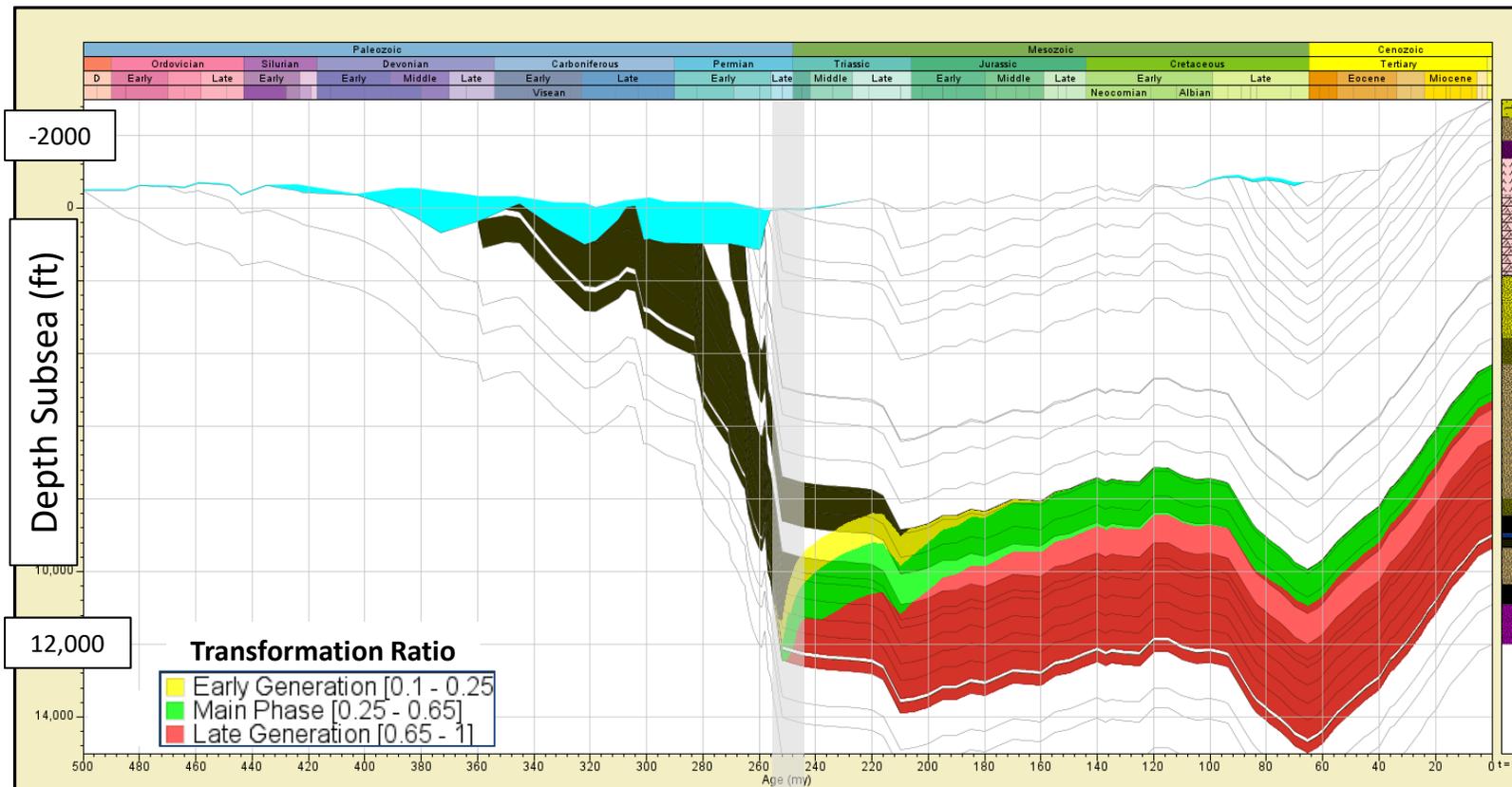
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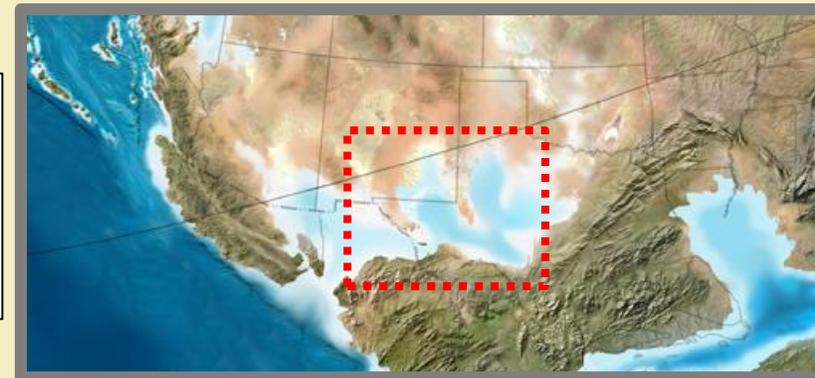
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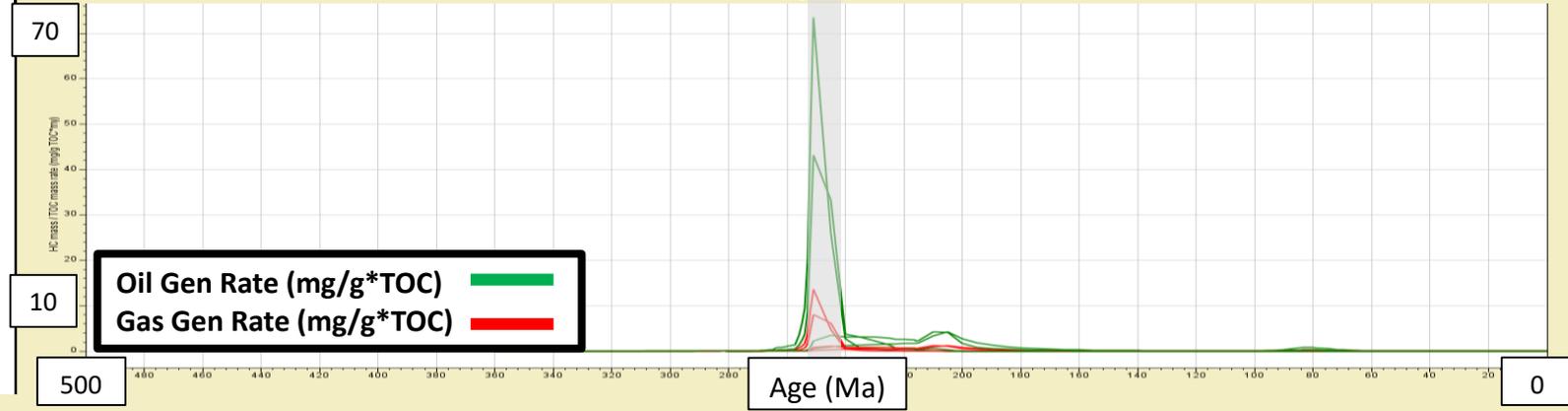
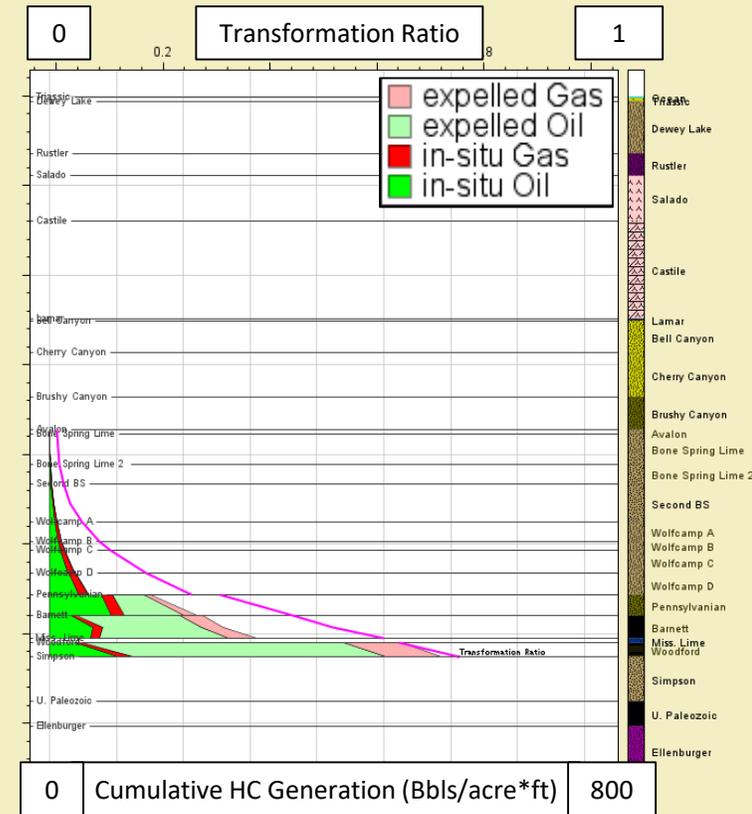
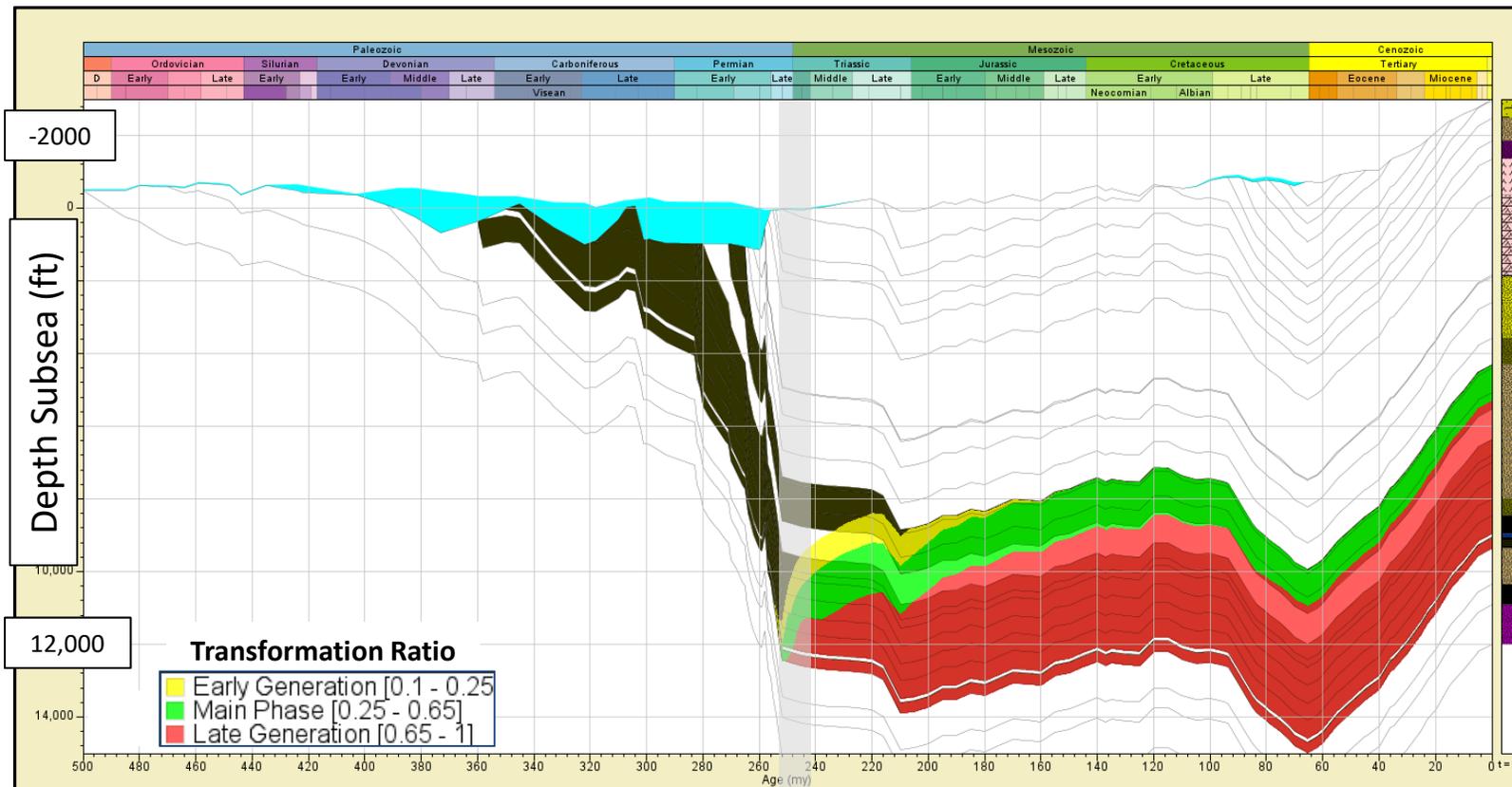
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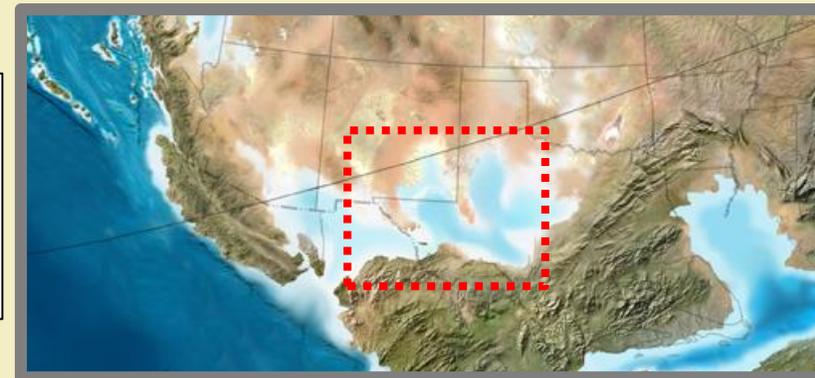
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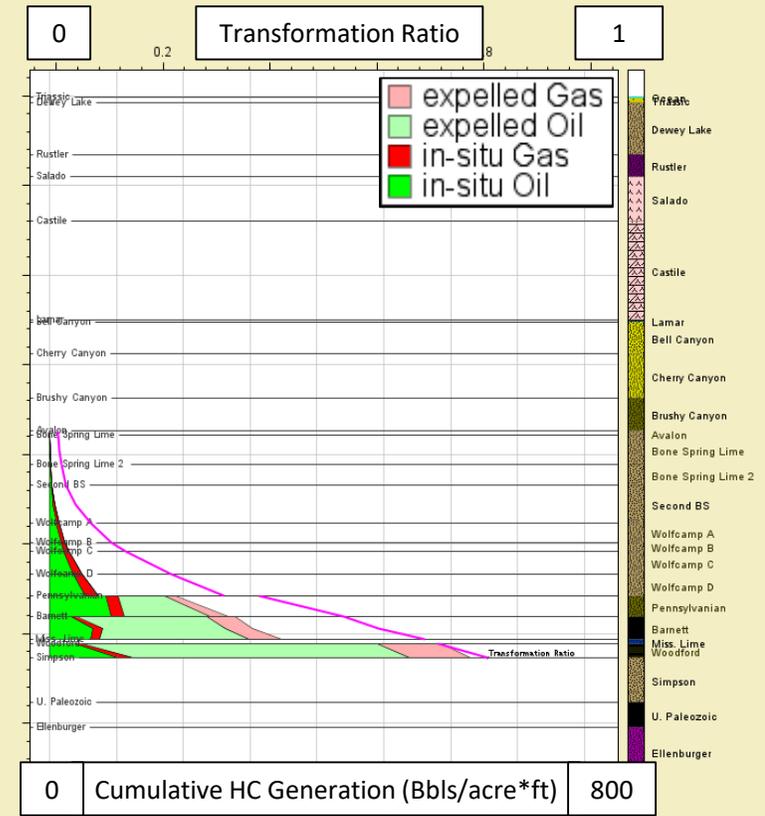
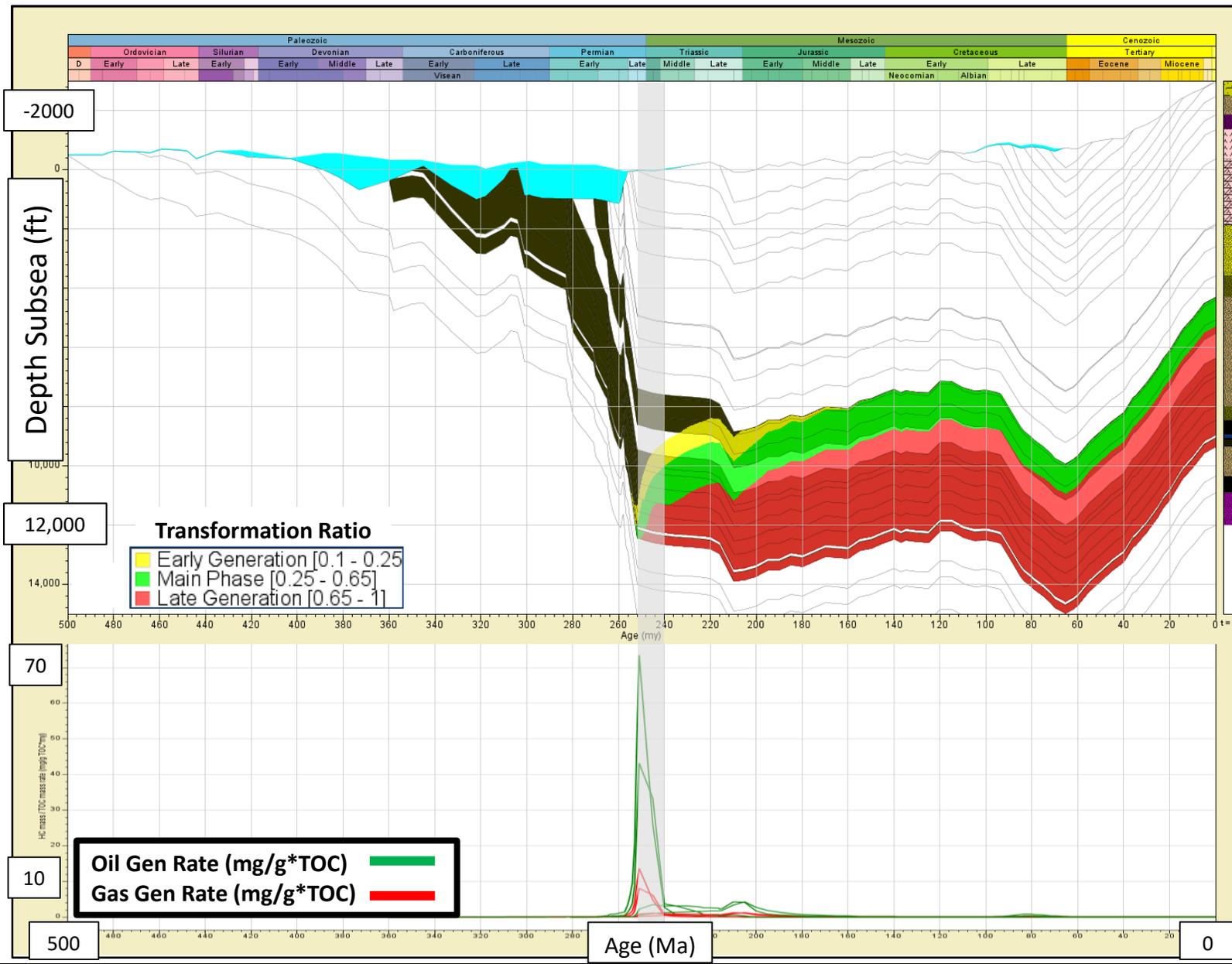
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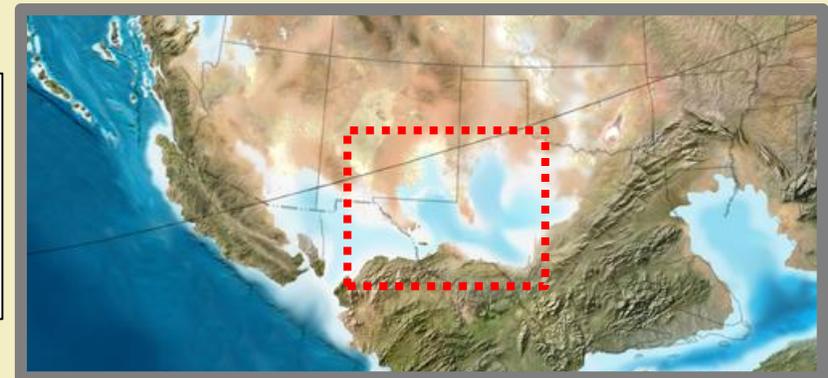
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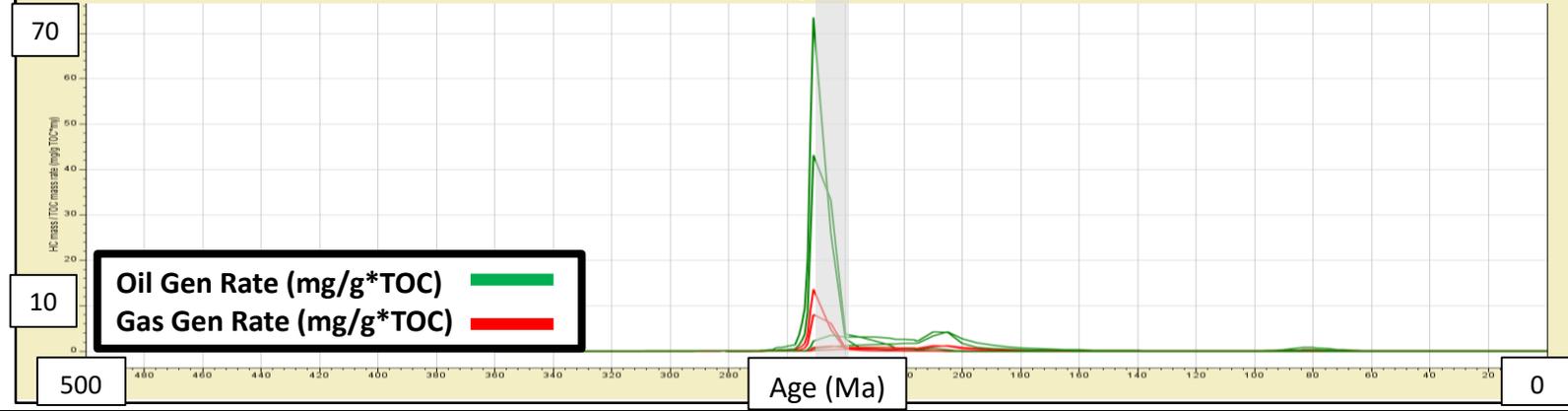
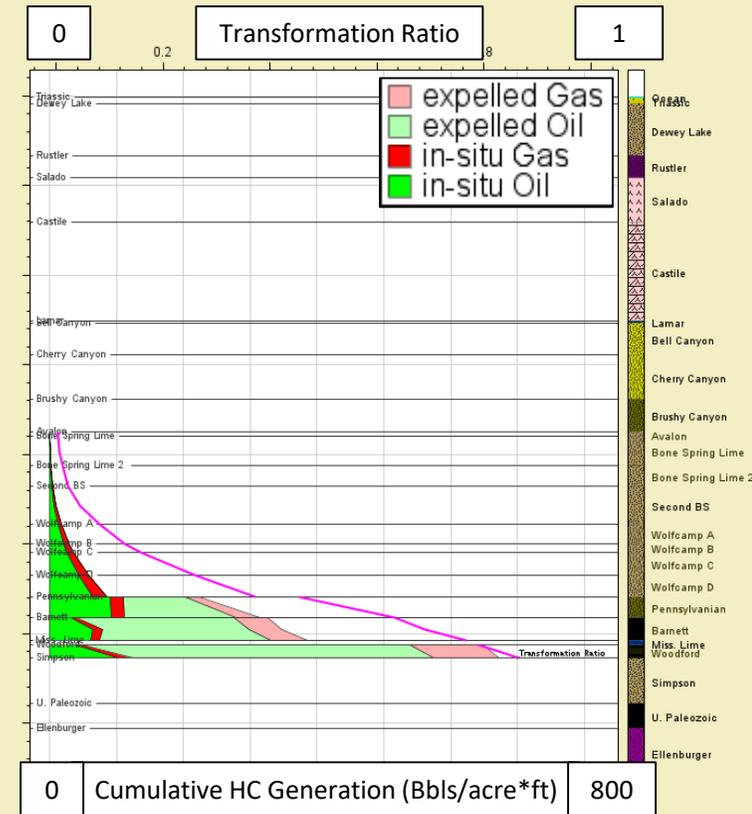
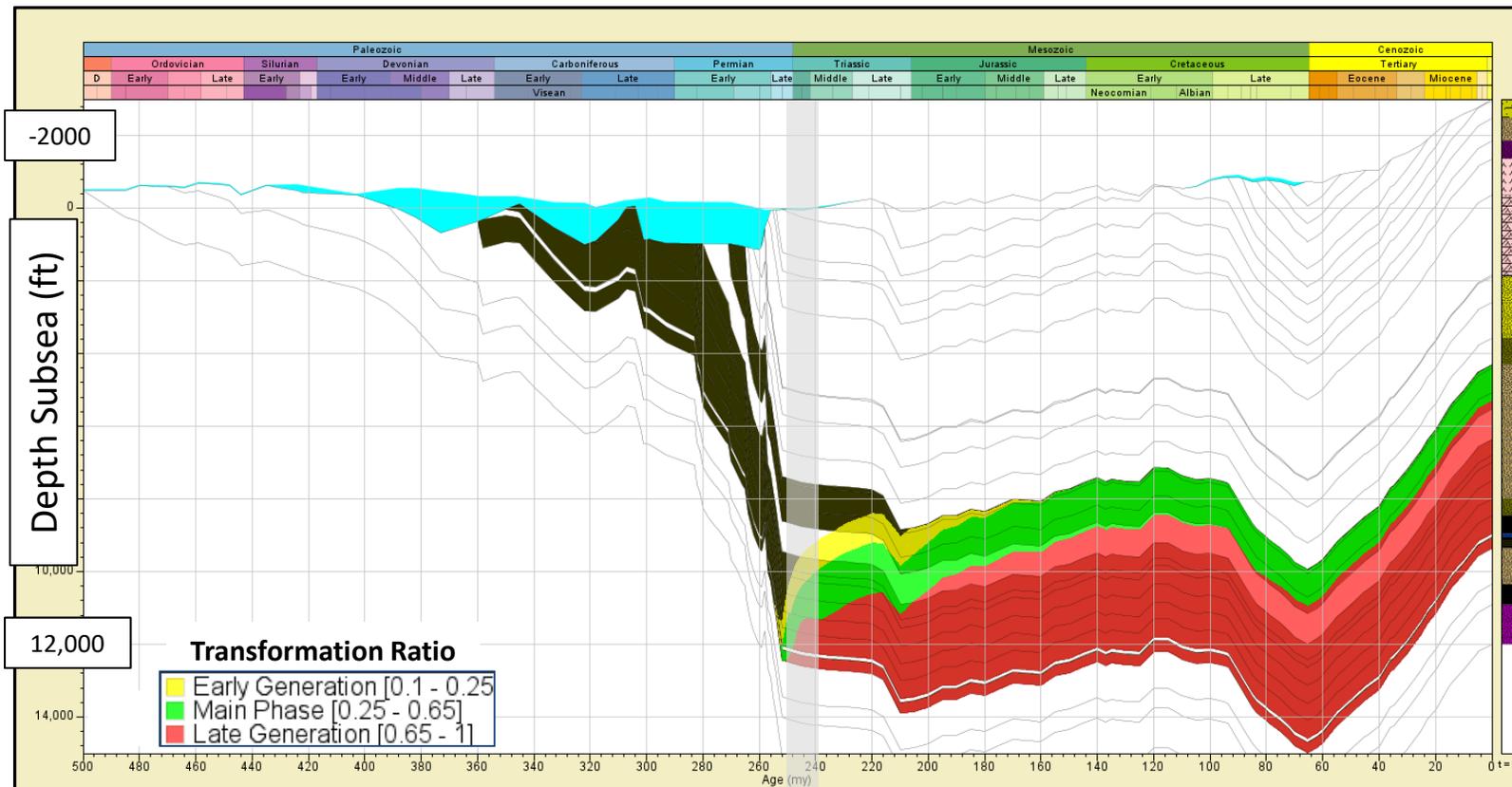
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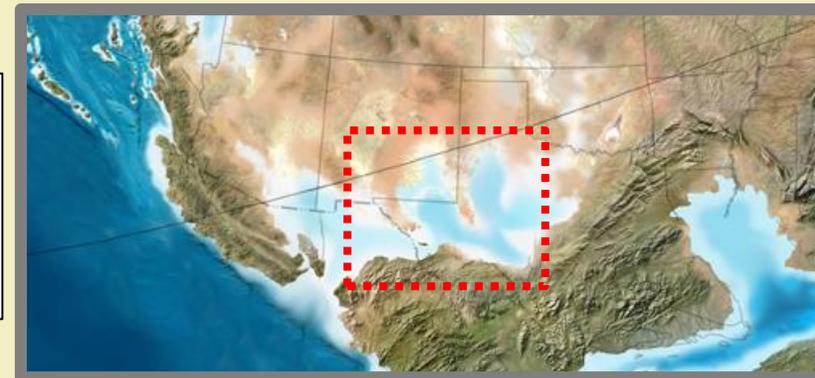
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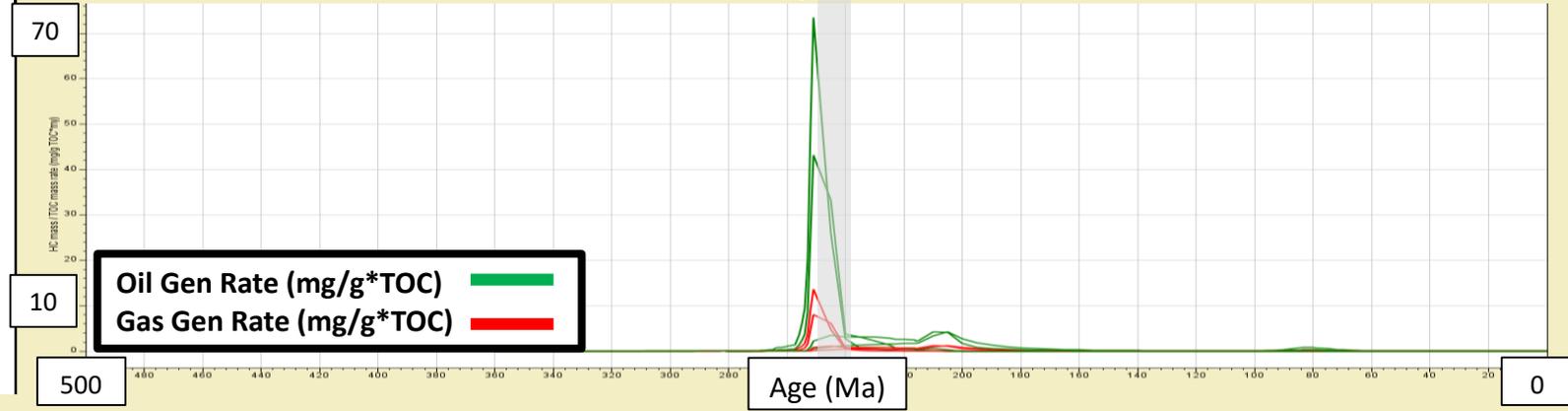
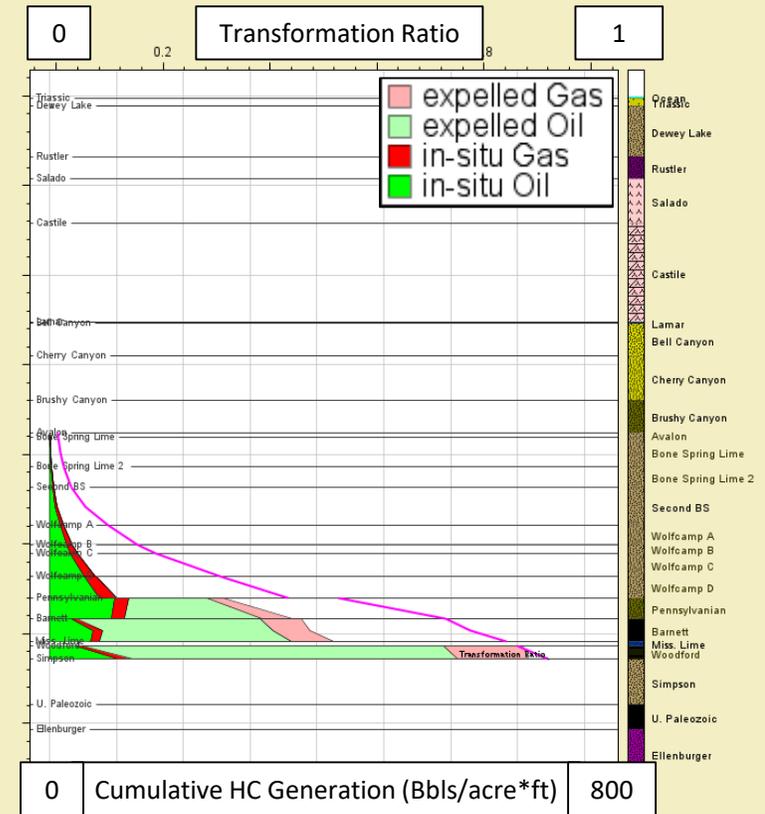
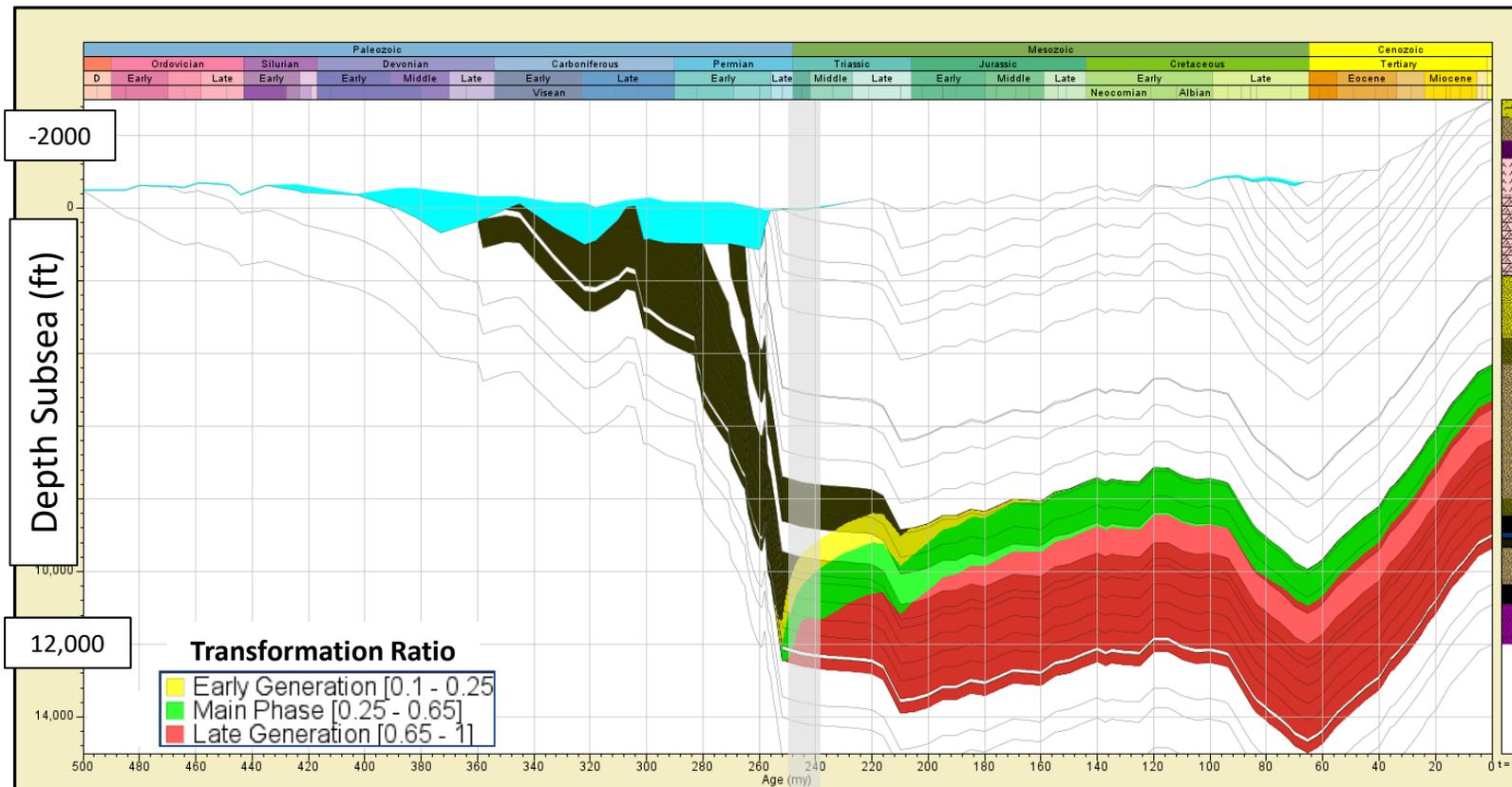
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Paleogeography



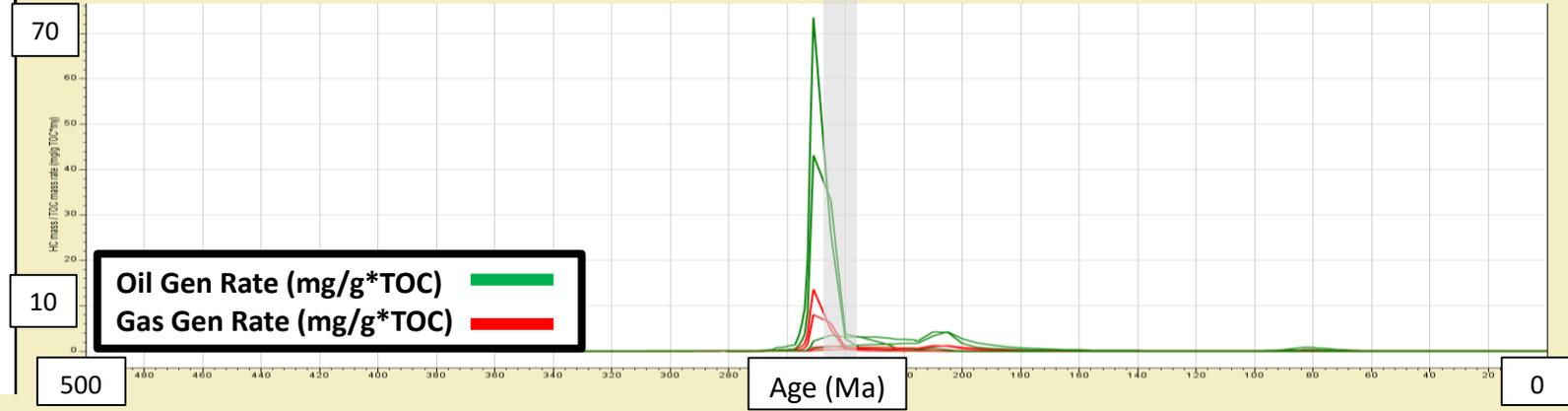
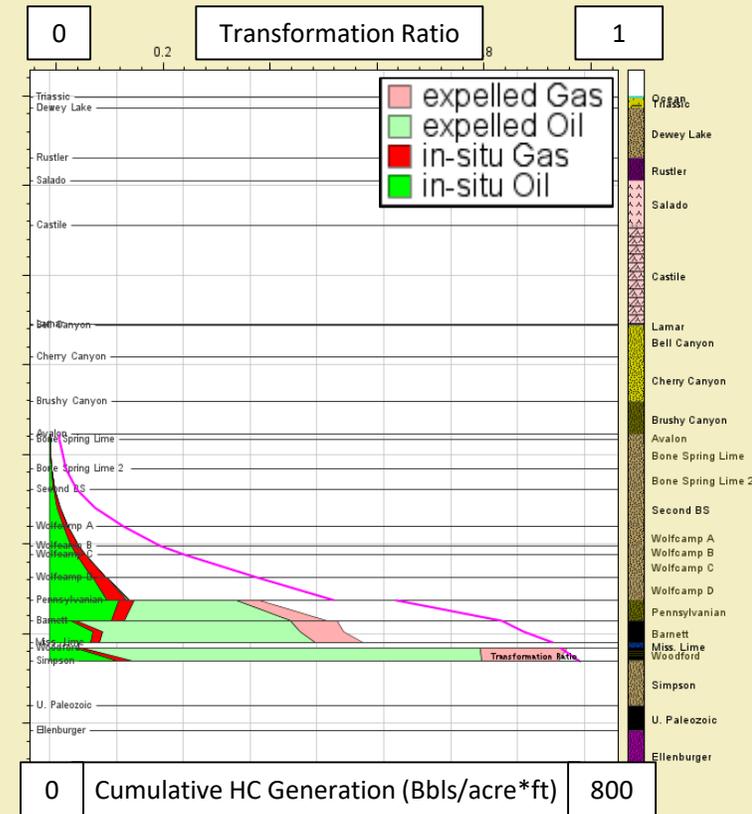
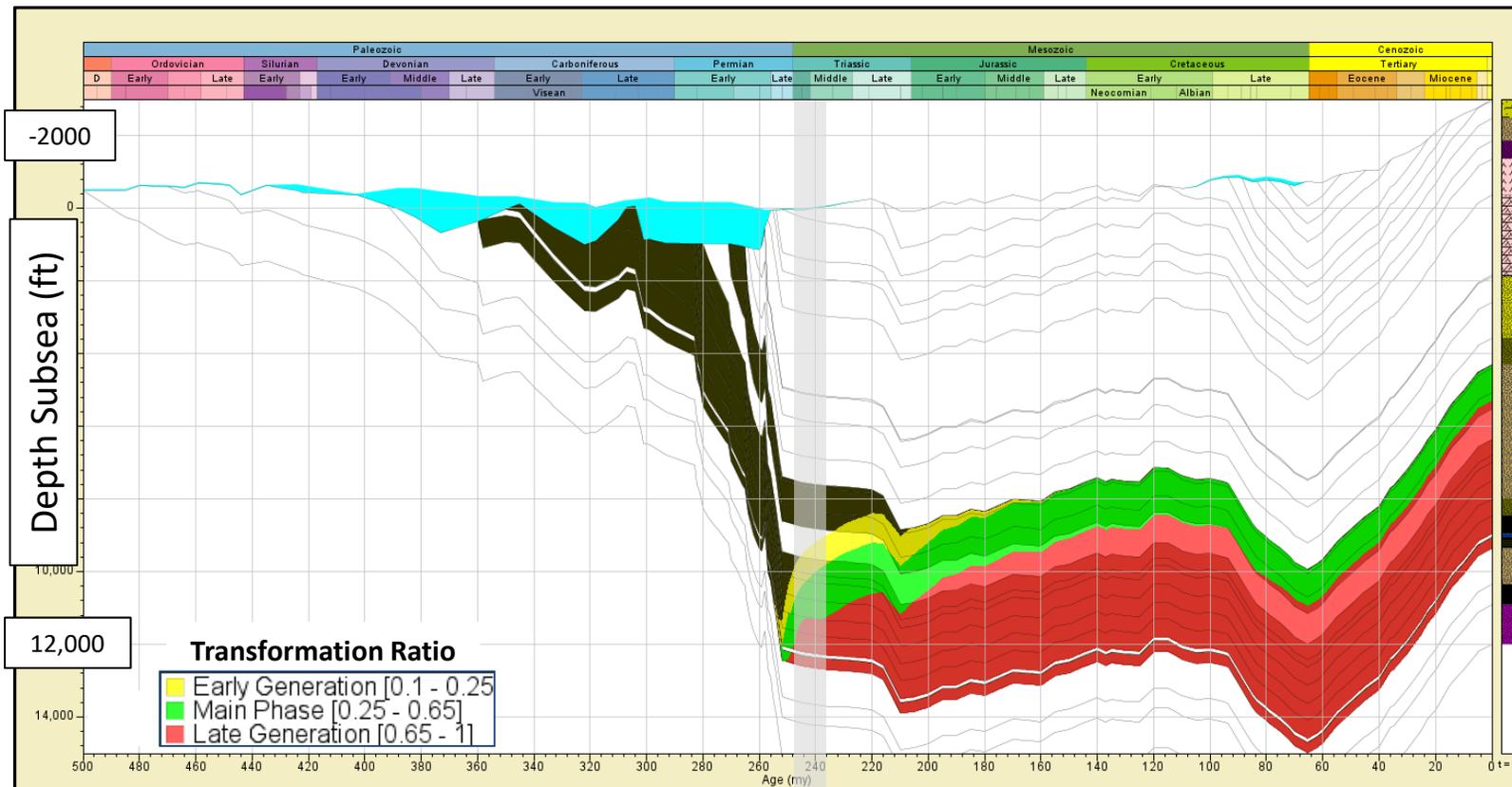
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Paleogeography



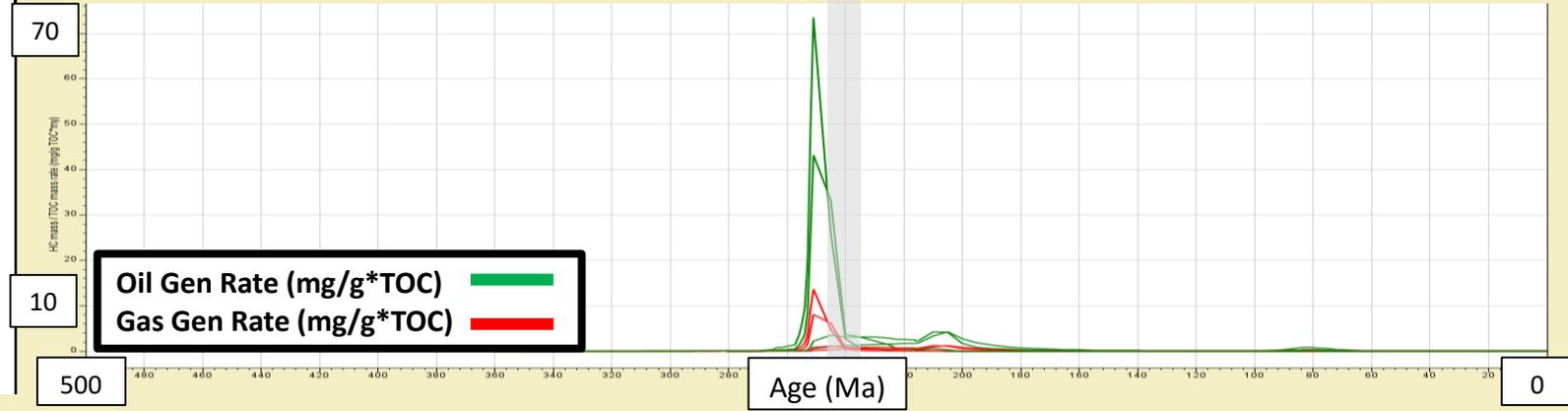
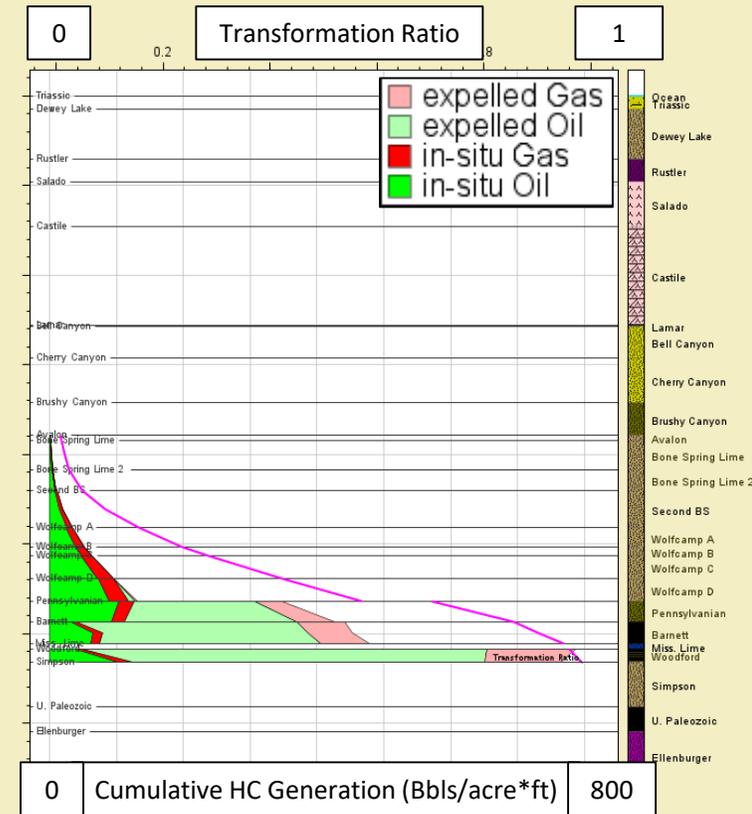
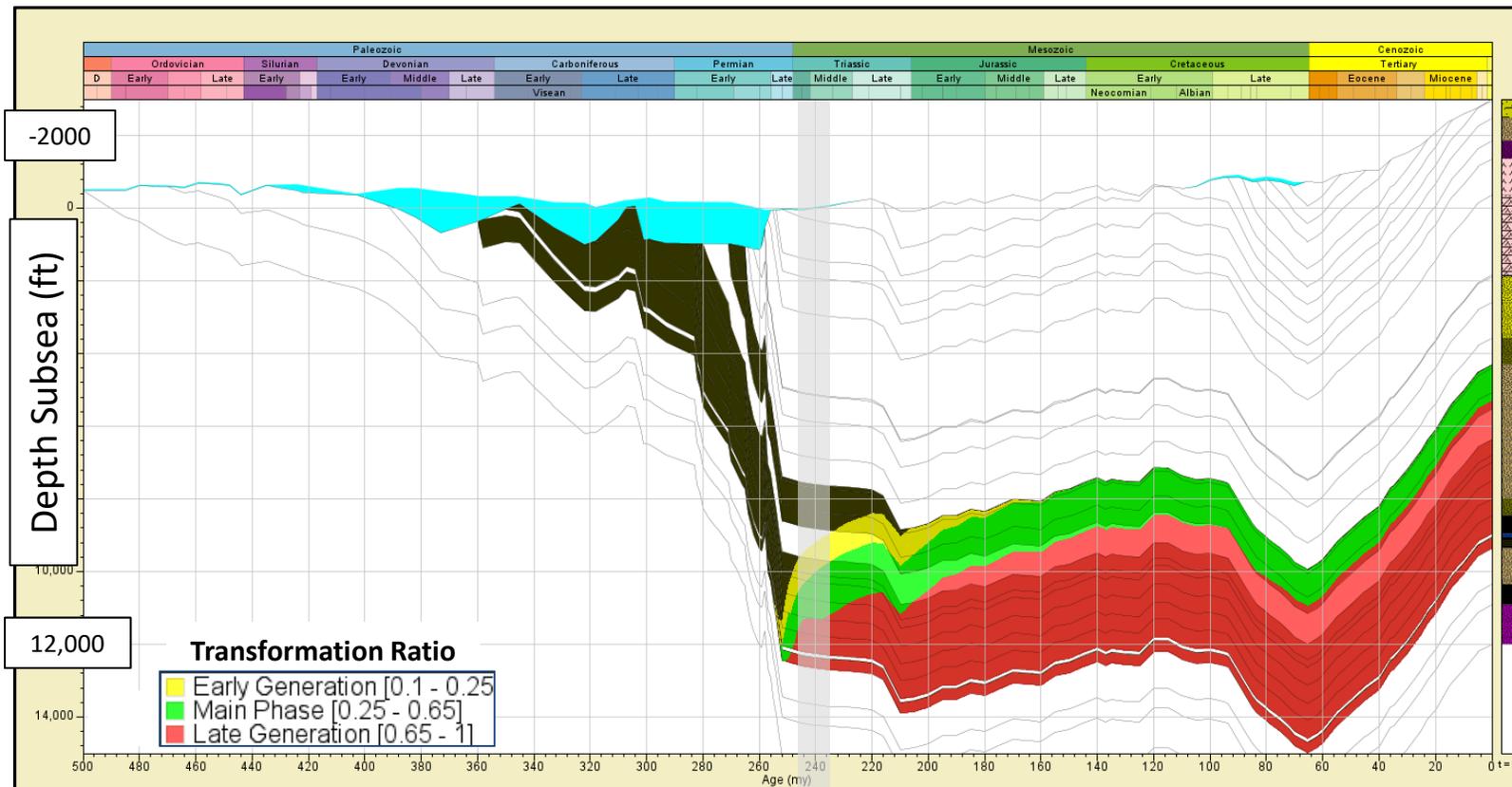
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Paleogeography



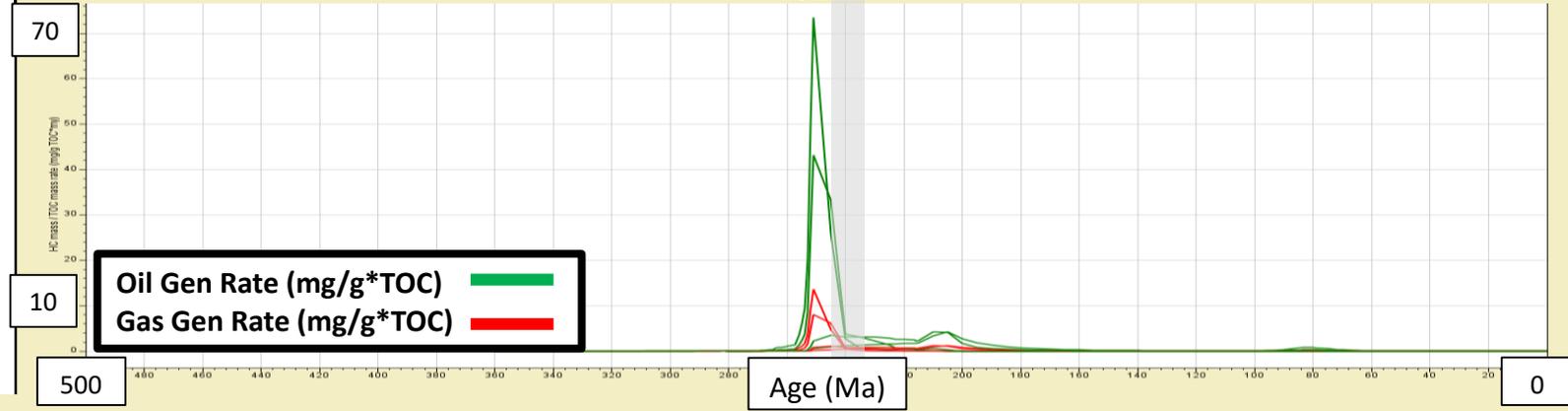
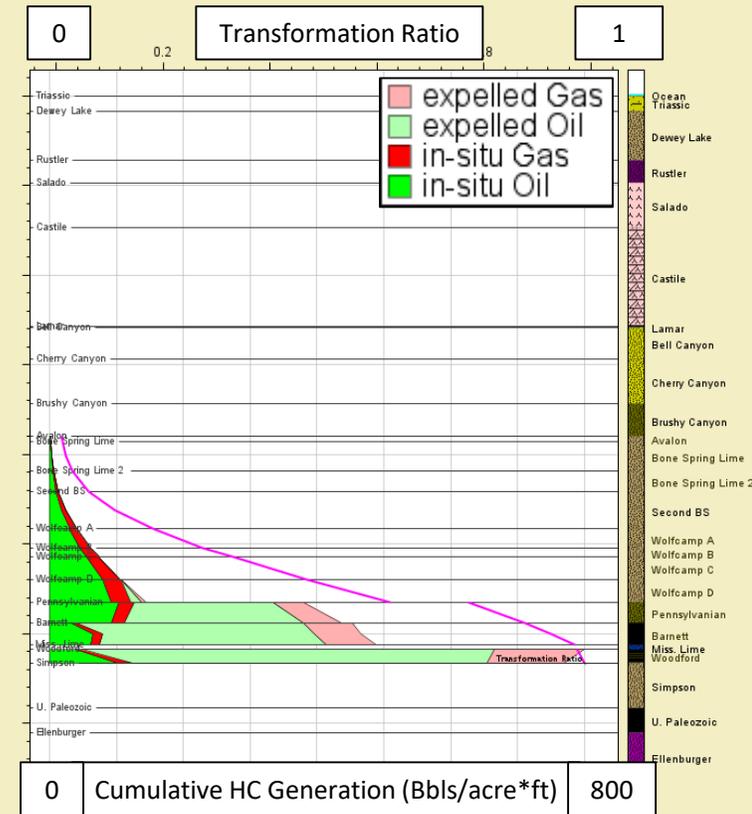
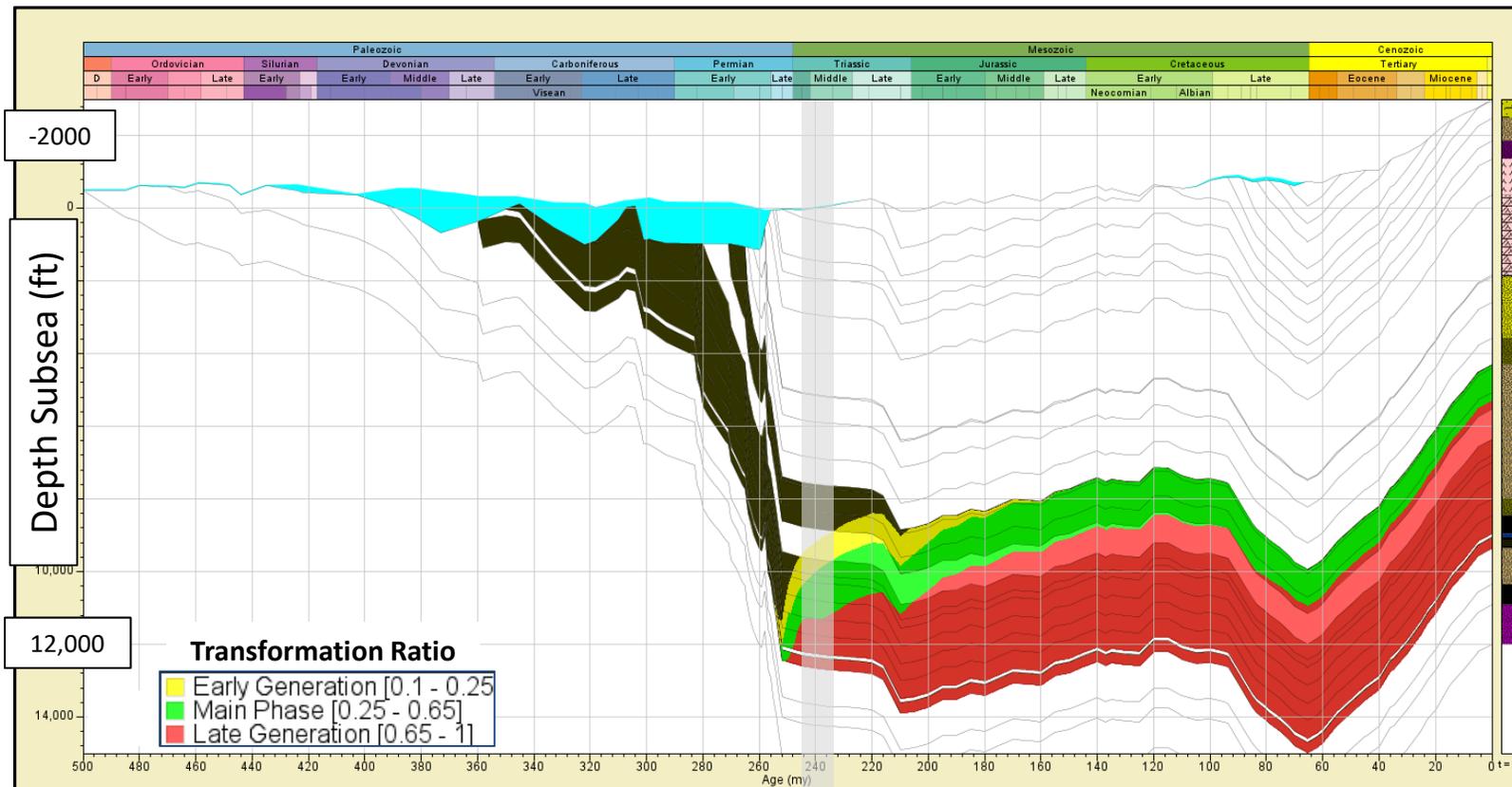
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Paleogeography



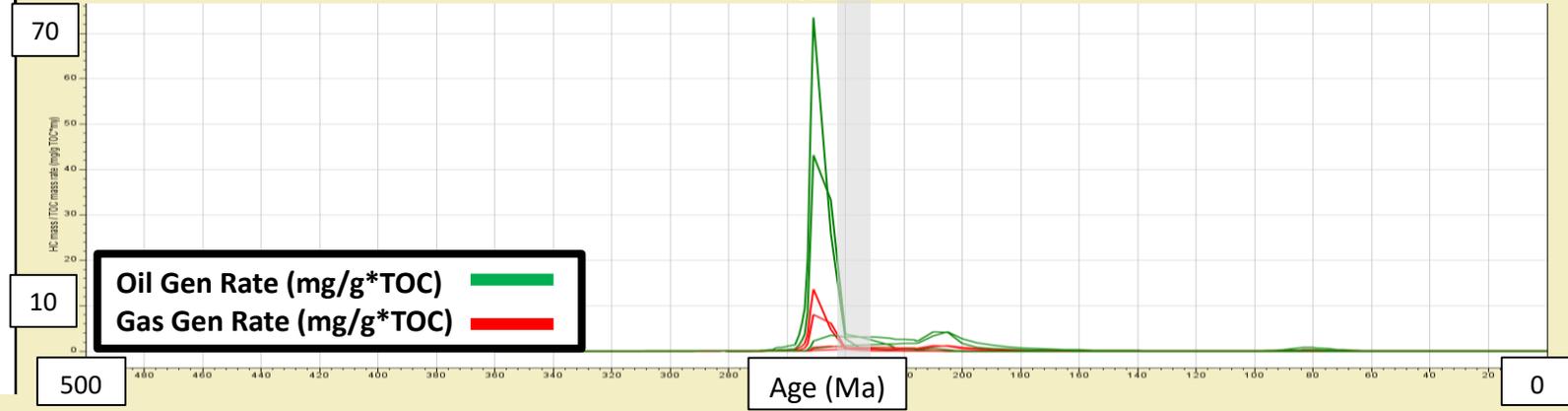
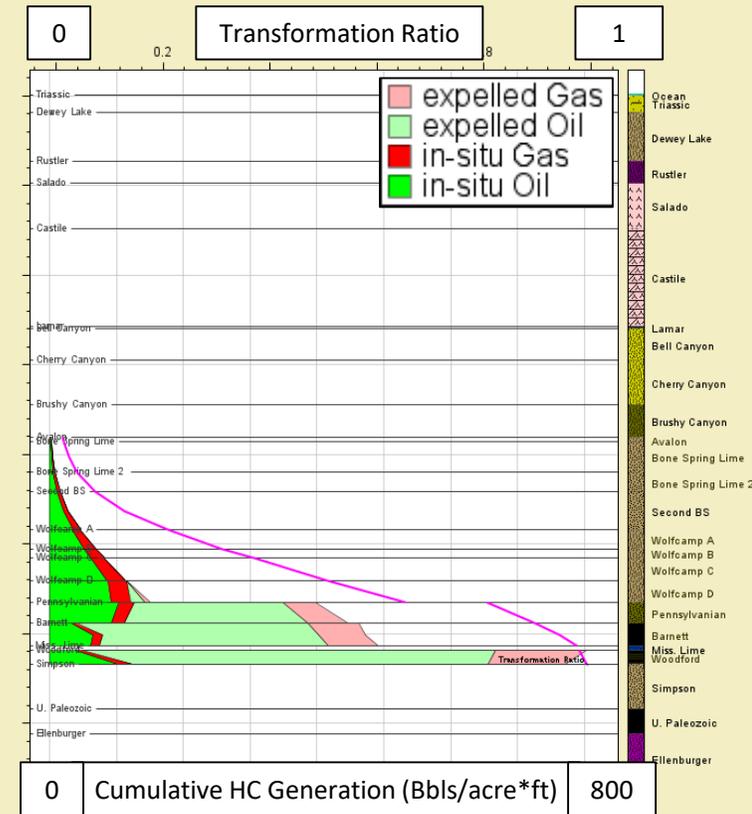
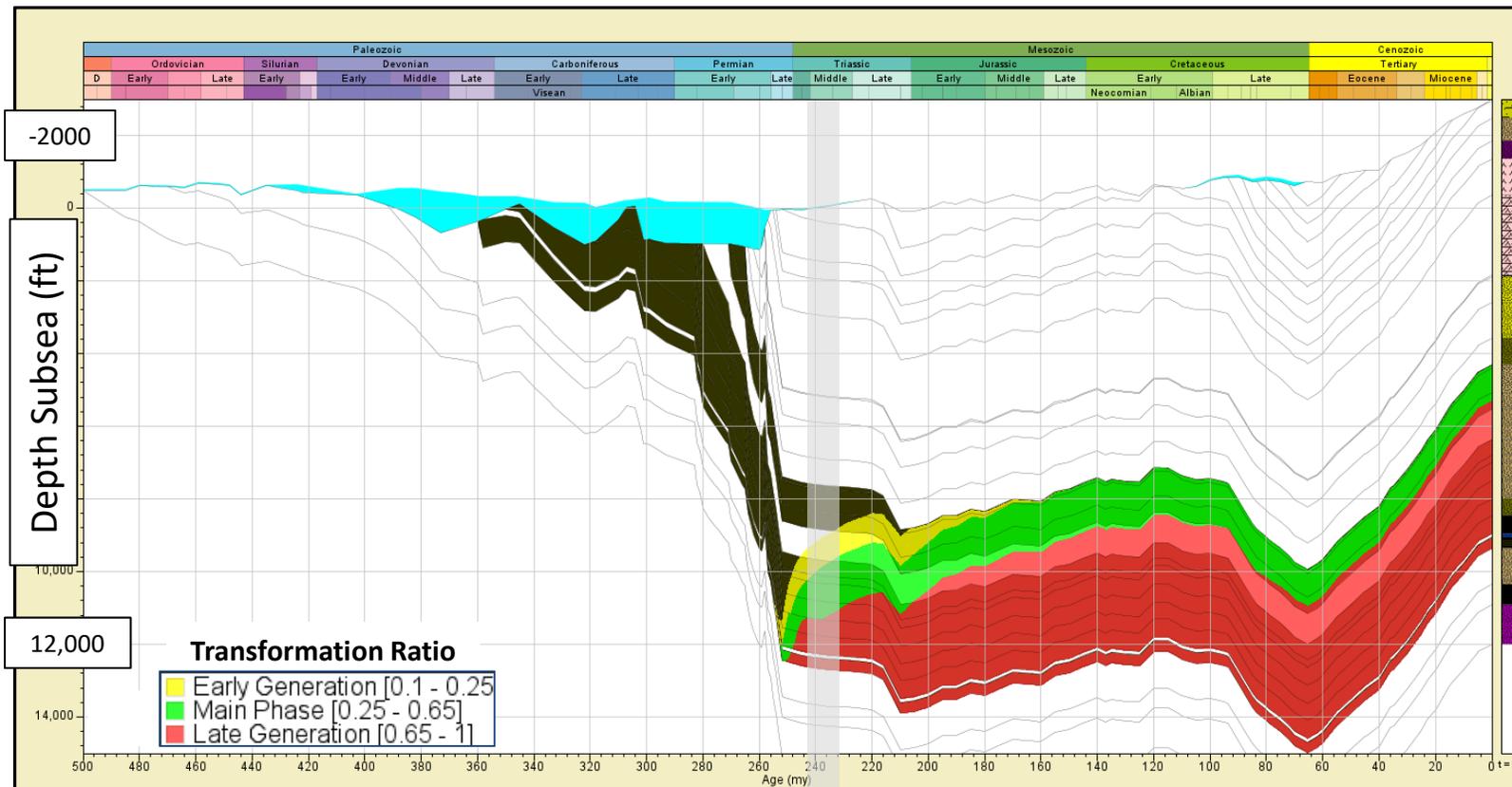
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Paleogeography



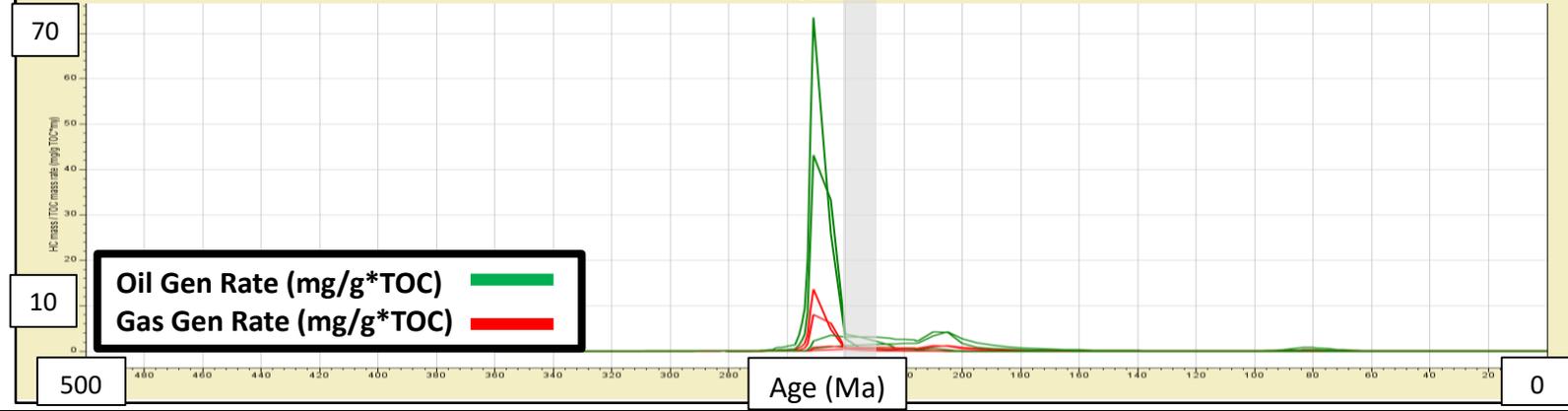
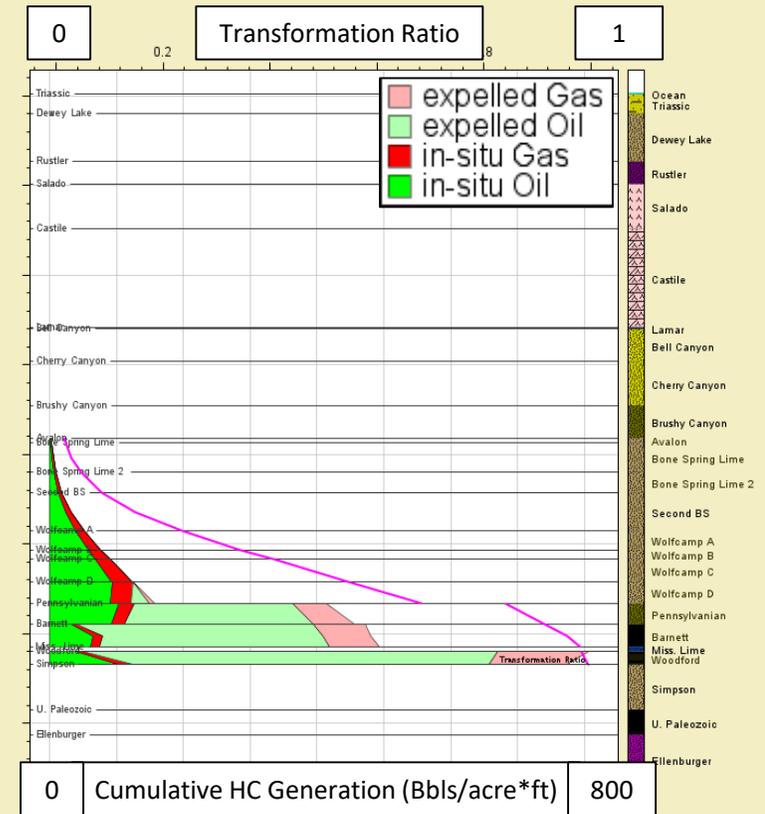
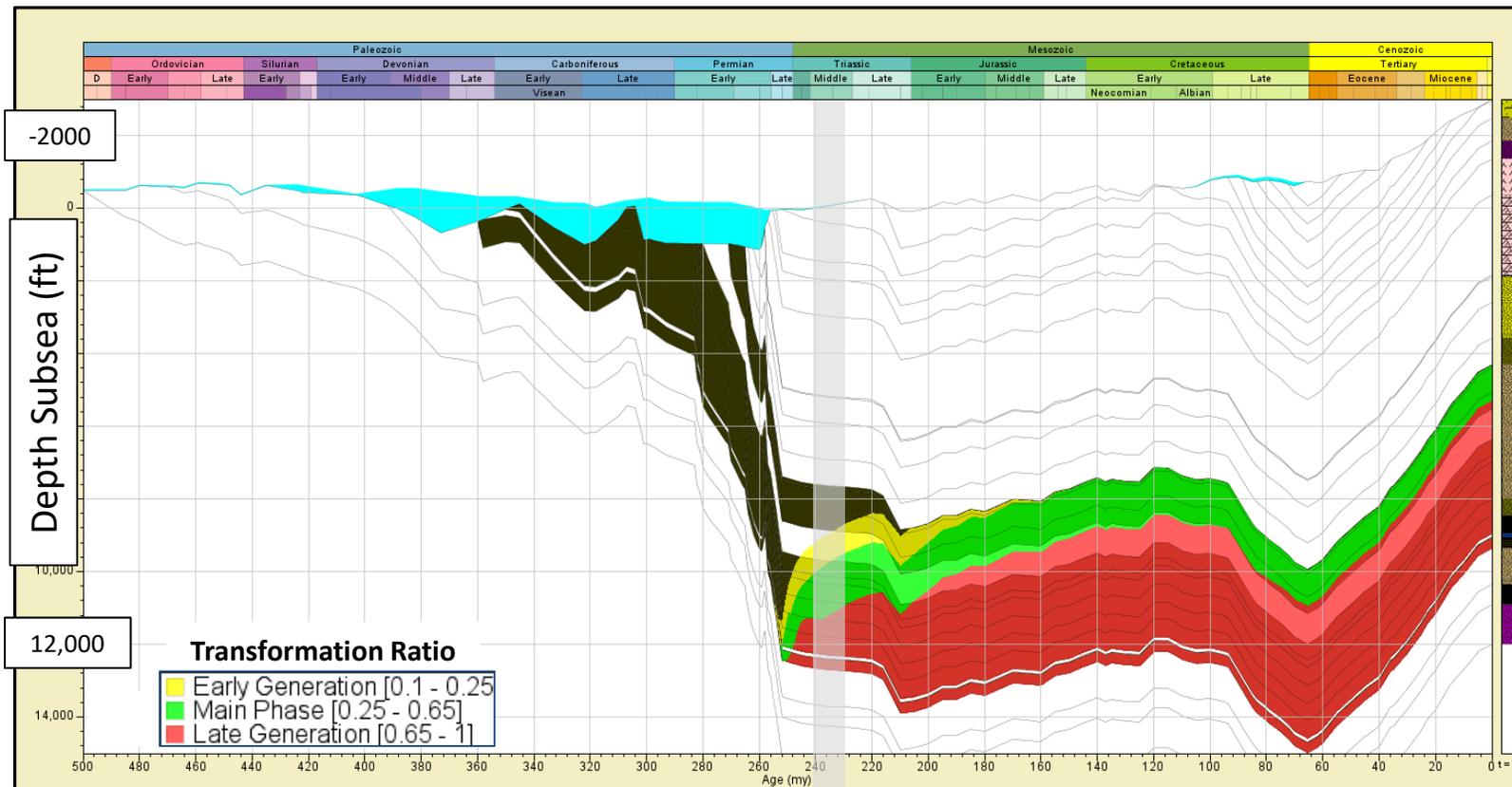
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Paleogeography



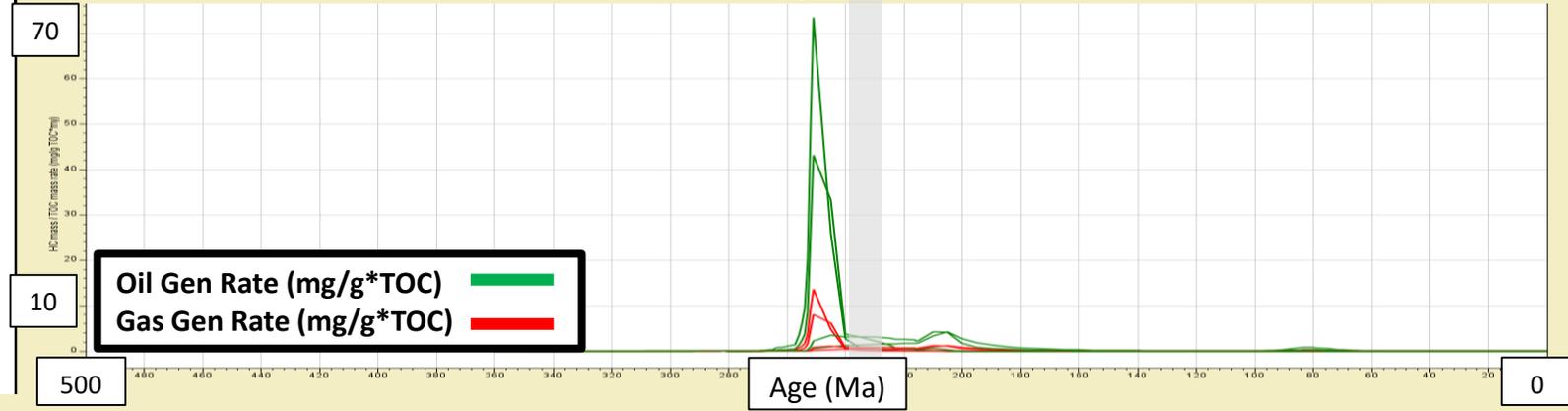
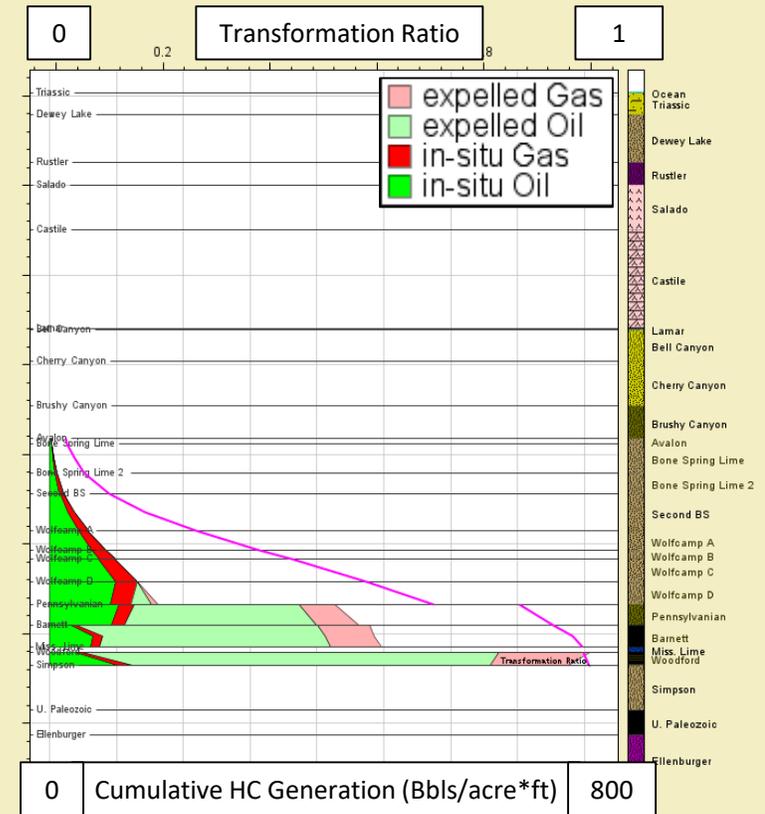
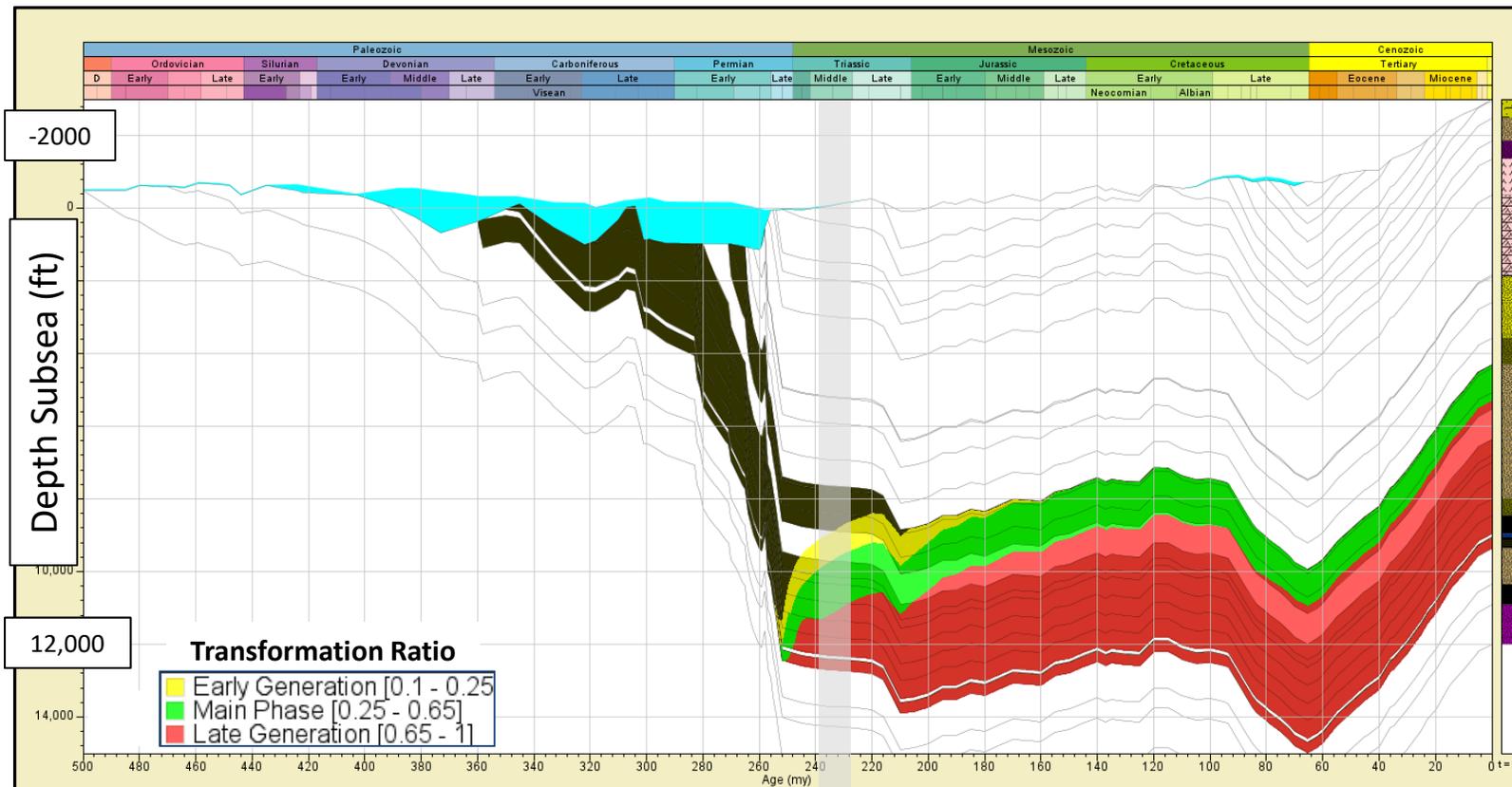
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Paleogeography



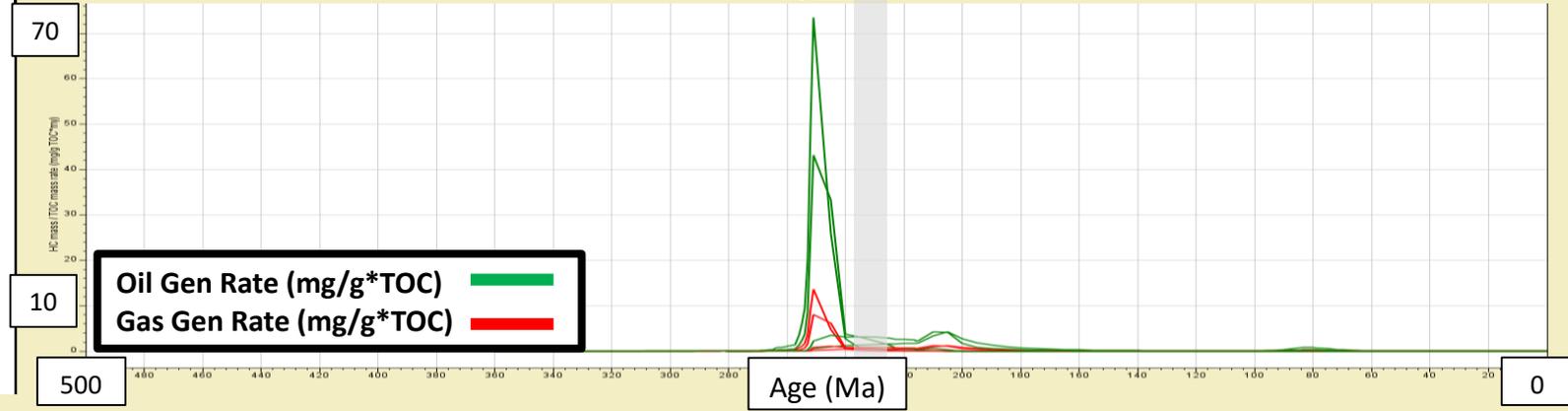
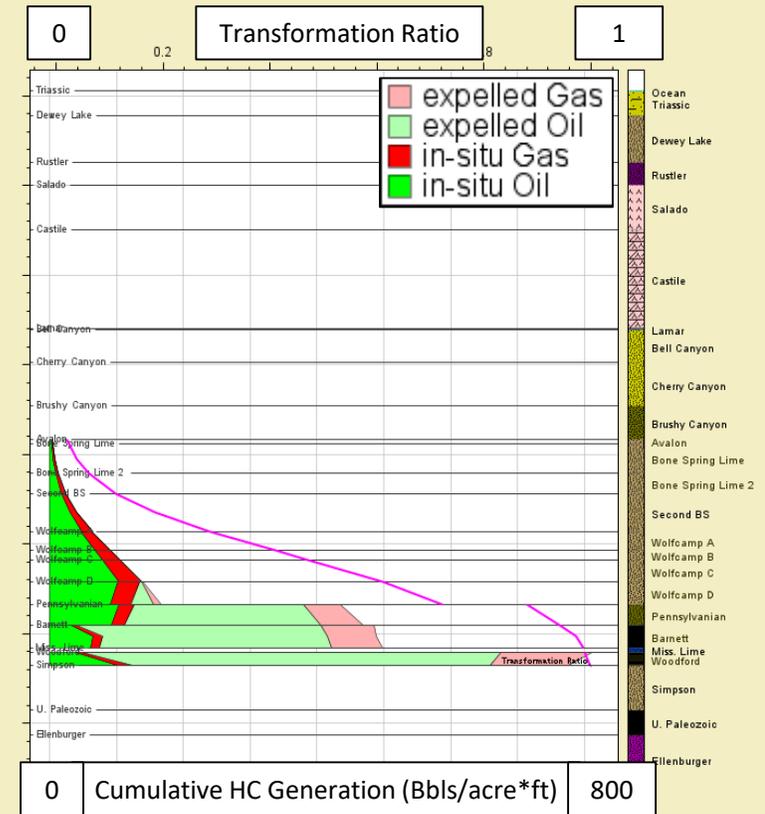
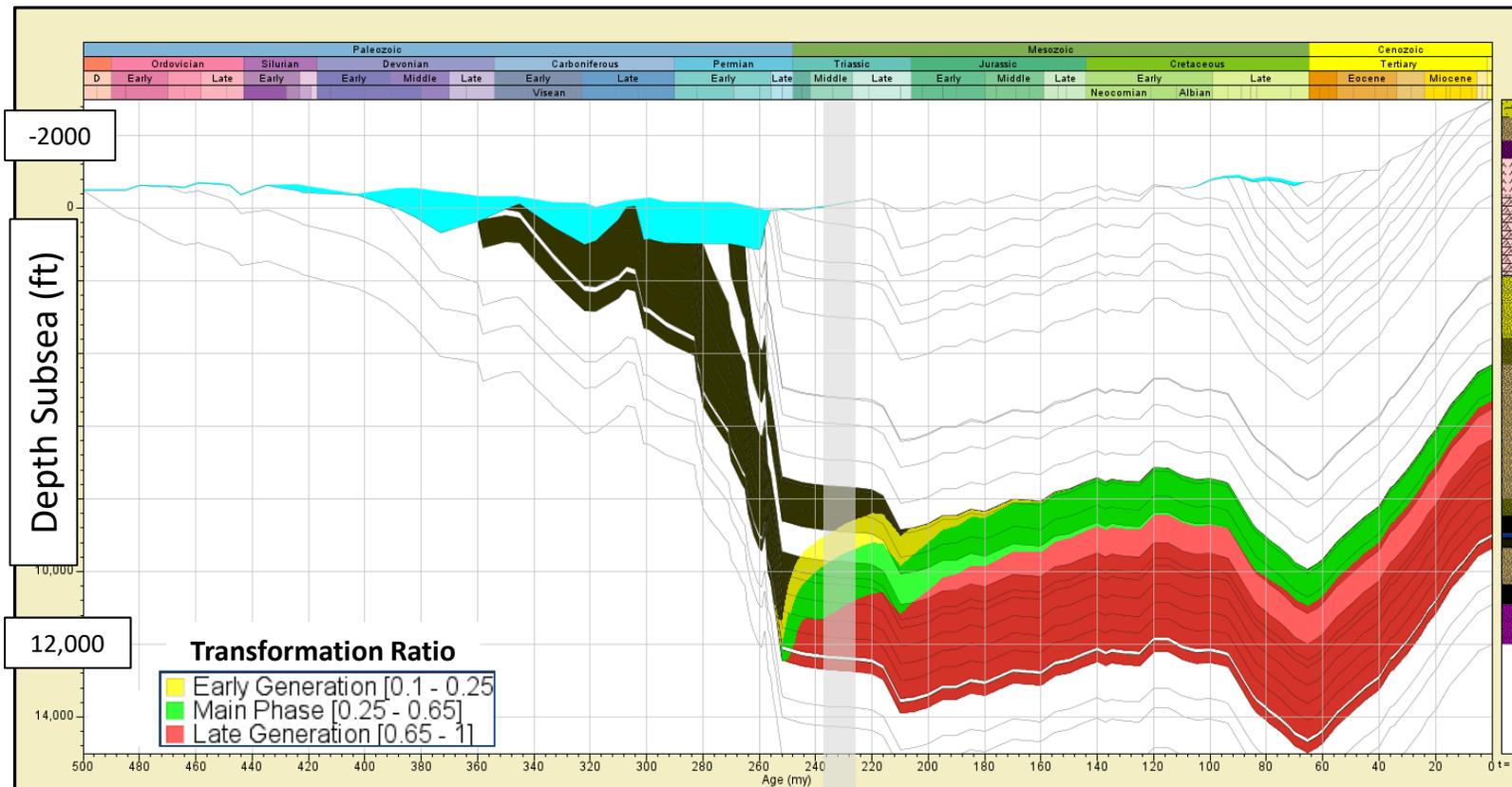
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Paleogeography



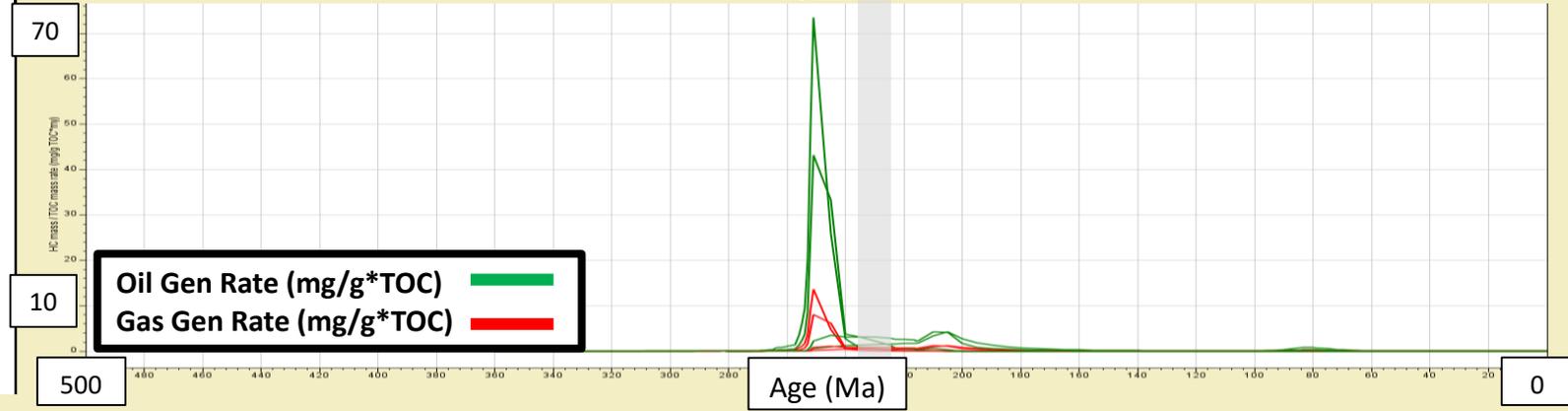
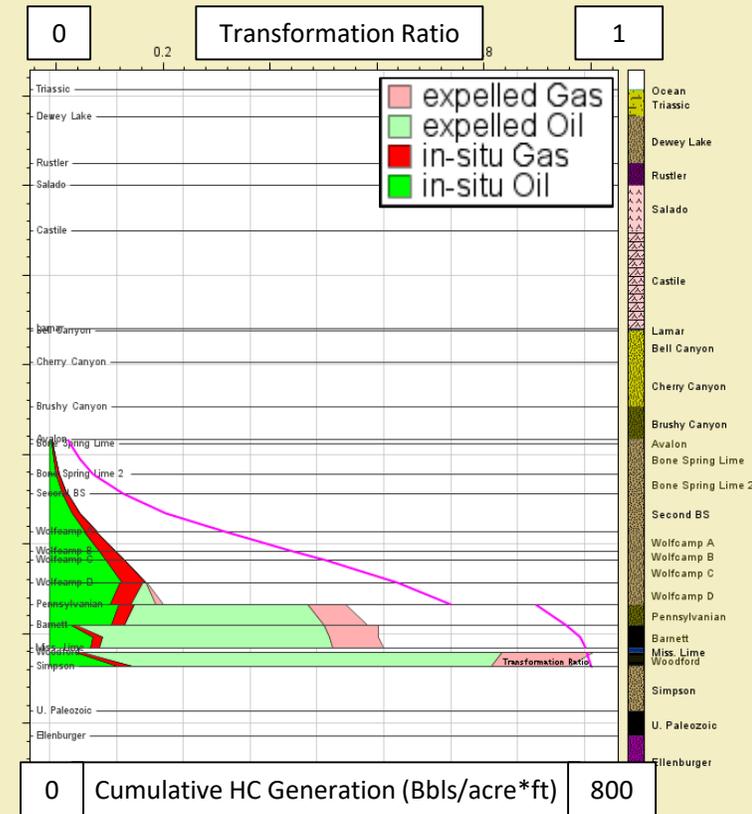
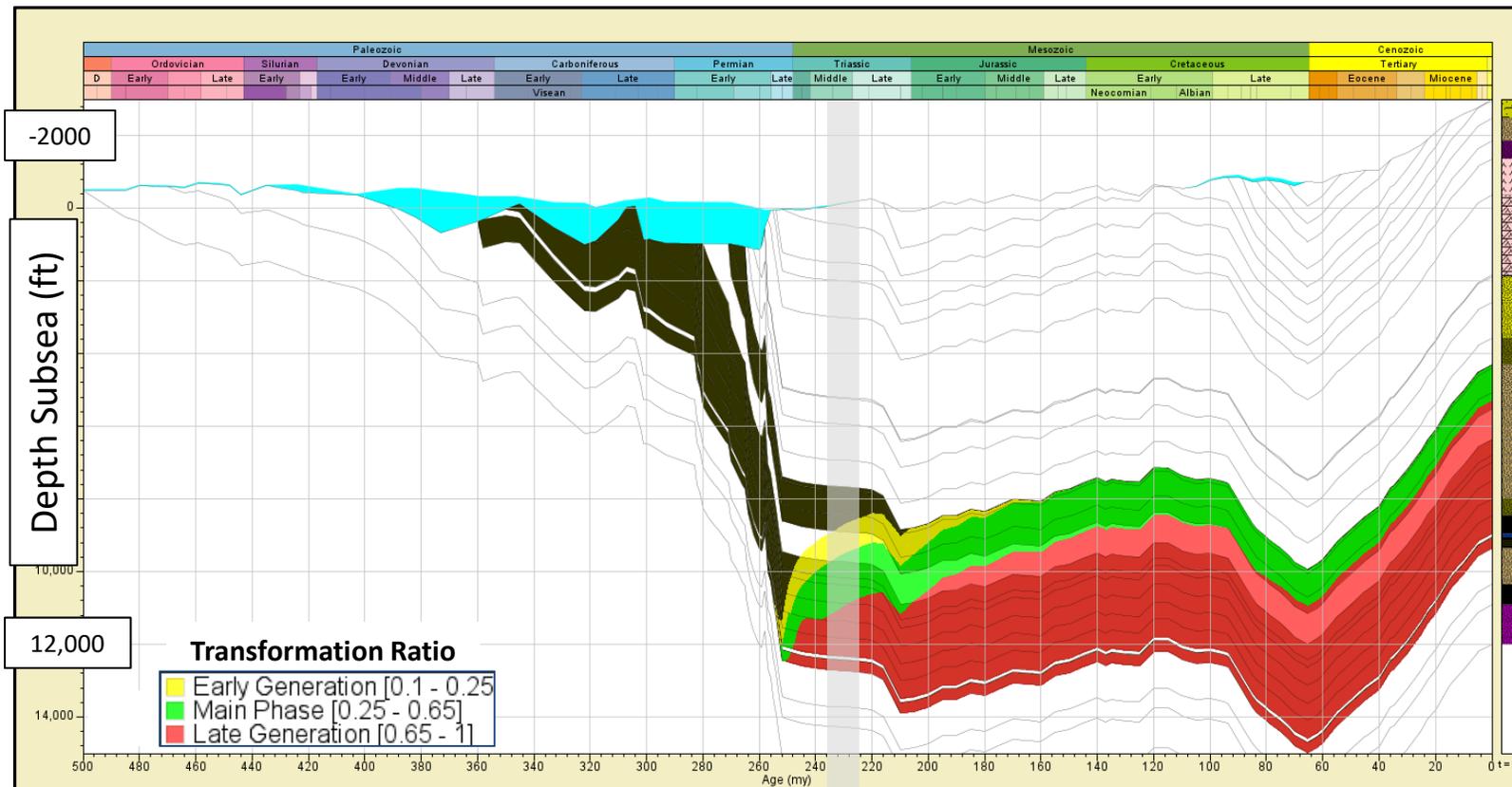
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Paleogeography



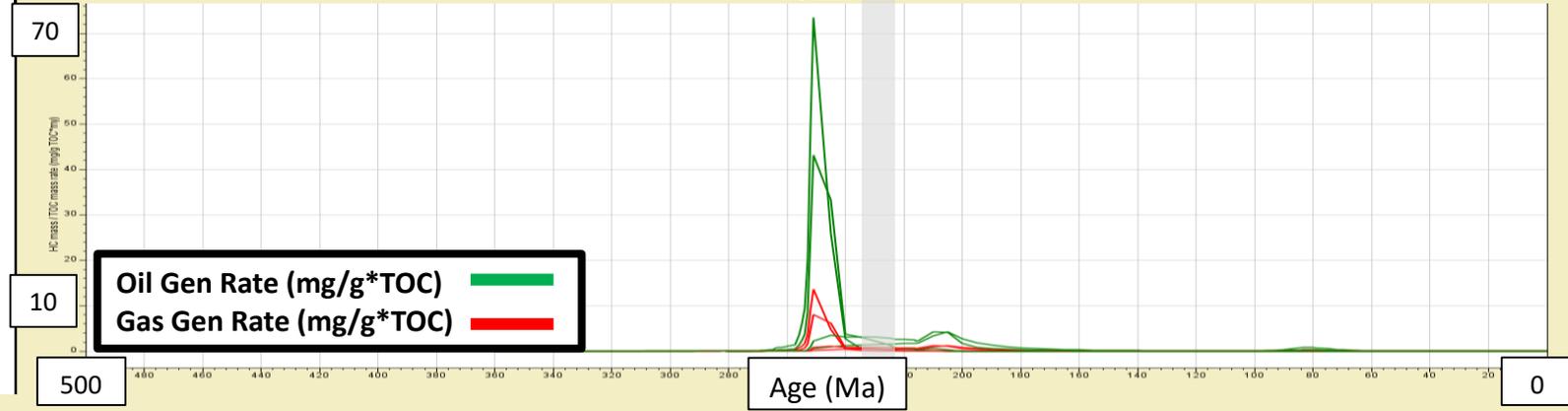
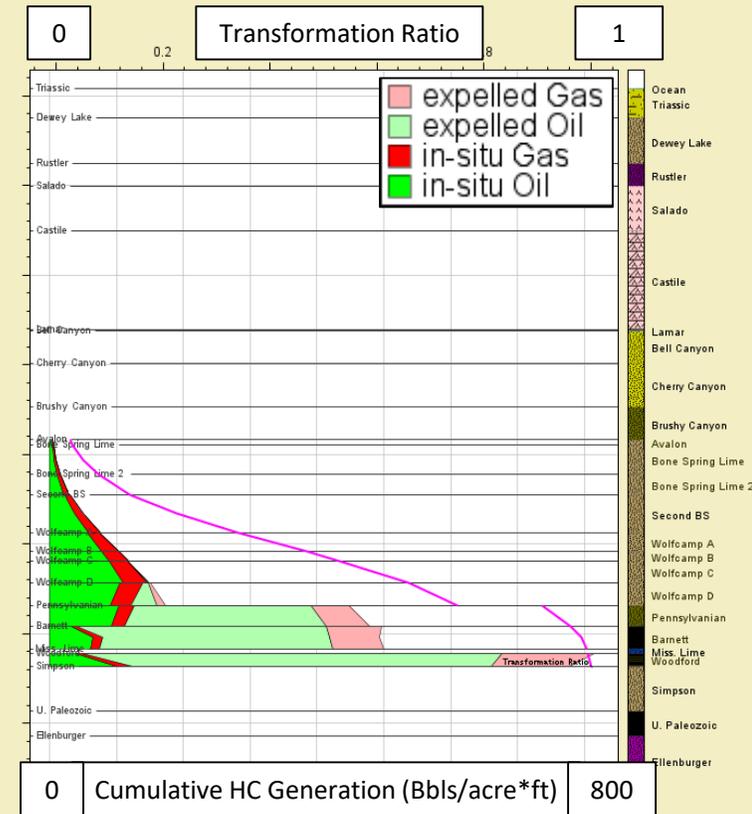
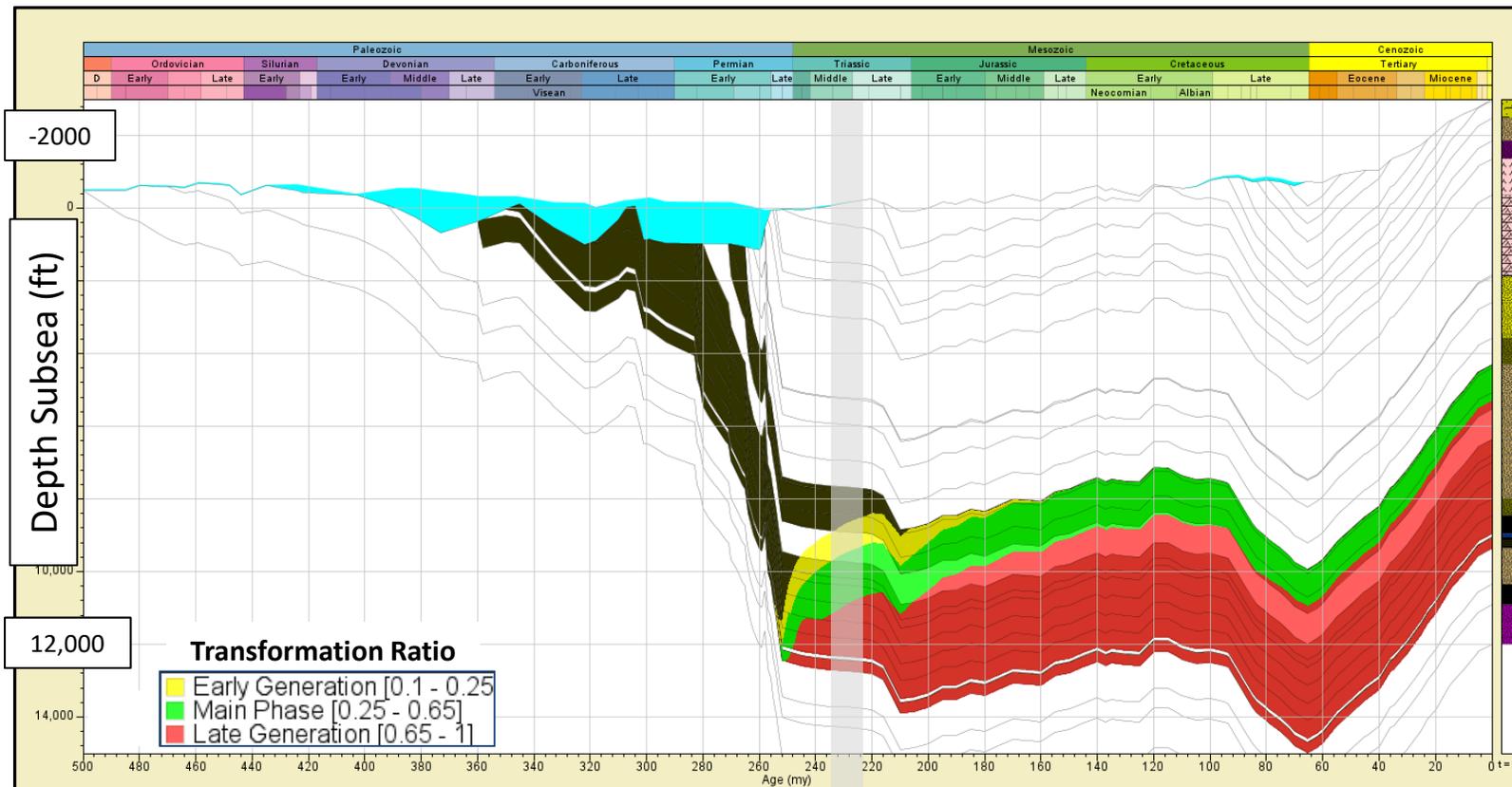
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Paleogeography



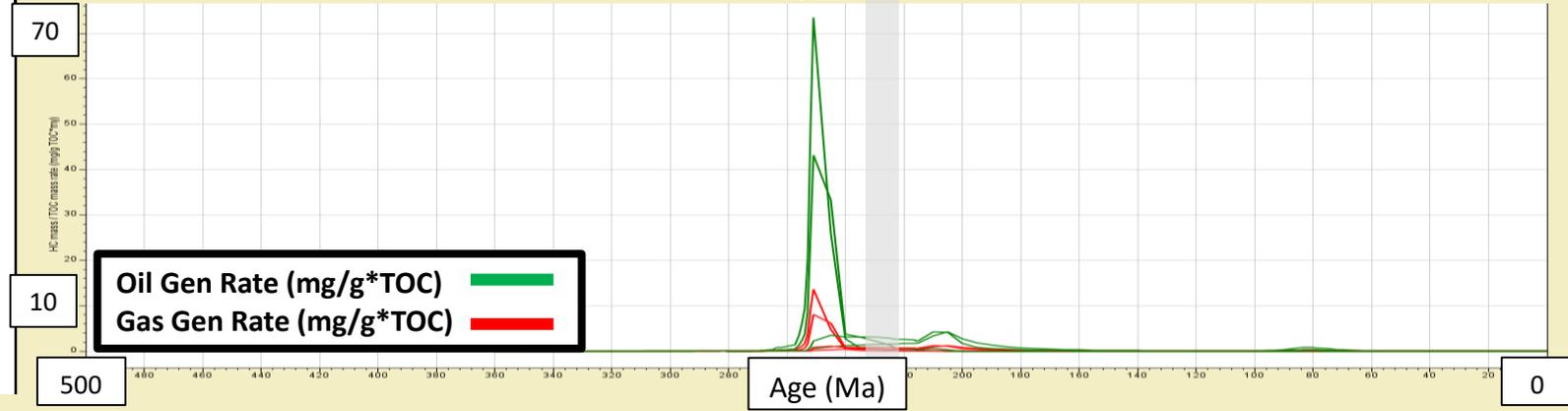
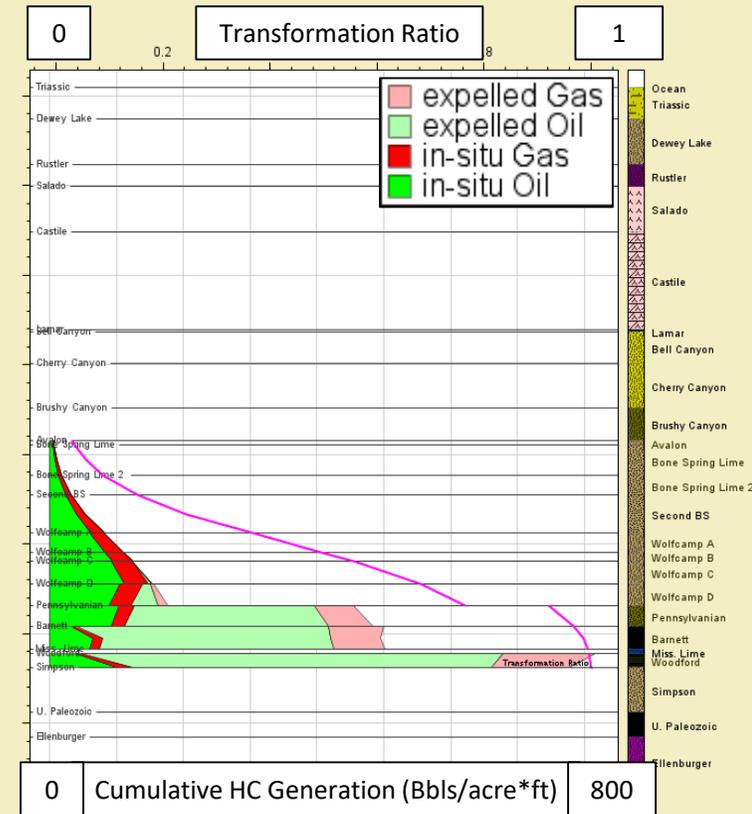
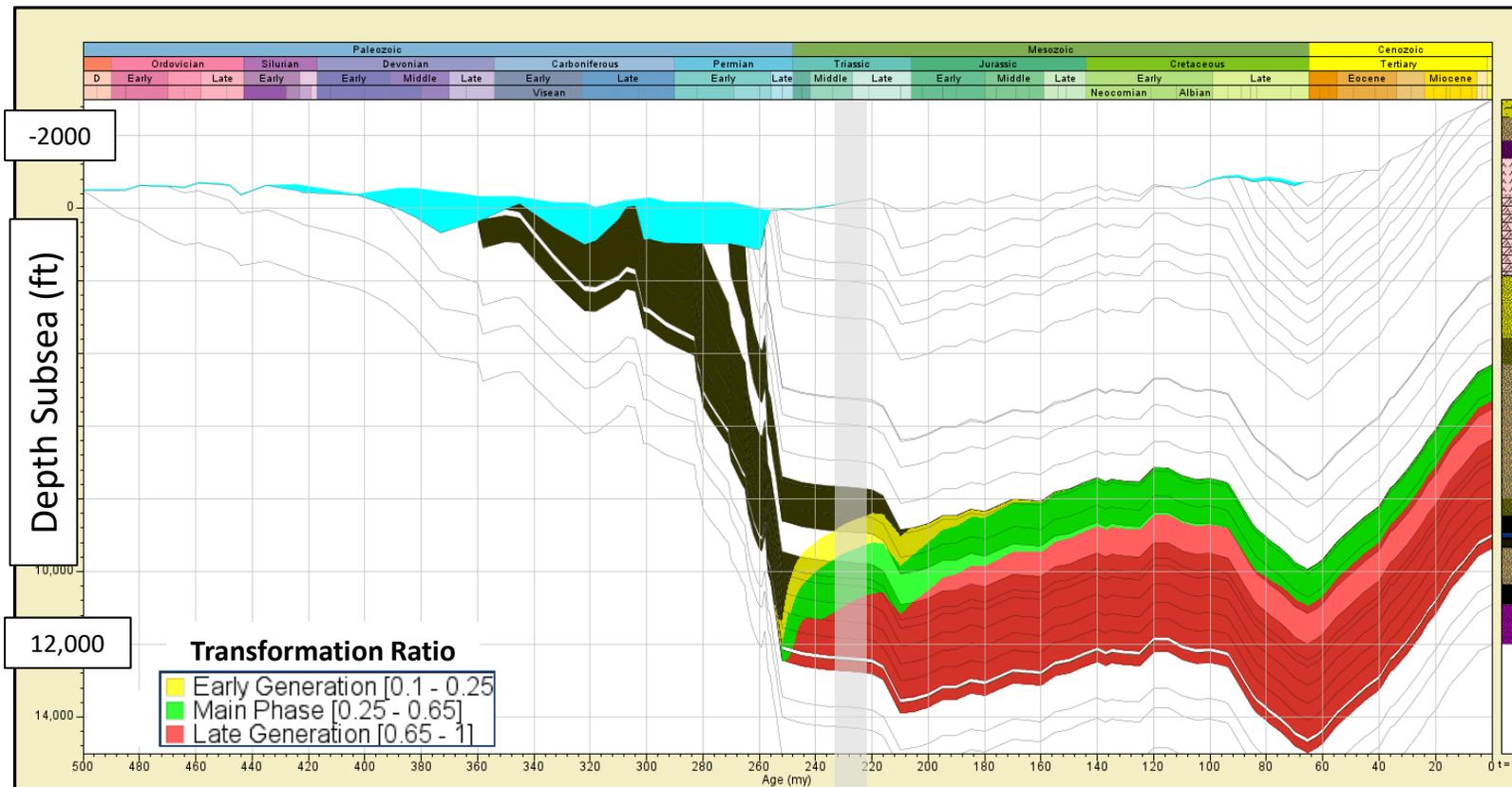
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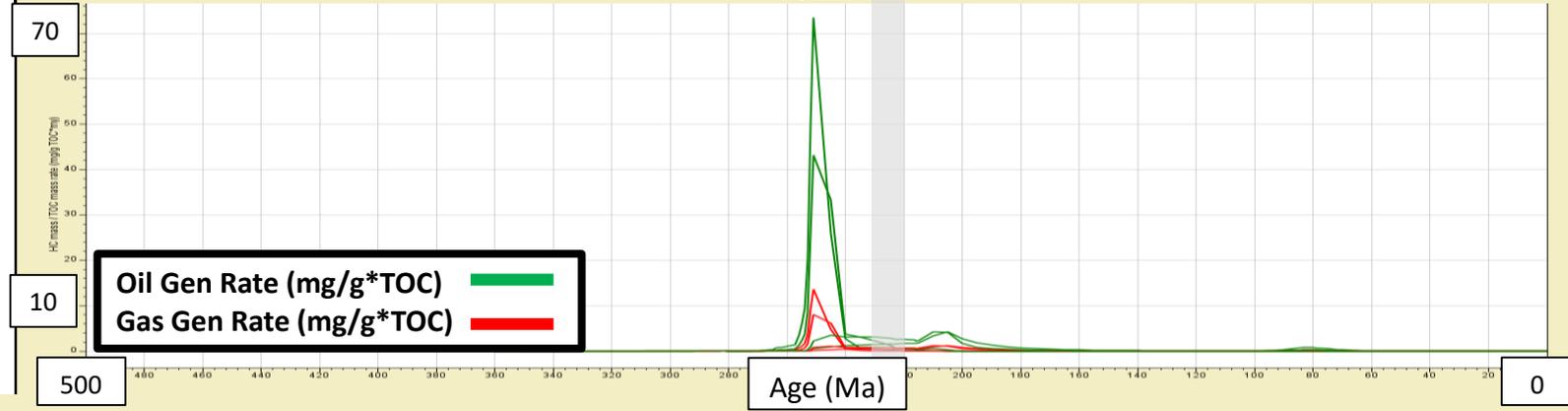
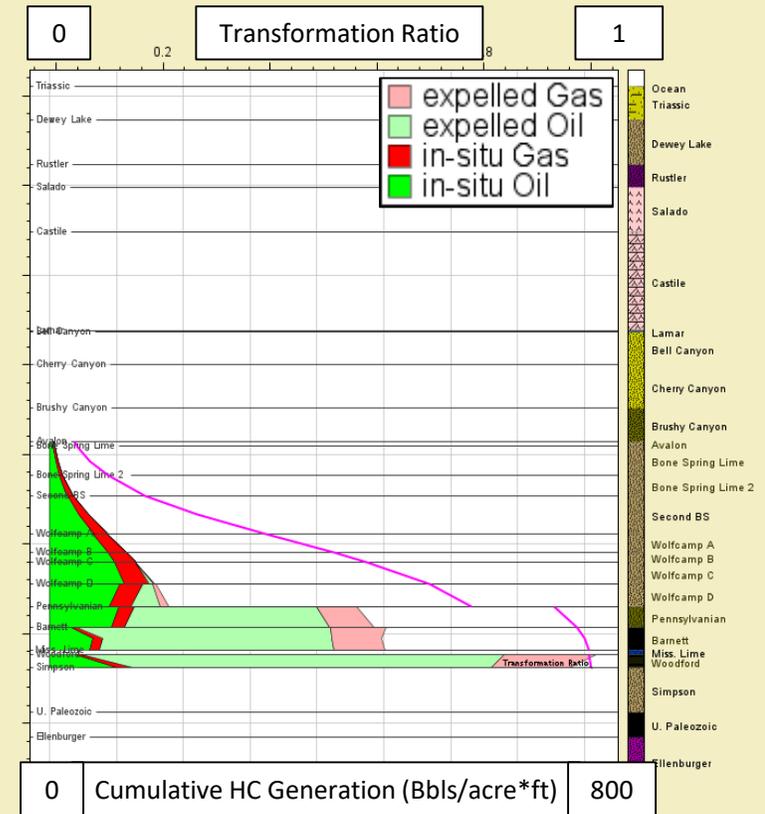
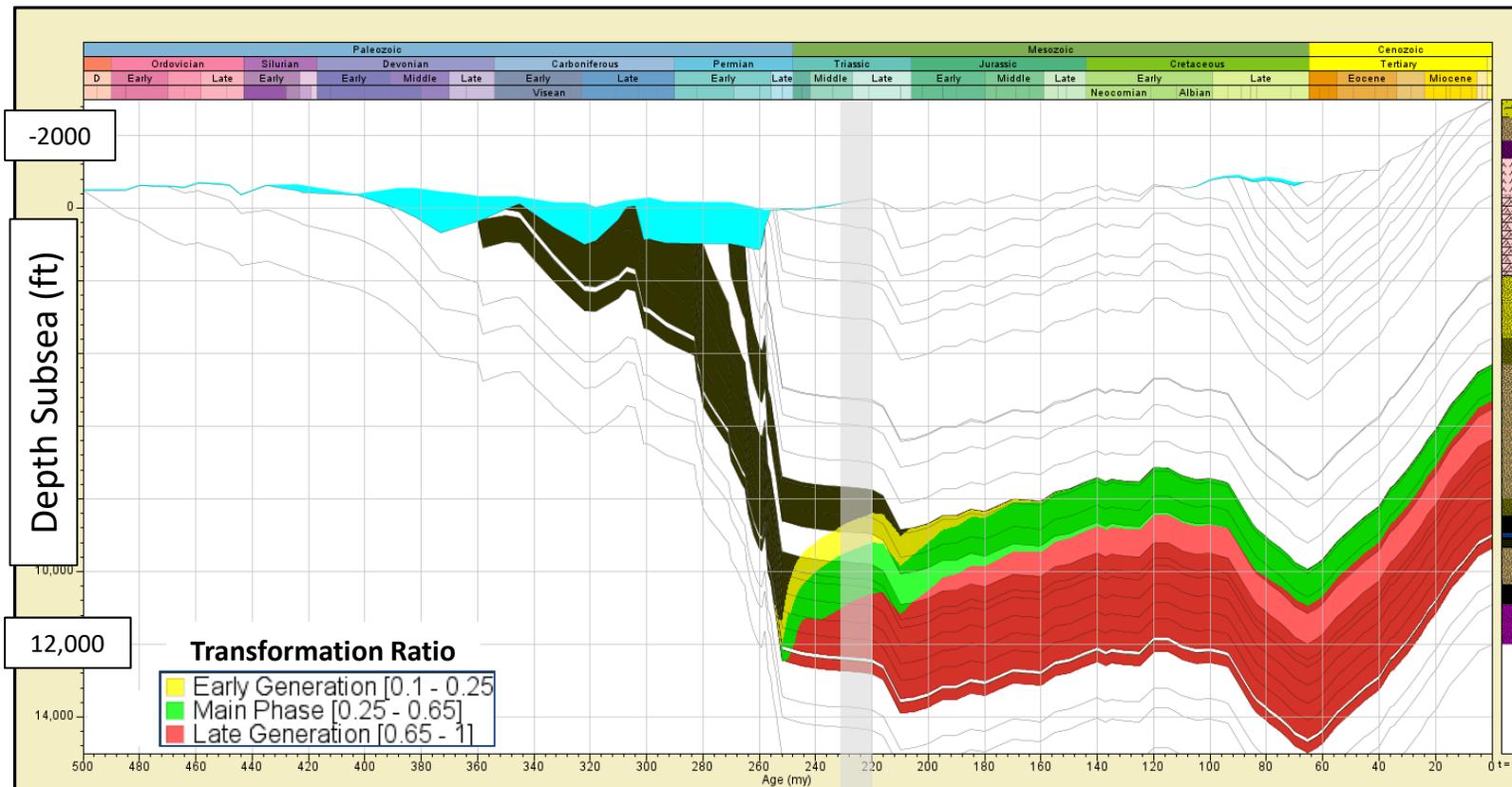
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Paleogeography



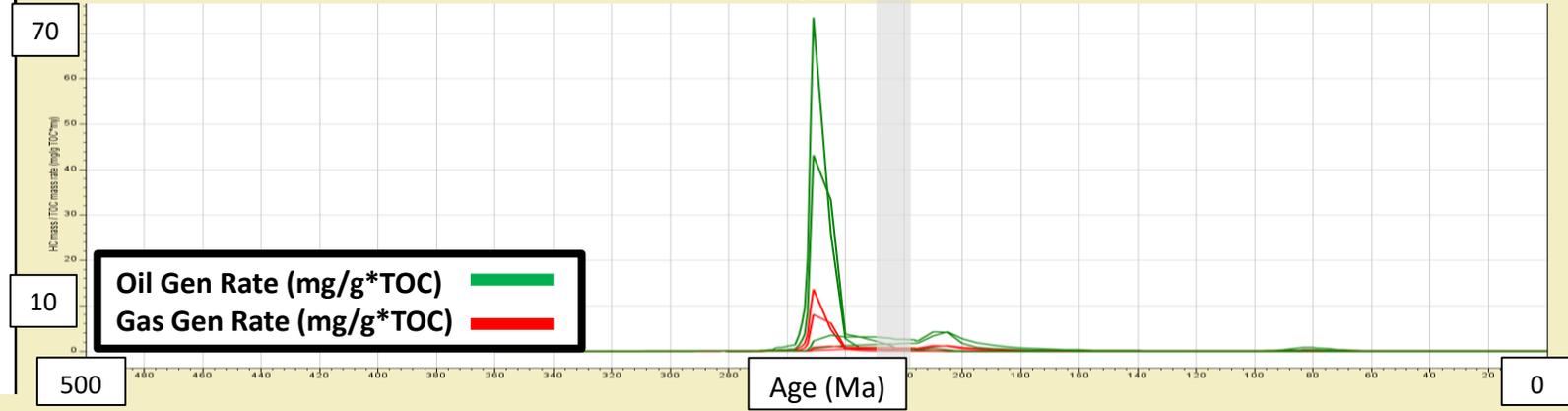
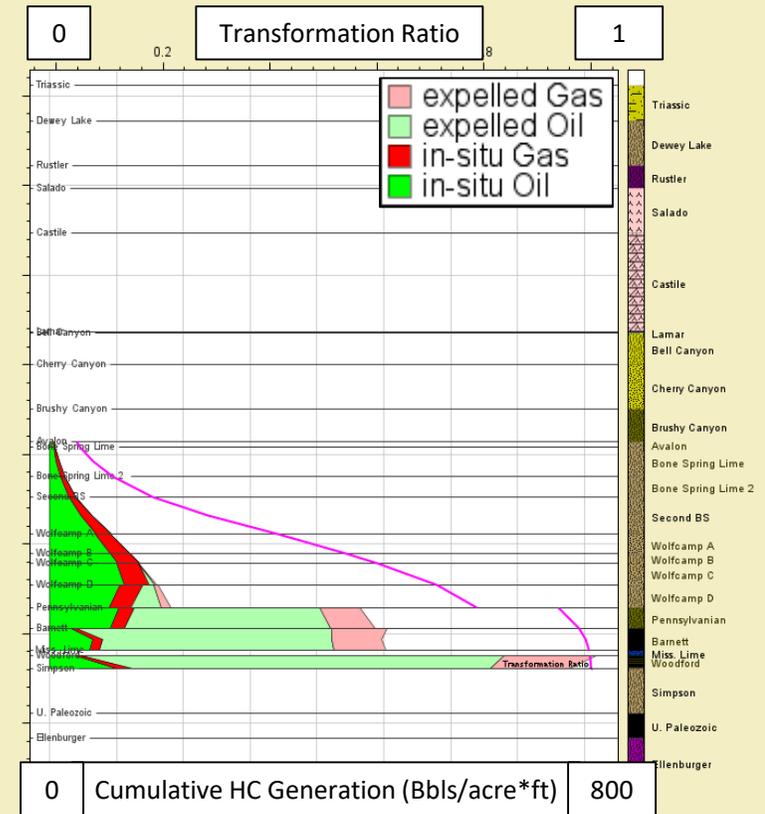
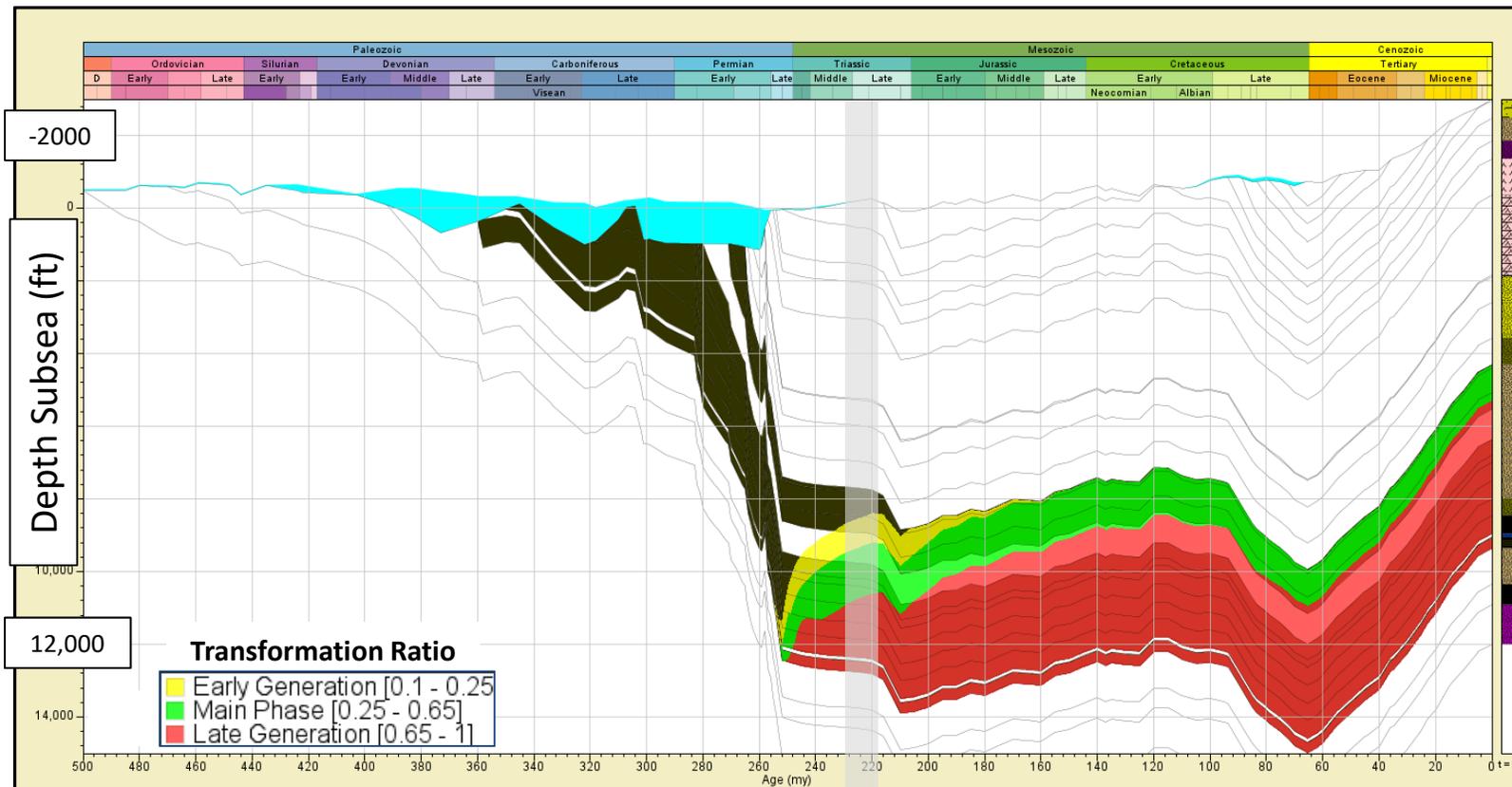
Time lapse of generation



Paleogeography



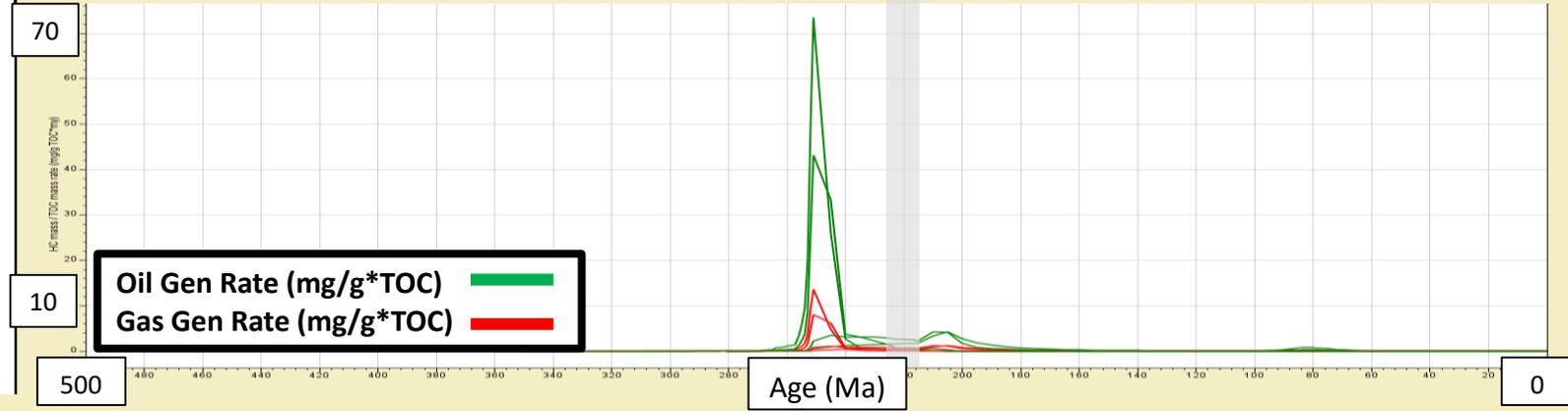
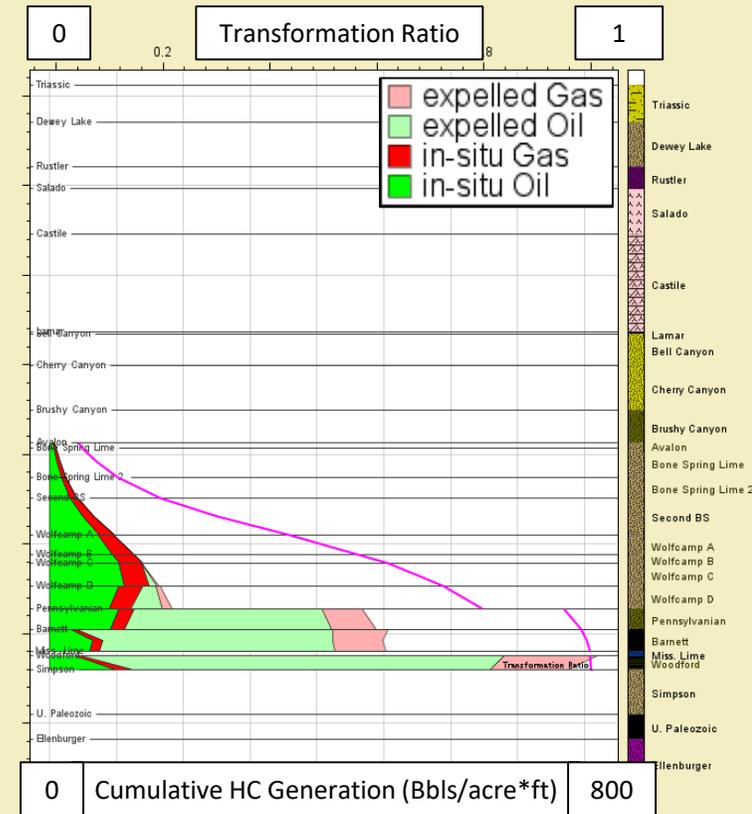
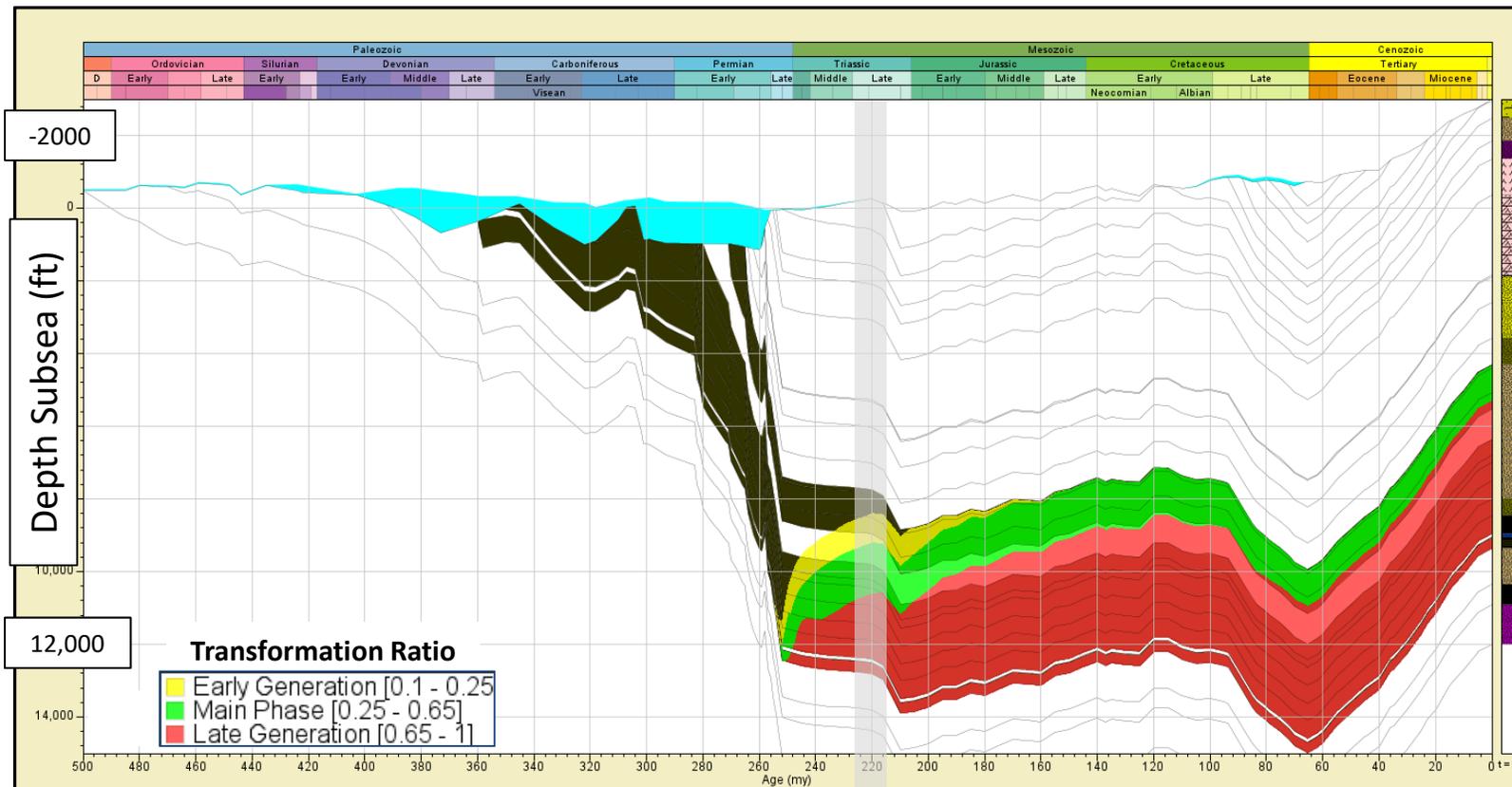
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Paleogeography



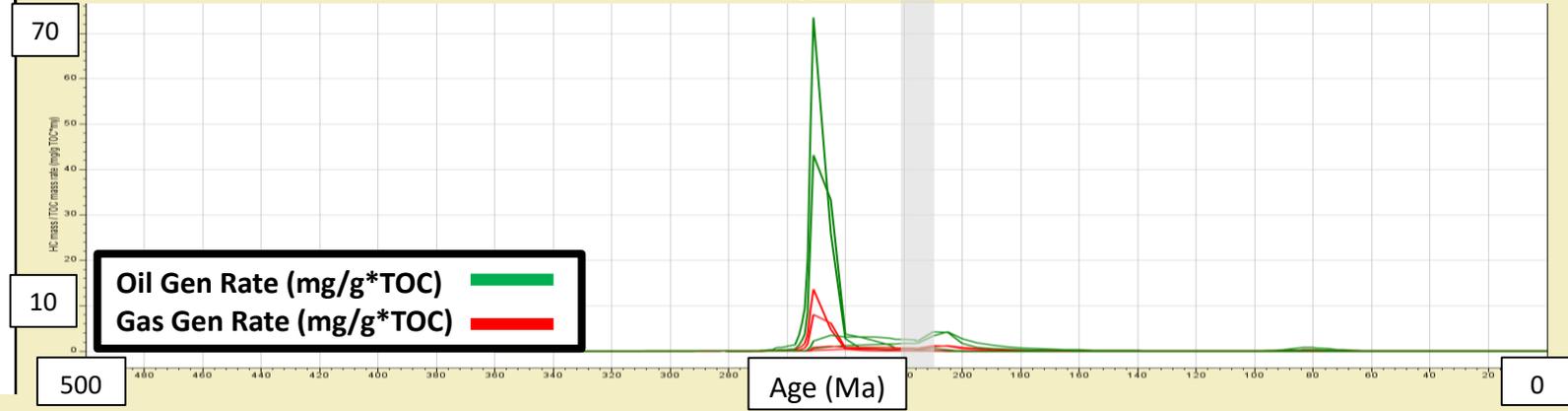
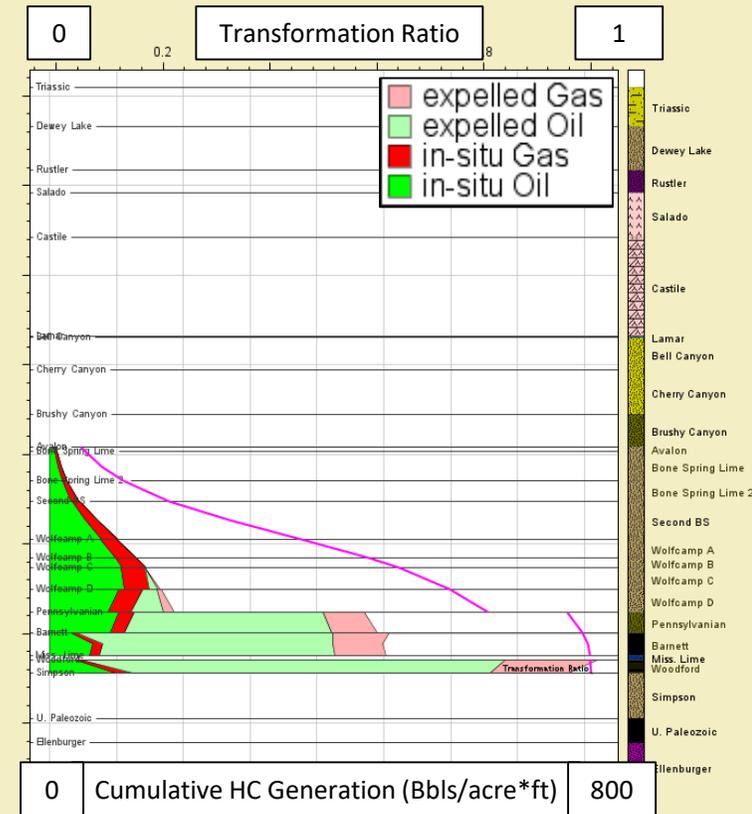
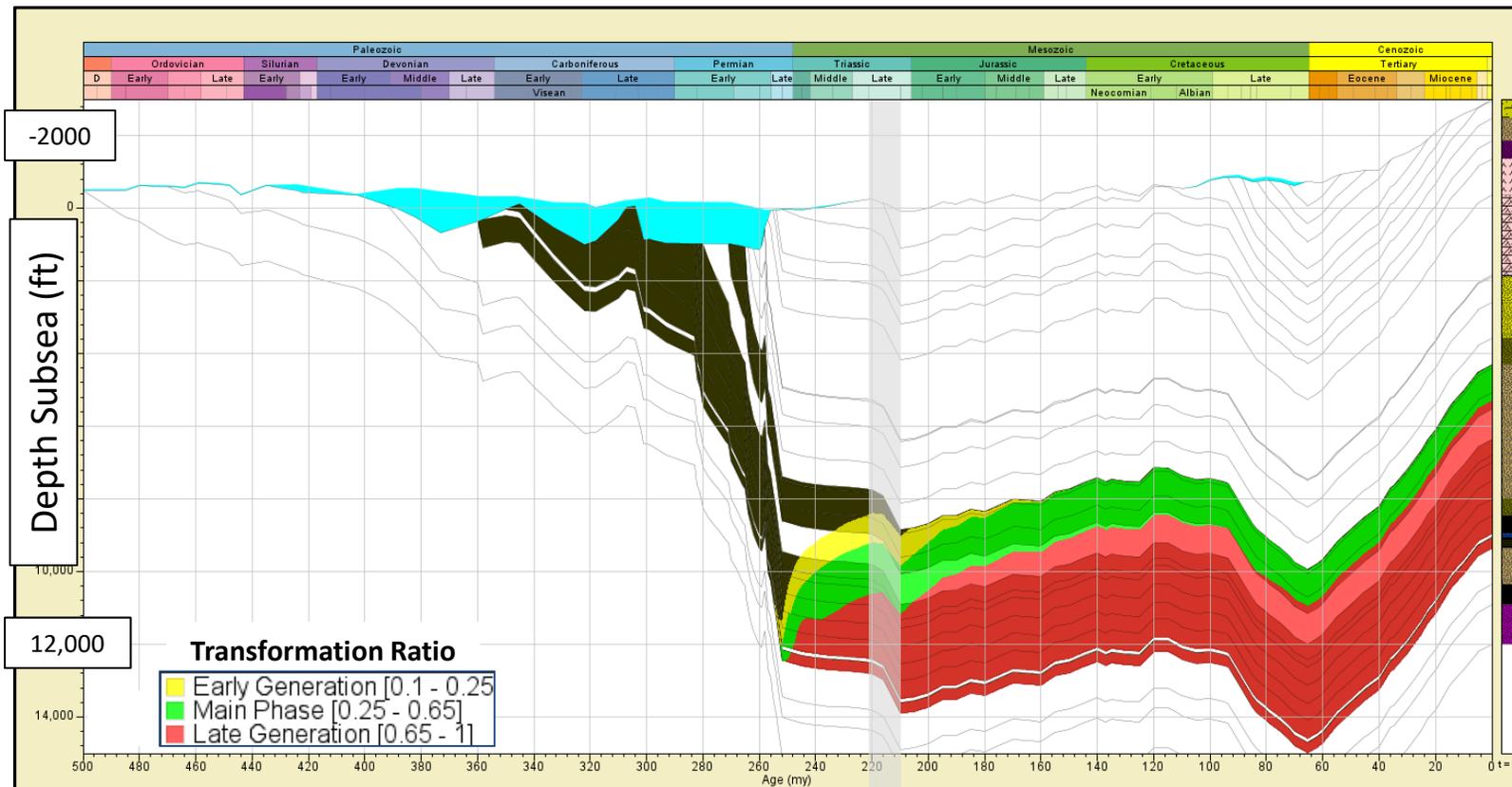
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Paleogeography



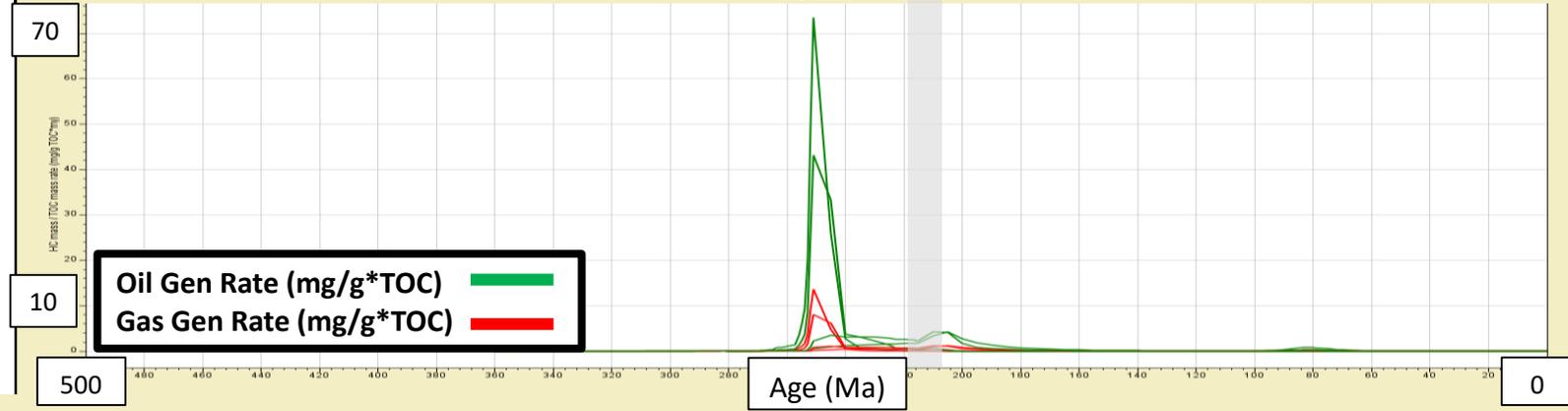
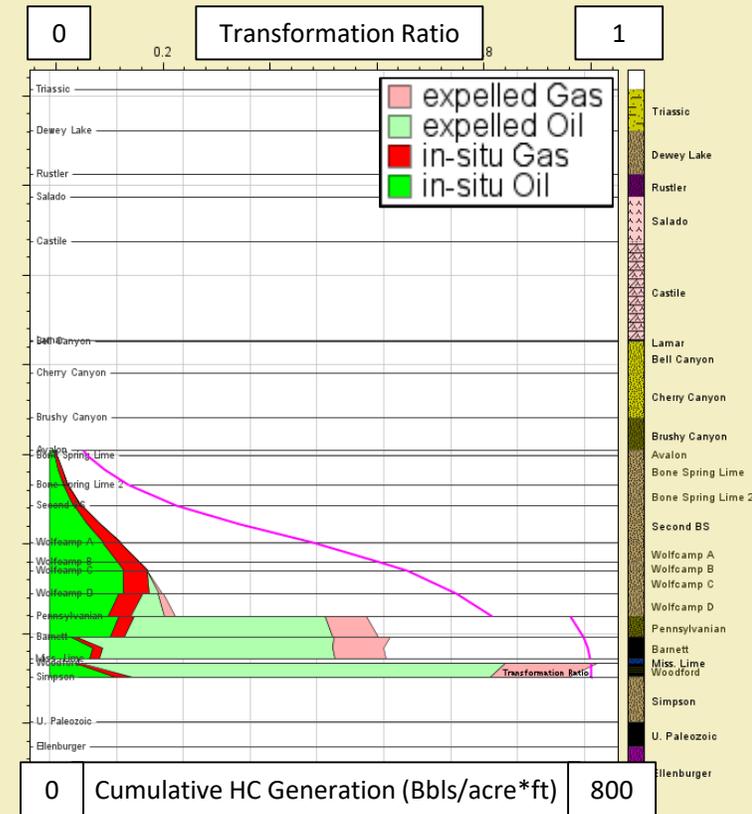
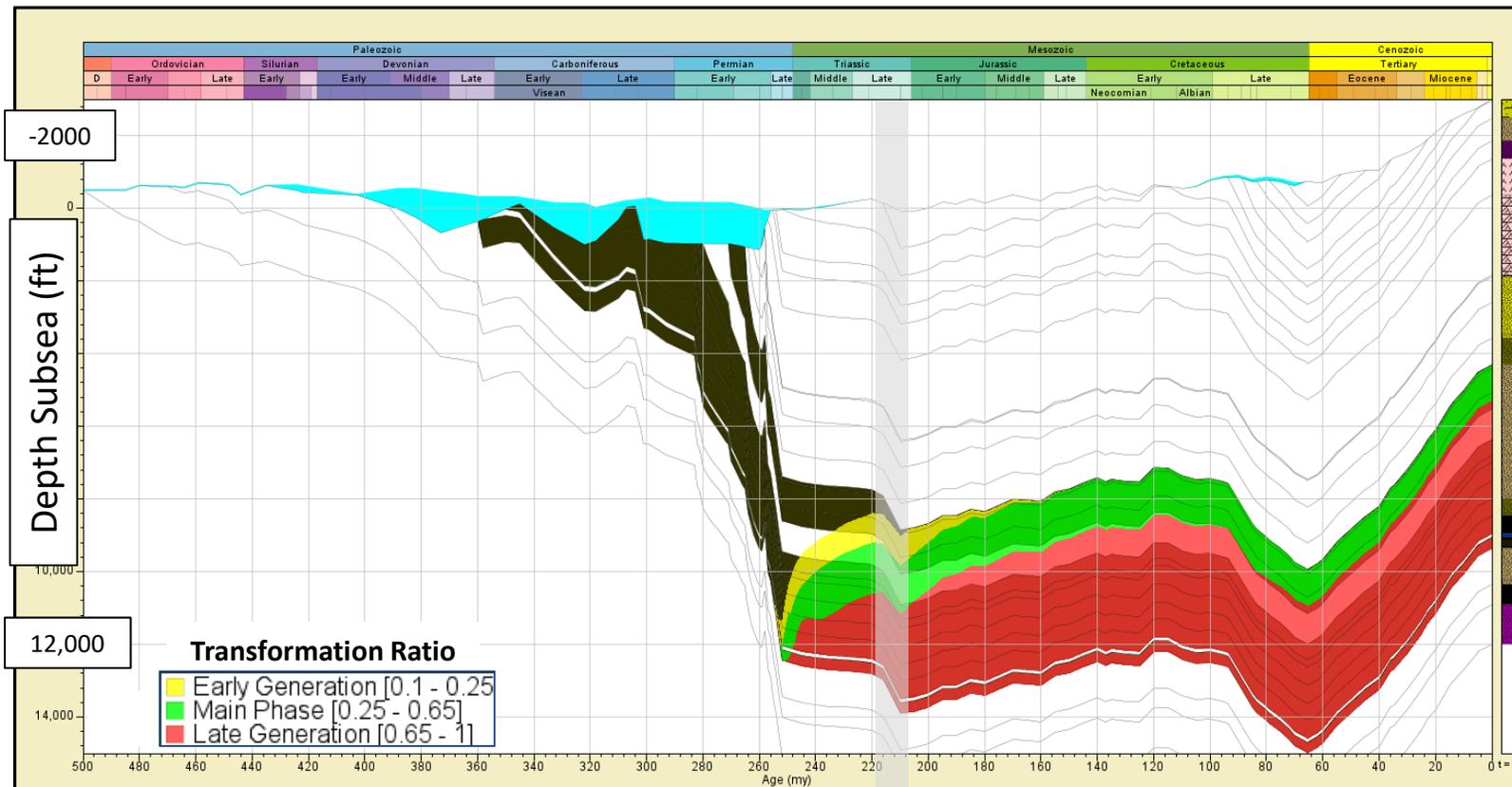
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Paleogeography



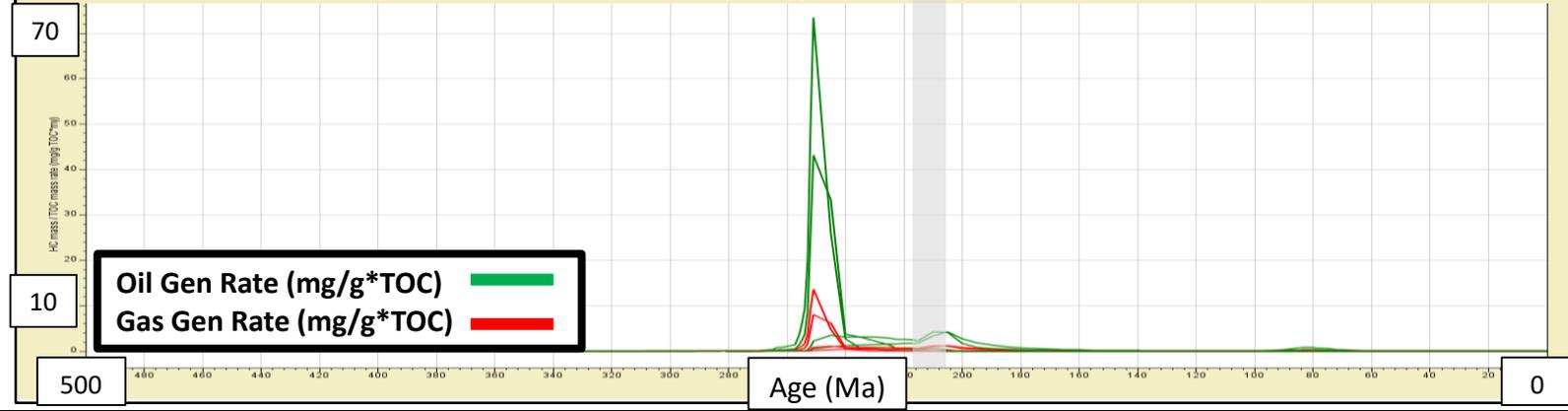
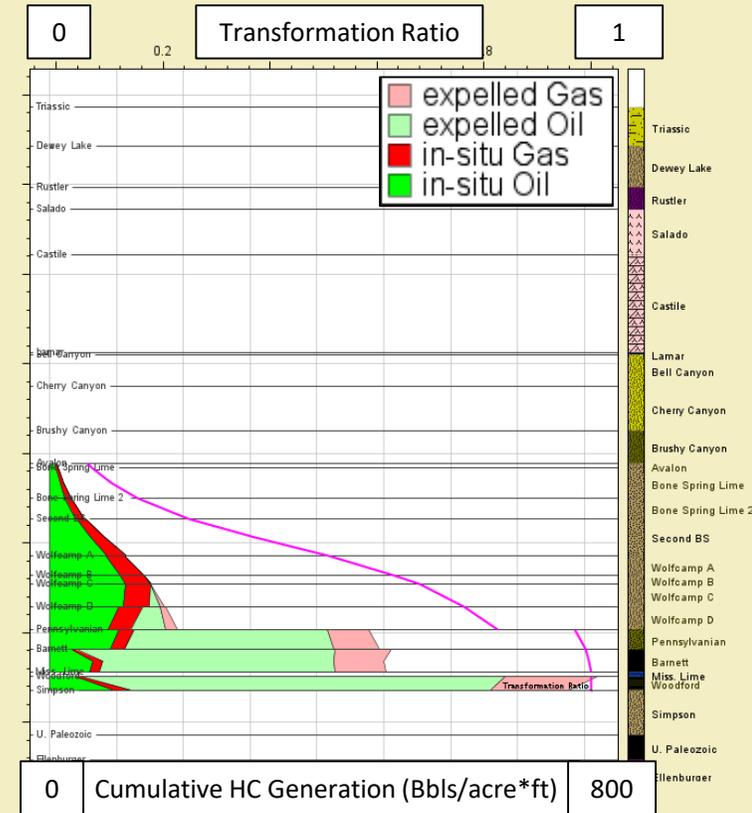
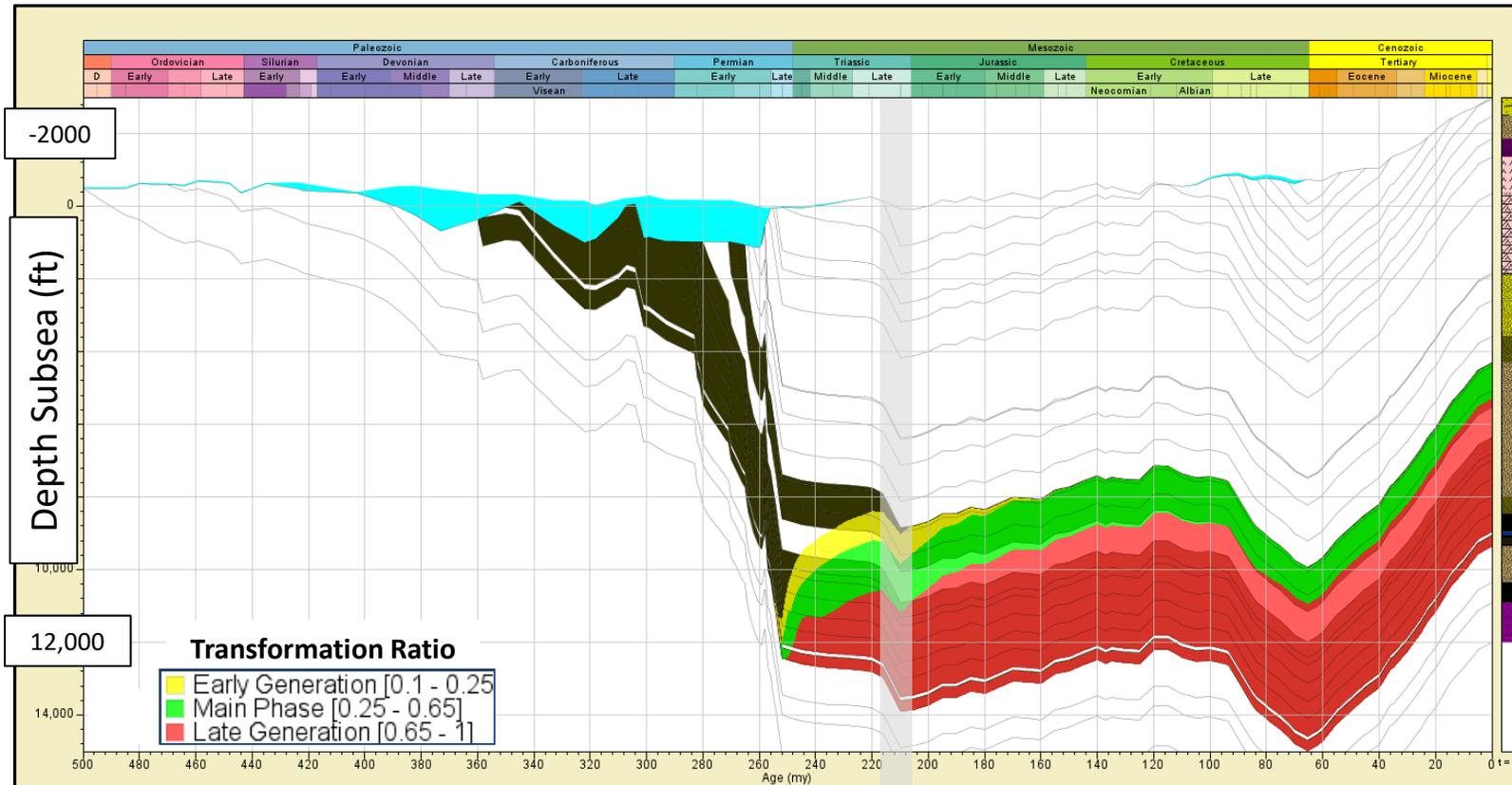
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Paleogeography



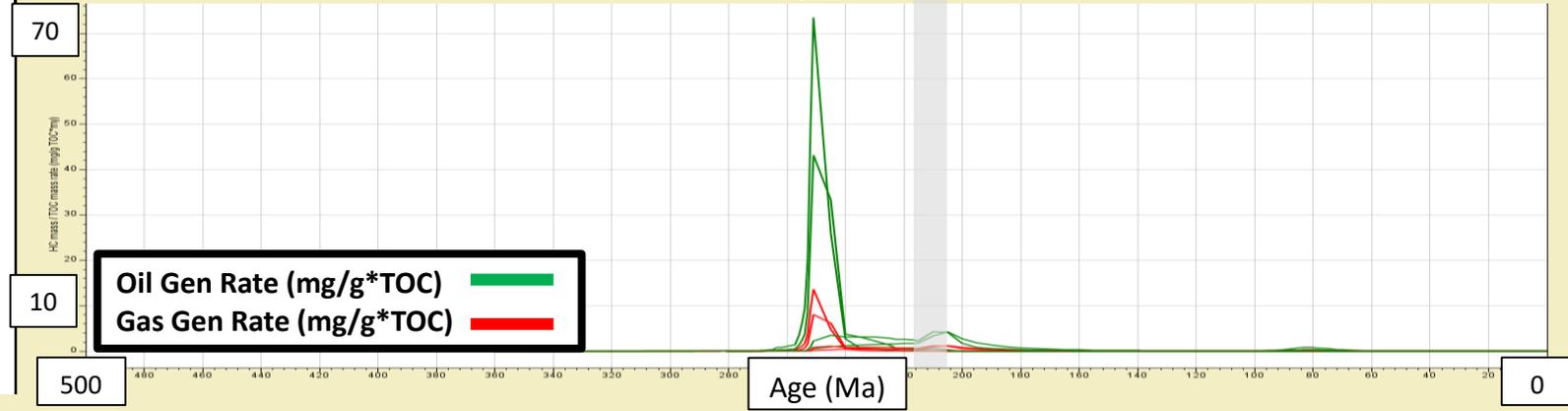
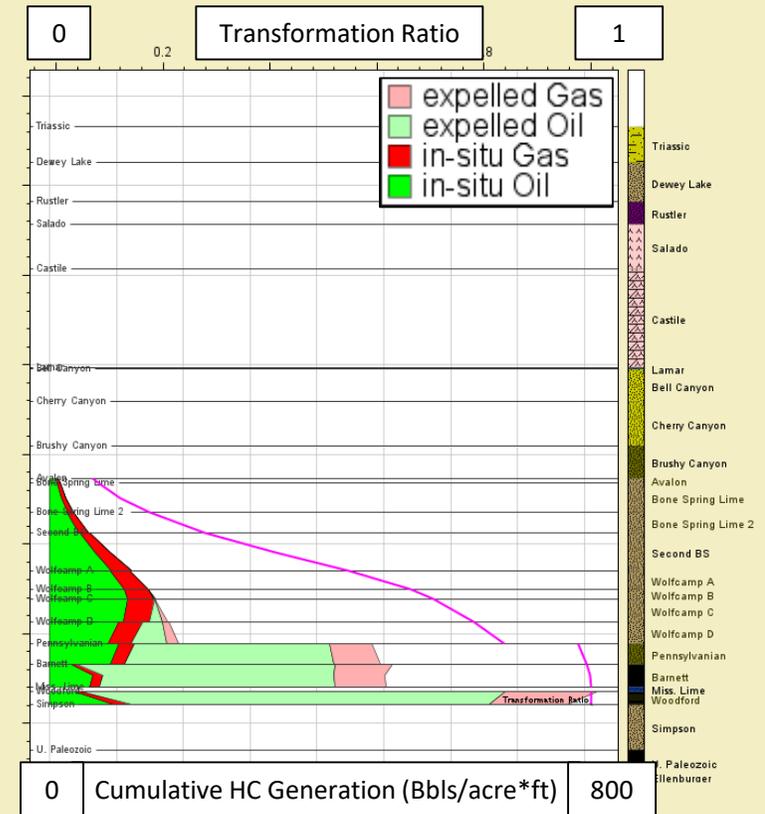
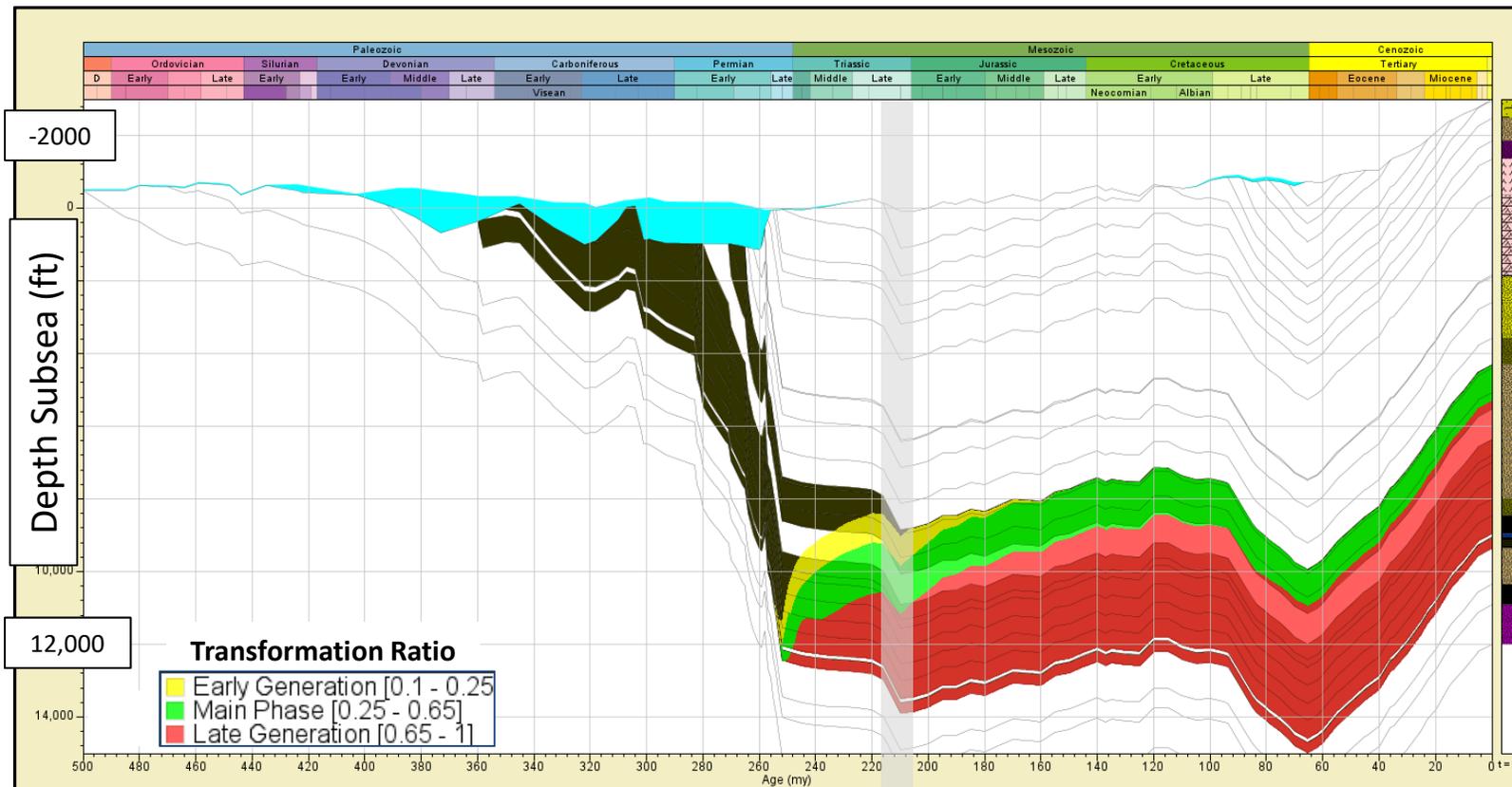
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Paleogeography



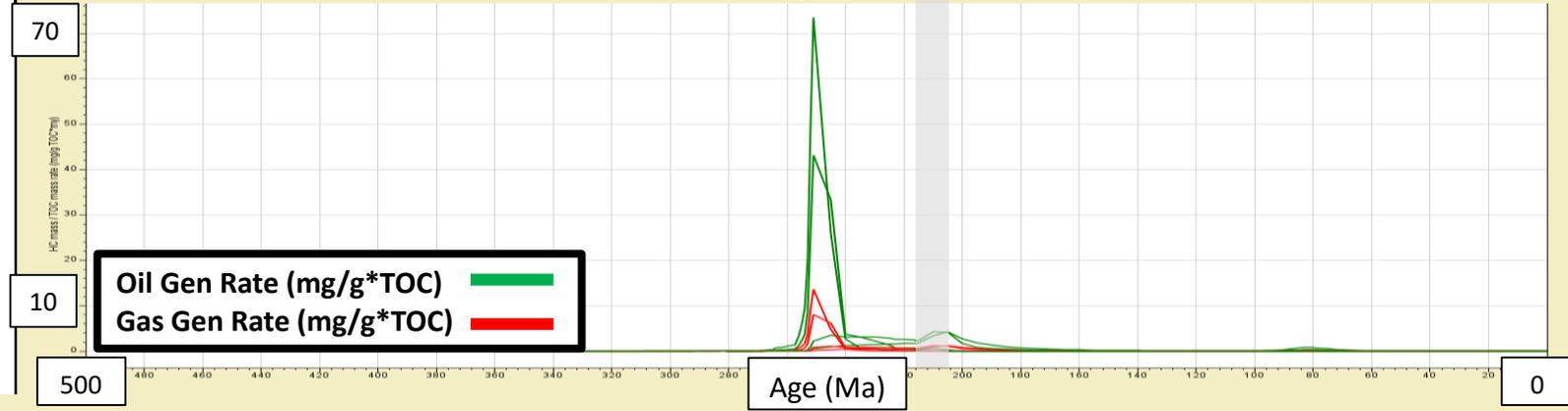
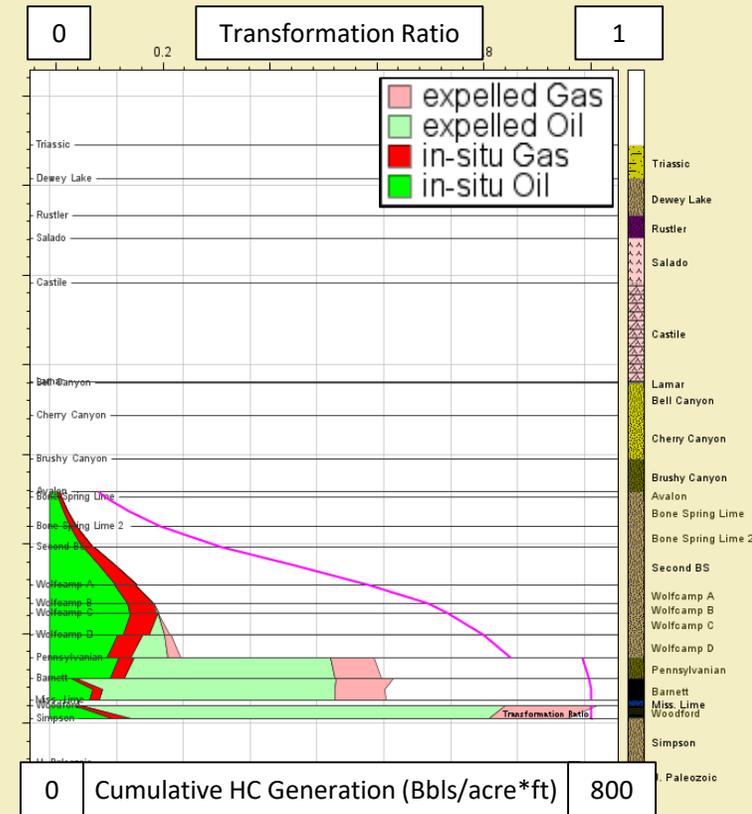
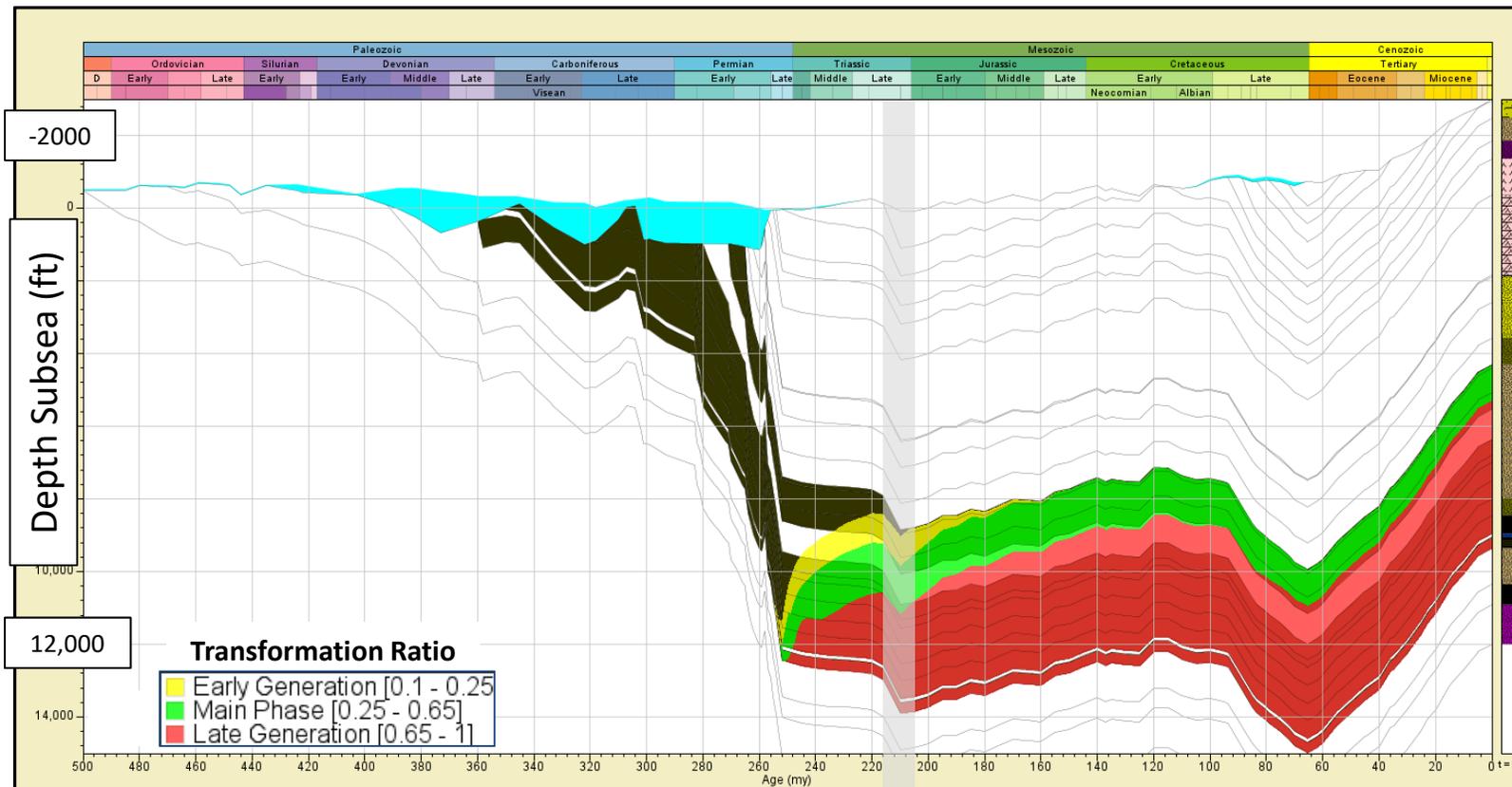
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Paleogeography



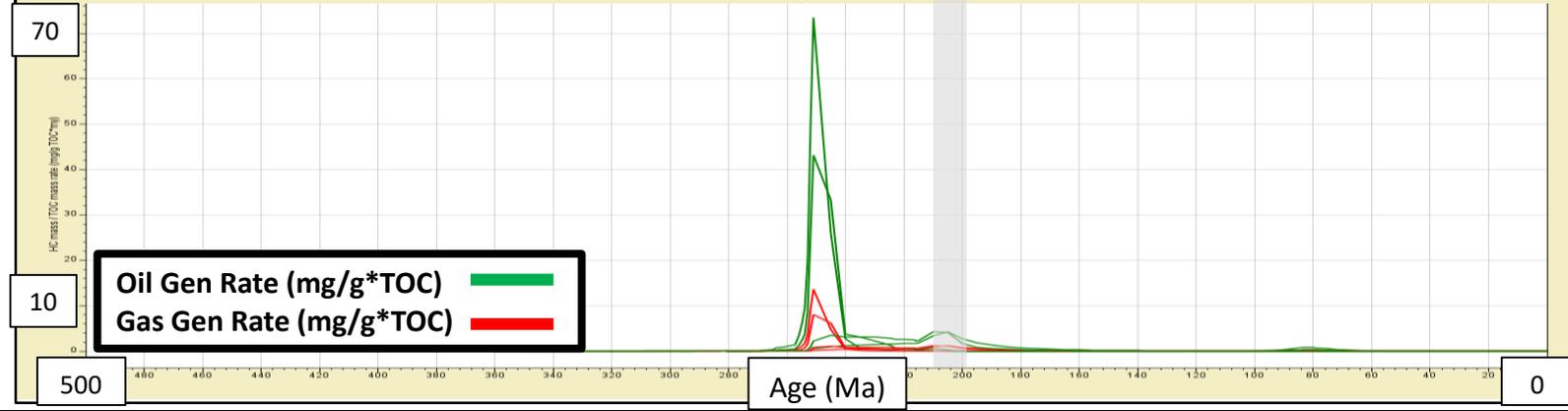
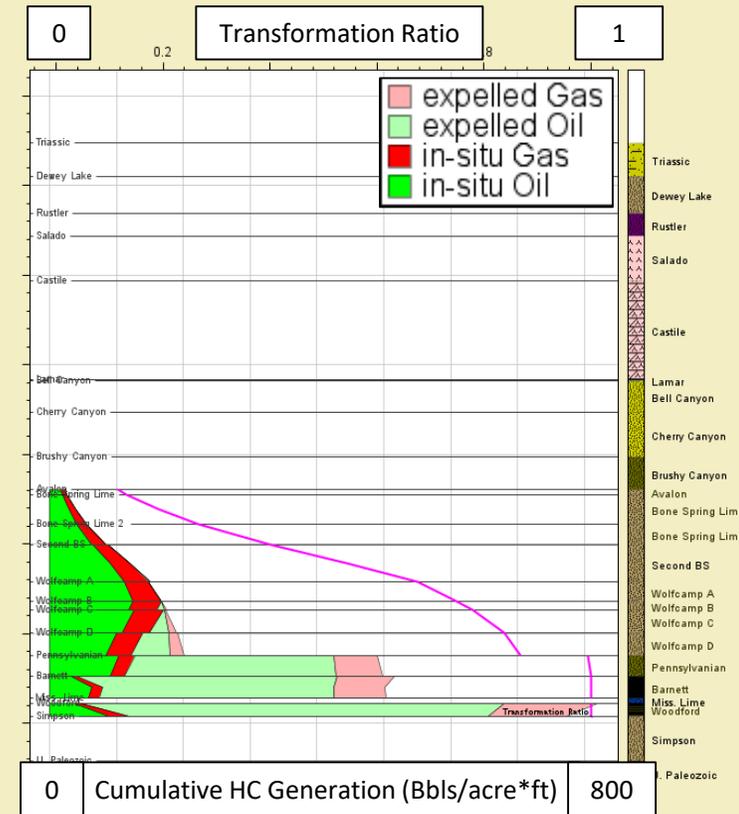
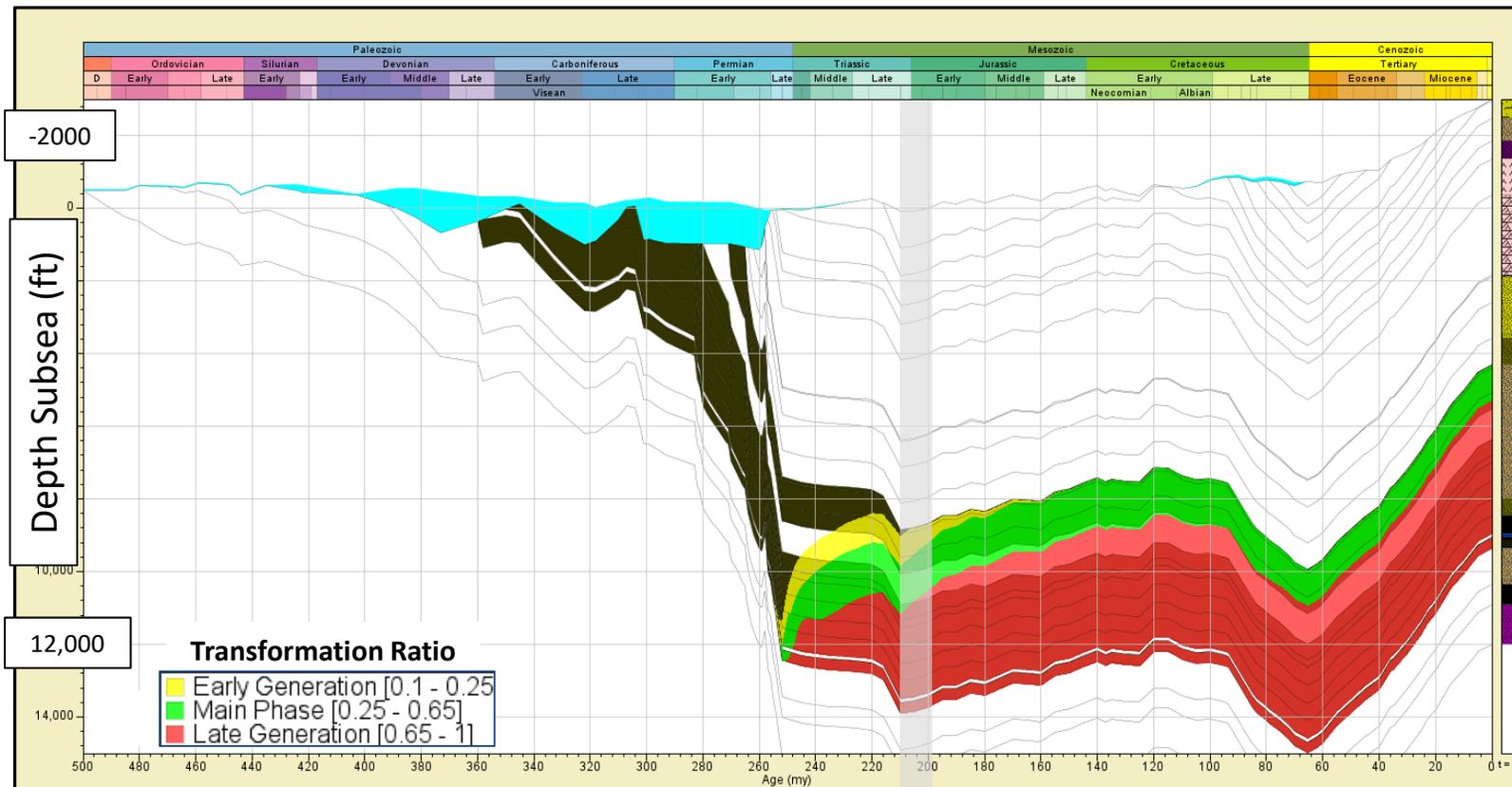
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Paleogeography



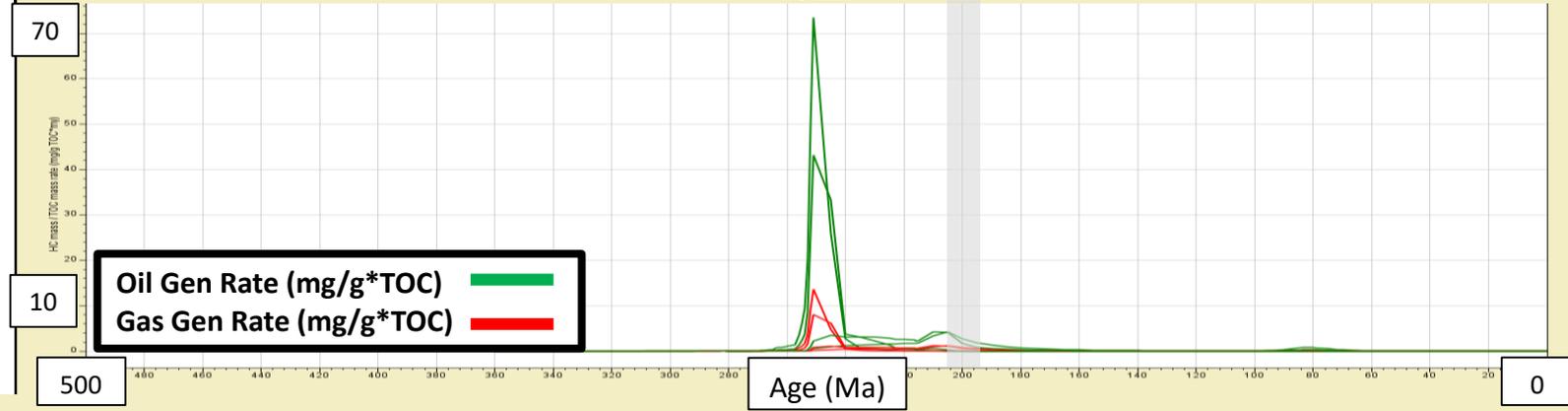
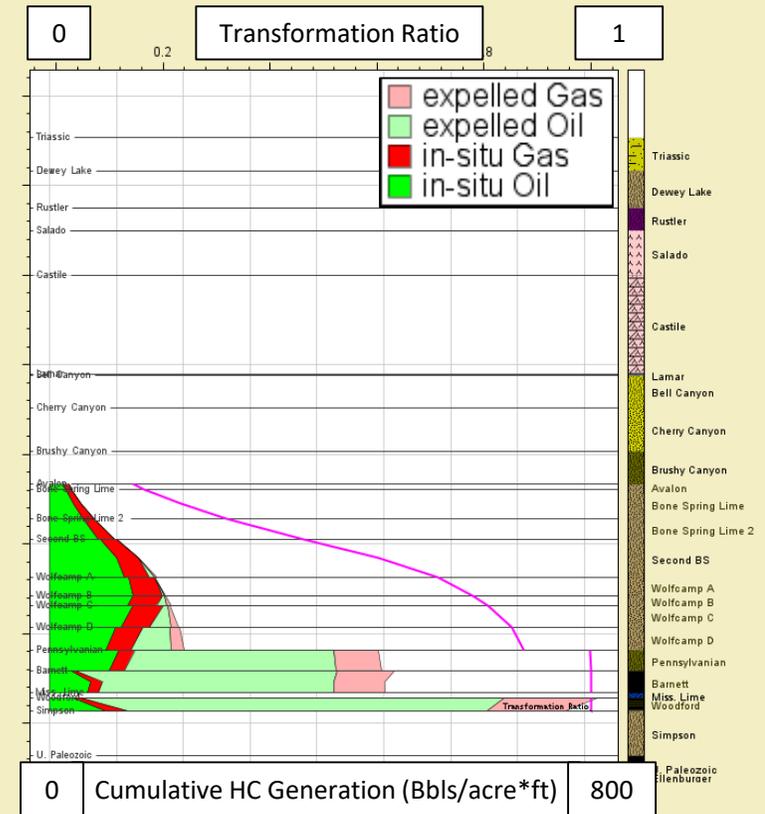
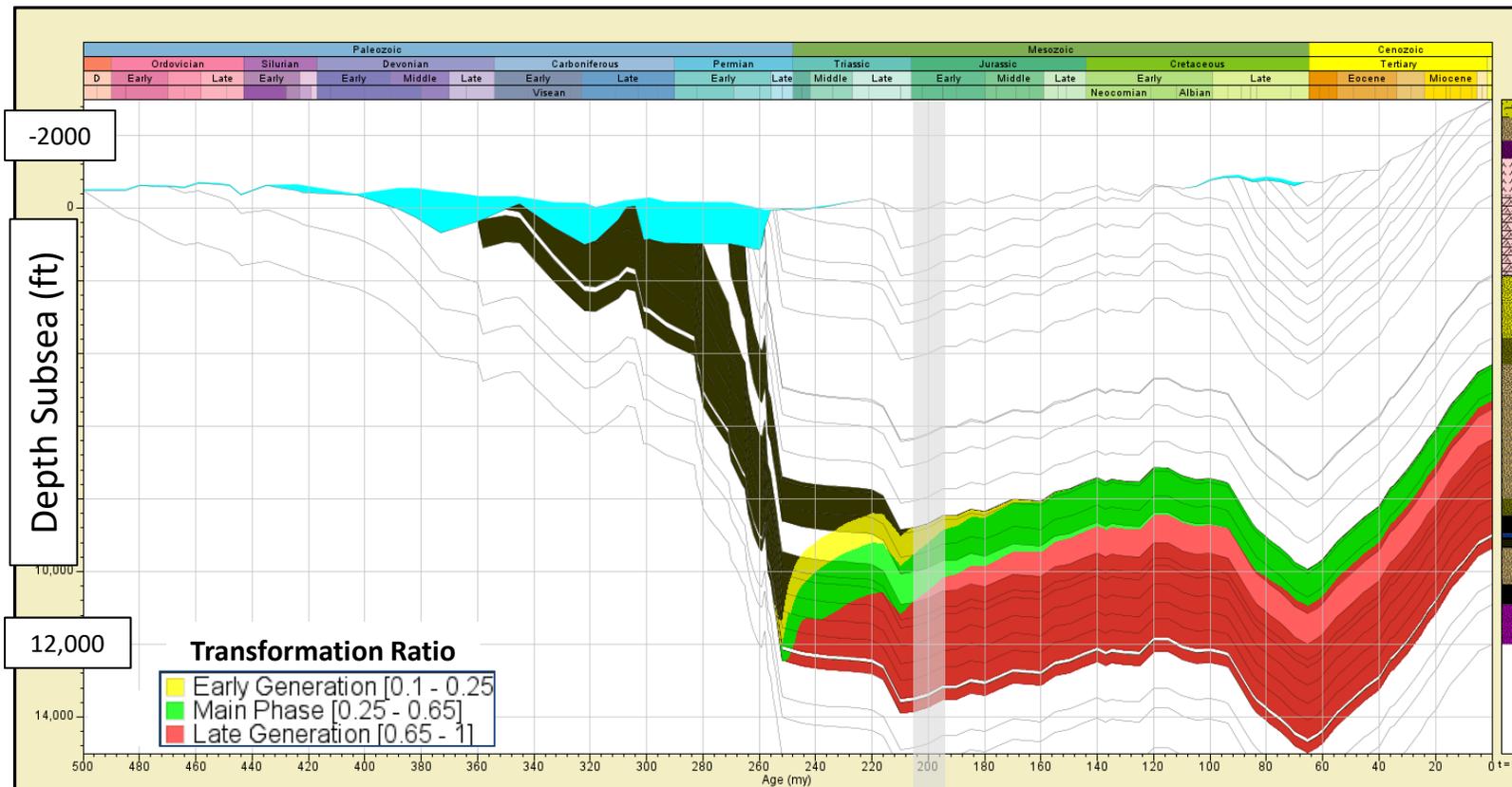
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Paleogeography



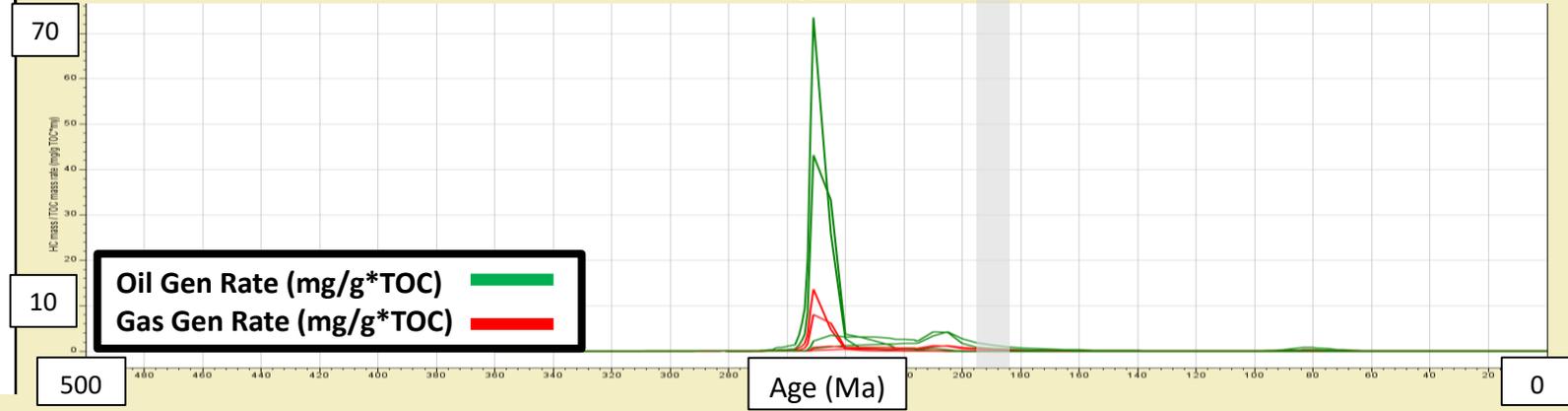
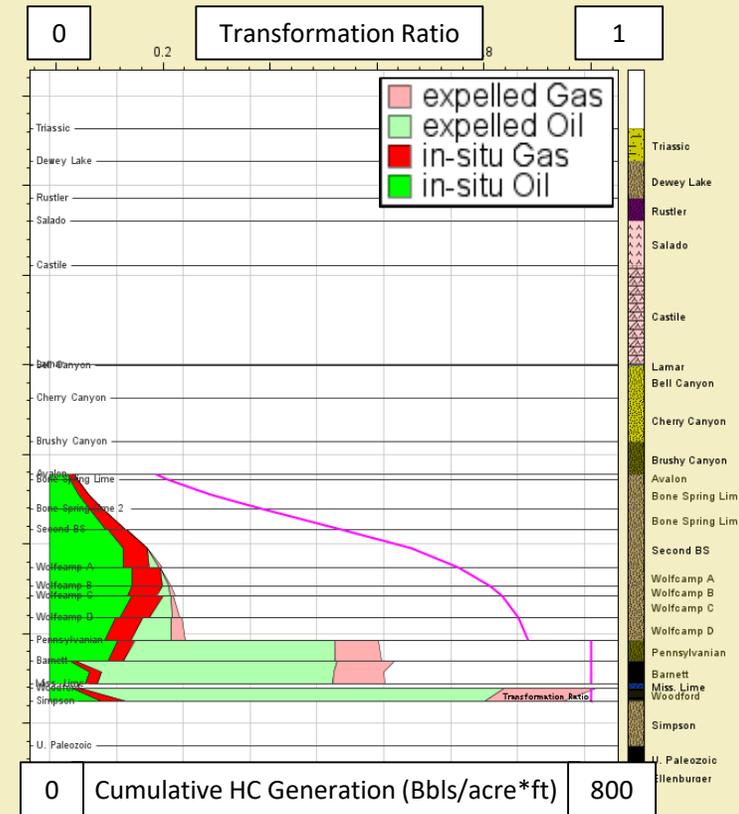
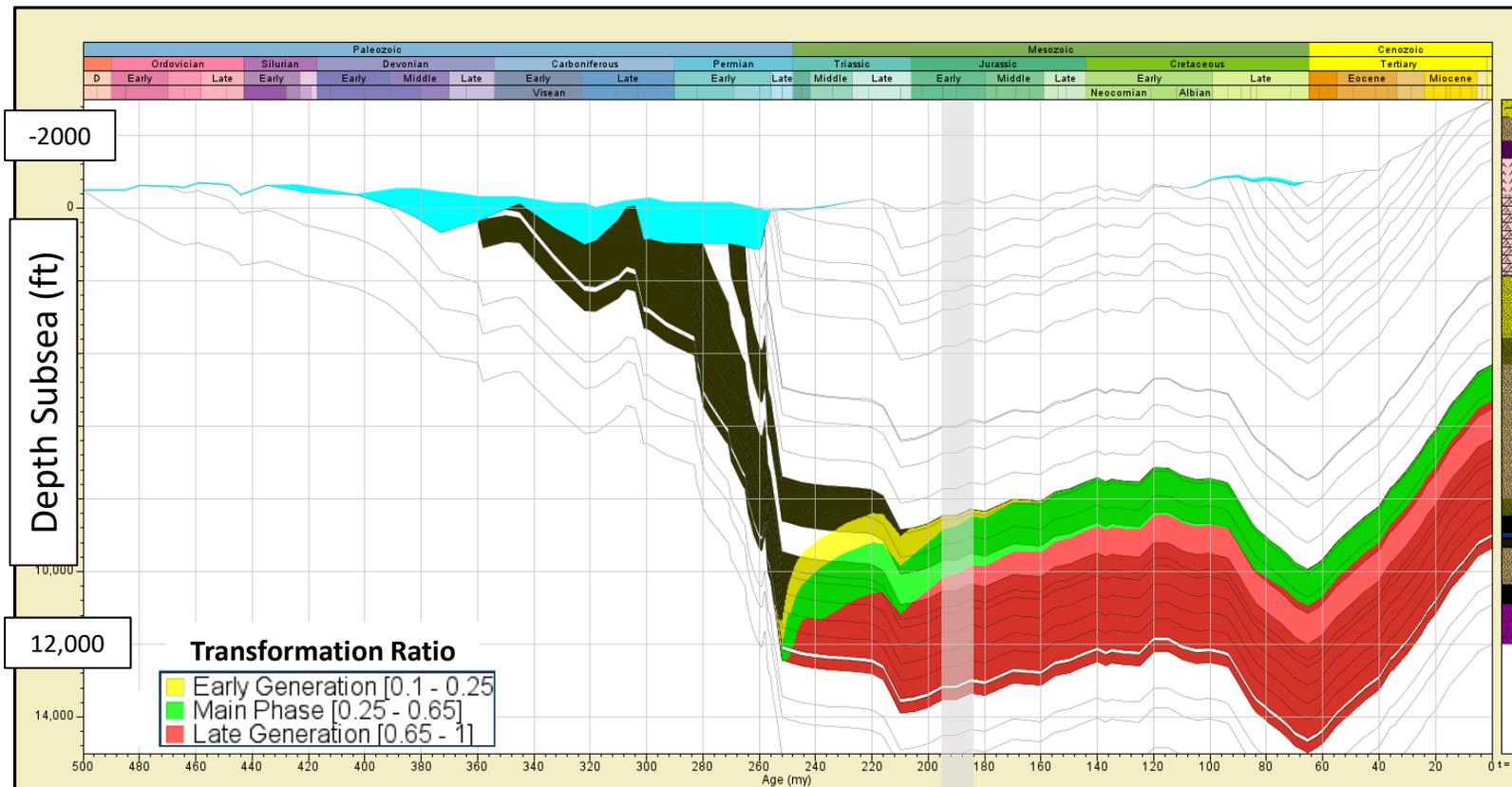
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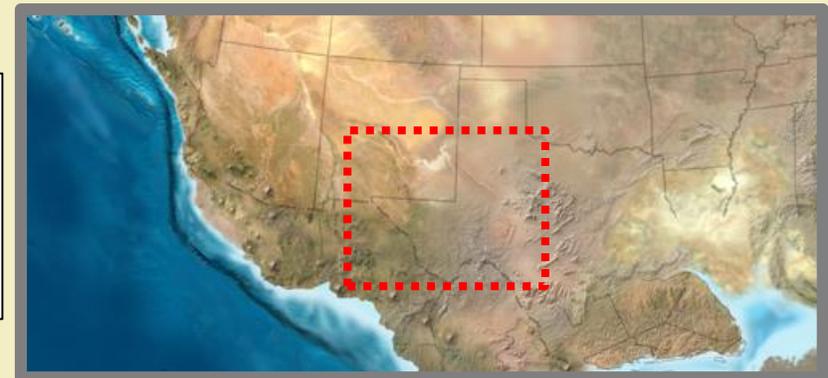
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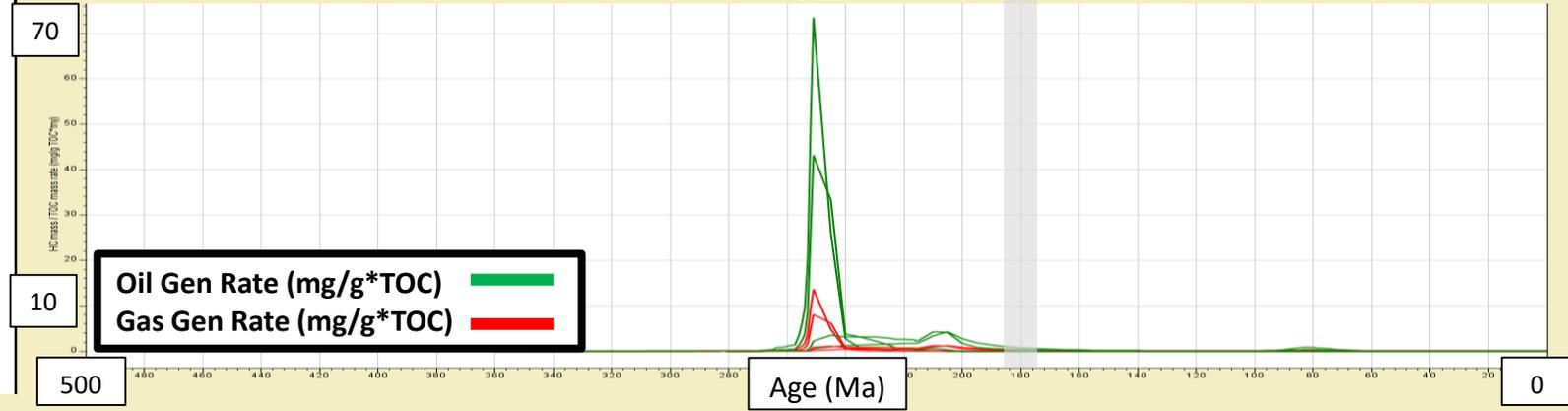
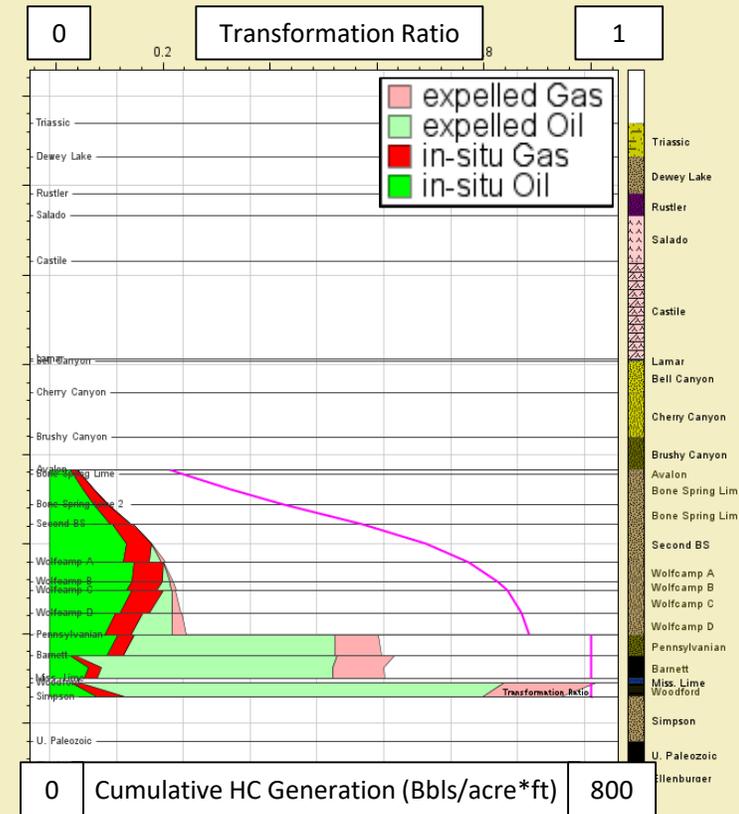
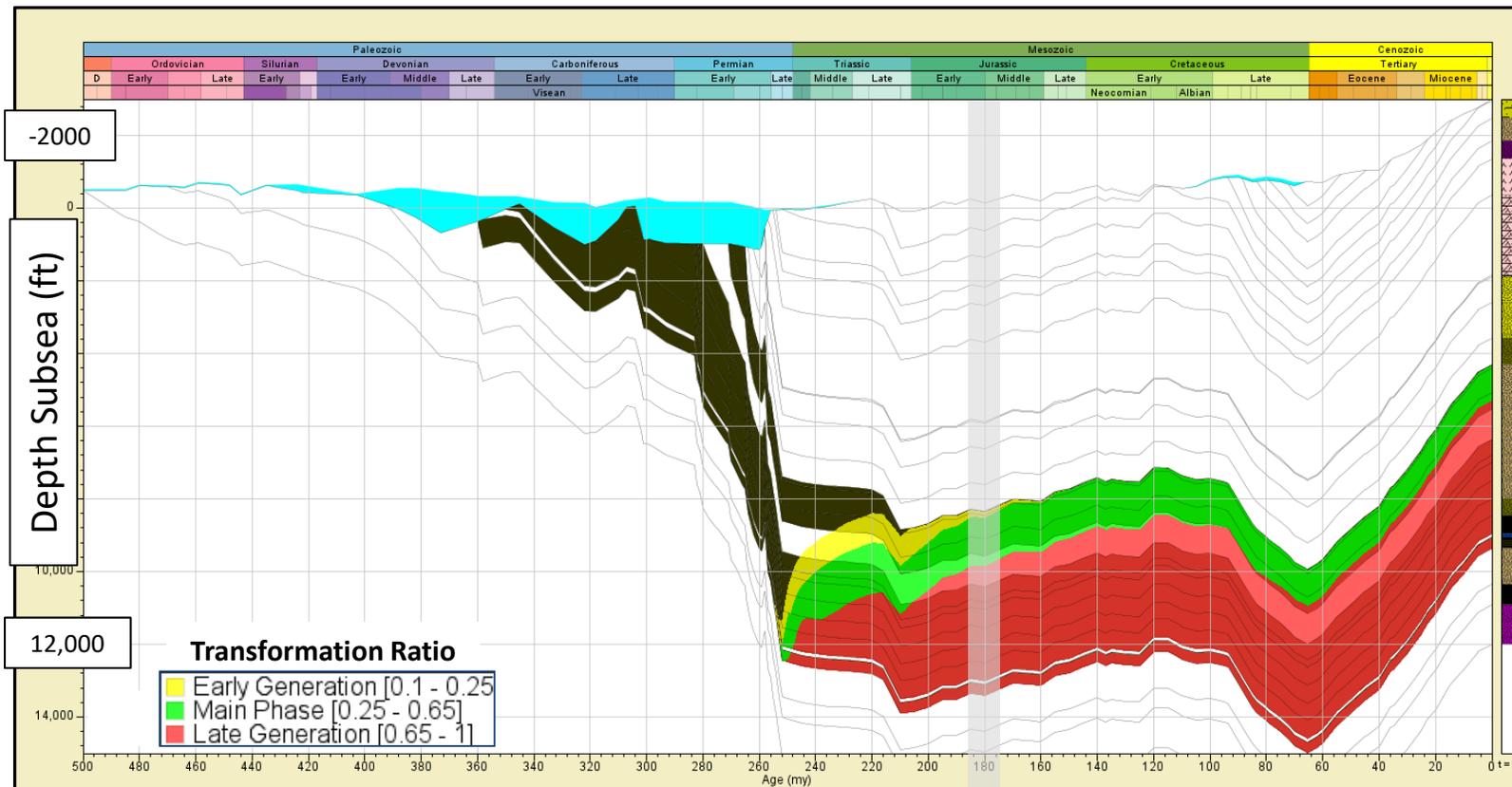
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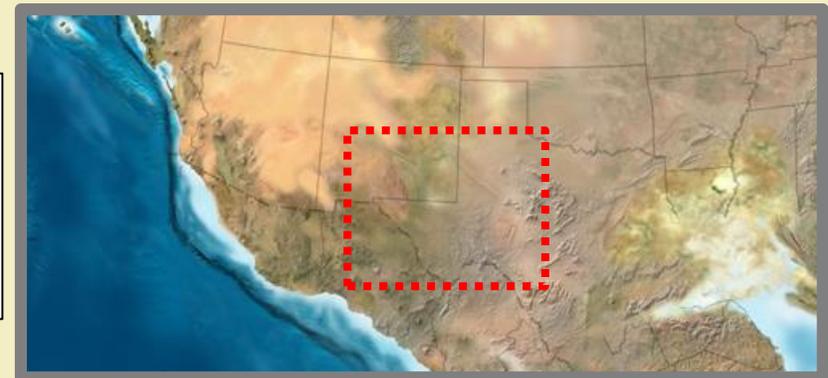
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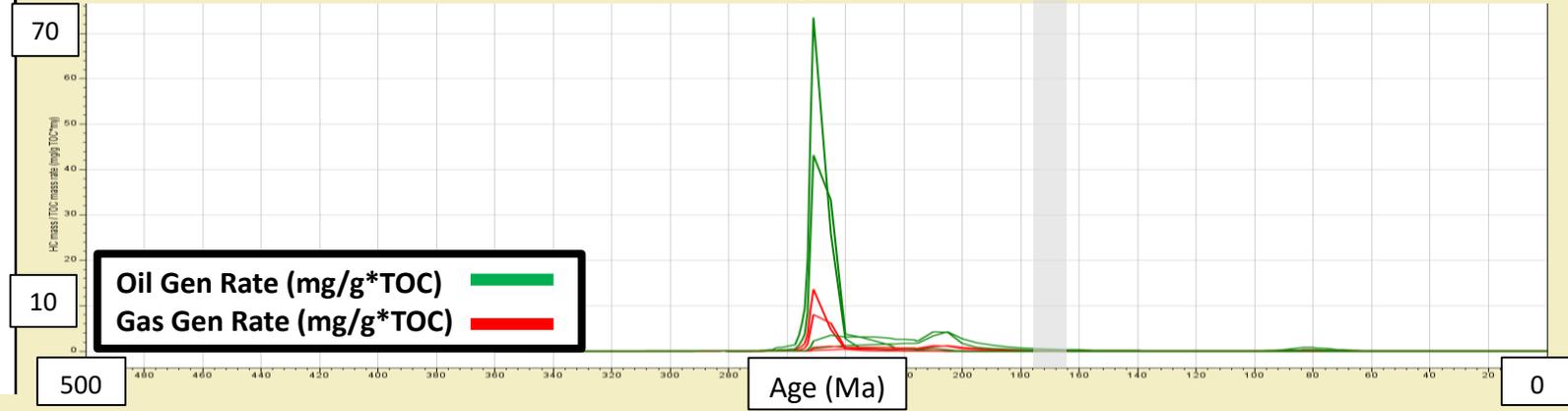
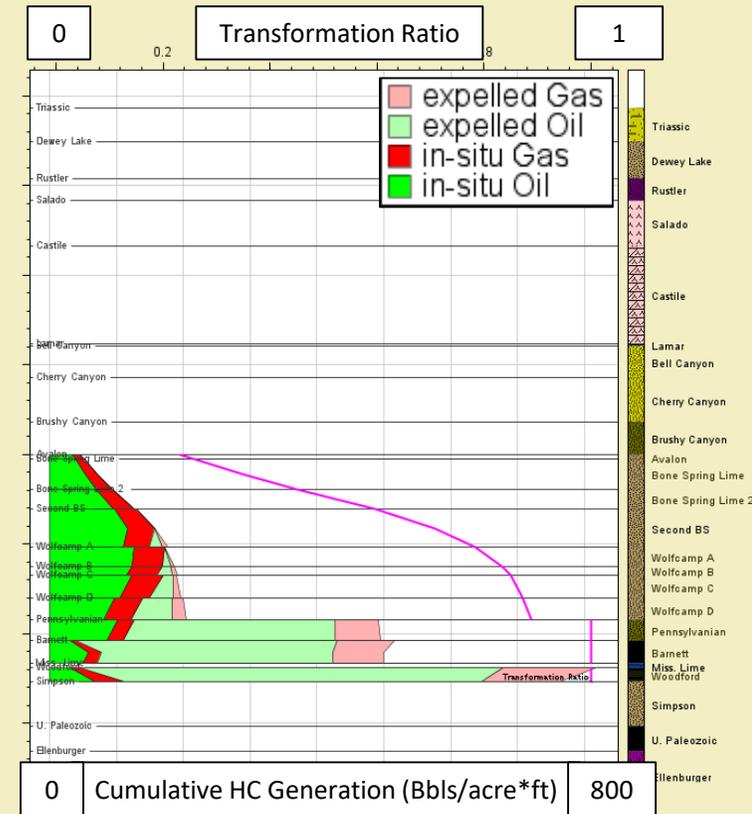
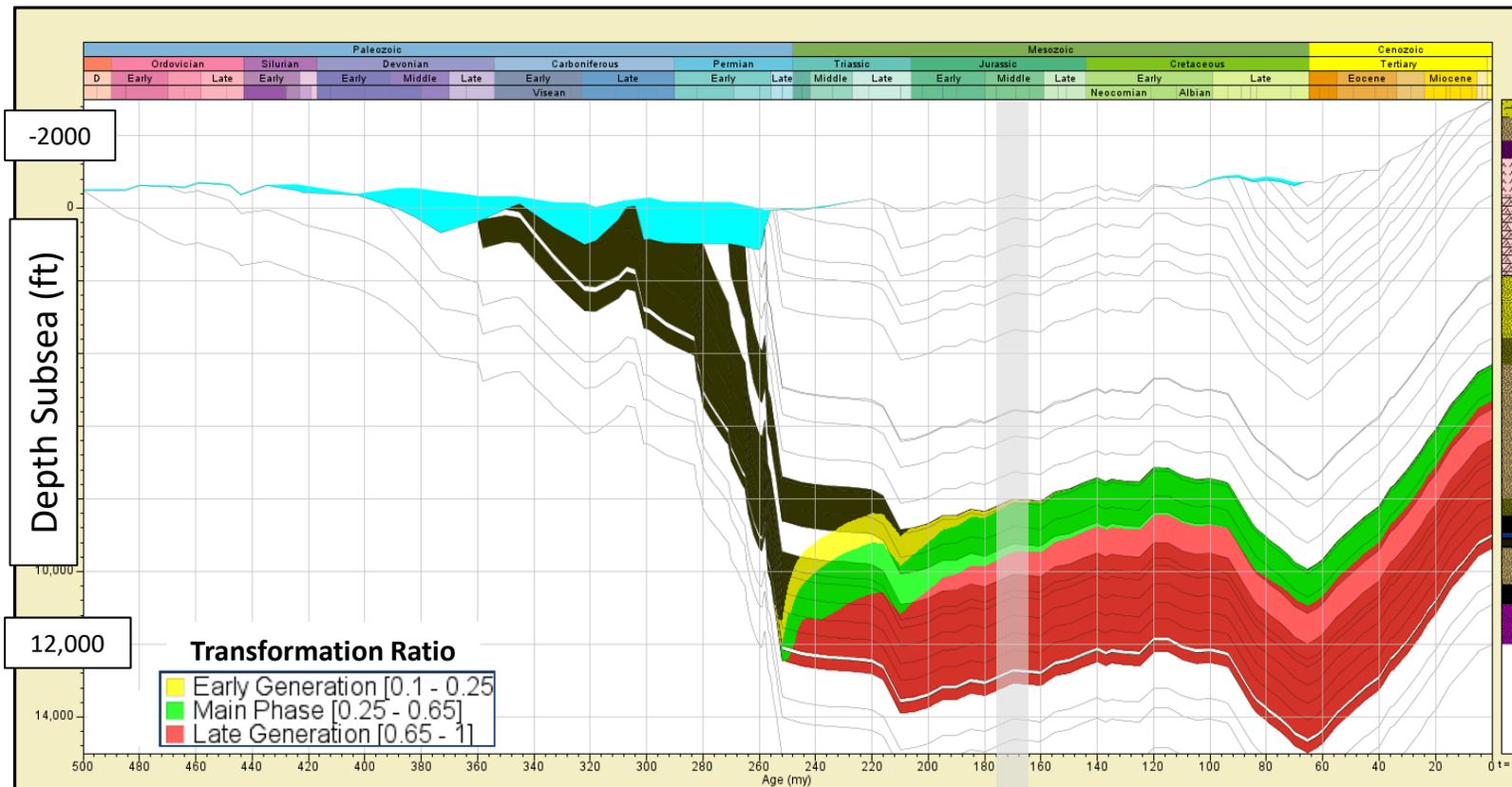
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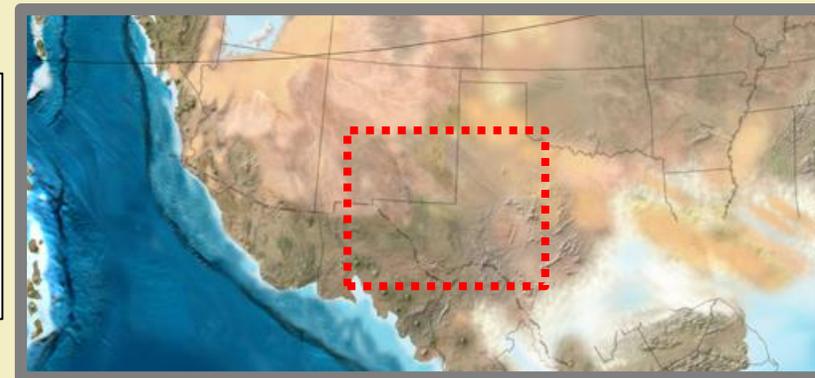
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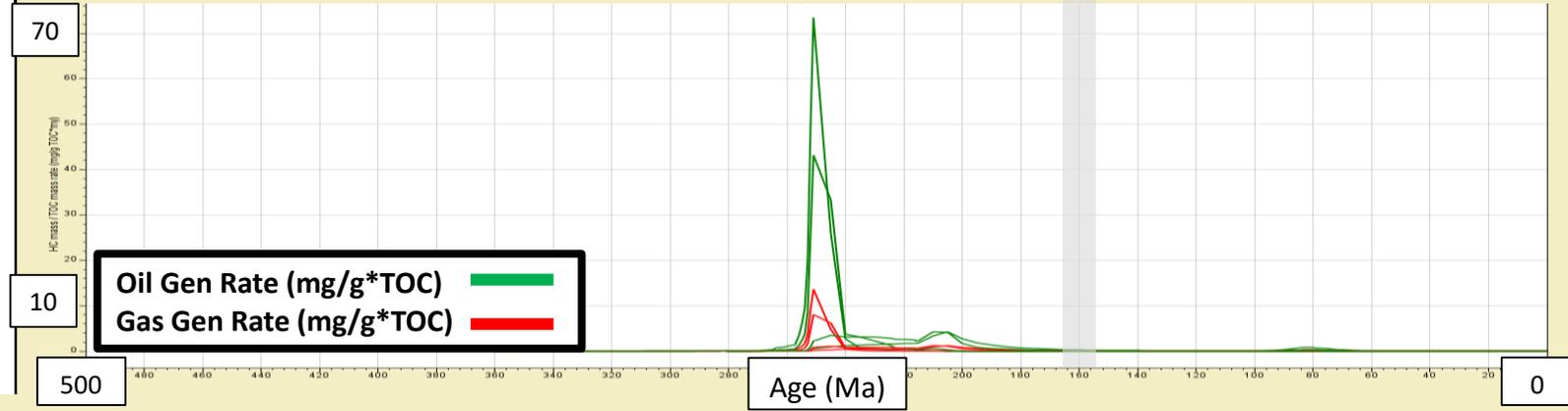
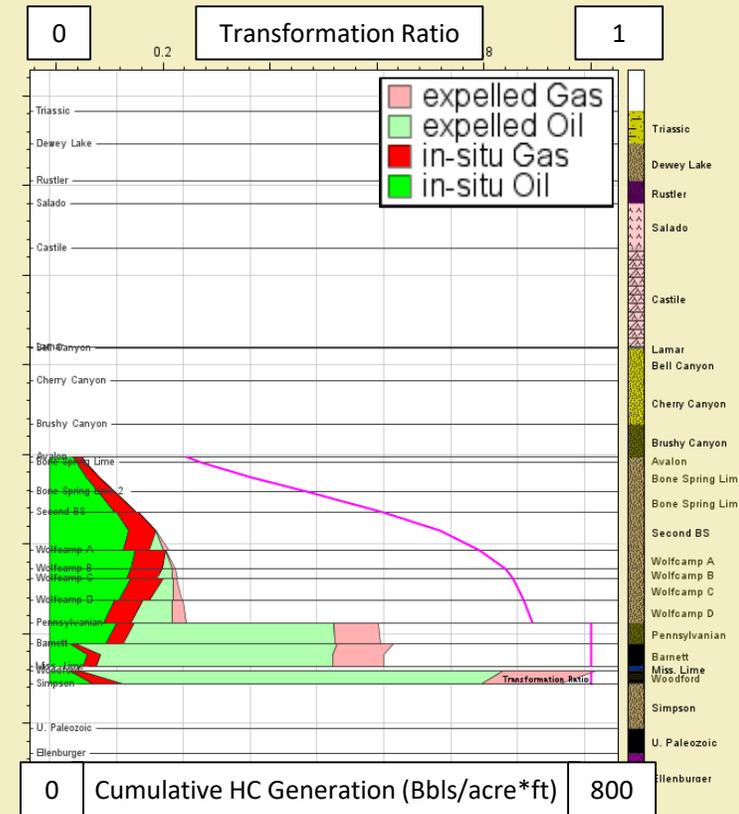
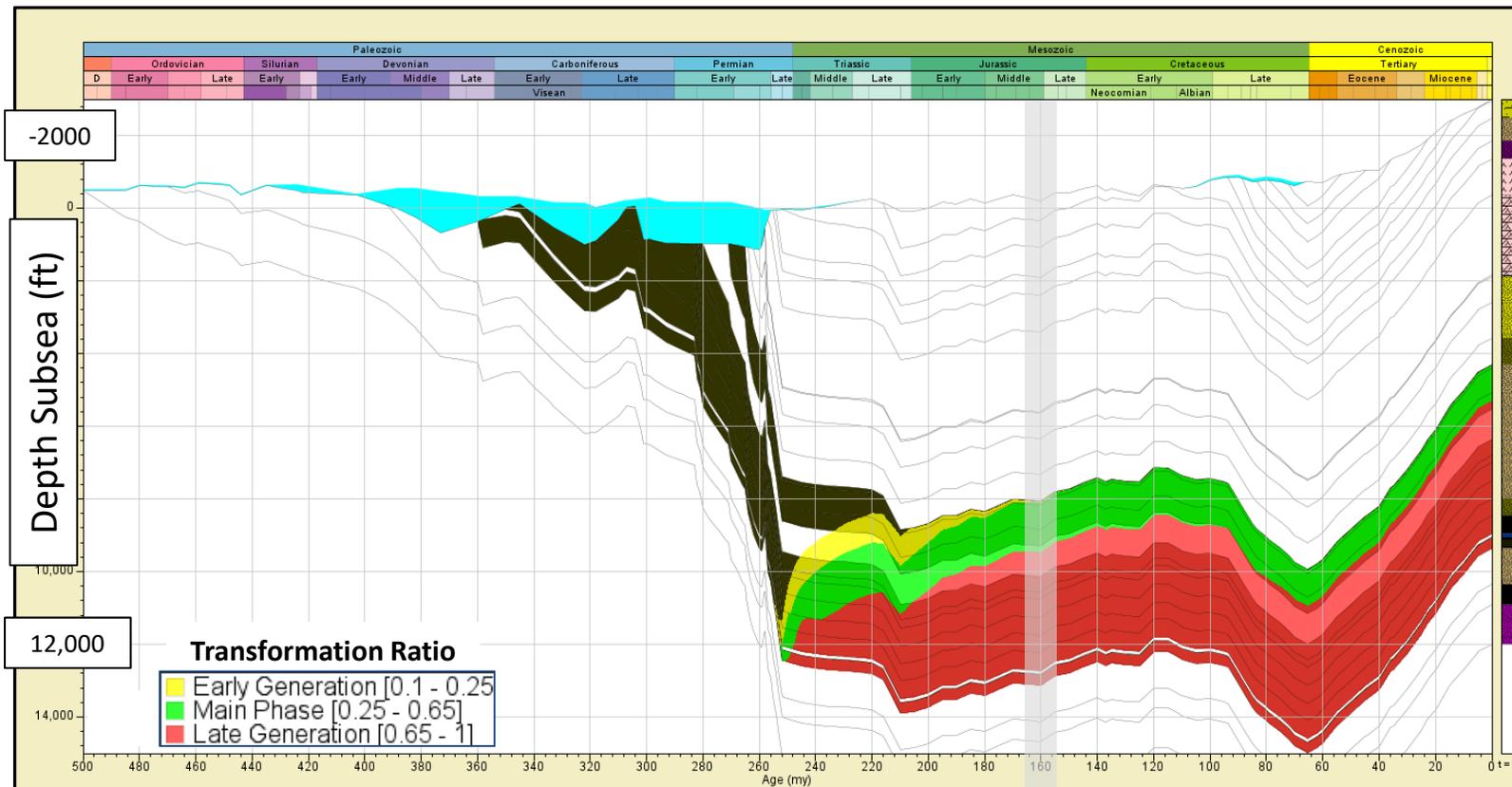
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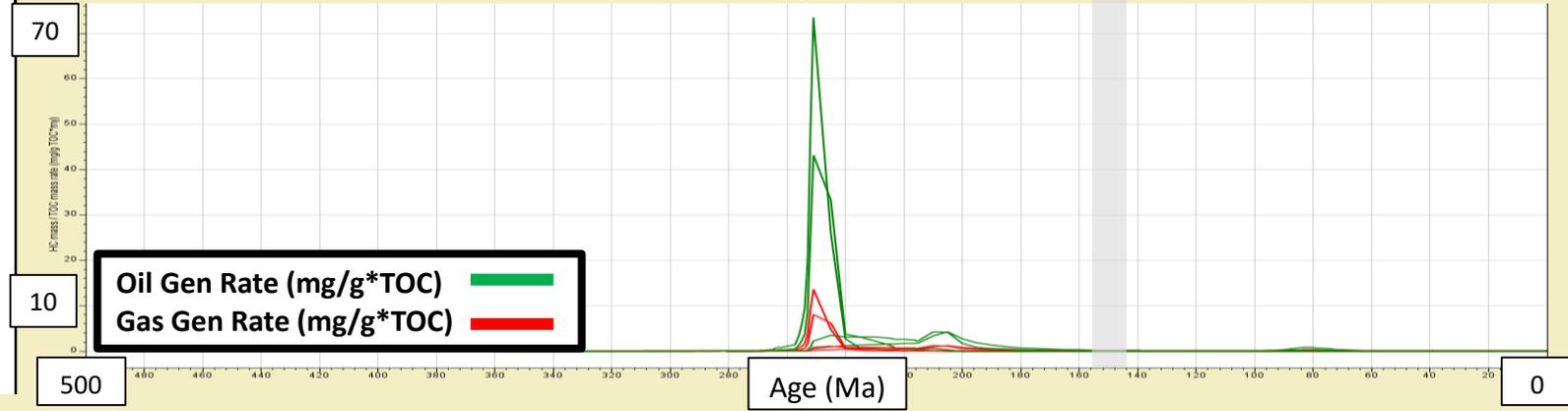
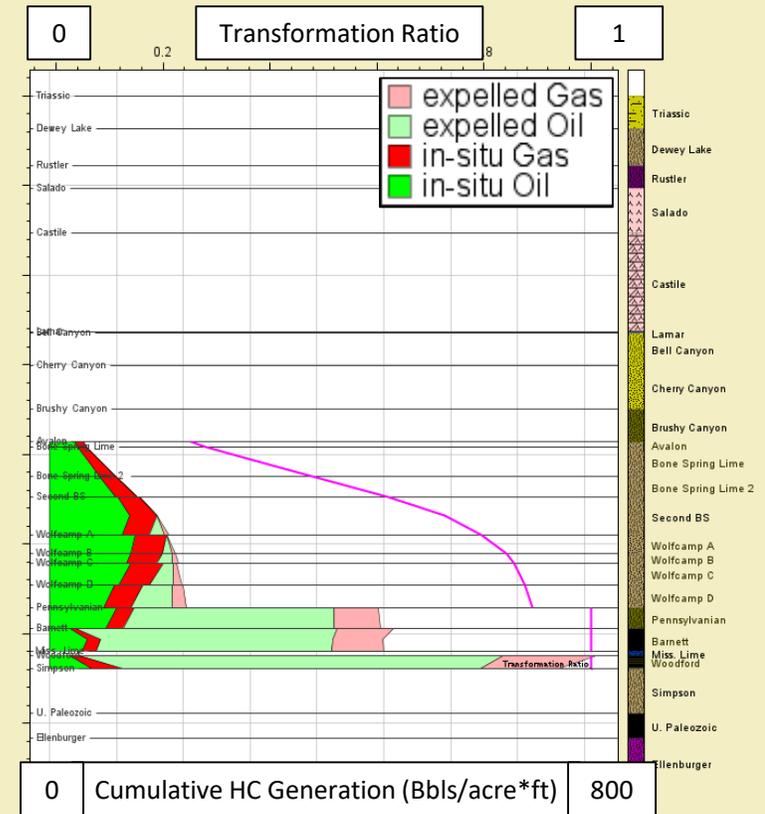
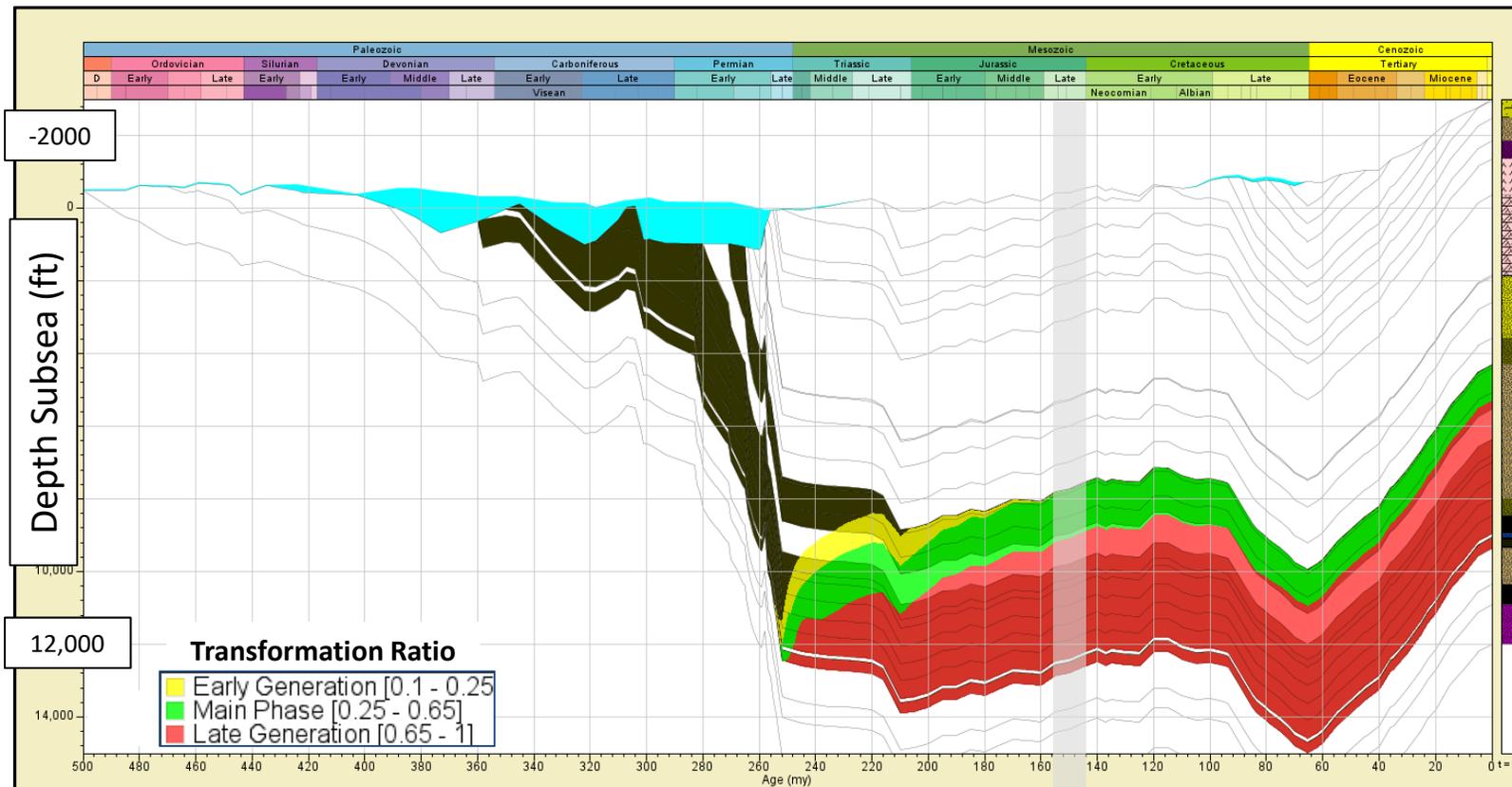
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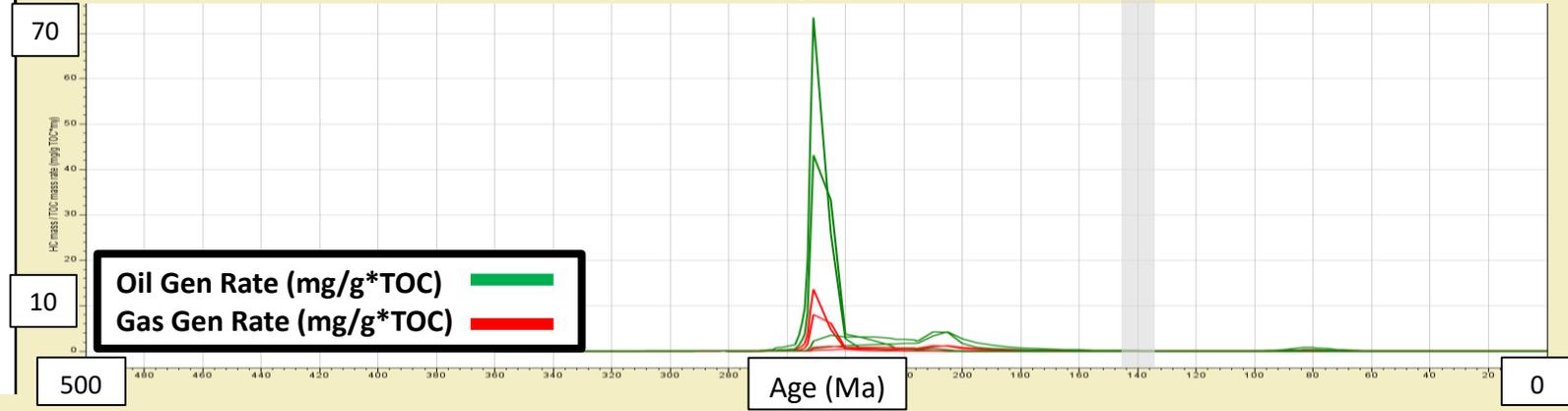
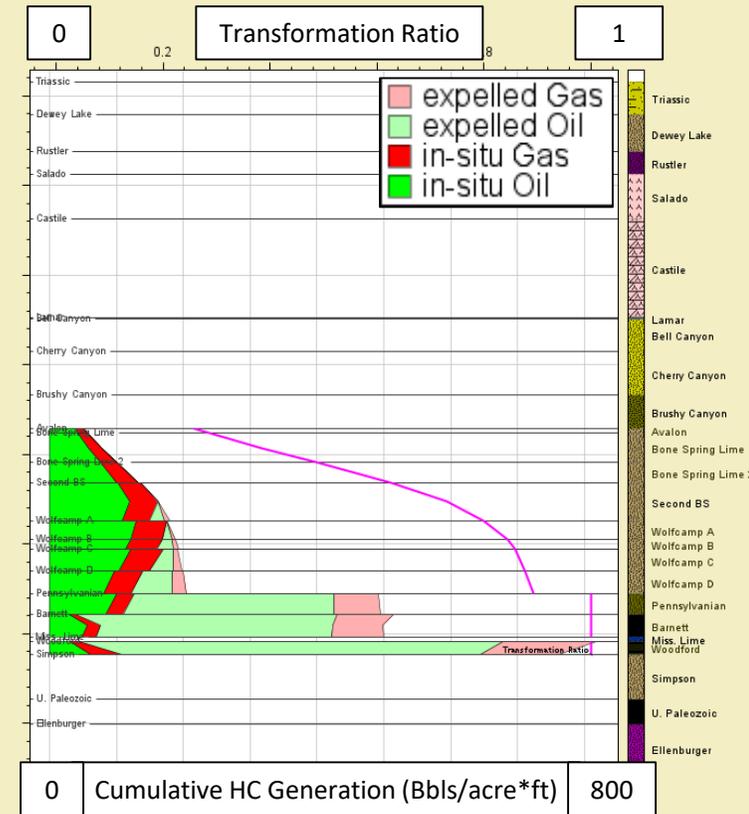
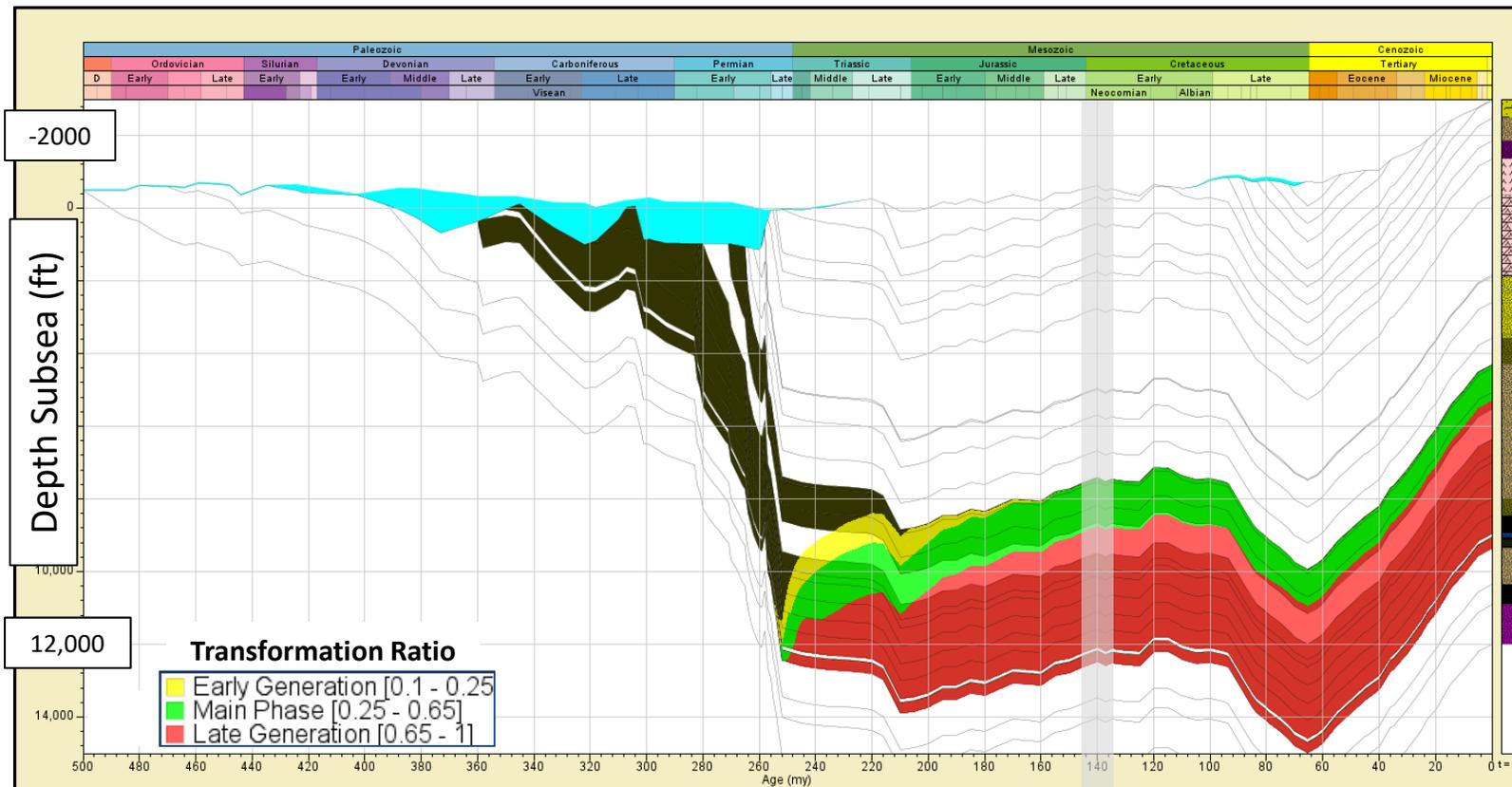
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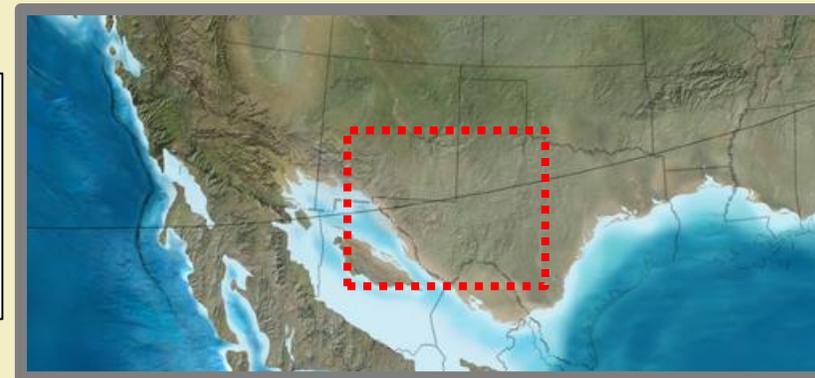
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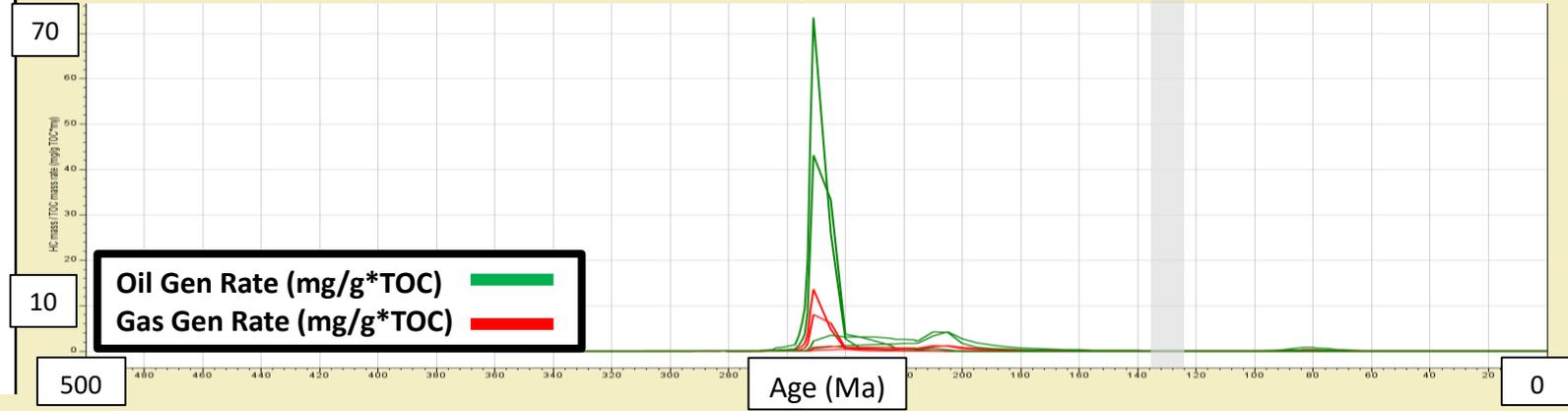
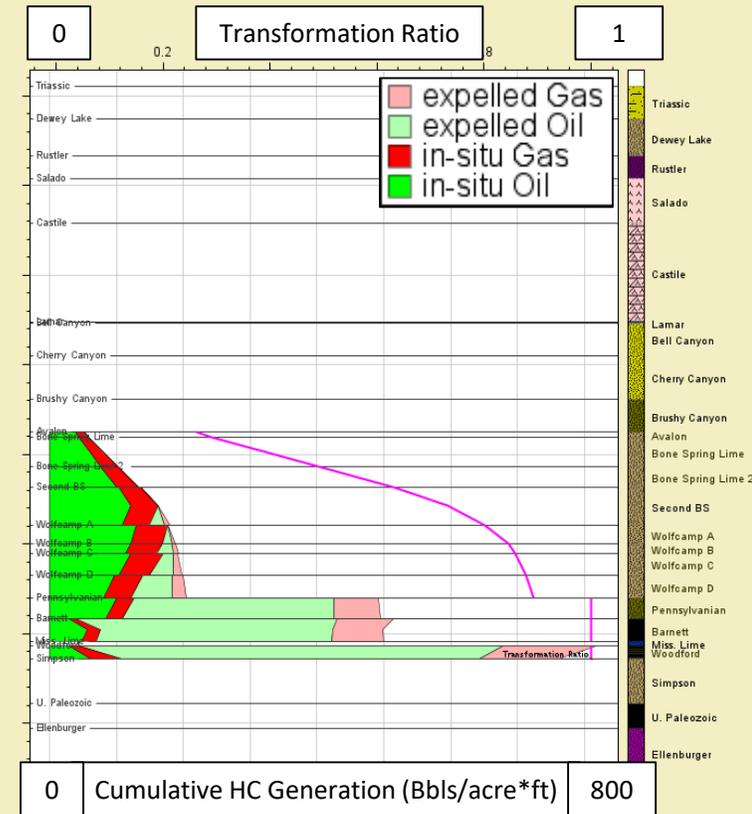
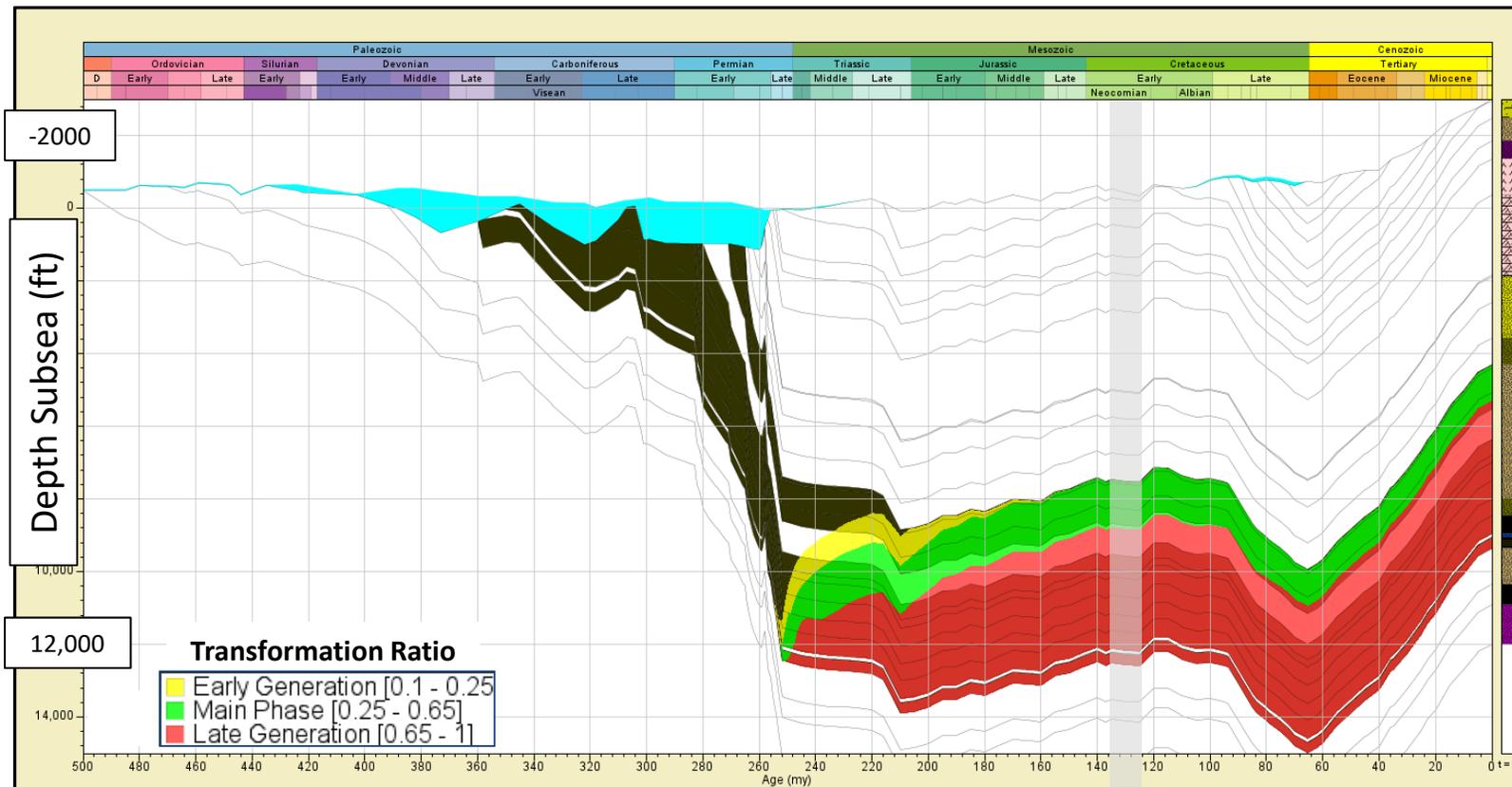
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Paleogeography



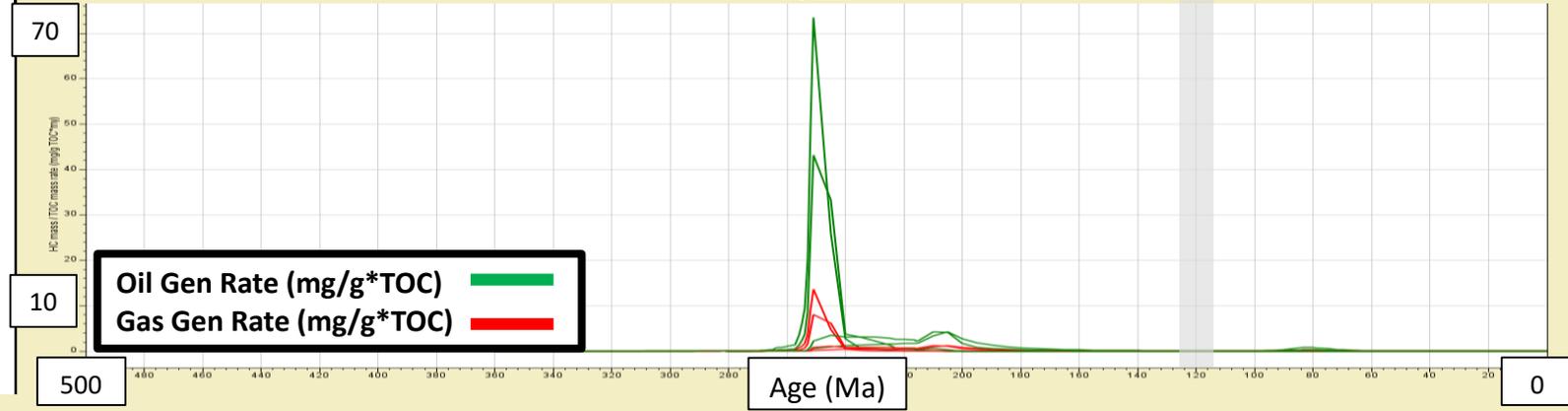
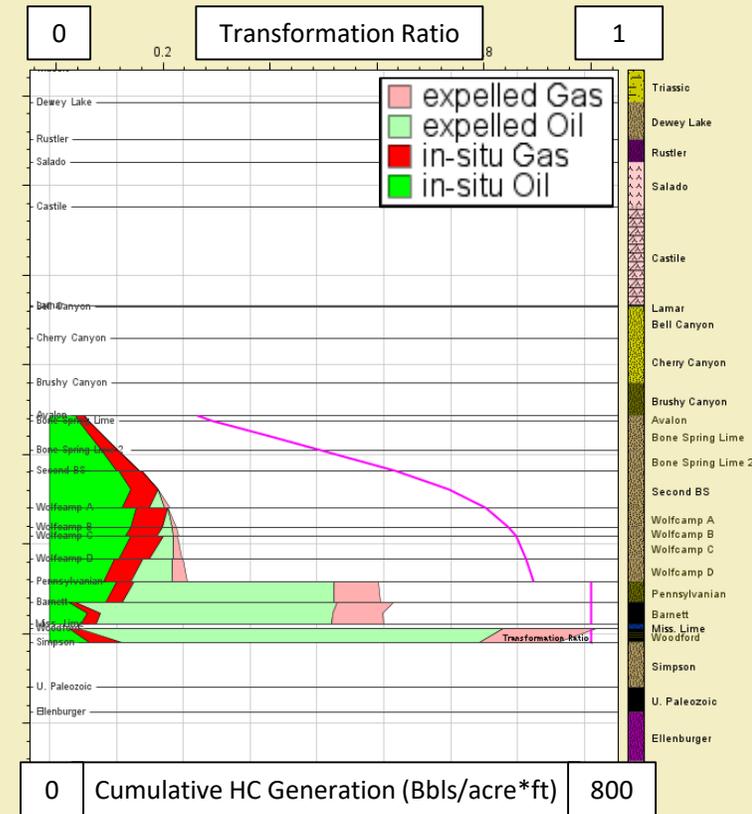
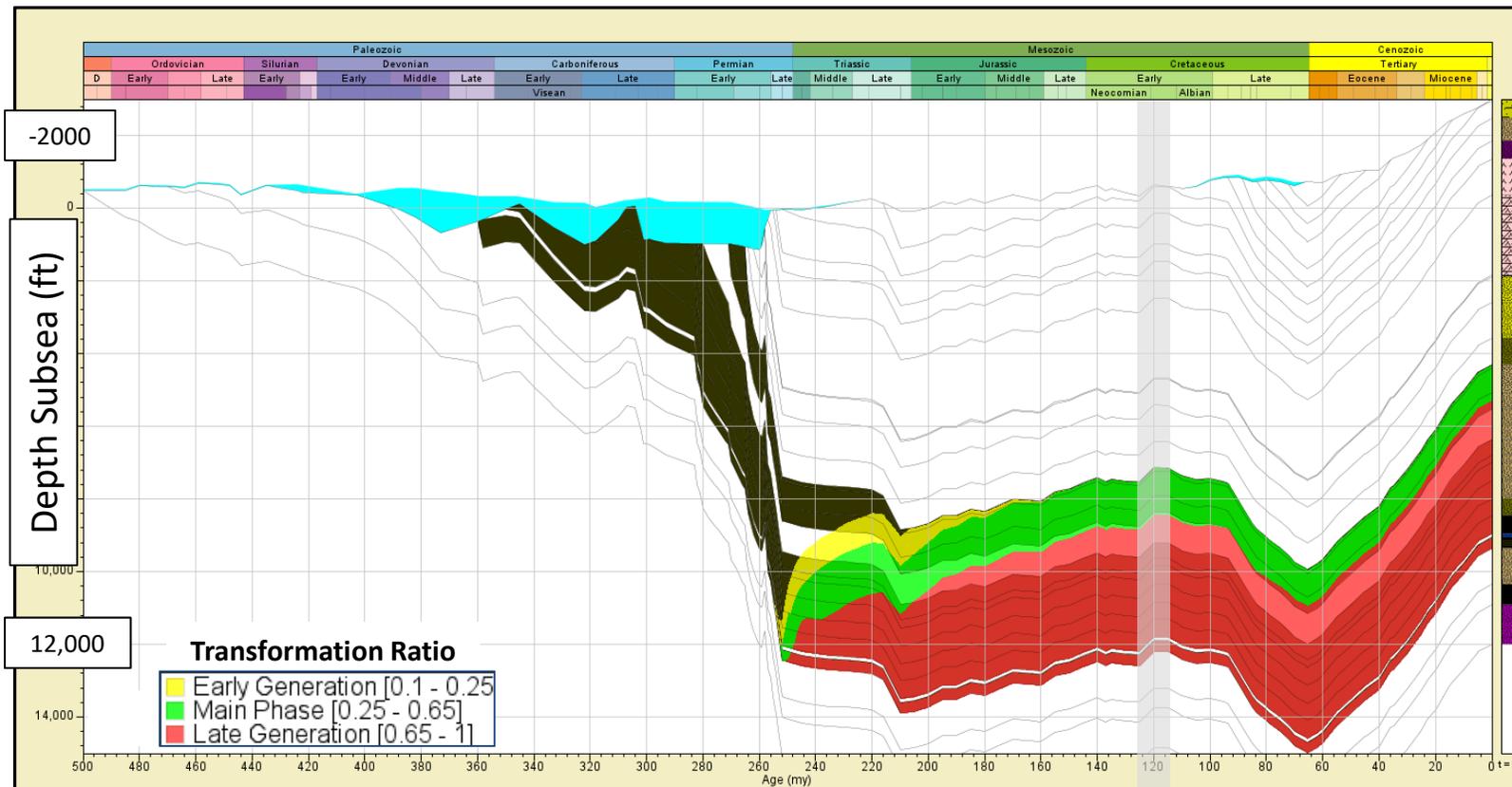
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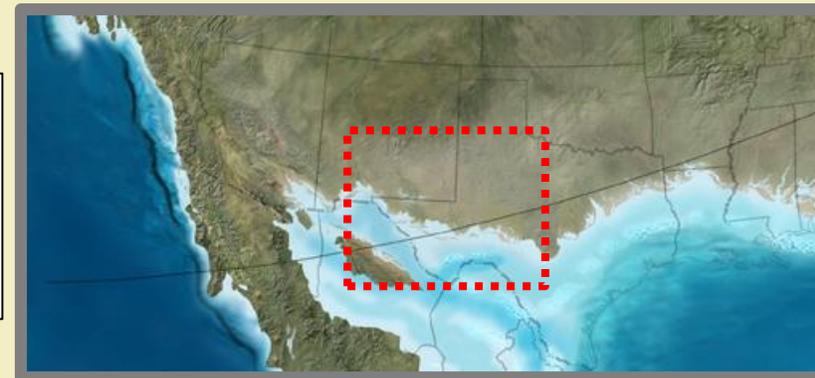
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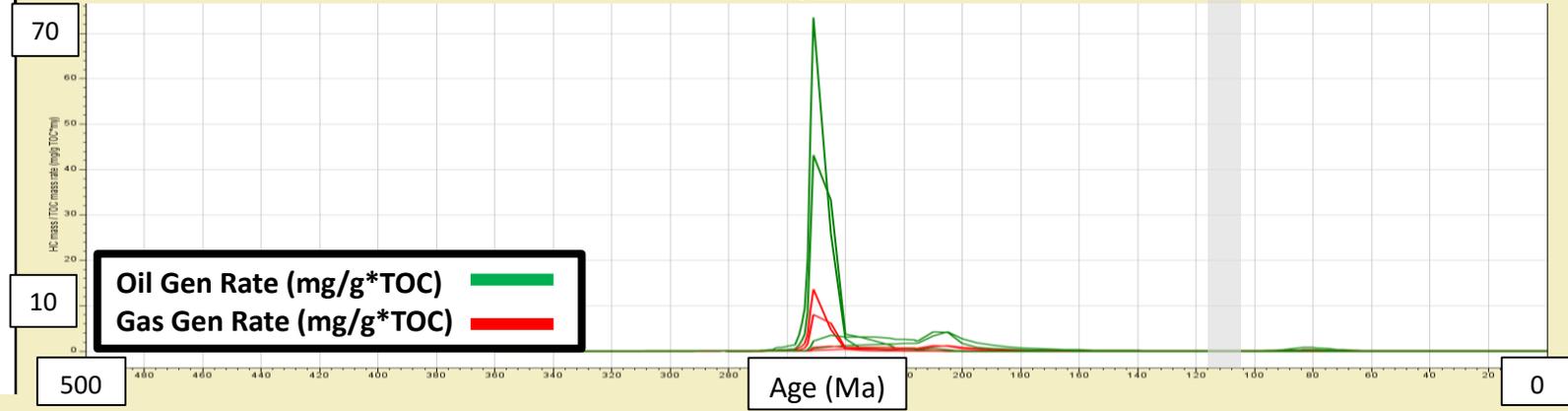
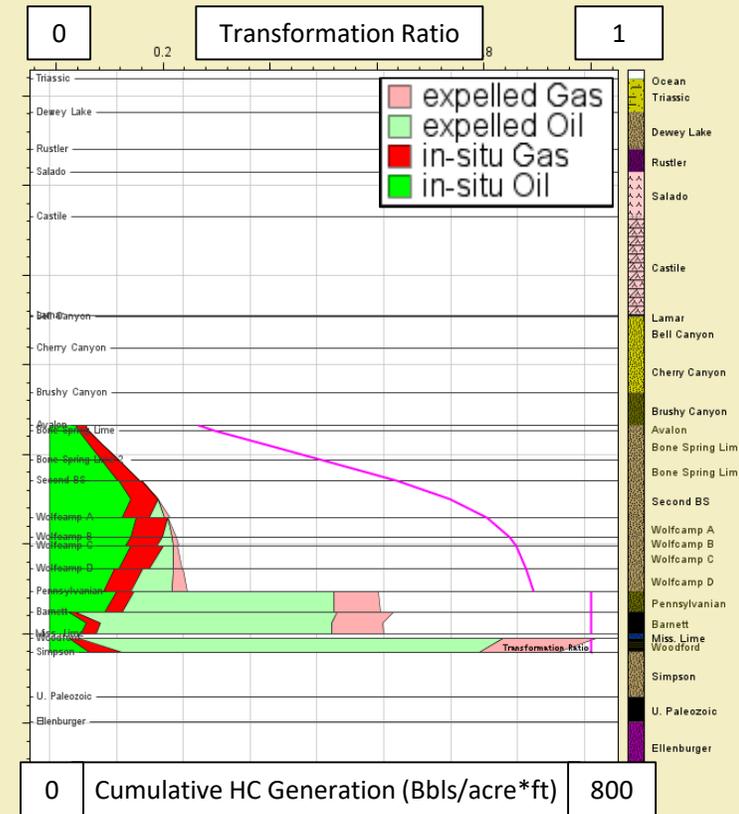
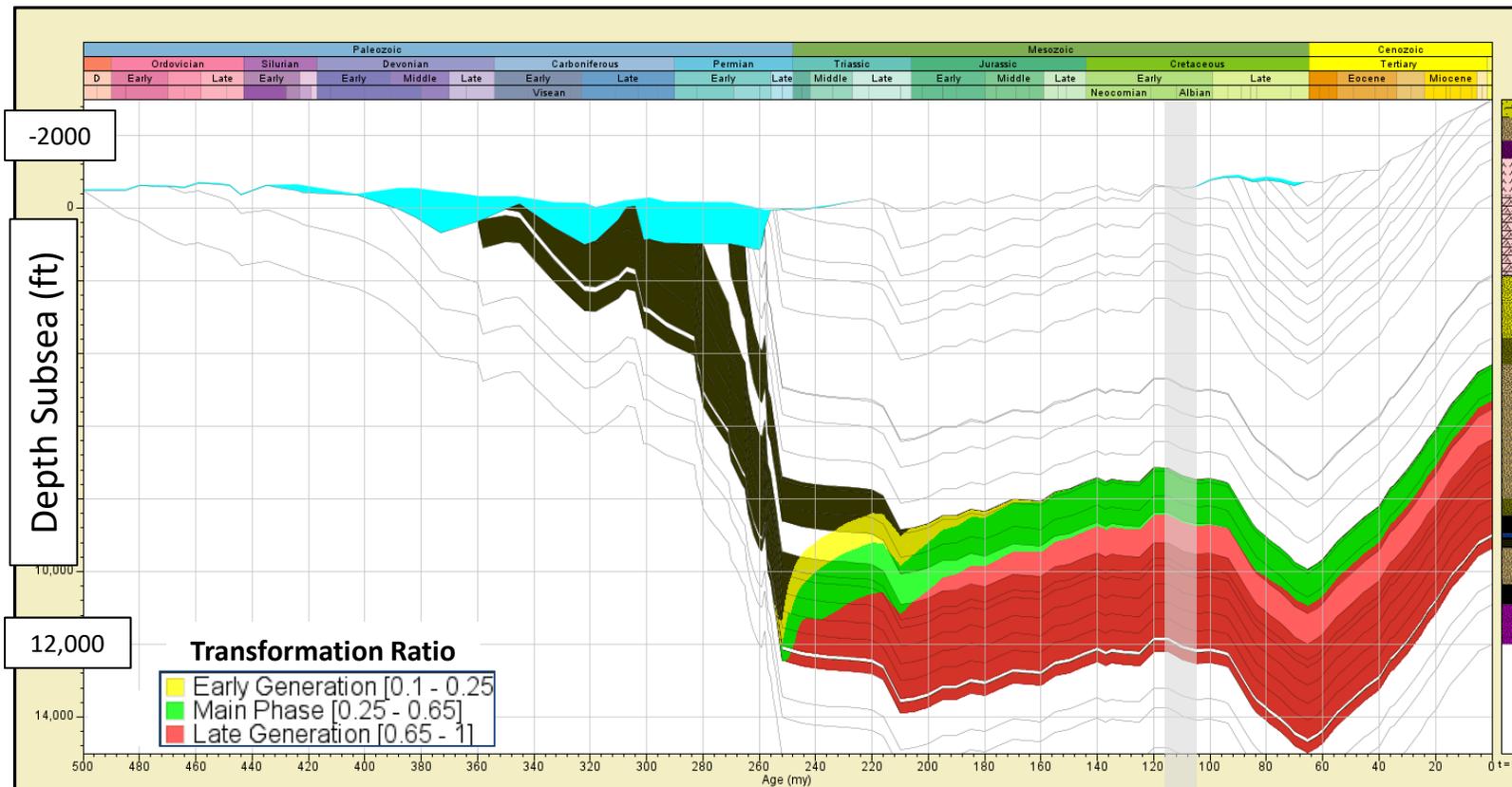
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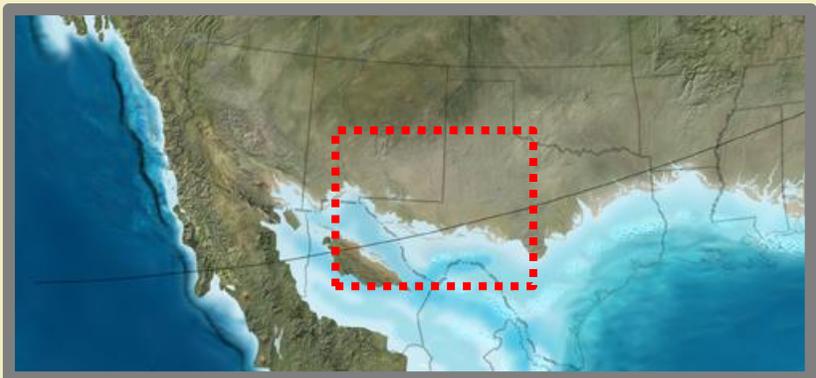
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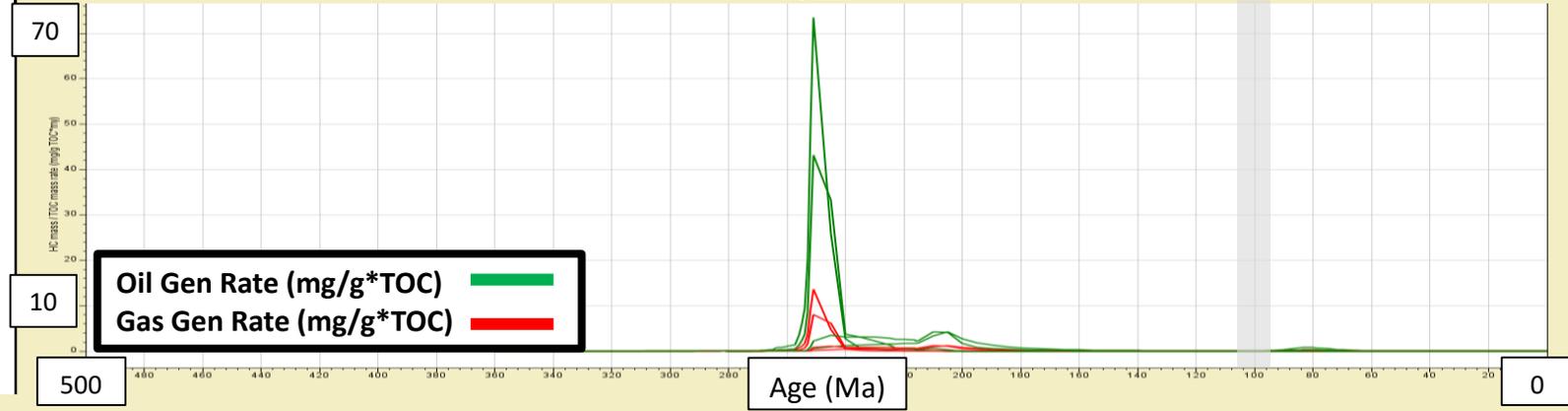
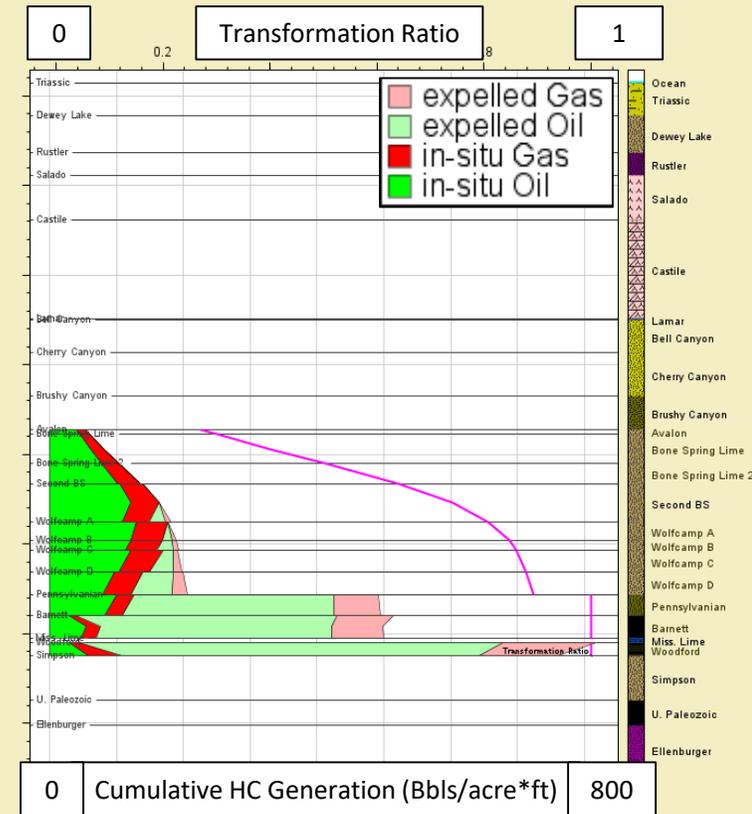
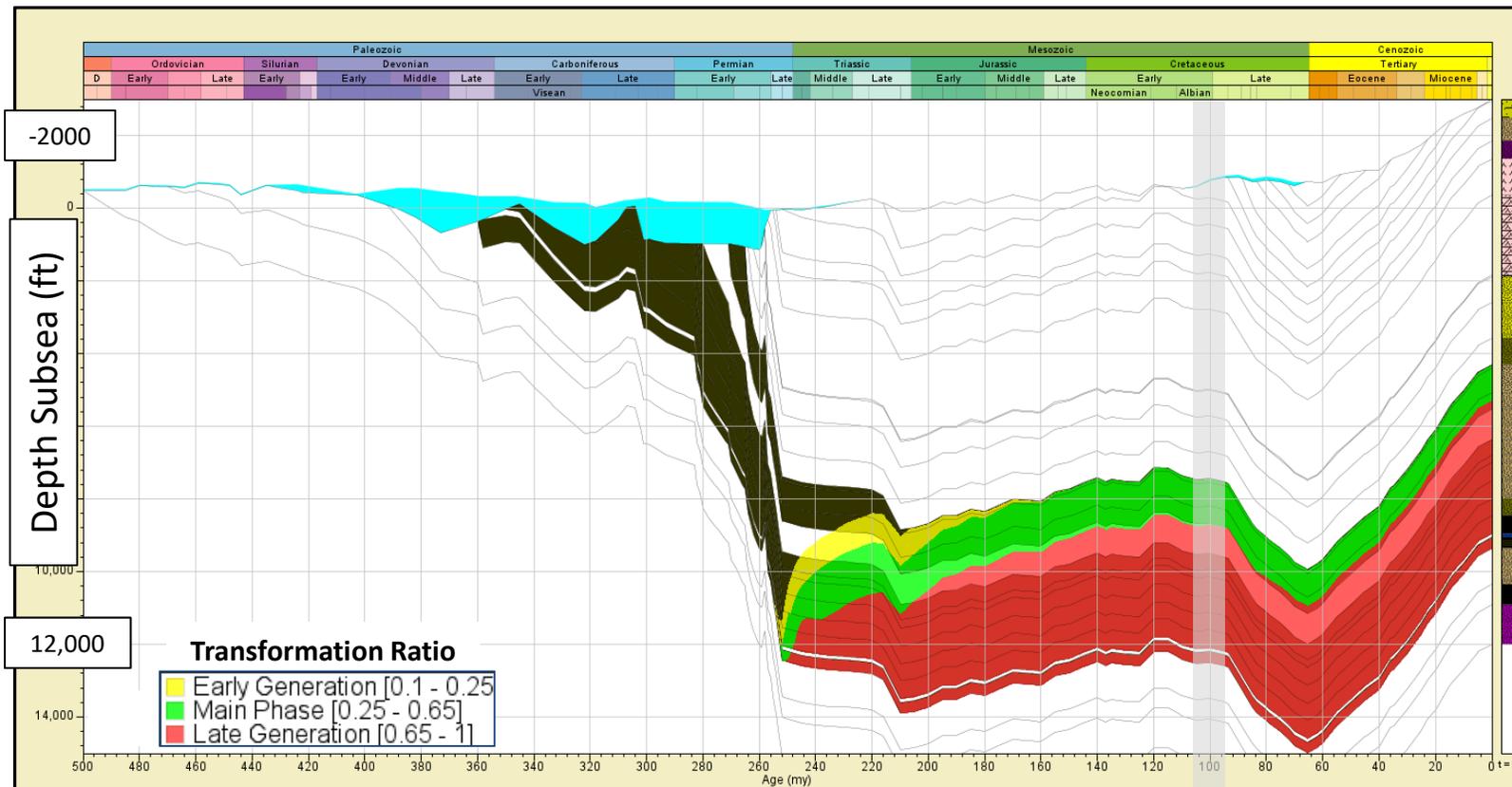
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Paleogeography



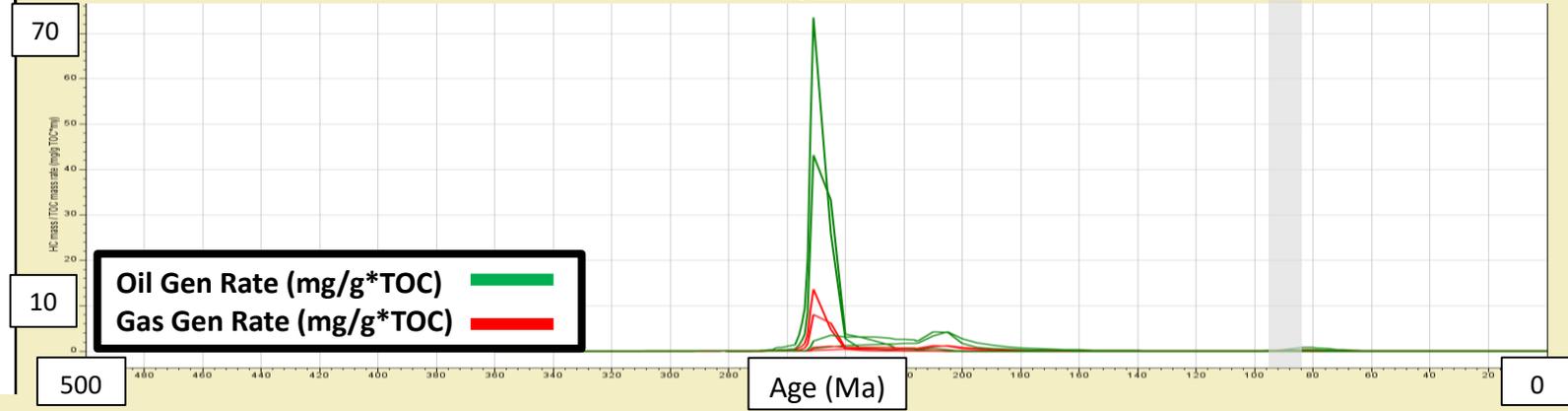
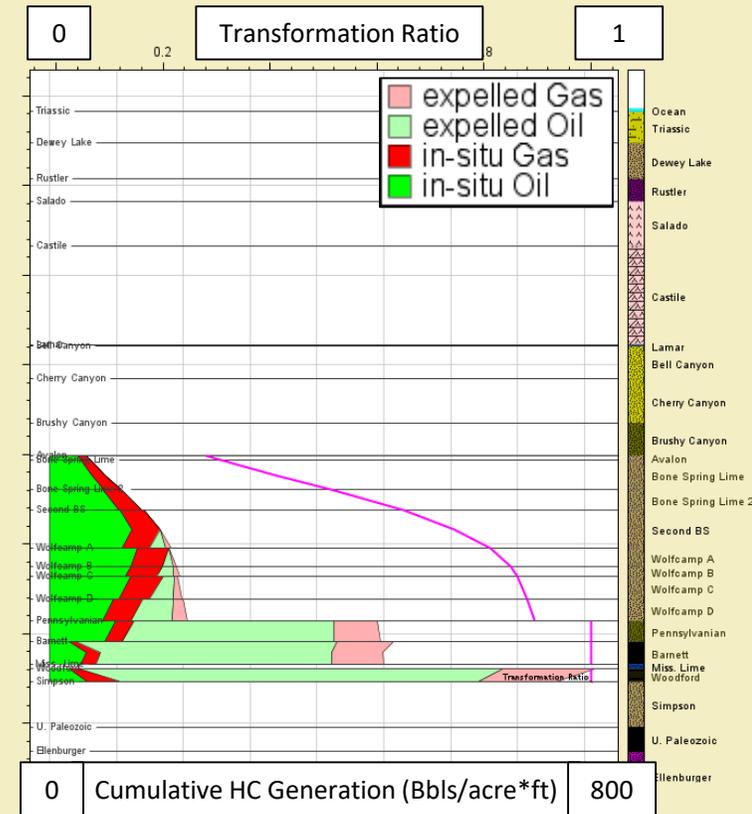
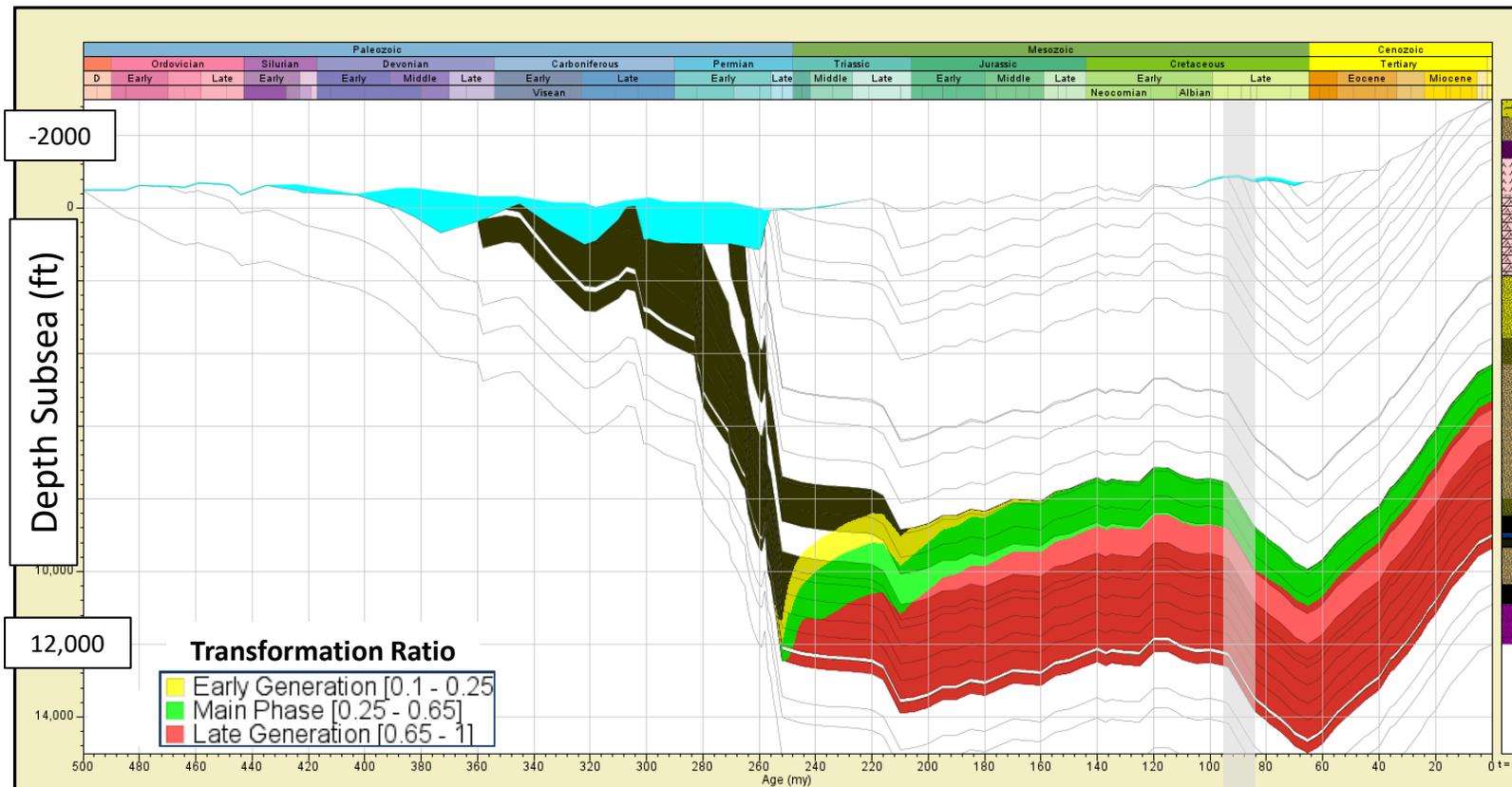
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Paleogeography



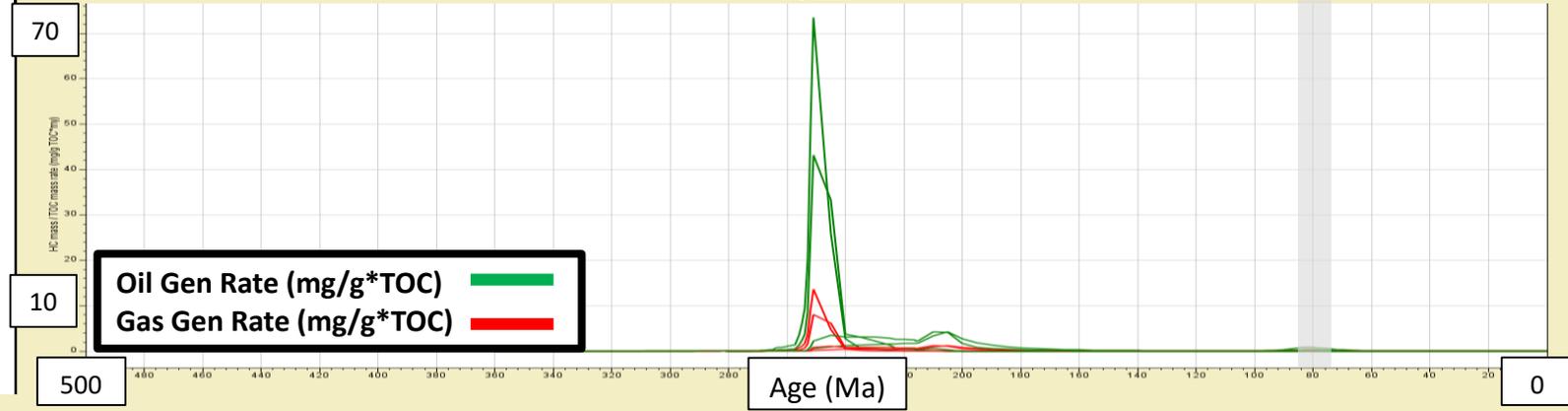
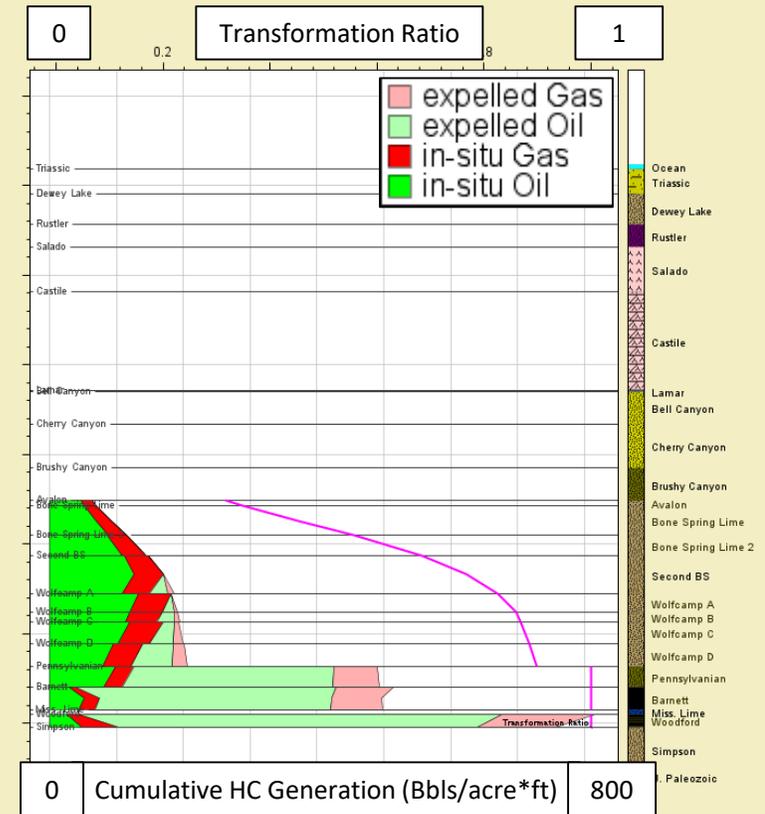
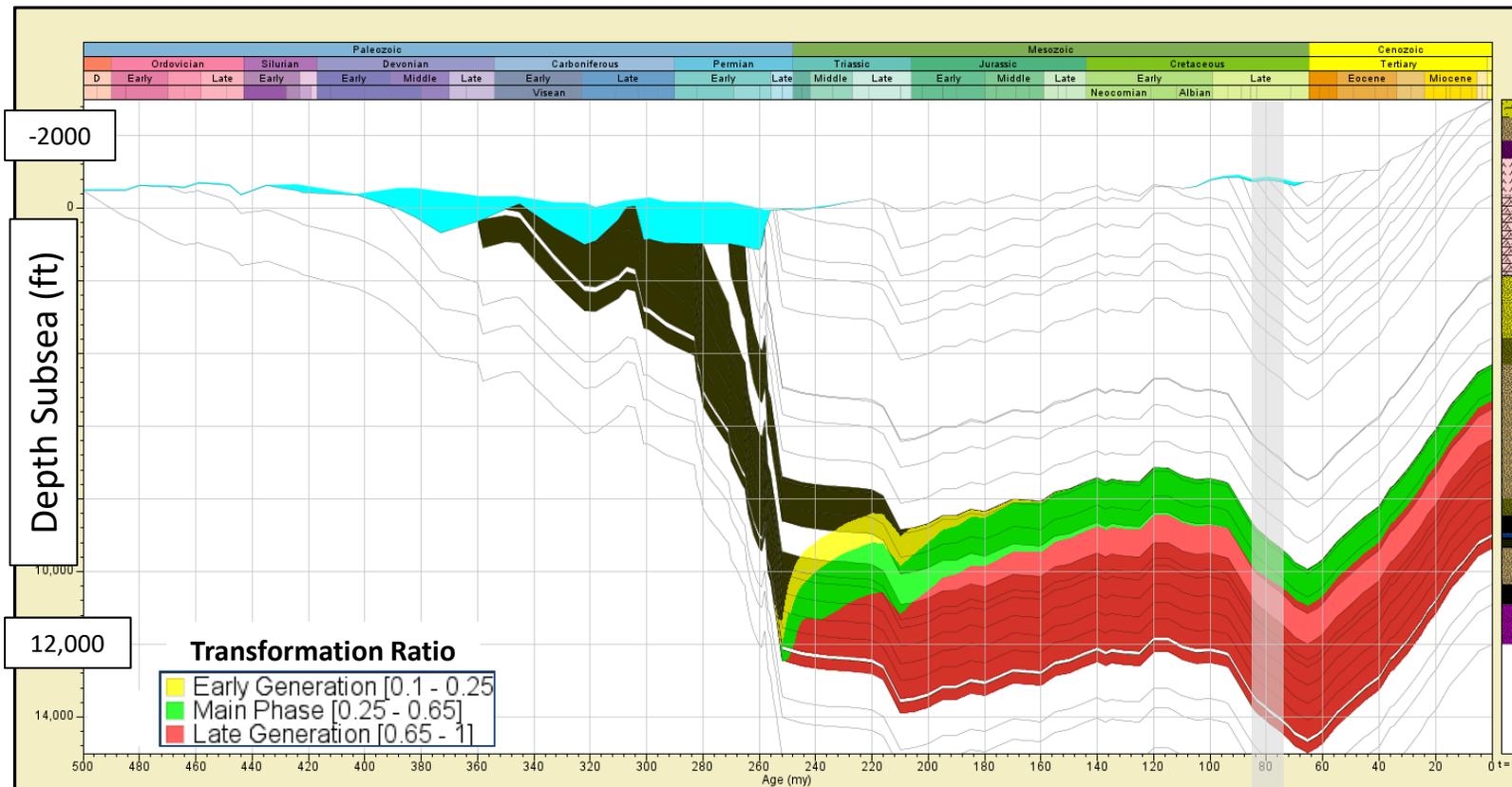
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Paleogeography



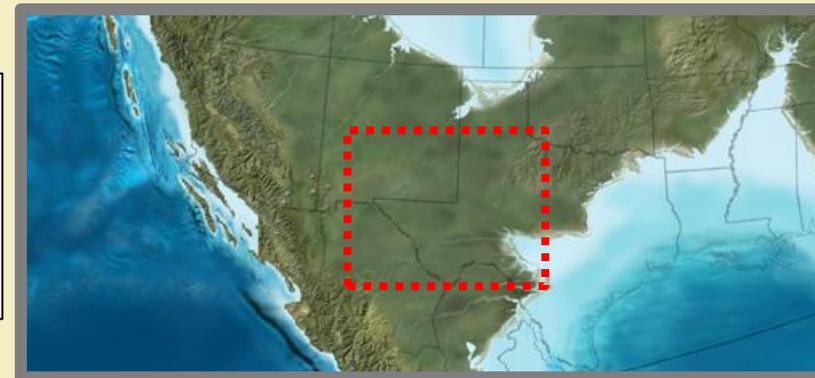
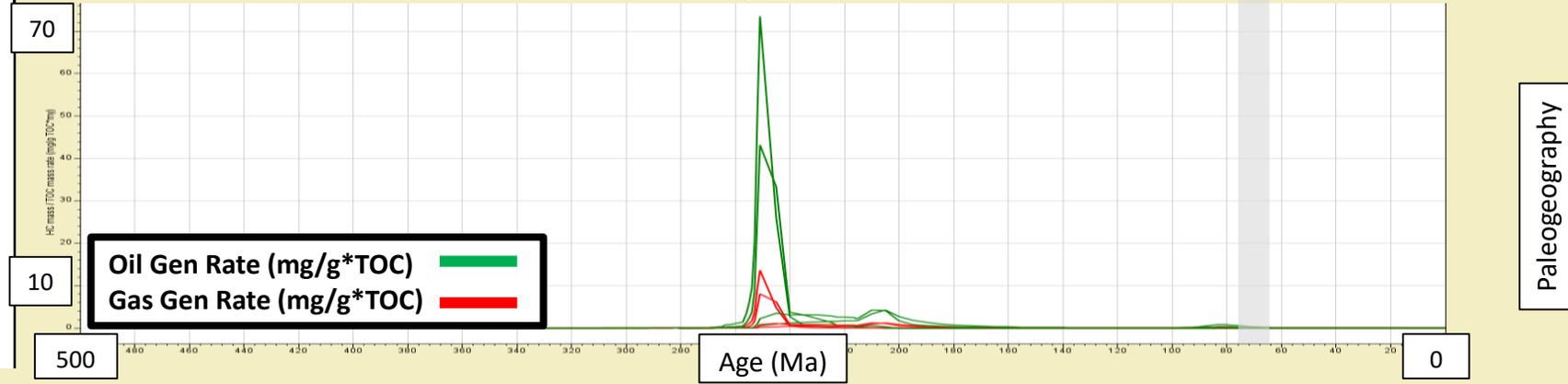
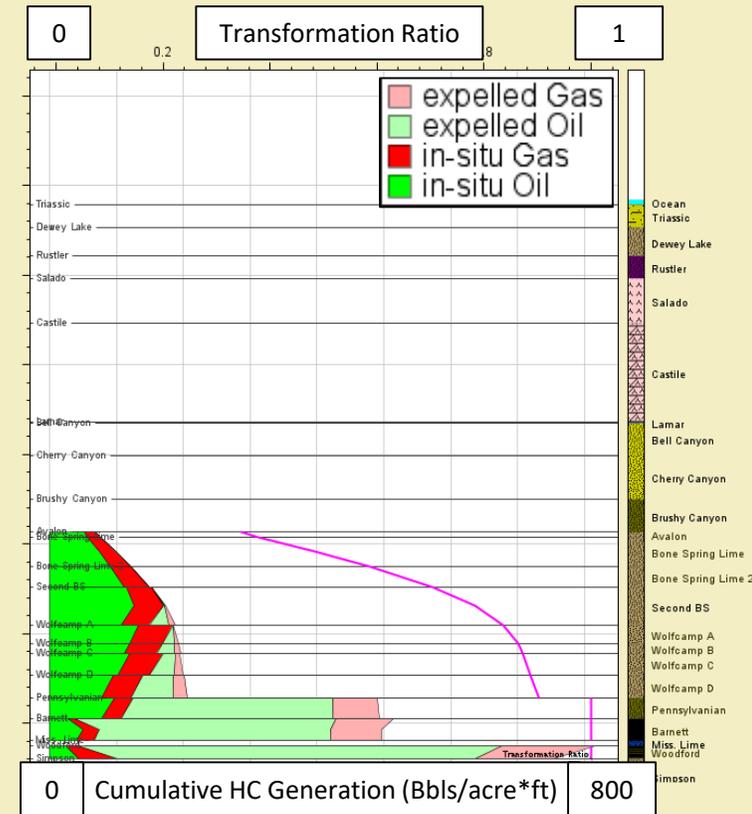
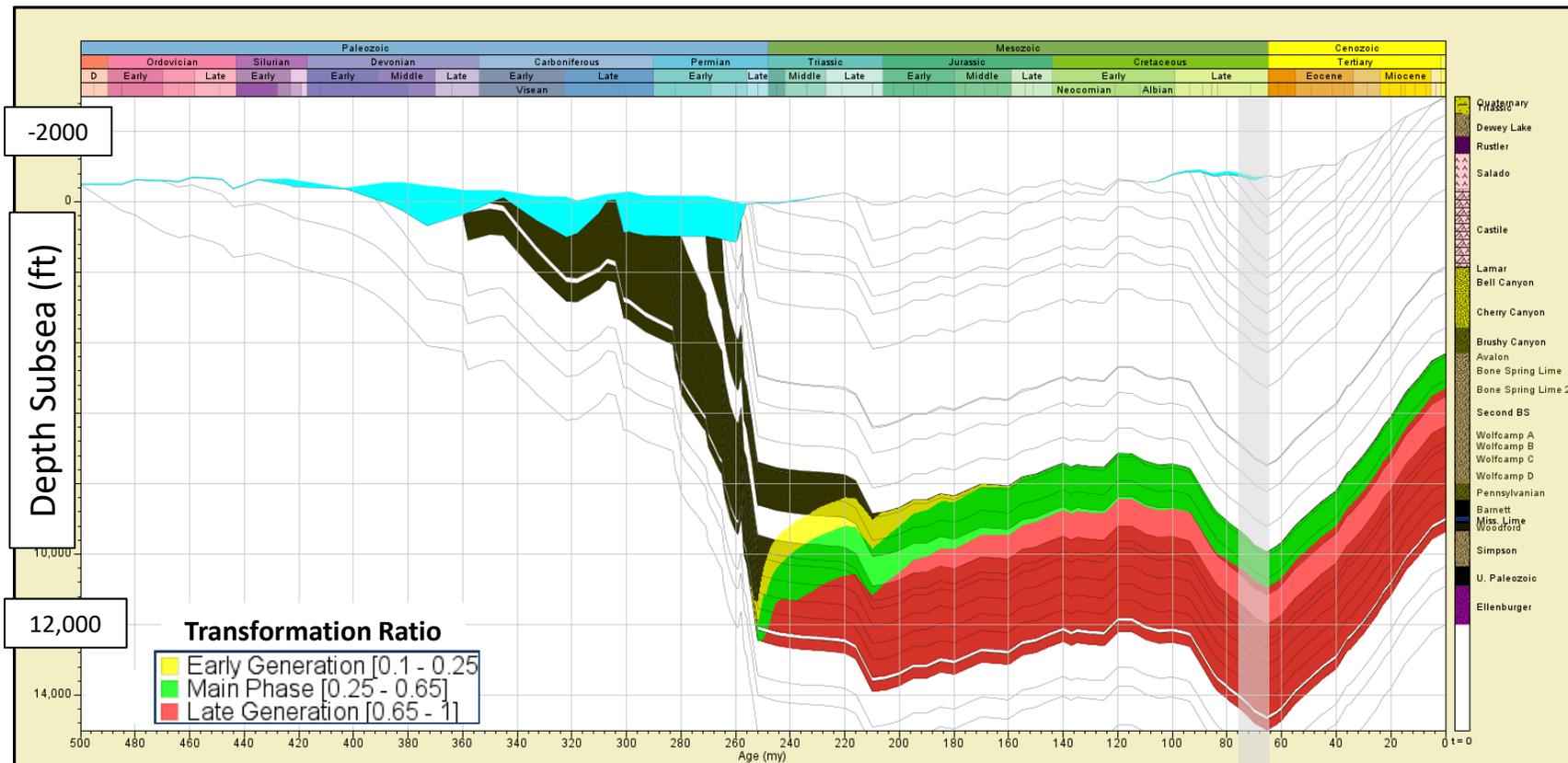
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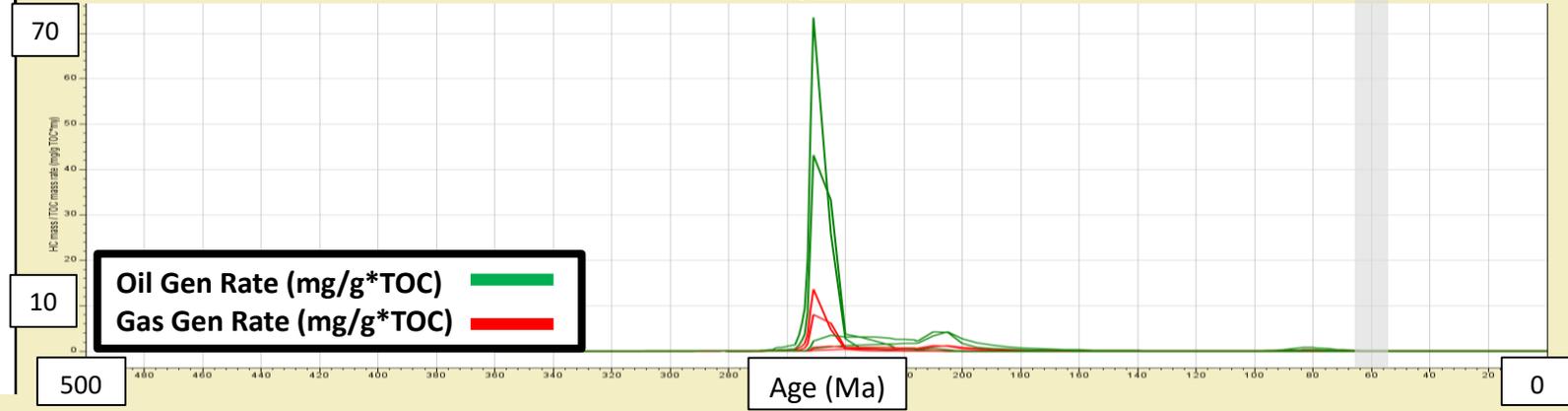
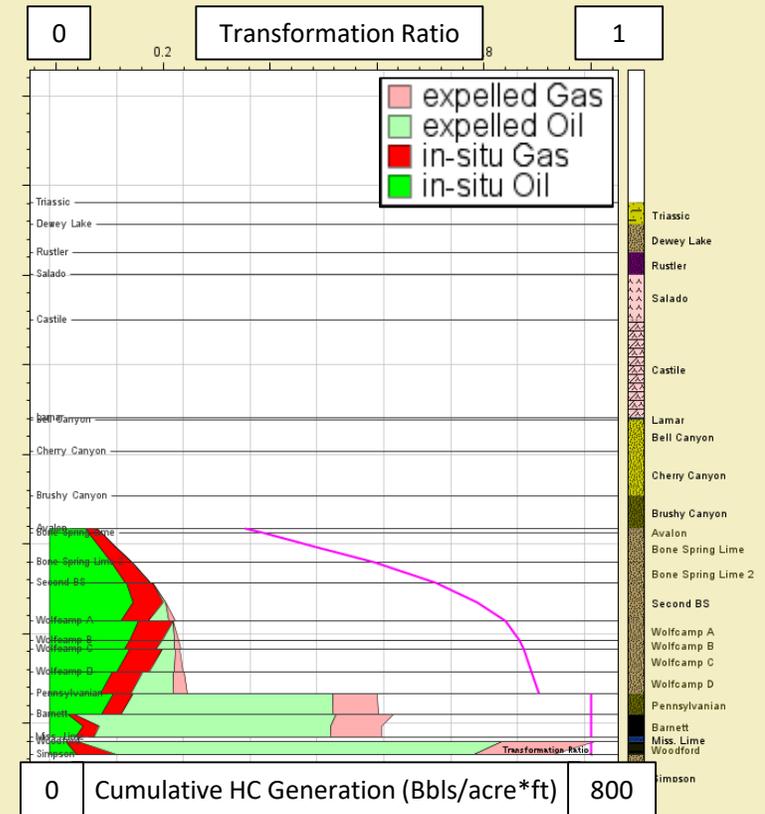
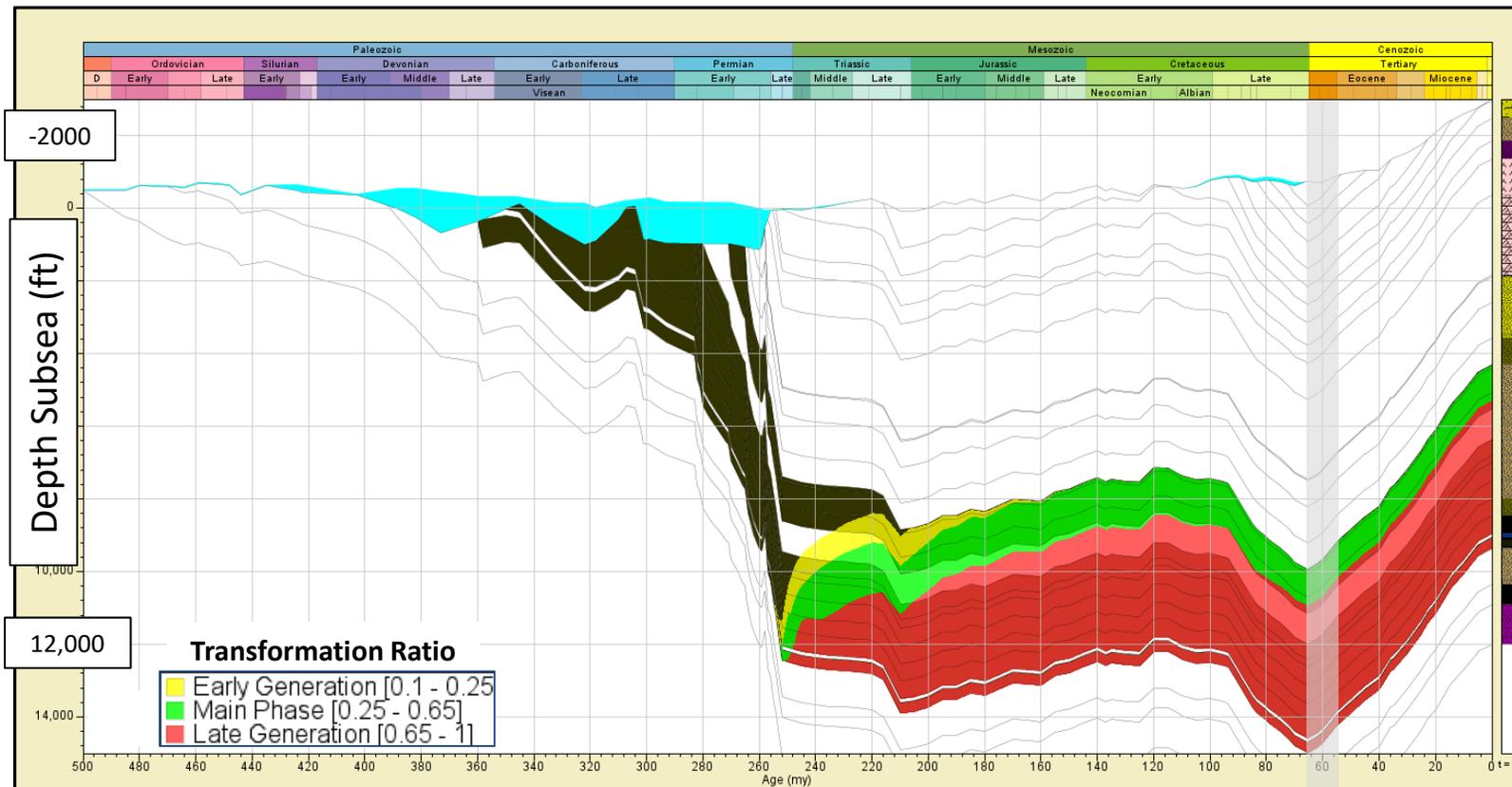
Paleogeography



Time lapse of generation



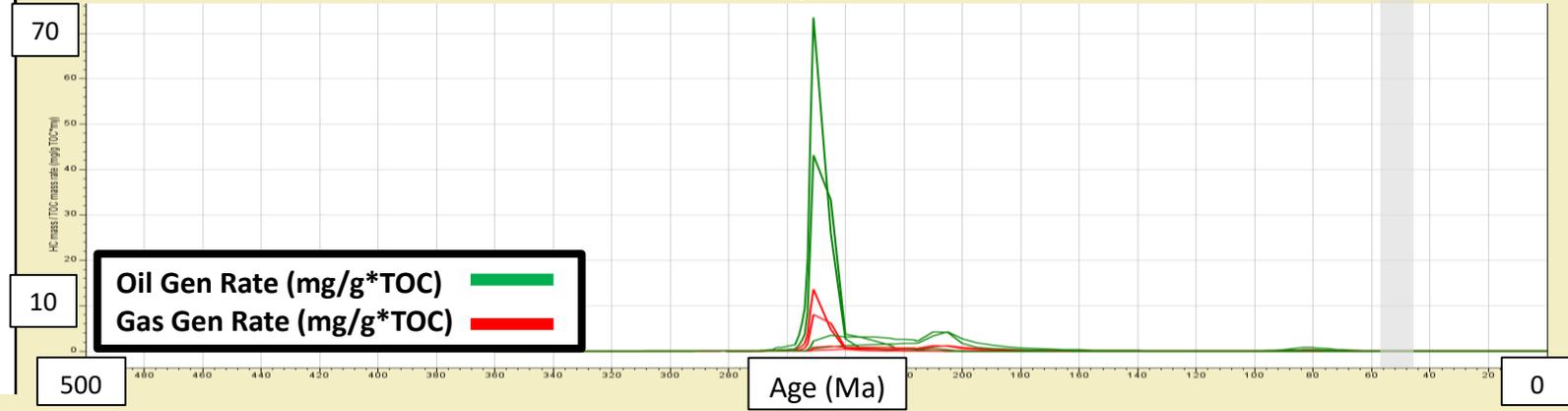
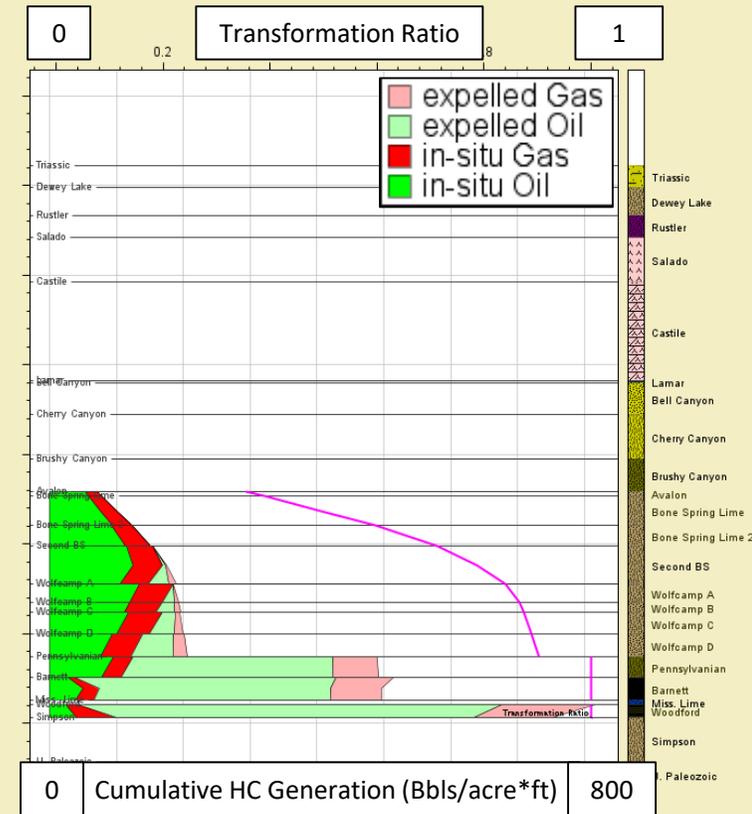
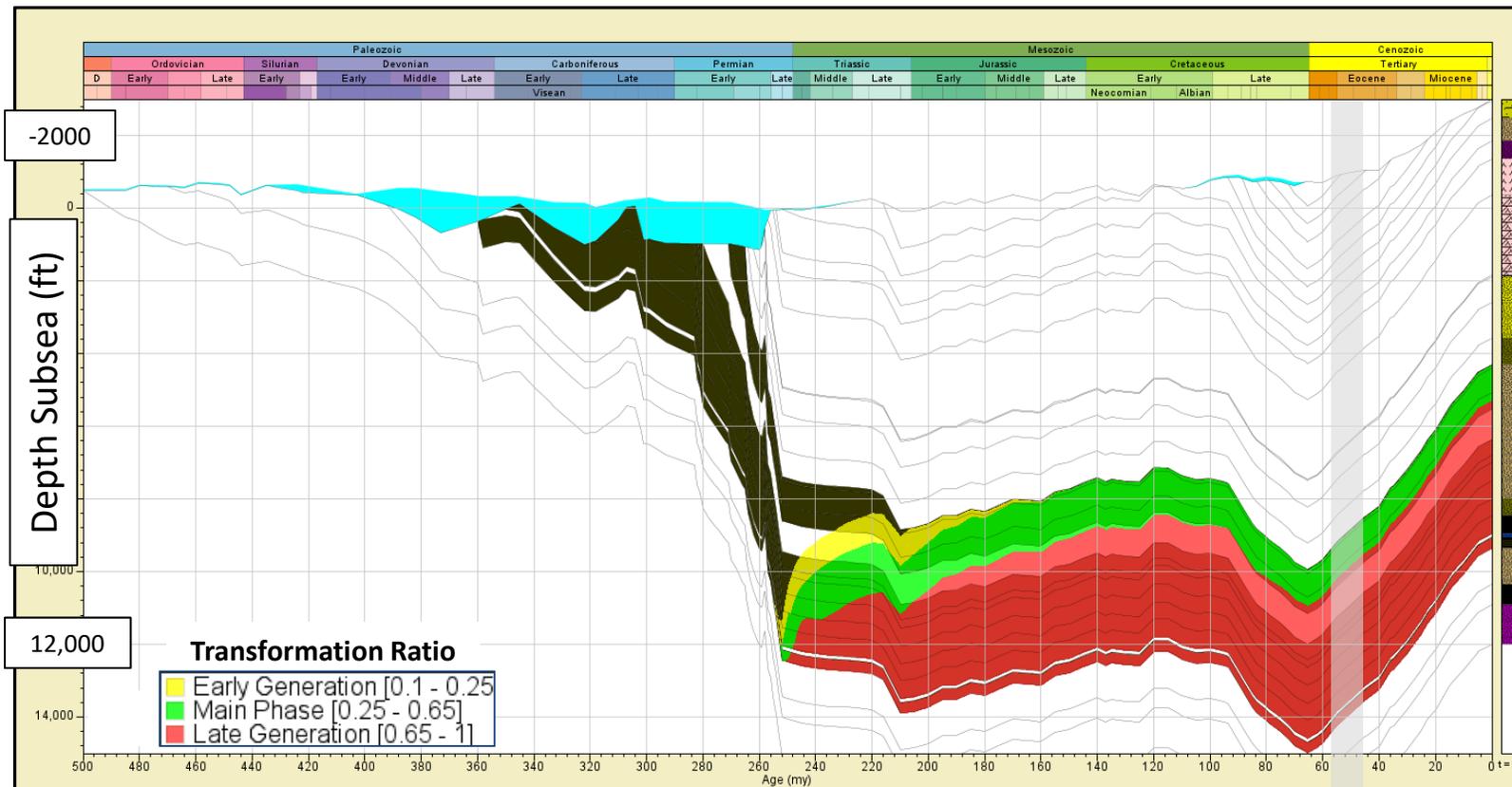
Time lapse of generation



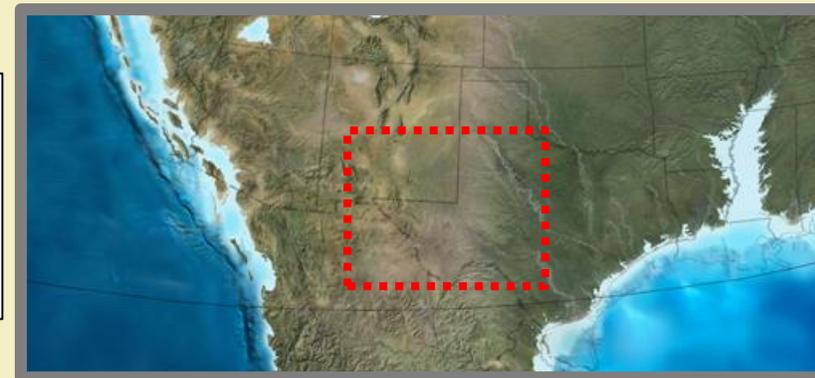
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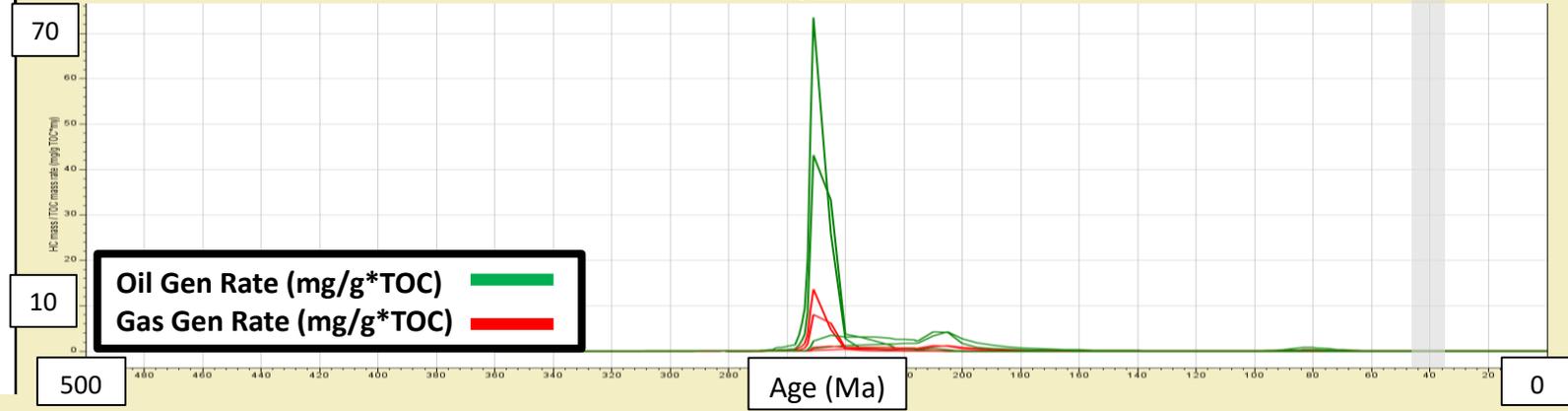
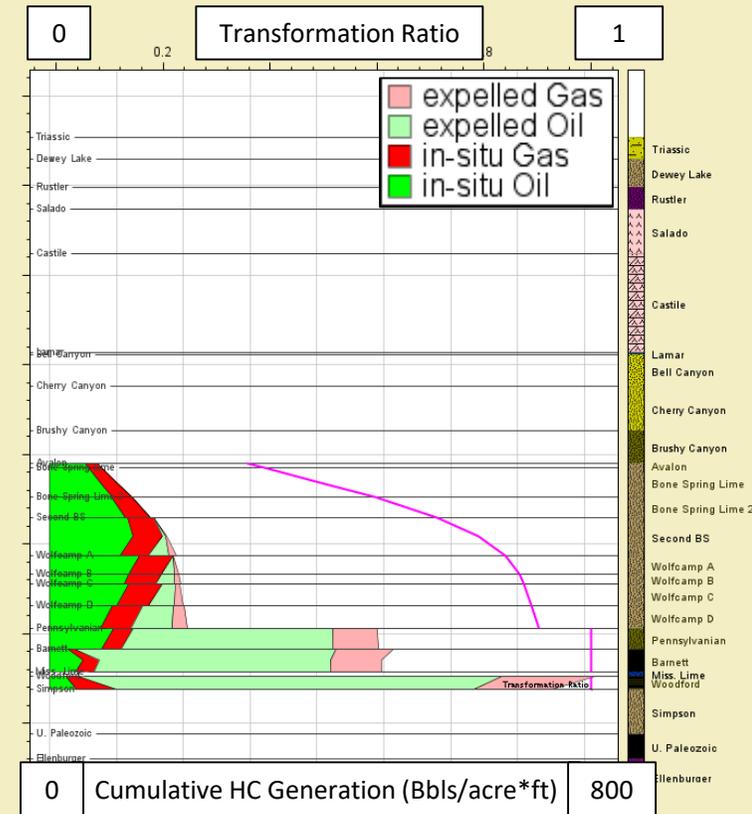
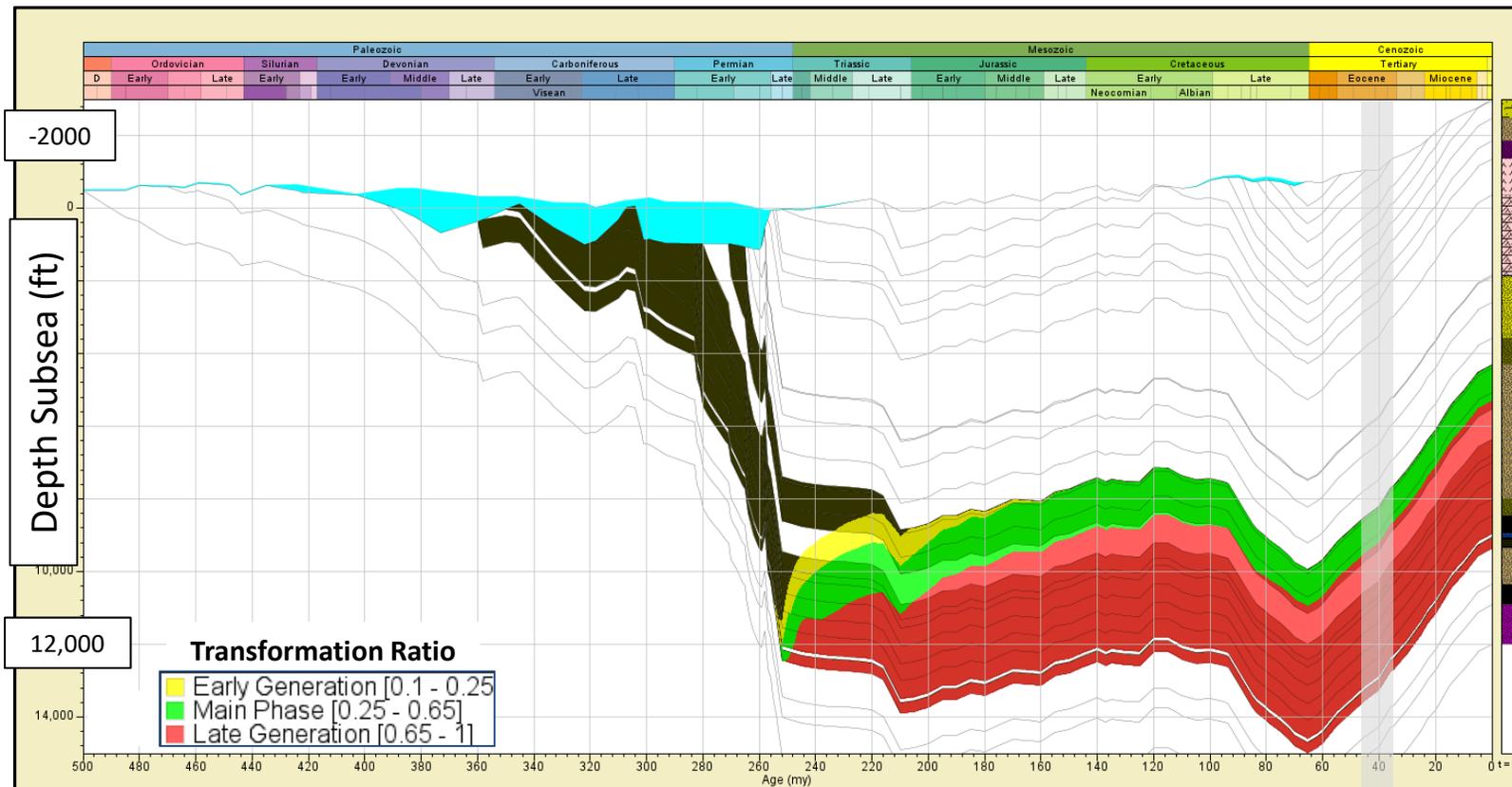
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Paleogeography



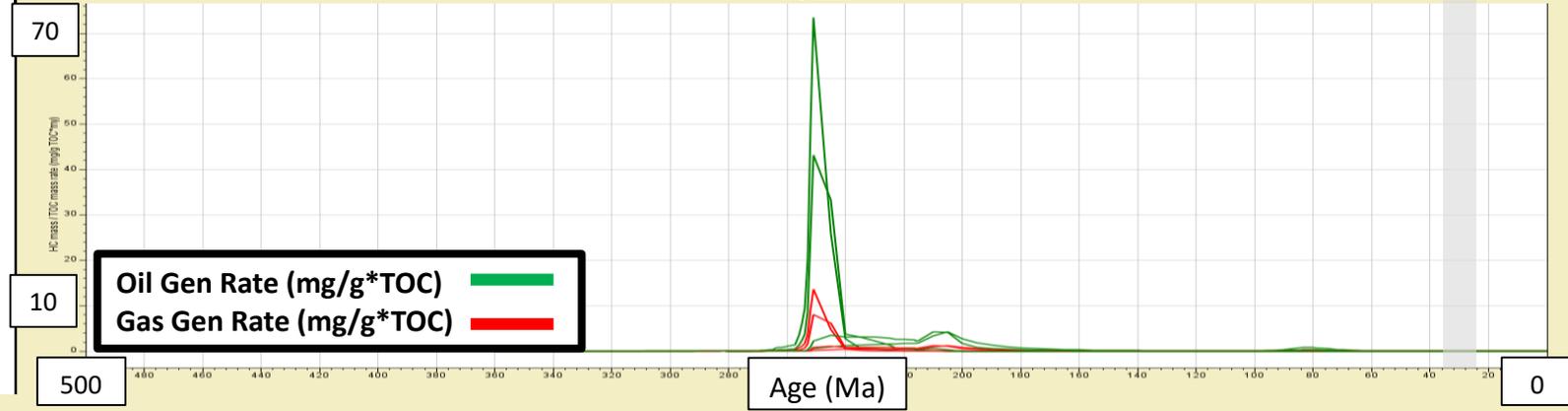
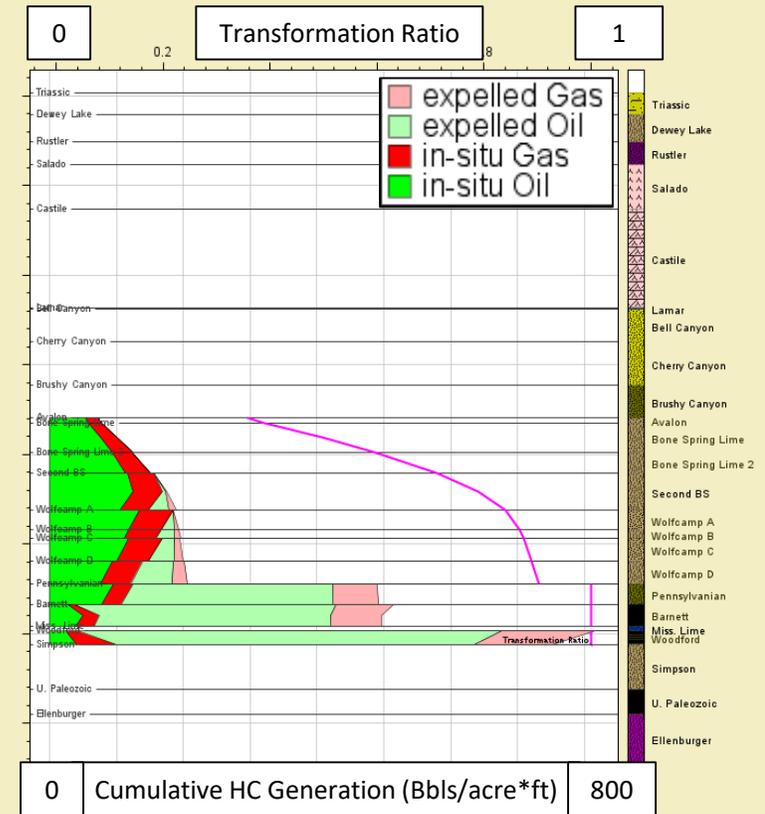
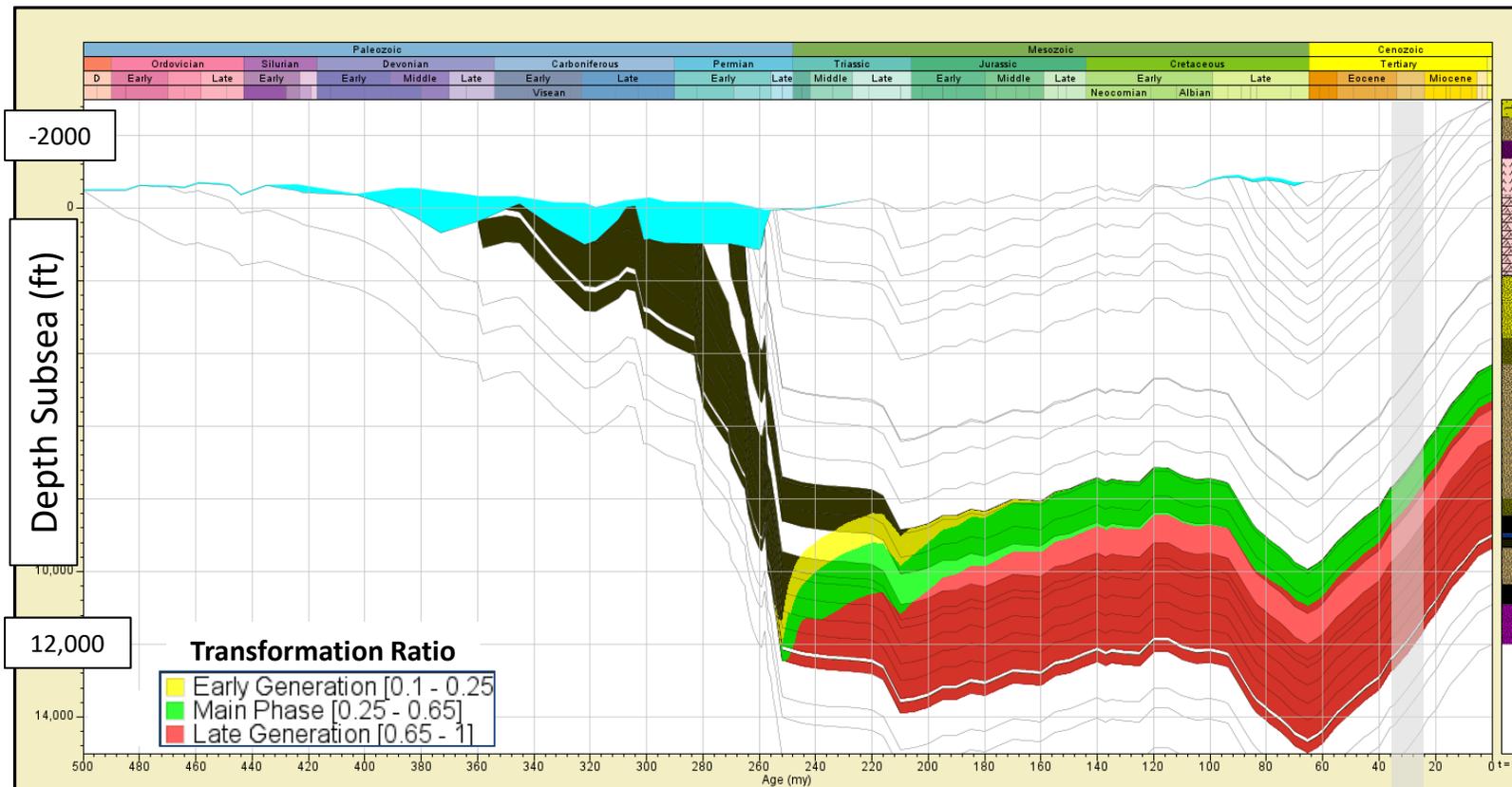
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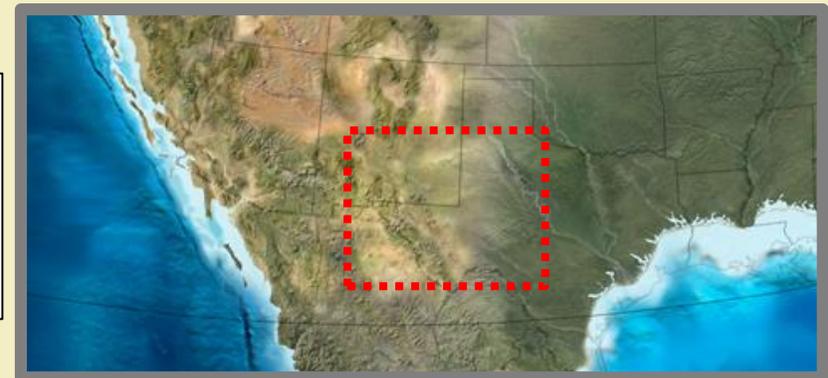
Paleogeography



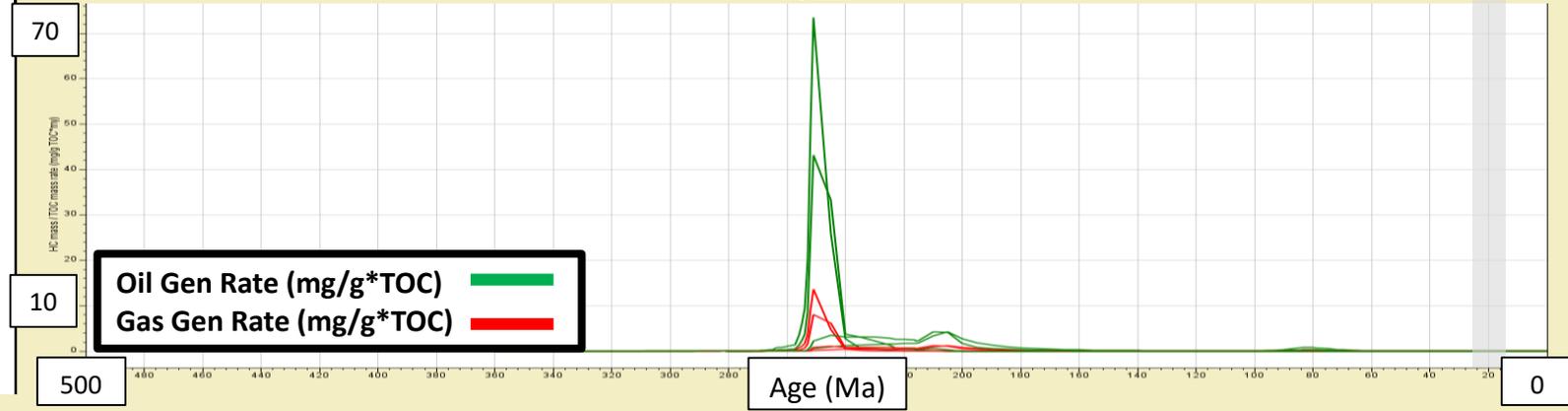
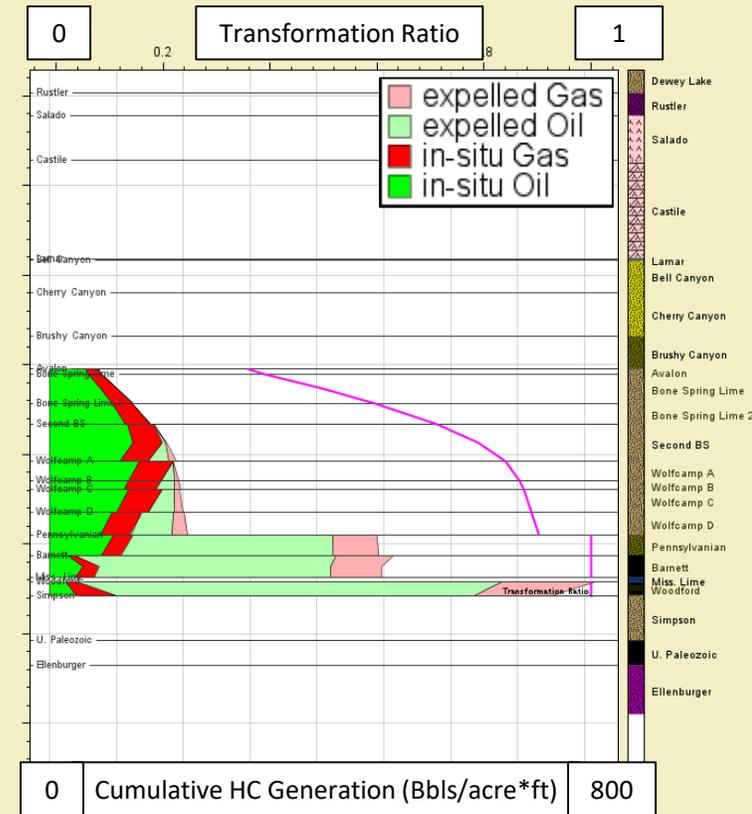
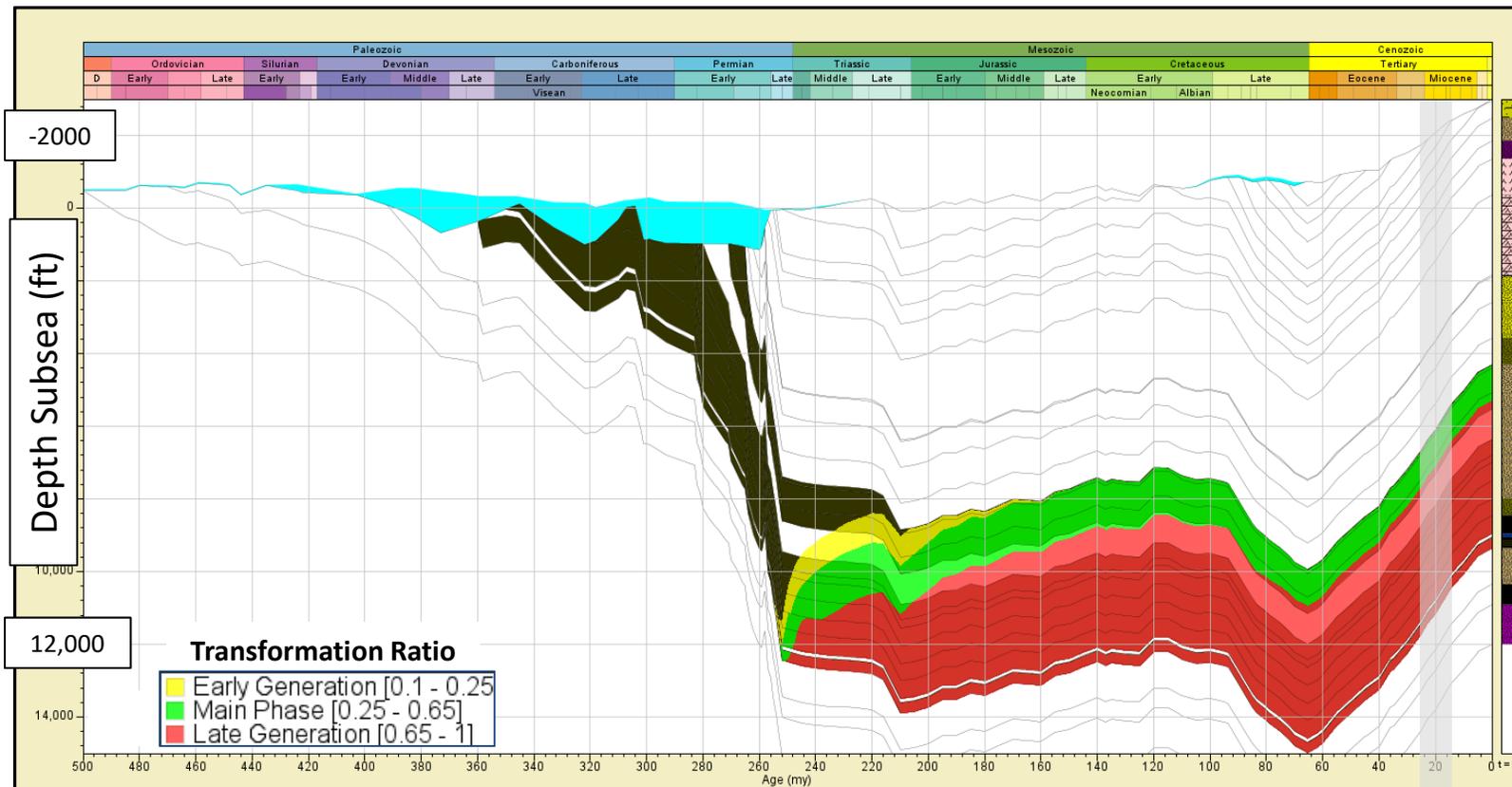
Time lapse of generation



Paleogeography



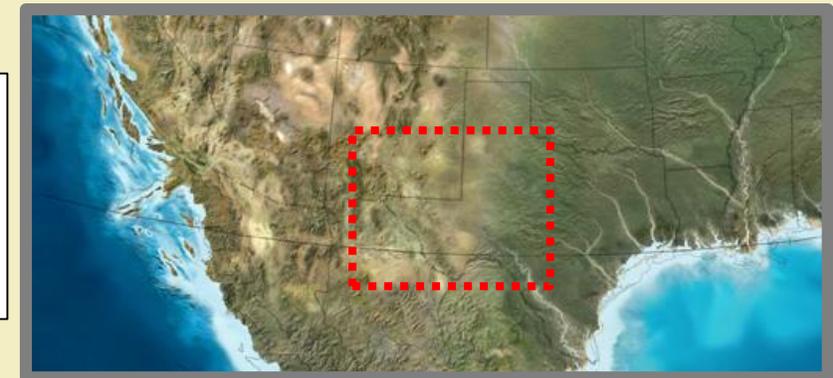
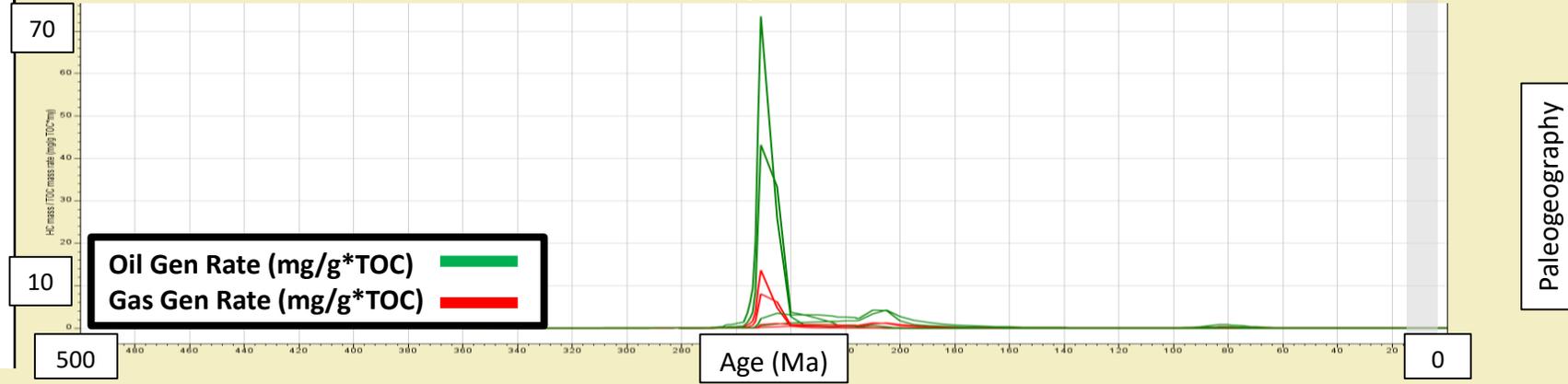
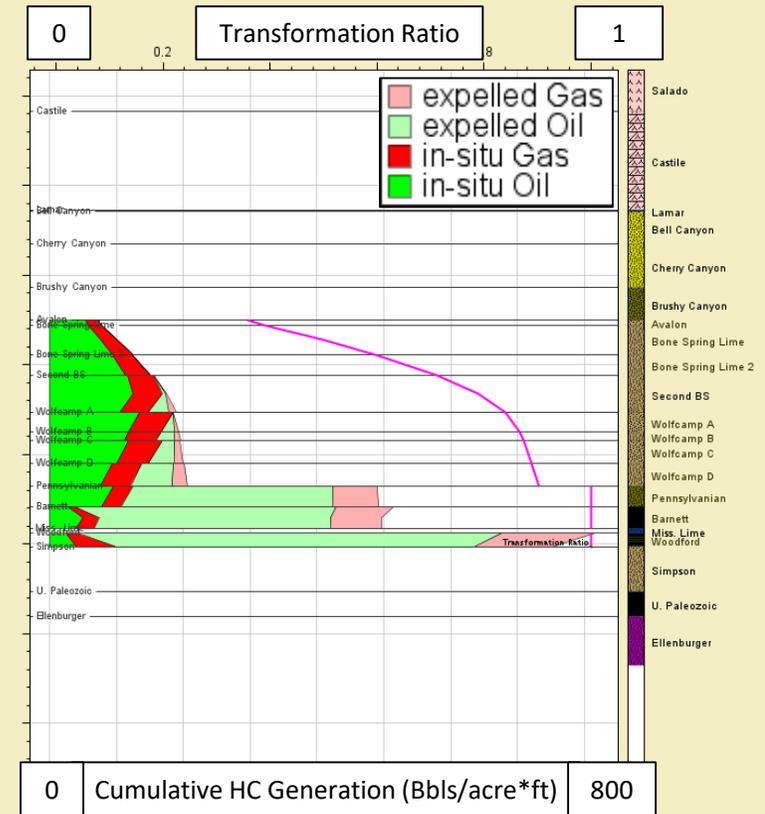
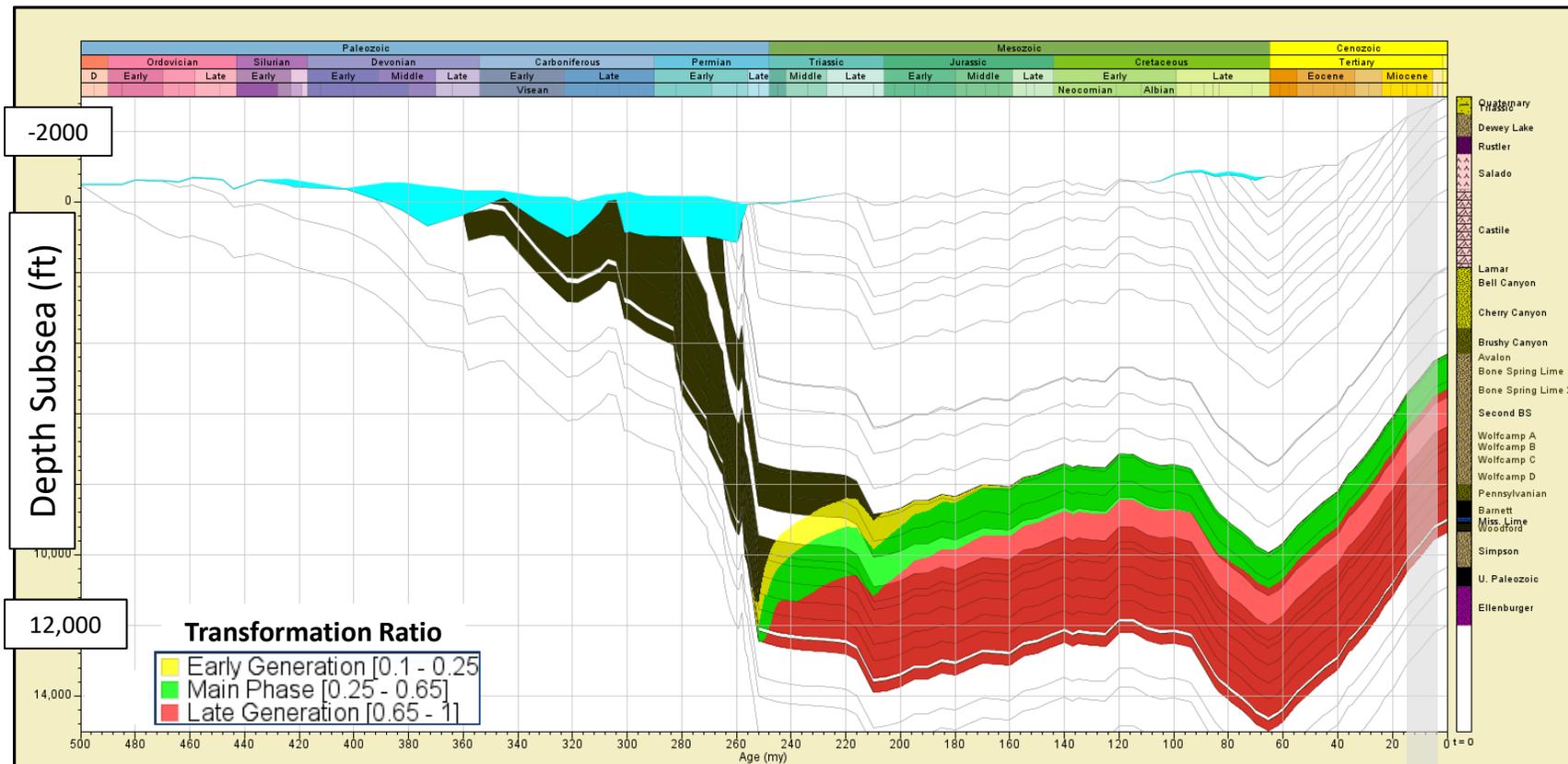
Time lapse of generation



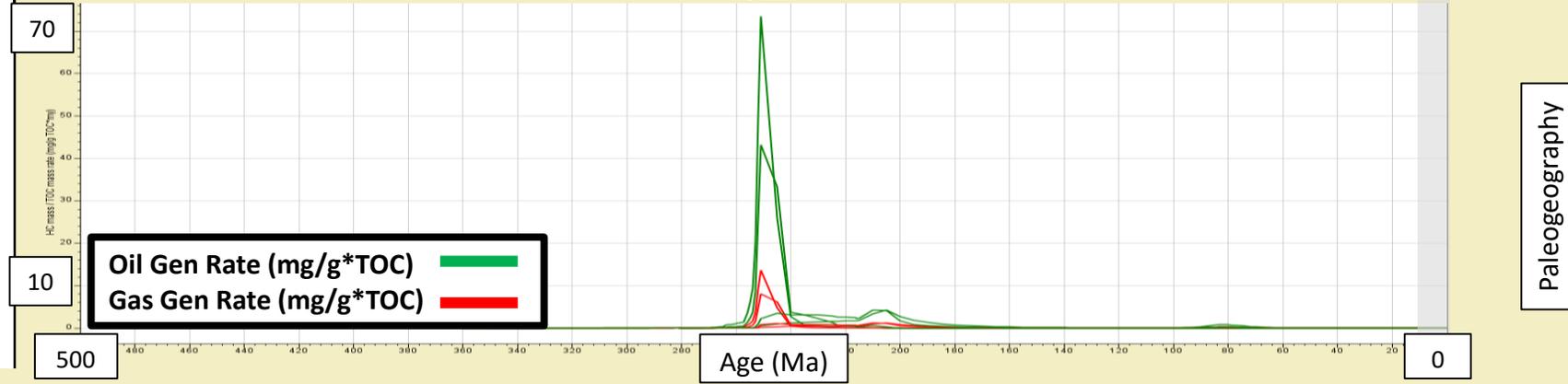
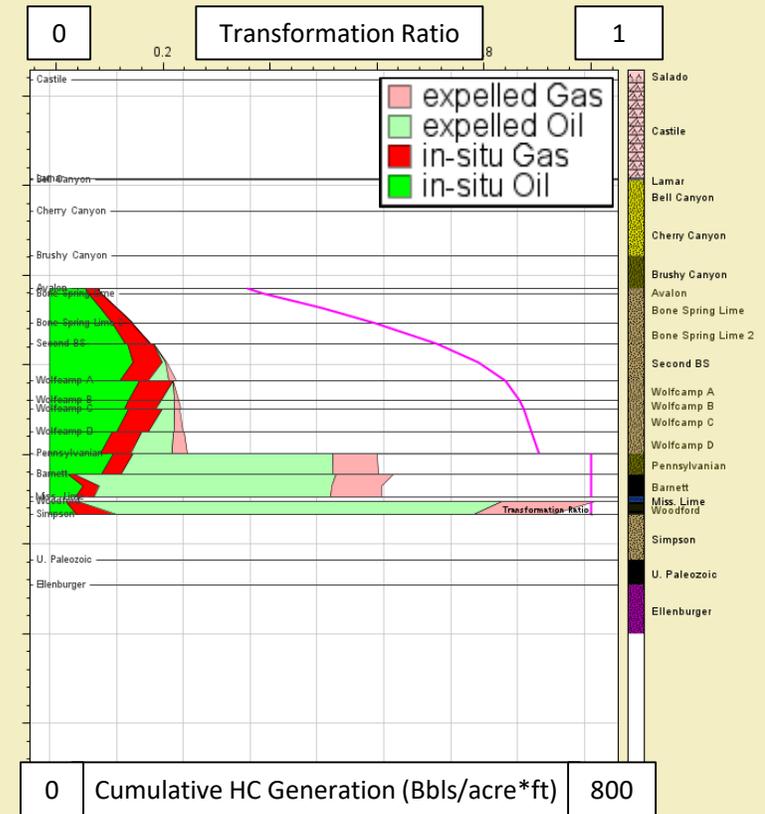
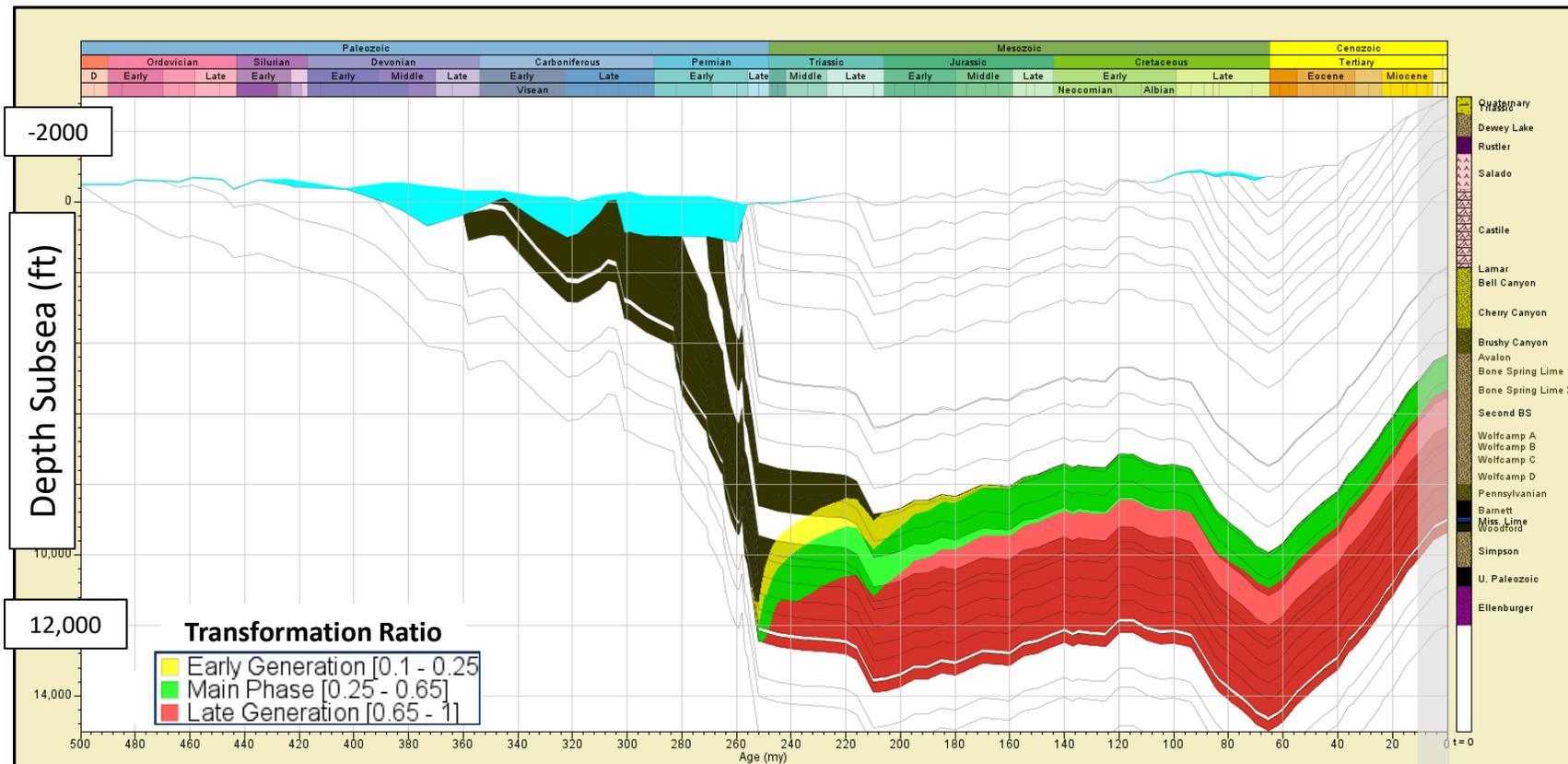
Paleogeography



Time lapse of generation

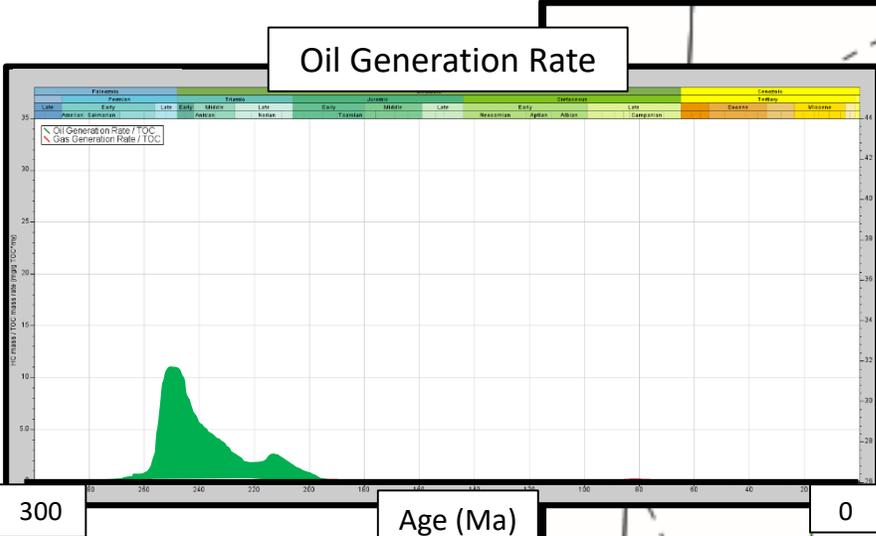


Time lapse of generation

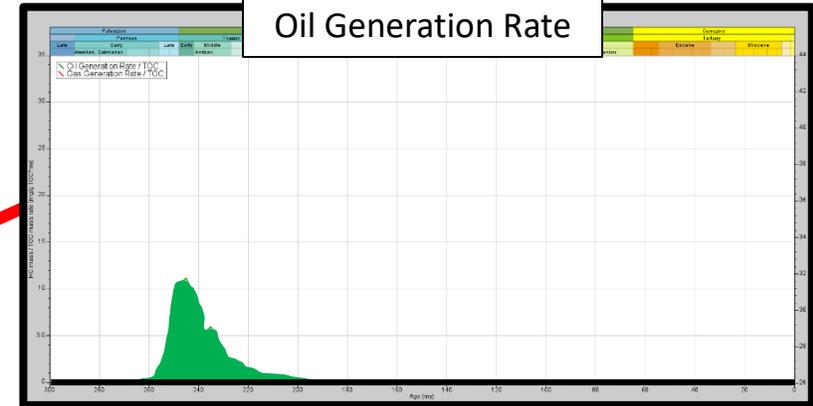


Age Plots – Wolfcamp Hydrocarbon Generation

Oil Generation Rate



Oil Generation Rate



Age (Ma)

300

0

*Unable to match thermal maturity data

Age (Ma)

300

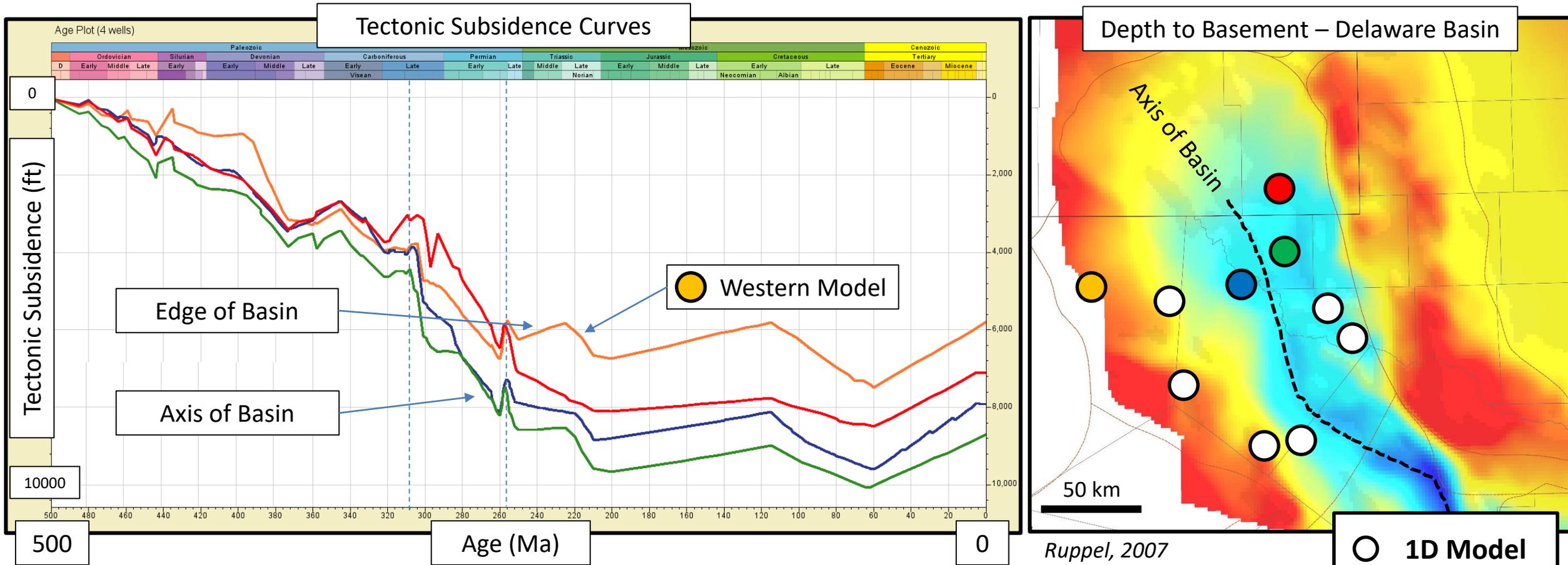
0

300

Age (Ma)

0

Tectonic Subsidence Curves



- Center of basin experienced roughly 3,200 ft. of tectonic subsidence in Permian Phase
- Western edge of basin experienced lower magnitude subsidence at equivalent rate
- Tectonic subsidence quantifies **changes in crustal thickness** responsible for accommodation, uplift

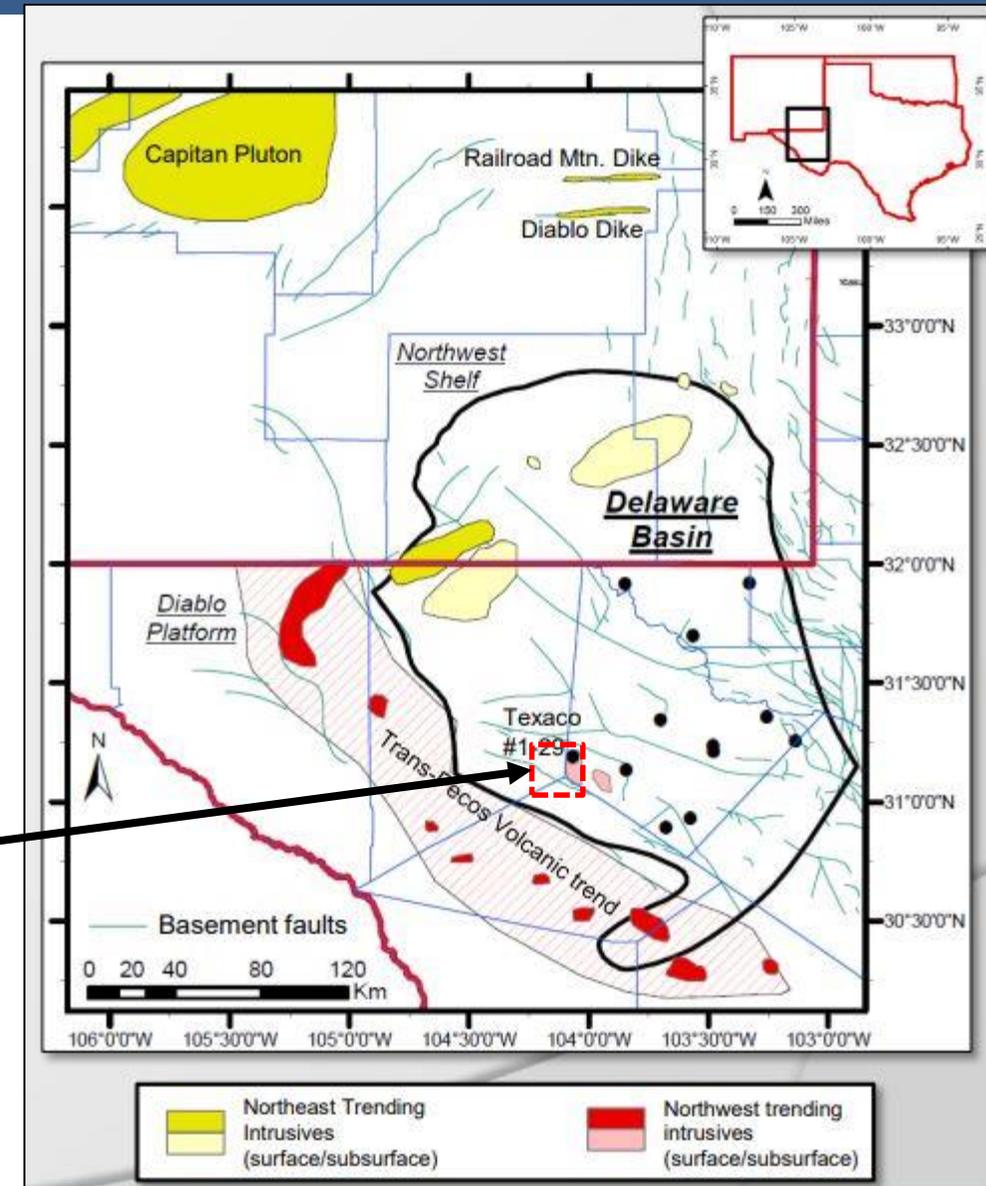
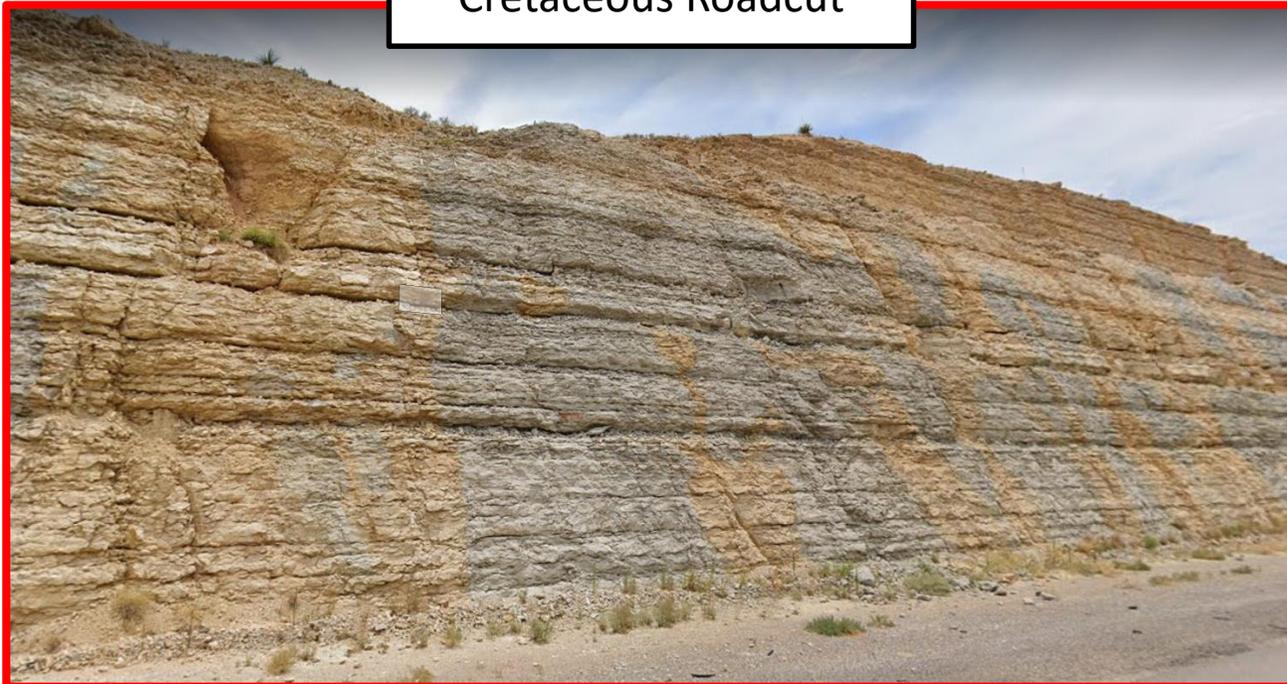
Outline

- Introduction to Delaware Basin
- Building and Calibrating Models
- Results of Models
- **Uncertainty Analysis**
- Crustal Model
- Conclusions

Key Uncertainties in Basin

- Amount of missing Cretaceous Sediment
 - estimates vary between 3-7,000 ft of sediment (Roberts and Kirschbaum, 1995; Sinclair, 2007)

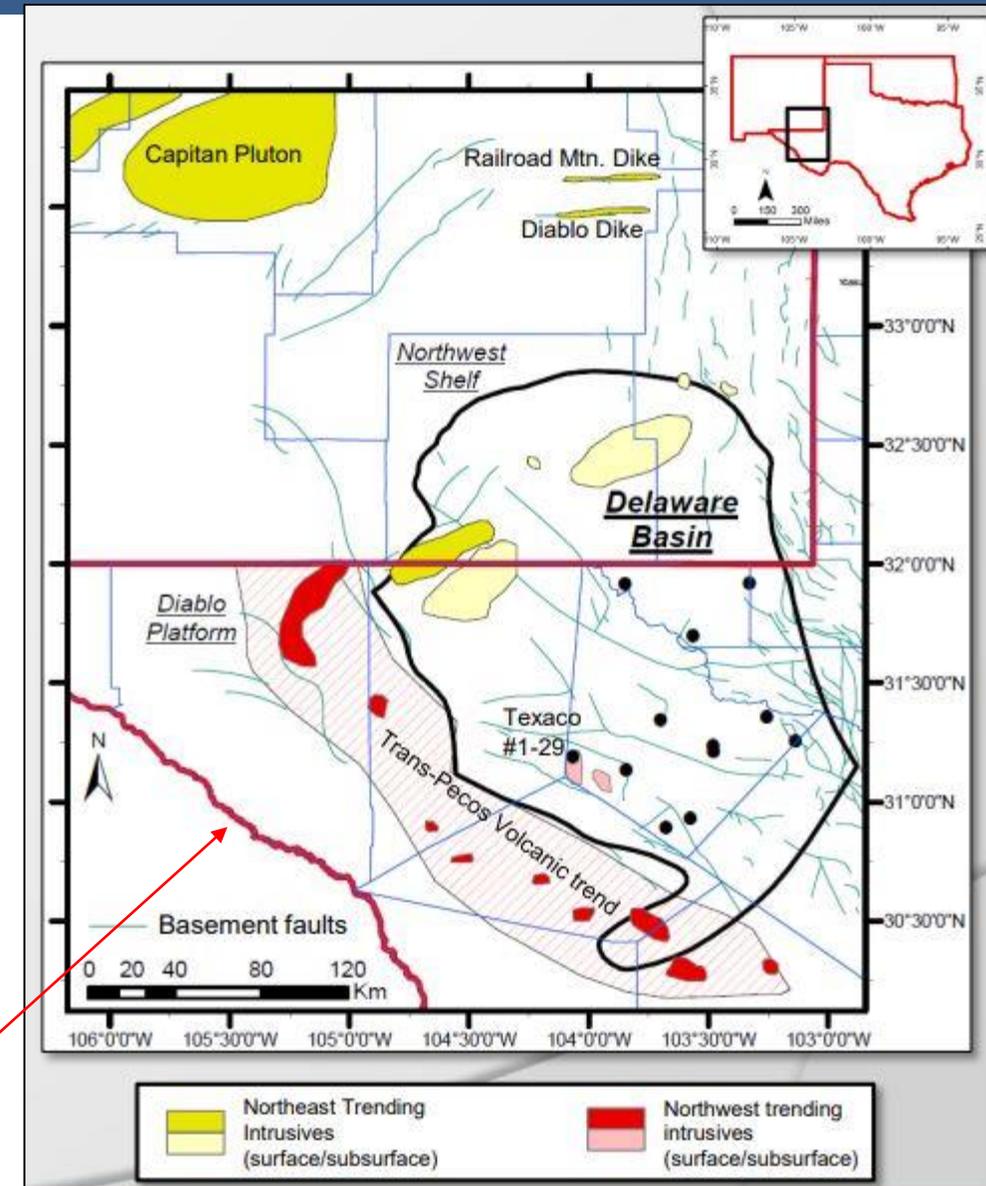
Cretaceous Roadcut



Key Uncertainties in Basin

- Amount of missing Cretaceous Sediment
 - estimates vary between 3-7,000 ft of sediment (Roberts and Kirschbaum, 1995; Sinclair, 2007)
- Paleo Heat Flow in basin – higher heat flows indicated by geochemical data
- Crustal Geology – Rio Grande Rifting and intrusives

Rio Grande Rift Axis

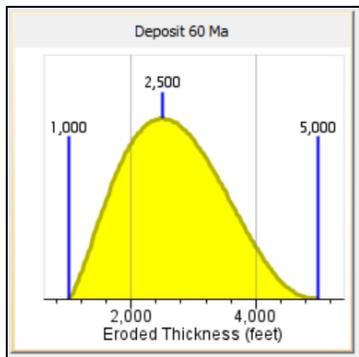


Sensitivity to Geologic Events

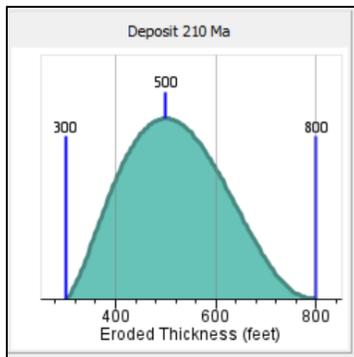
- Run non-discrete model with range of inputs for uplift events
- Test range of possible missing sediment thickness, vary heat flow

Eroded Sediment Thickness Distributions

Cretaceous

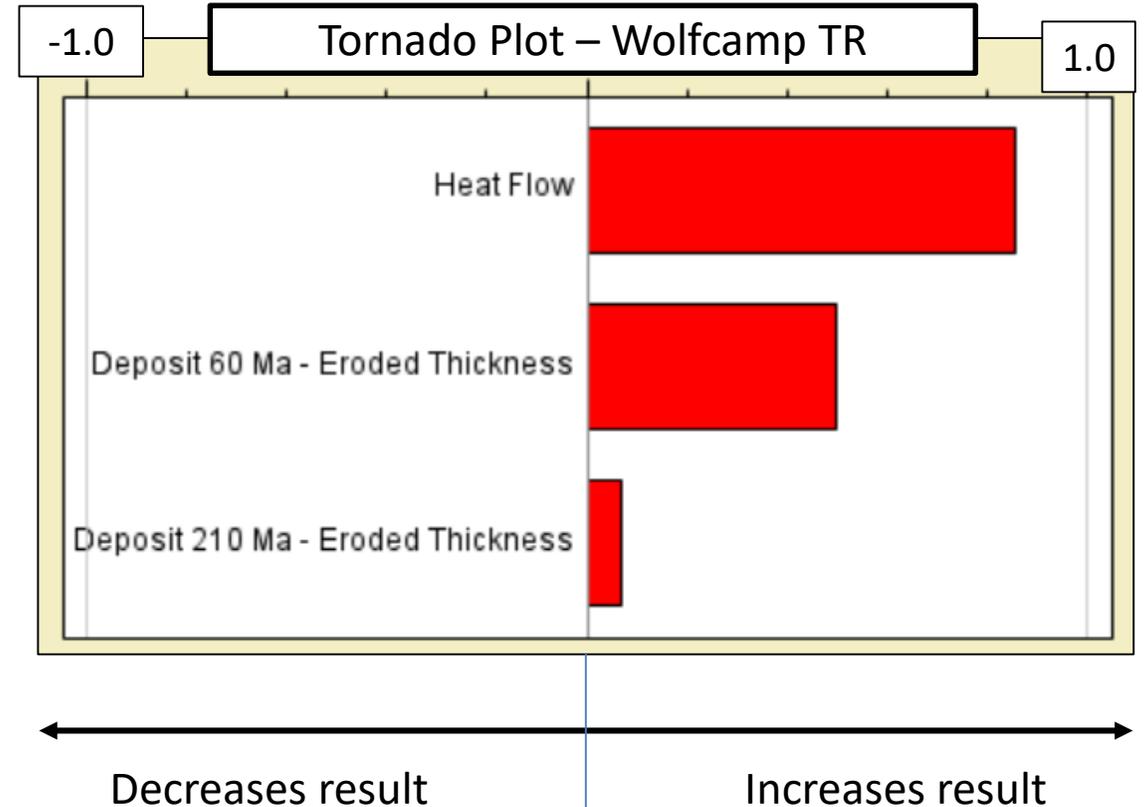


Triassic



Heat Flow

- Rifting - beta value of 1.4 (Wilson et al., 2005)
- Higher heat flows in basin interior (Pawlewicz, 1987)

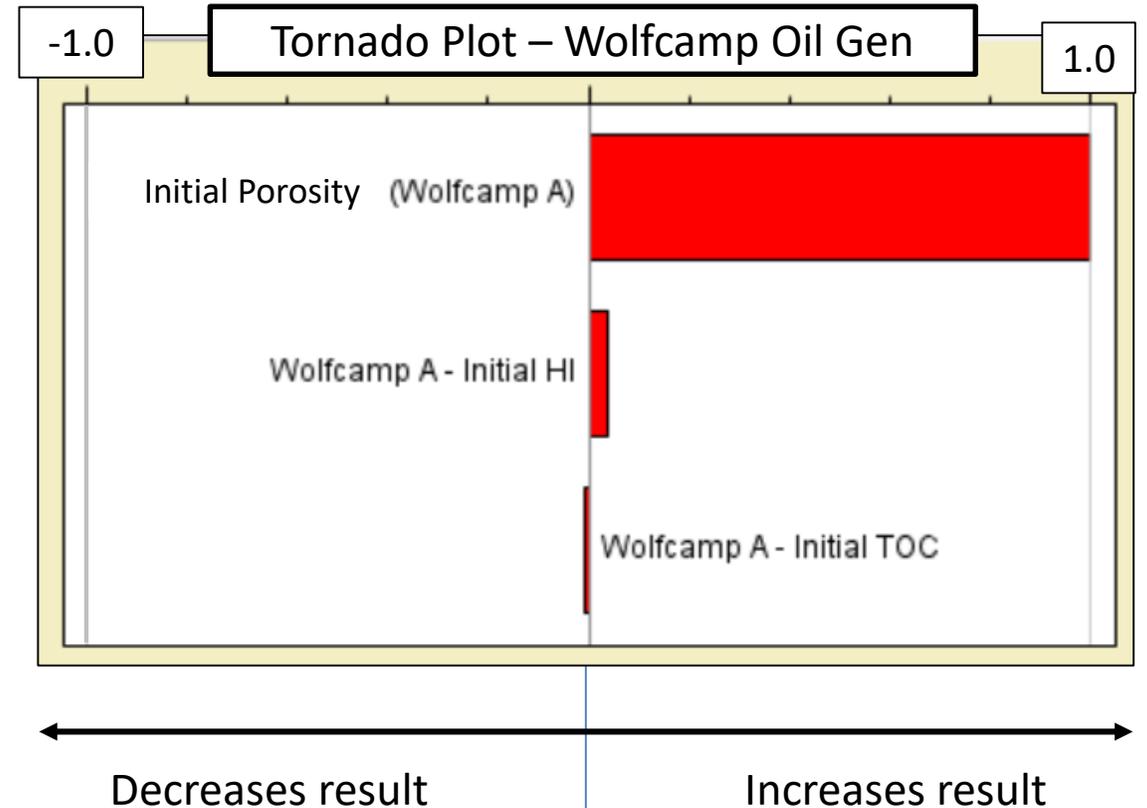
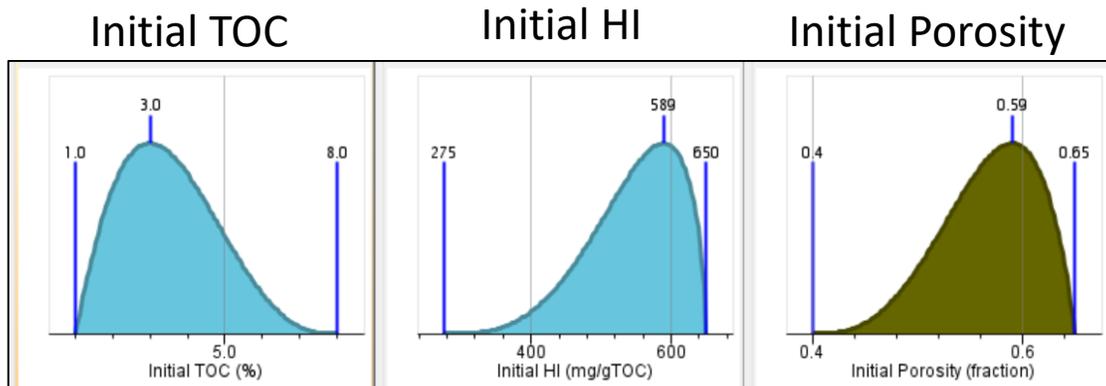


- Heat flow history has highest magnitude affect on Wolfcamp Transformation Ratio

Sensitivity to Source Rock Geochemistry

- Test range of possible geochemical variation
 - TOC
 - Kerogen Type
 - Lithology

Wolfcamp Source Rock Parameters



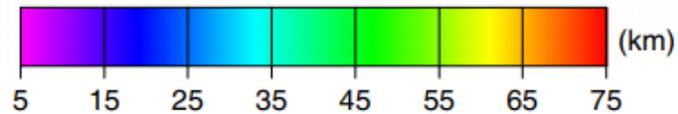
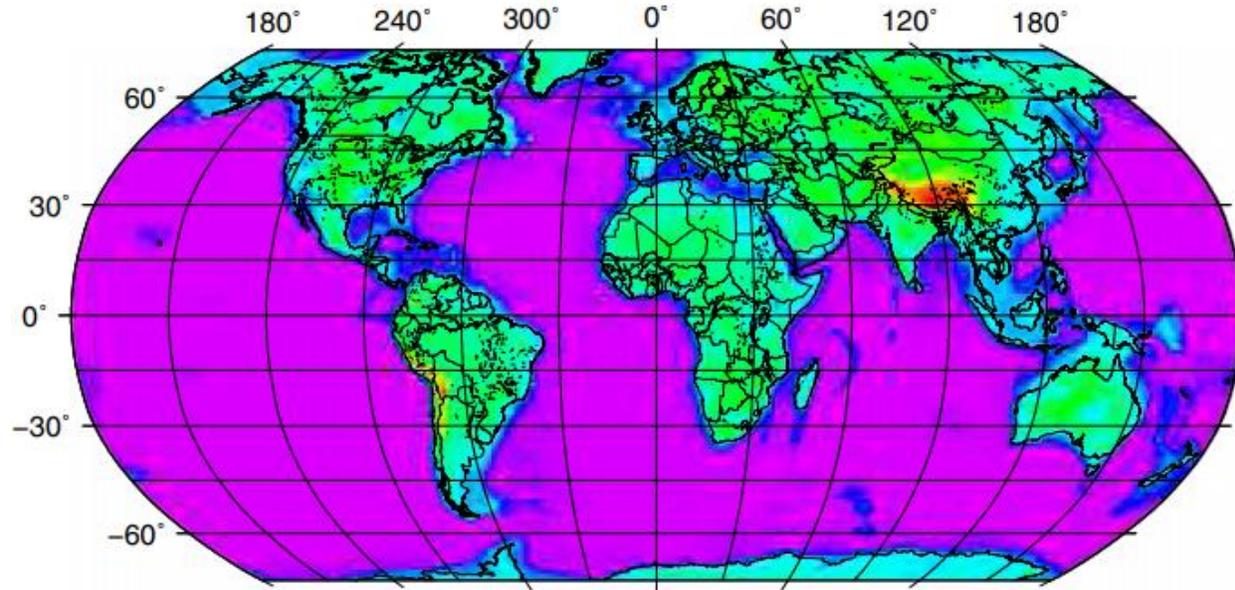
- **Initial porosity** has significantly larger effect on oil generation in model
- Error from IP propagates into thermal properties of rocks (Thermal Conductivity, Heat Capacity)

Outline

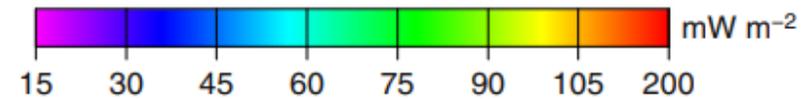
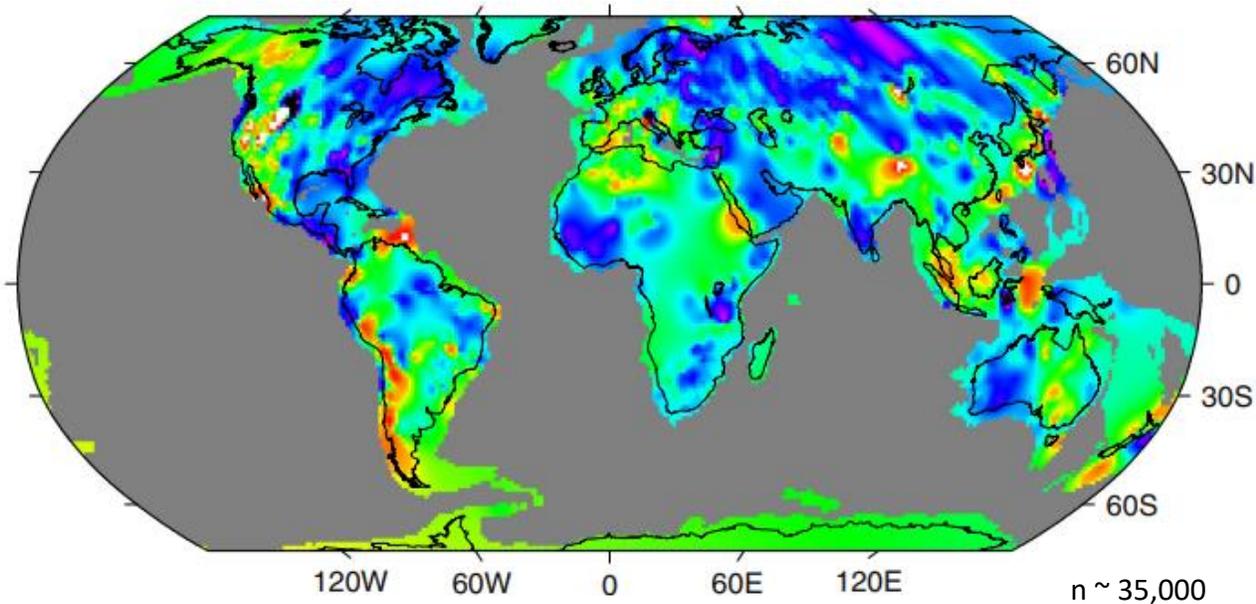
- Introduction to Delaware Basin
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- **Crustal Model**
- Conclusions

Crustal Model - Inputs

Crustal Thickness



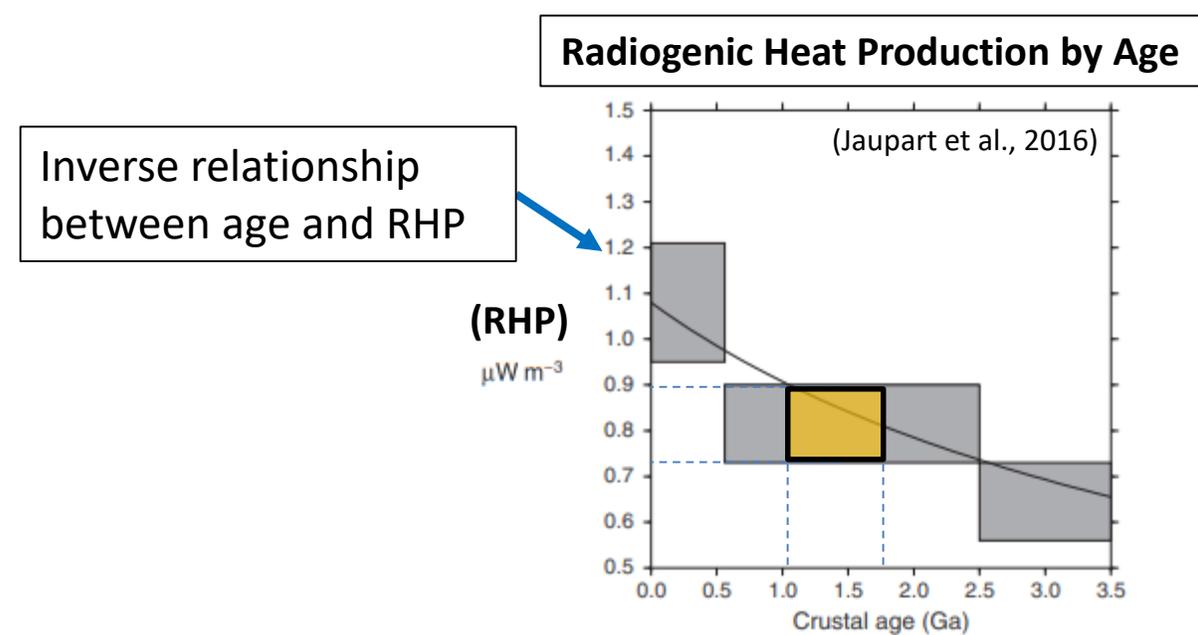
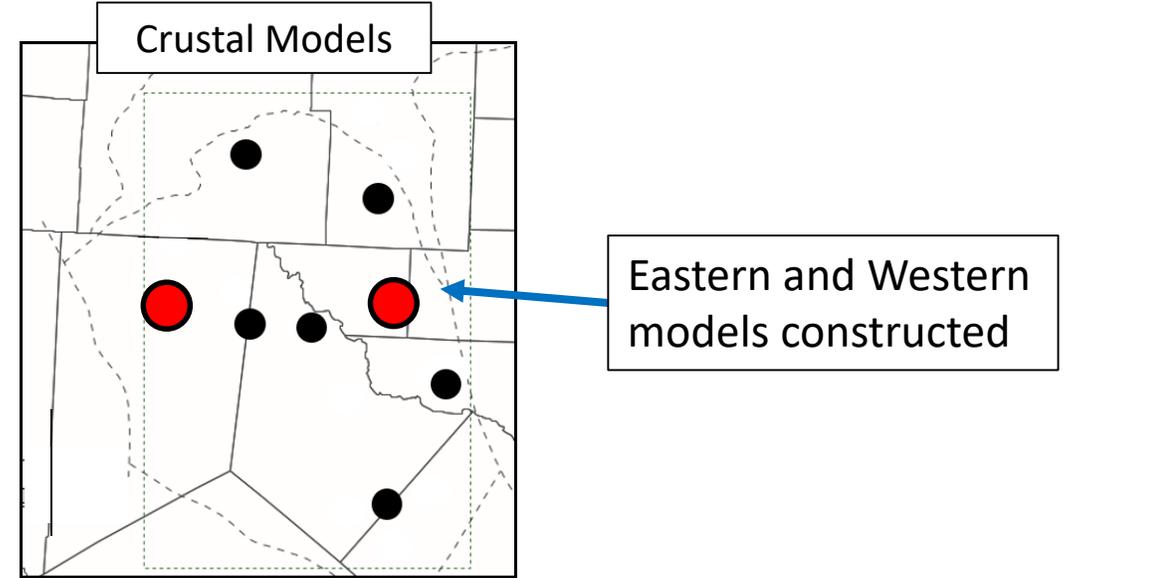
Continental Heat Flux



- Plate collision boundaries stand out with high heat flux and crustal thickness
- Tectonically stable areas with variable heat flux are due to compositional variations in crust

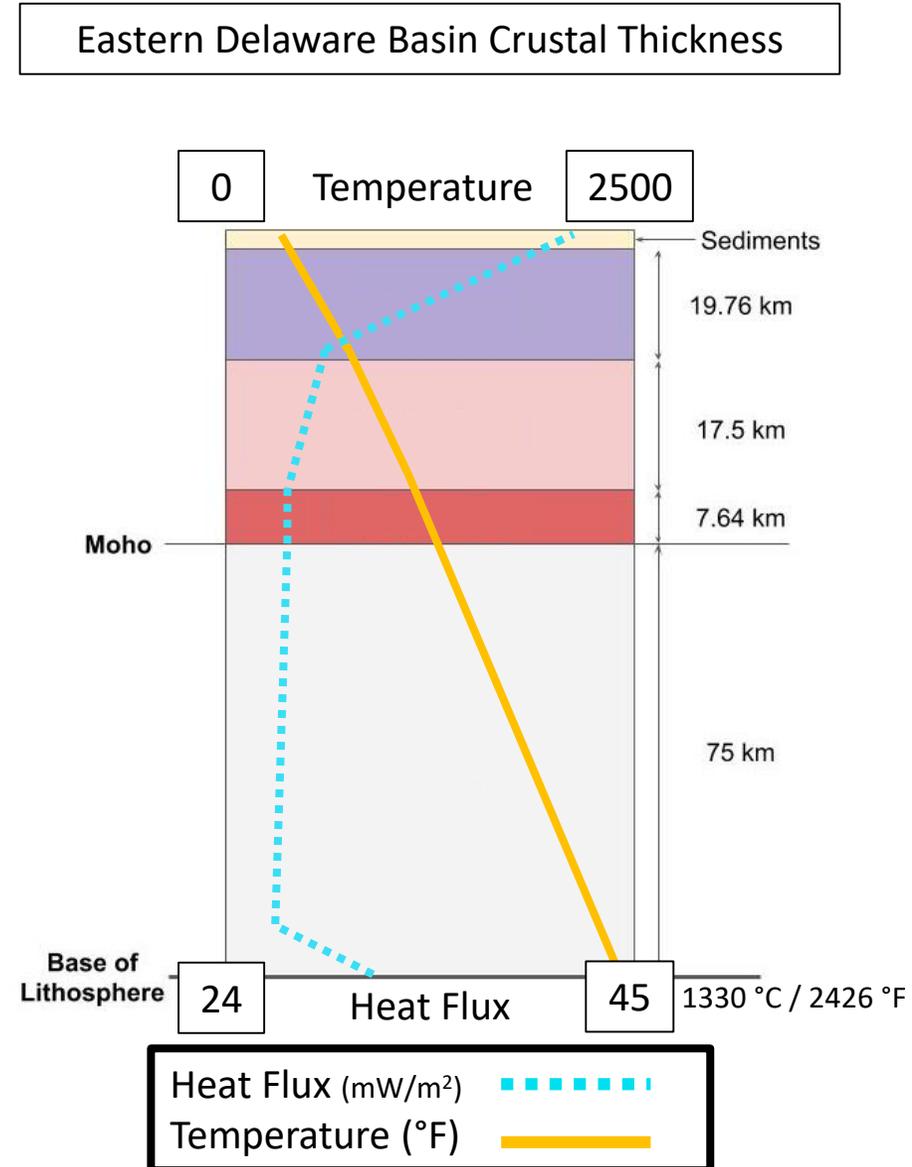
Crustal Model - Inputs

- Thermal properties of crust not directly measurable in basins
- Analysis of Deep boreholes, xenoliths, exposed crust for:
 - Conductivity, heat capacity, **radiogenic heat production (RHP)**
- Two key factors:
 - Abundance of radioactive elements
 - Geologic Age
- Delaware Basin crust 1.7 – 1.1 Ga (U/Pb)
(Adams and Keller, 1996)



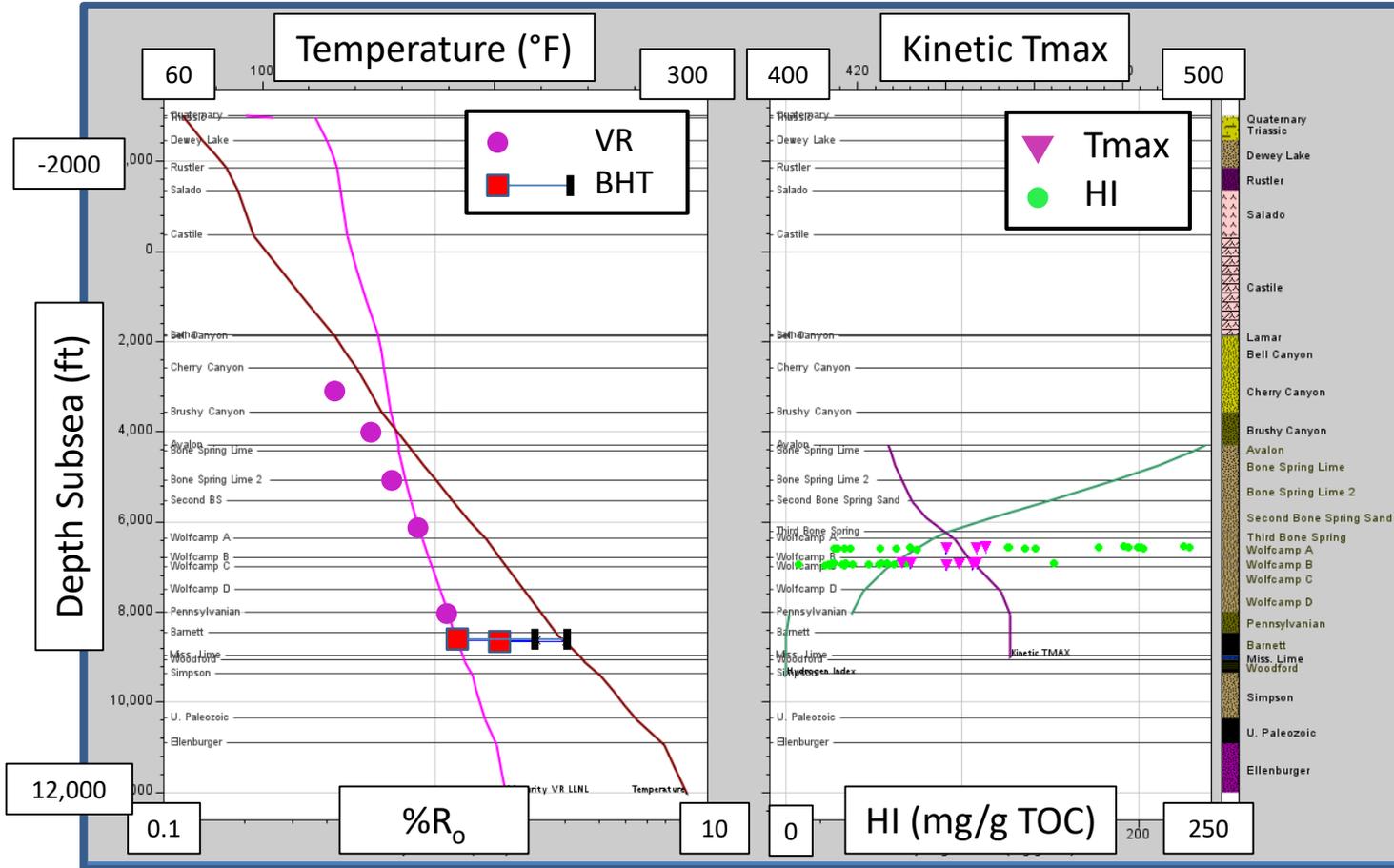
Crustal Model - Inputs

- Lawrence Livermore National labs global crustal thickness model ([Laske, et al 2013](#))
- Depth to asthenosphere global model ([Artemieva, 2006](#))
 - 120 – 125 km in Delaware Basin
 - Thins westward towards Rio Grande Rift
- Lower thermal boundary condition **temperature not heat flux**

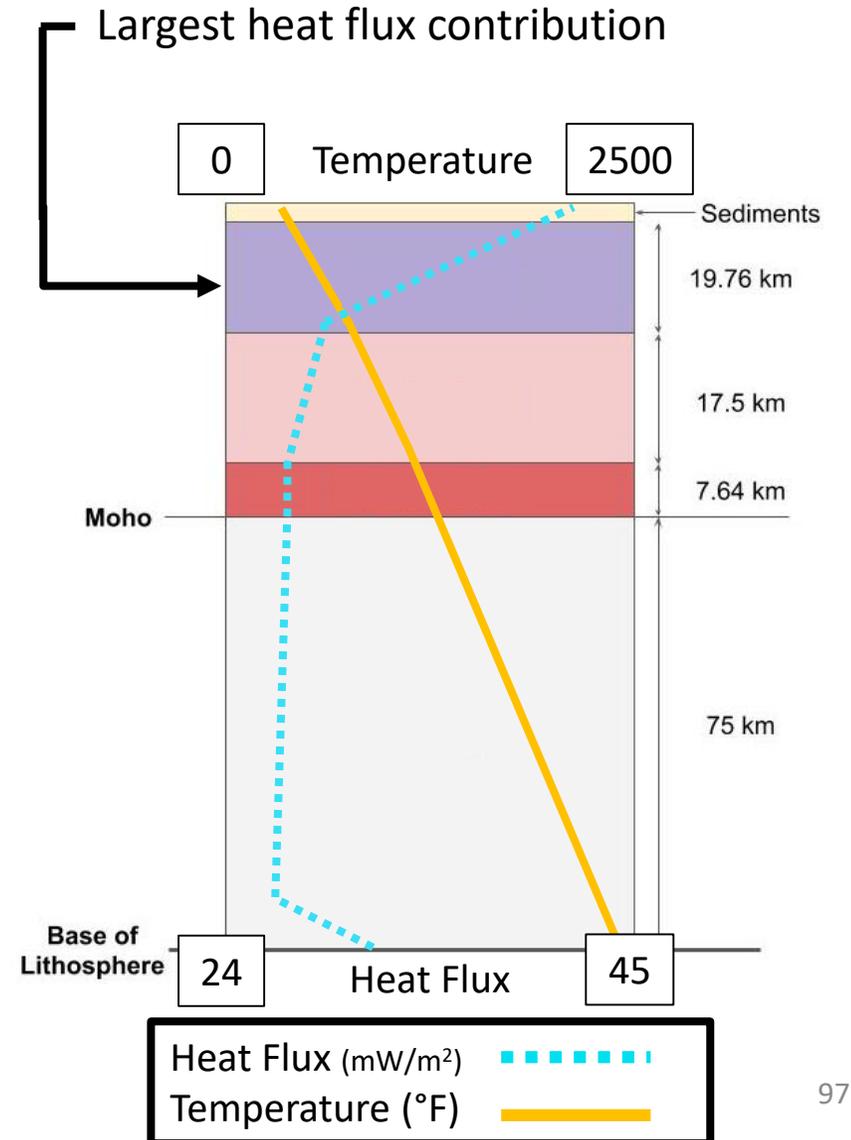


Crustal Model - Calibration

Depth Plots – Calibrated to BHT, Tmax, HI

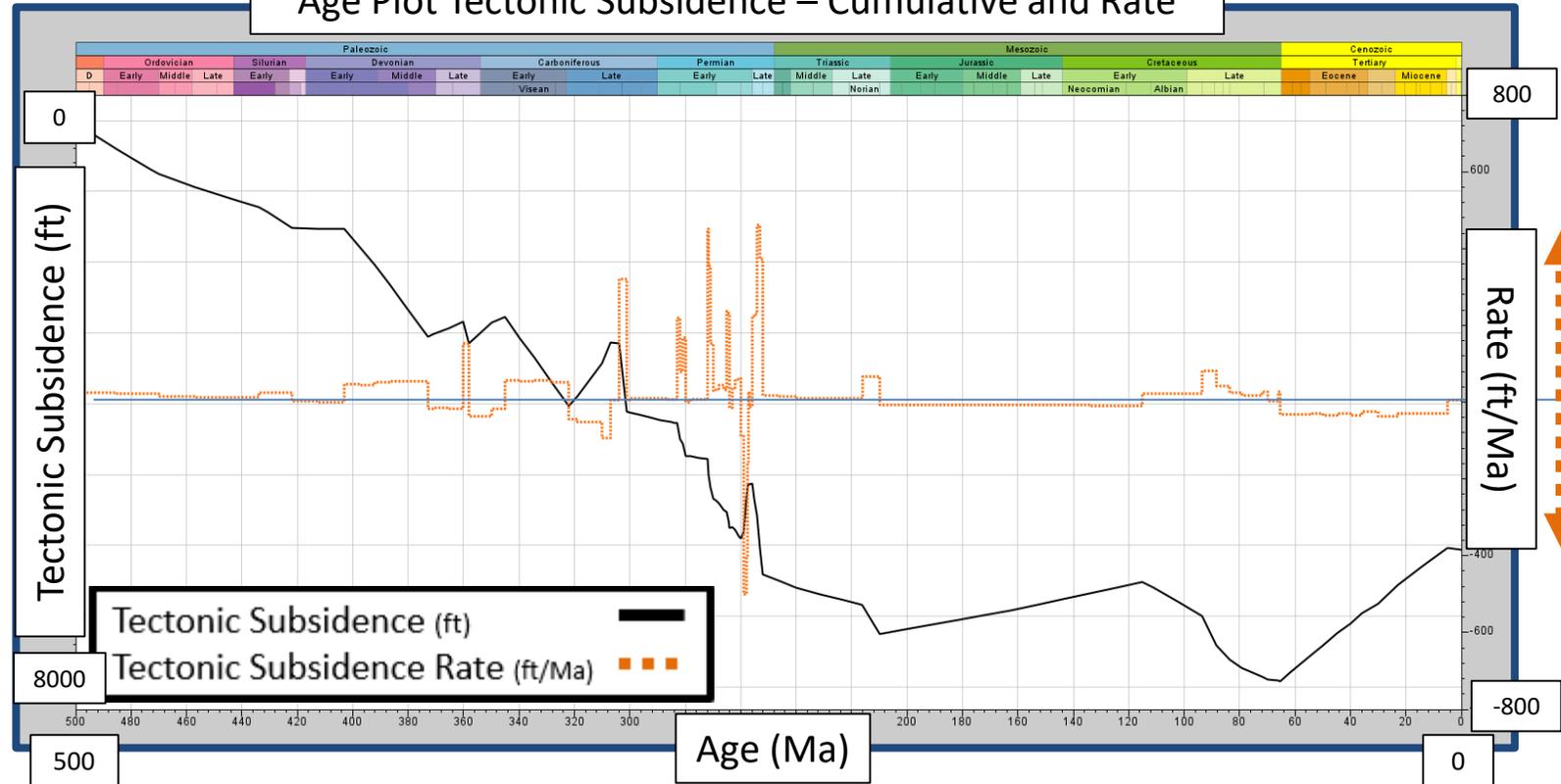


- Iteratively adjust thermal parameters to match BHT, Geochem*
- Fit model to measured data – **RHP of Upper Crust Most Influential**



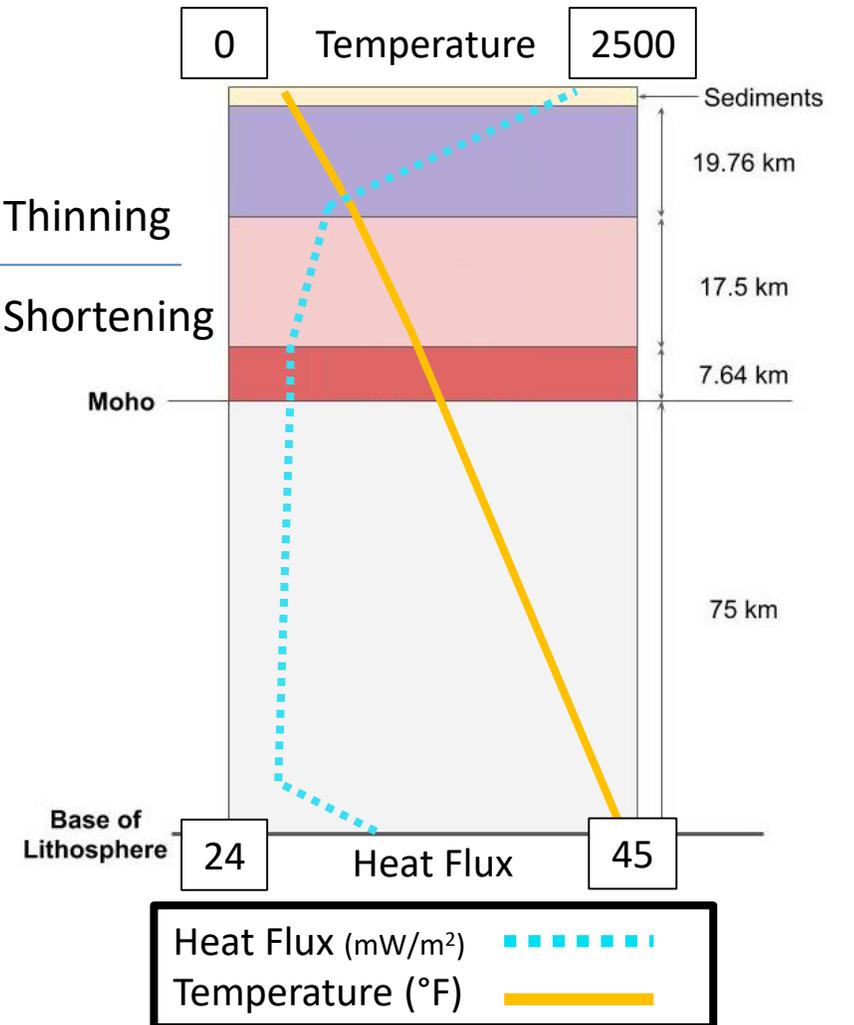
Crustal Model - Calibration

Age Plot Tectonic Subsidence – Cumulative and Rate



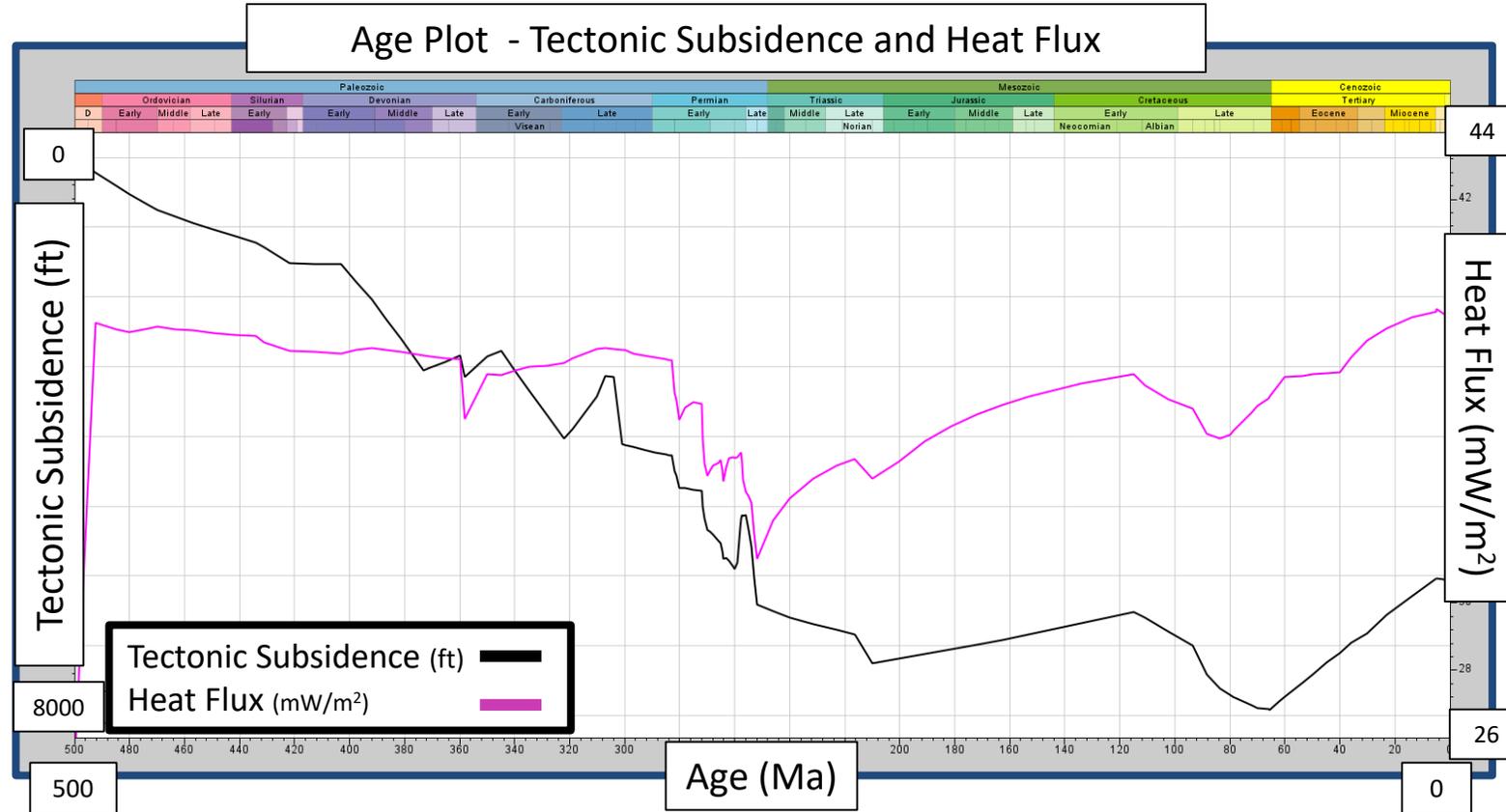
- Positive subsidence rate accounted for with crustal thinning, negative for crustal thickening
- Increasing subsidence through Paleozoic, followed by episodic shortening, minor Cretaceous sedimentation, uplift to present day

Eastern Delaware Basin Crustal Thickness



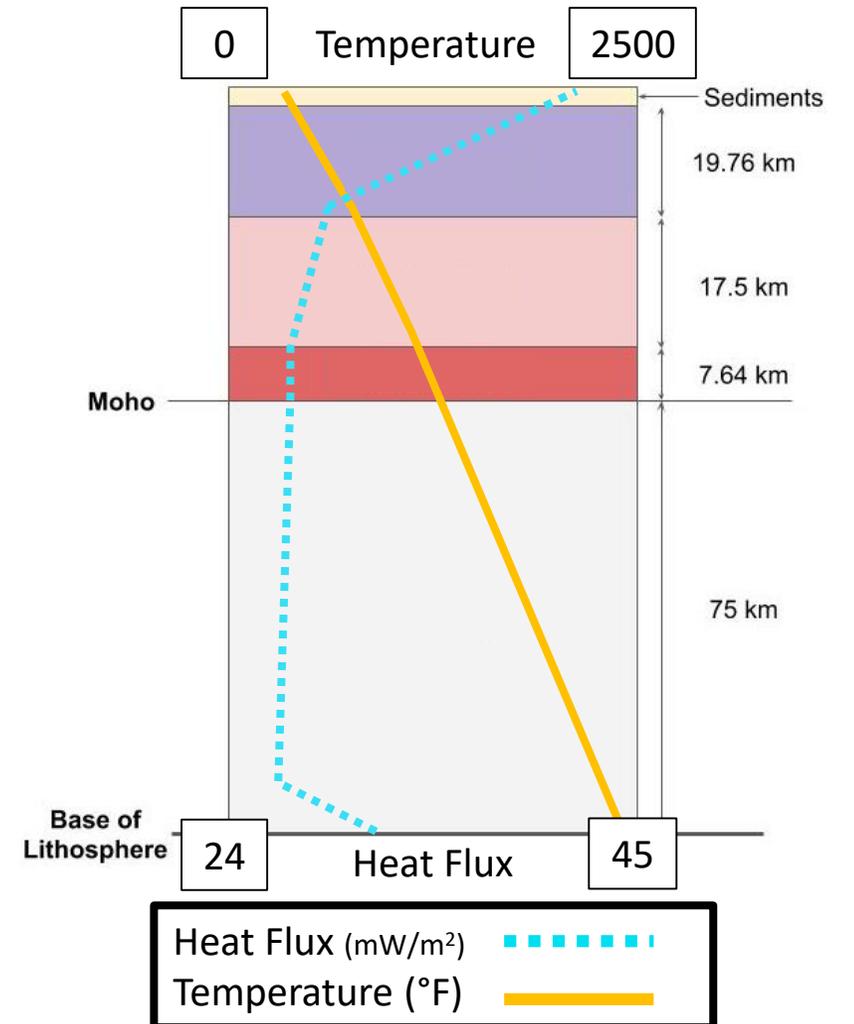
Crustal Model - Calibration

Age Plot - Tectonic Subsidence and Heat Flux



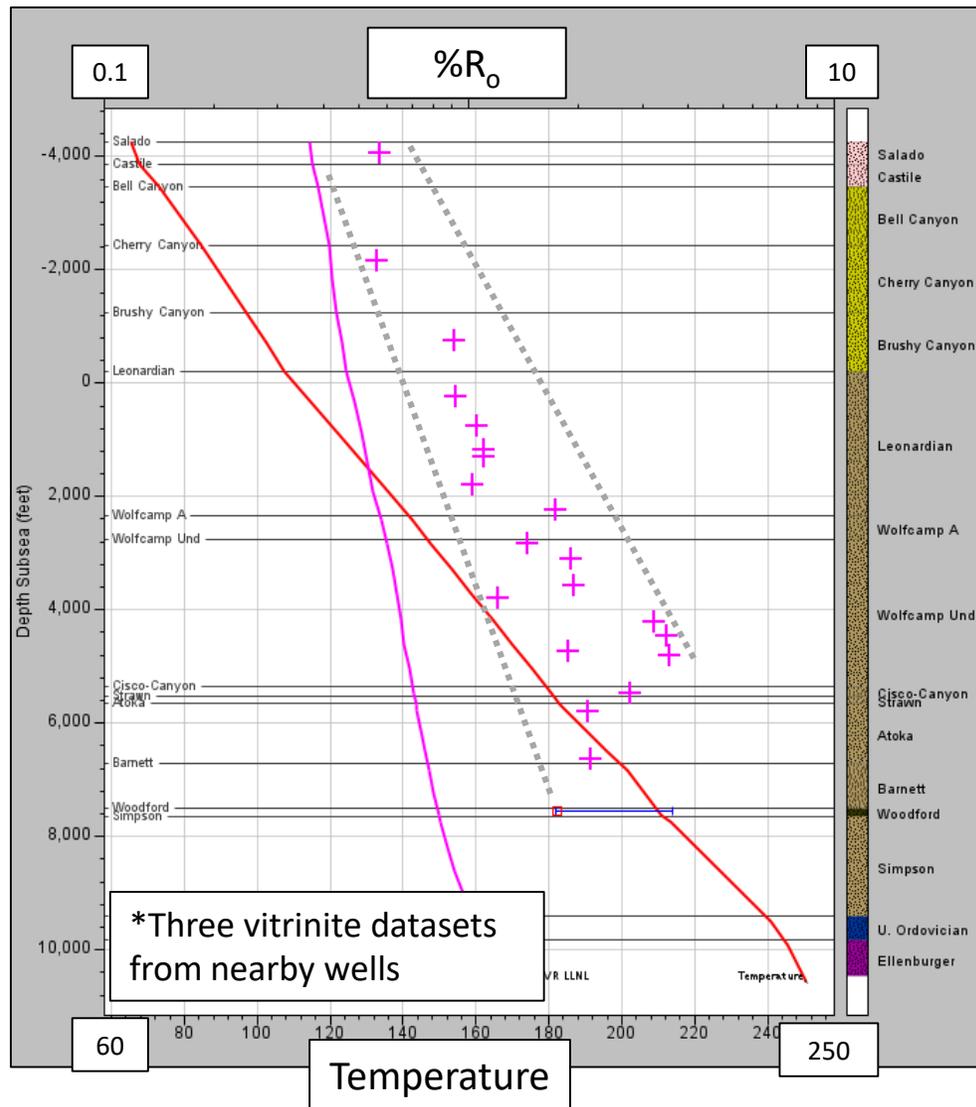
- Variable heat flux through time due to crustal thickness change
- Inverse relationship between heat flux and crustal thinning

Eastern Delaware Basin Crustal Thickness

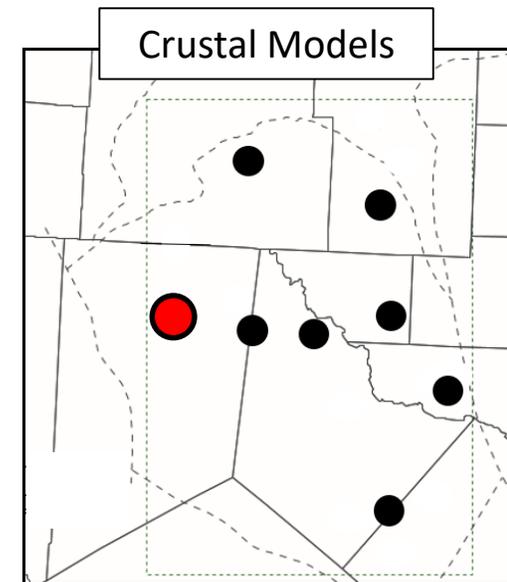


Western Delaware Crustal Model - Results

Depth Plot - Thermal and Geochemical Calibration

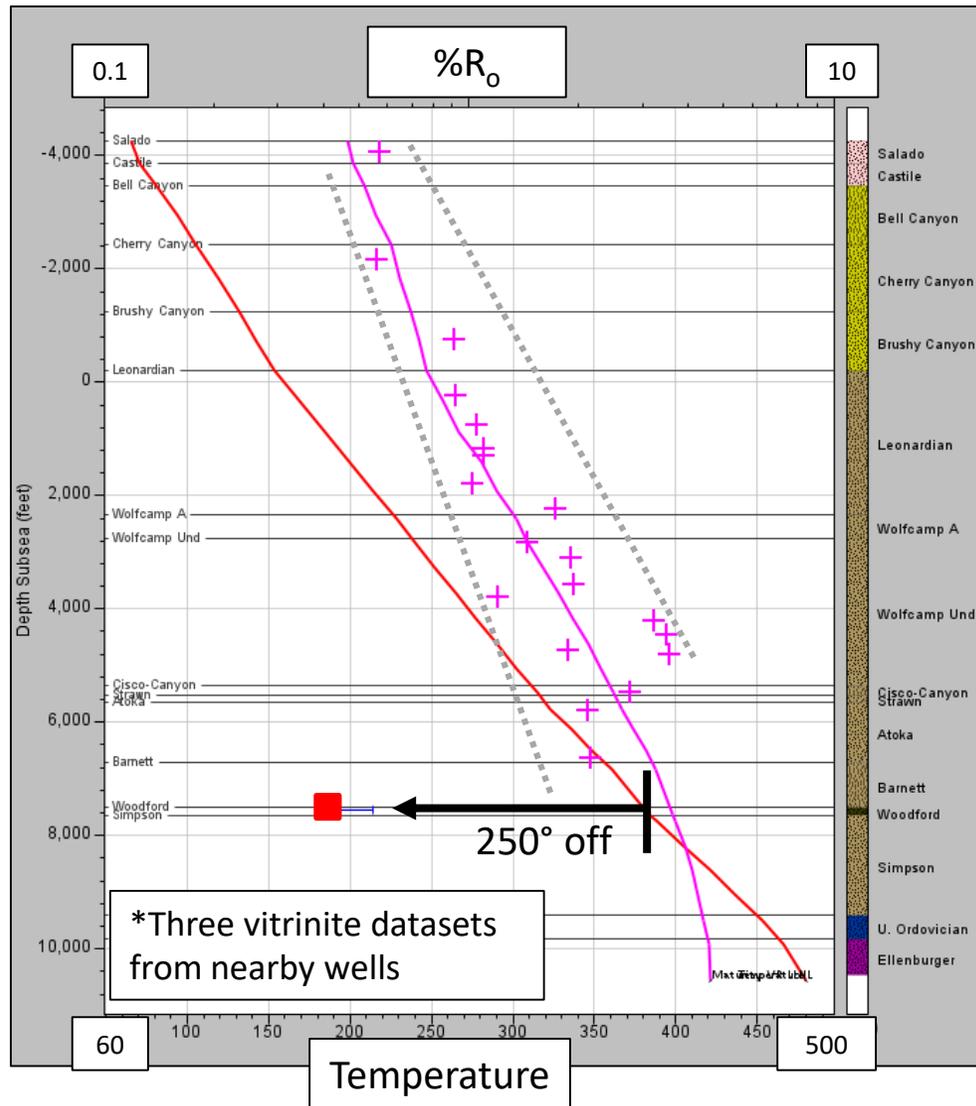


- Western Delaware Basin Model calibrated with separate crustal model, **could not account for thermal maturity**
- Model used to quantify how much heat necessary to accurately model thermal maturity
- Existing hypotheses:
 - **Radiogenic heat** associated with AGU
 - McKenzie-type **rifting** from Rio Grande
 - Collapse of Farallon plate, removal of lower lithosphere and **mantle upwelling**



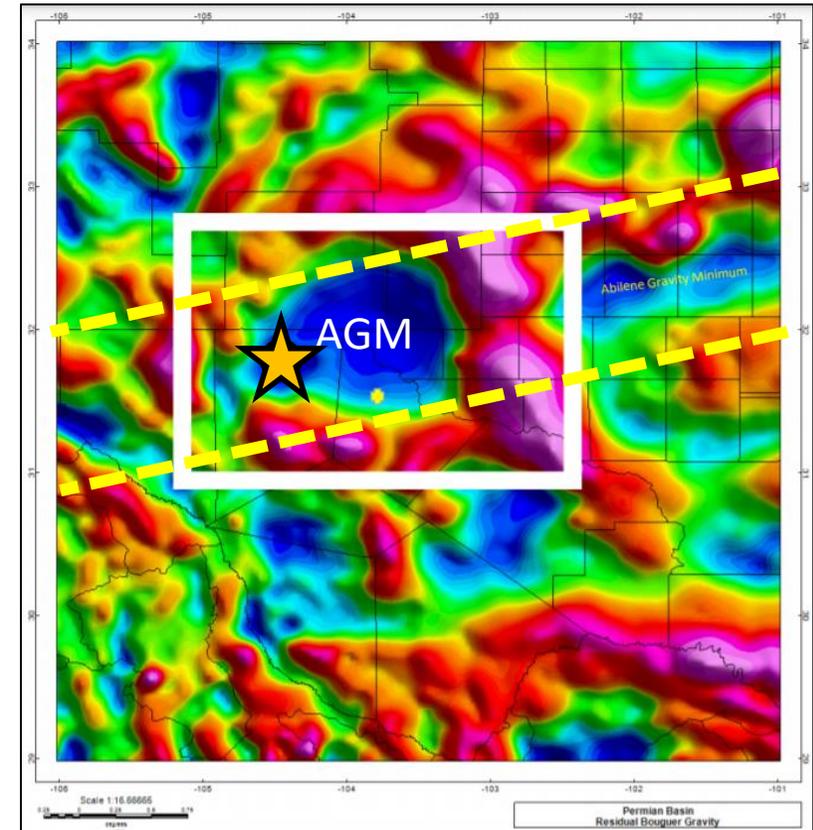
Radiogenic Heat

Depth Plot - Thermal and Geochemical Calibration



- Adams and Keller (2017) suggested high radiogenic heat beneath Abilene Gravity Minimum
- Increased radiogenic heat to model thermal maturity
- **Drastically overcalculates present day thermal gradient**

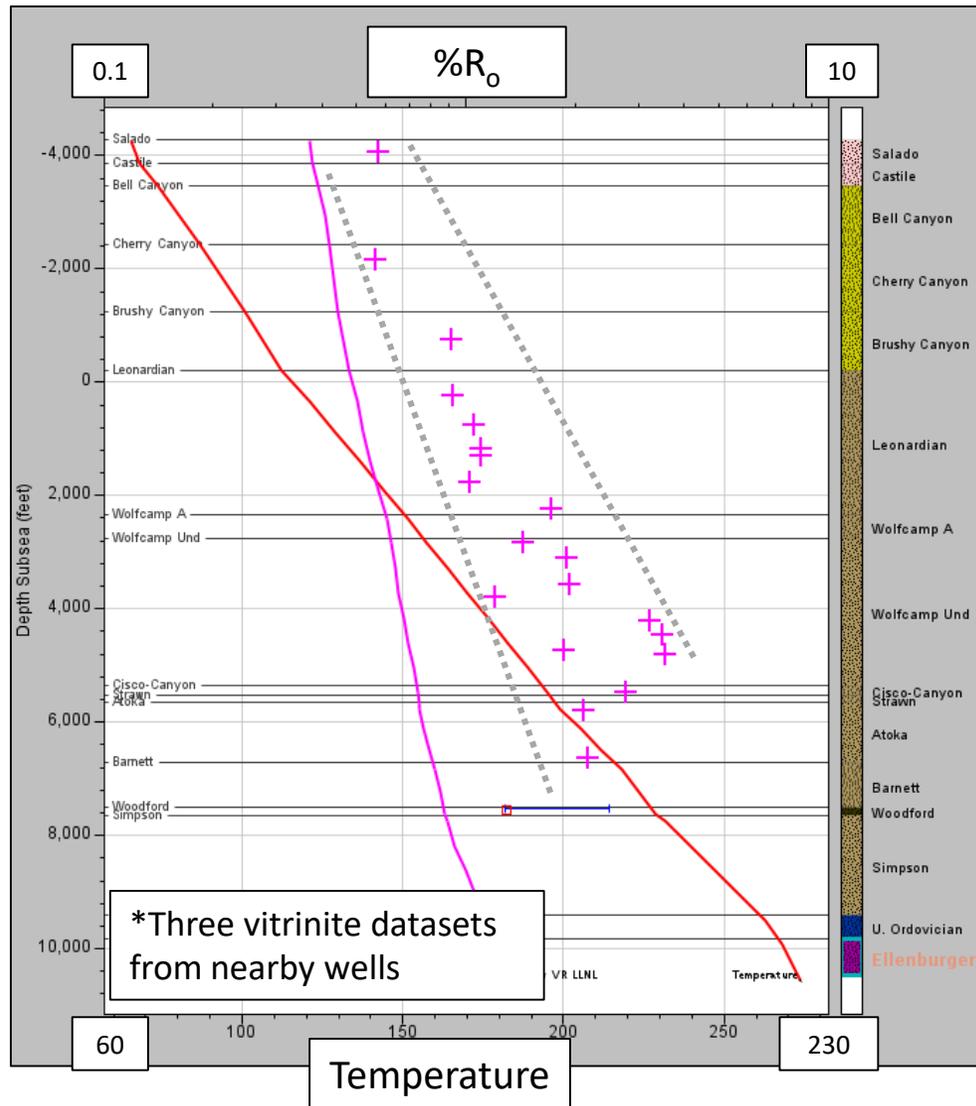
Permian Basin Residual Bouguer Gravity



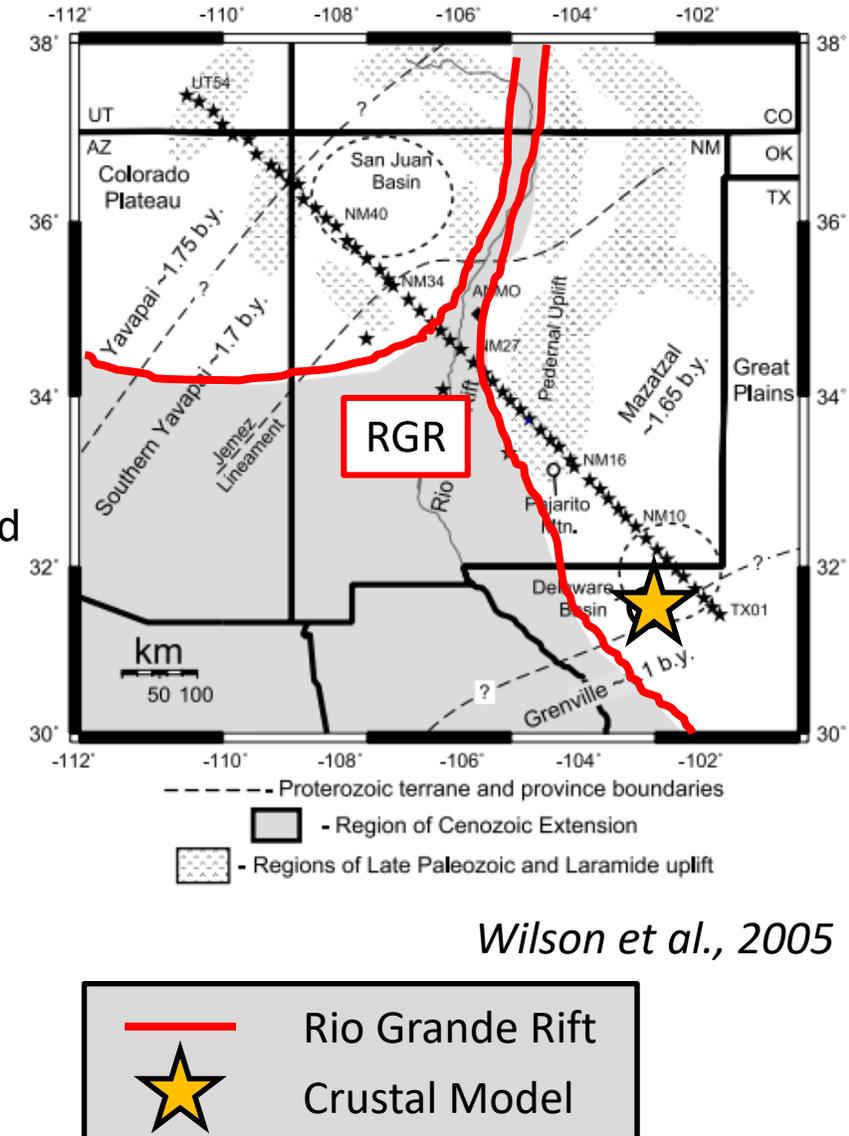
(Adams and Keller, 2017)

Mckenzie-Type Rifting

Depth Plot - Thermal and Geochemical Calibration

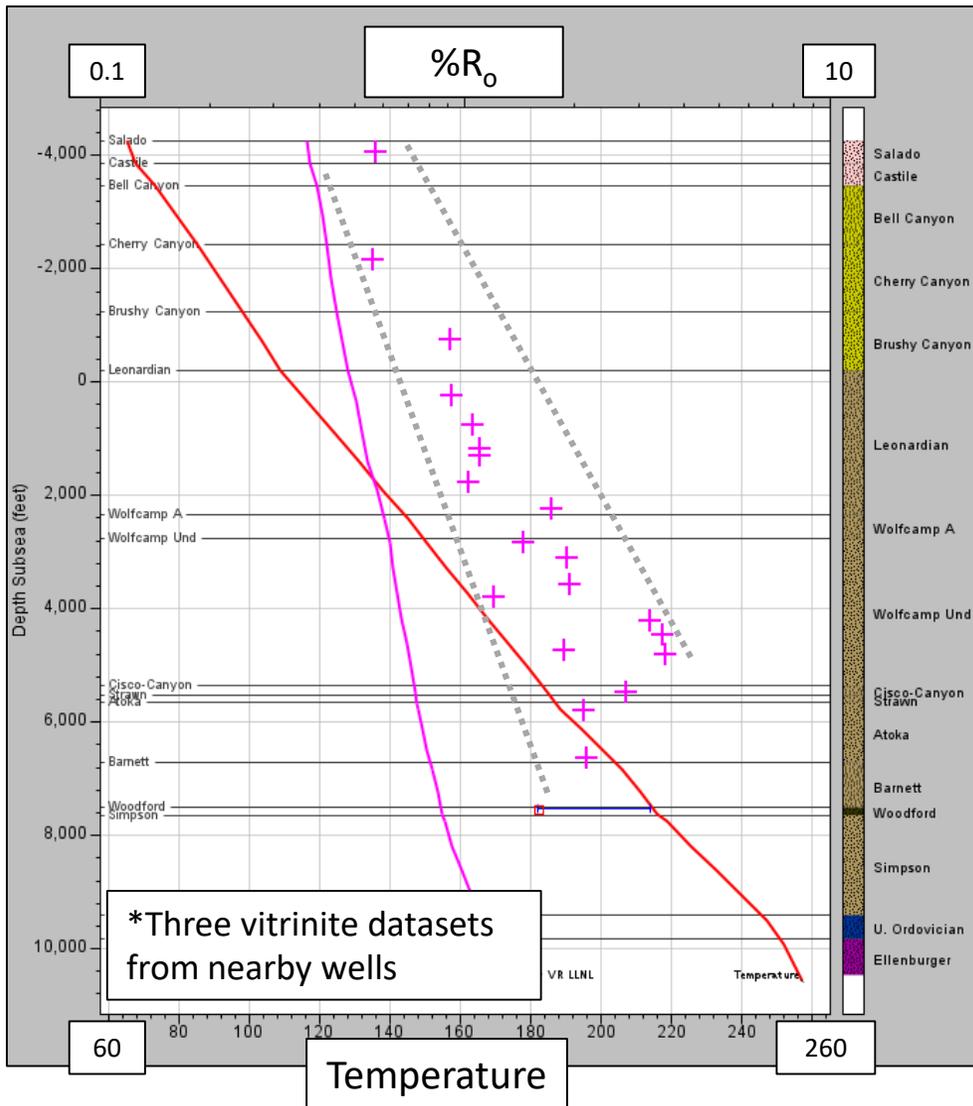


- Maximum of 50% thinning on Rio Grande Rift (*Manos and Perez, 2018*)
- Western Delaware experienced 10% thinning (*Henry, 1998*)
- Thinned crust 50% at 30 Ma
- **further reduces thermal maturity**



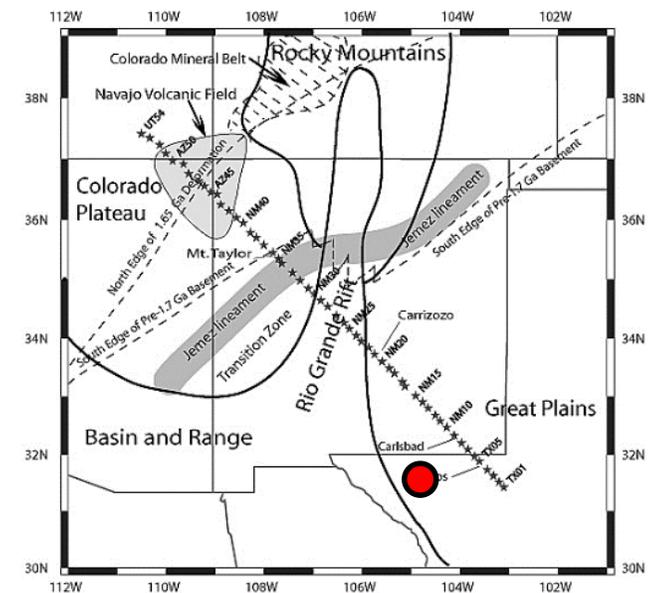
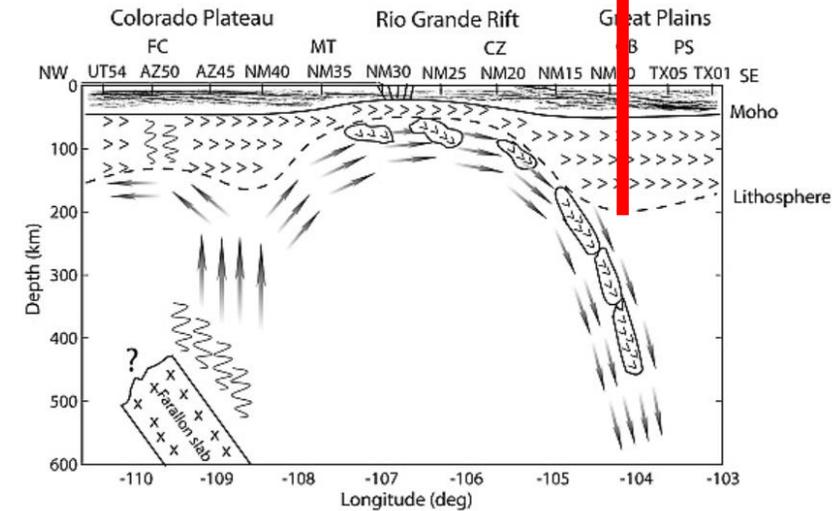
Mantle Convection

Depth Plot - Thermal and Geochemical Calibration



- Subduction of Farallon plate removed lower lithosphere
- Lower lithosphere was 10's of km thicker
- Thicker lower lithosphere until 28.5 Ma
- Requires higher radiogenic heat, still undercalculates maturity

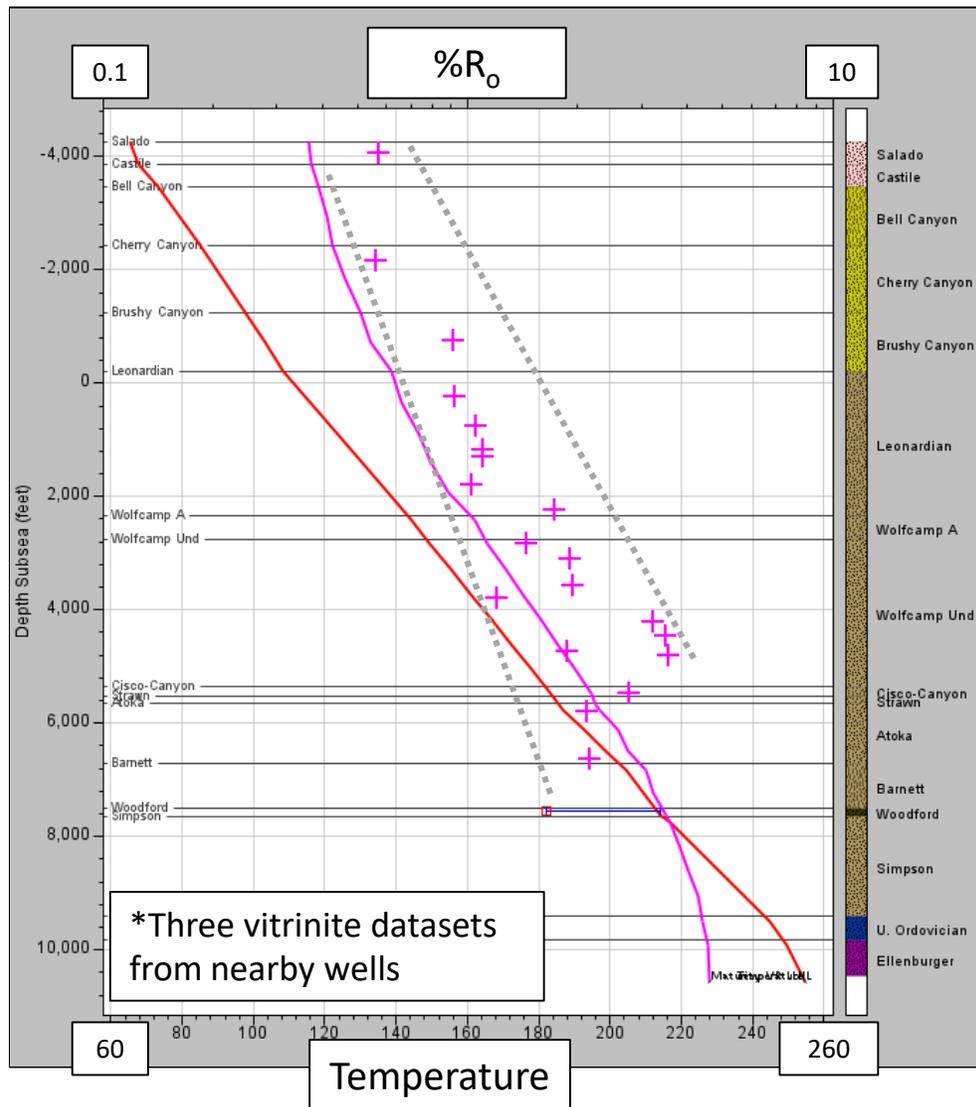
Model location



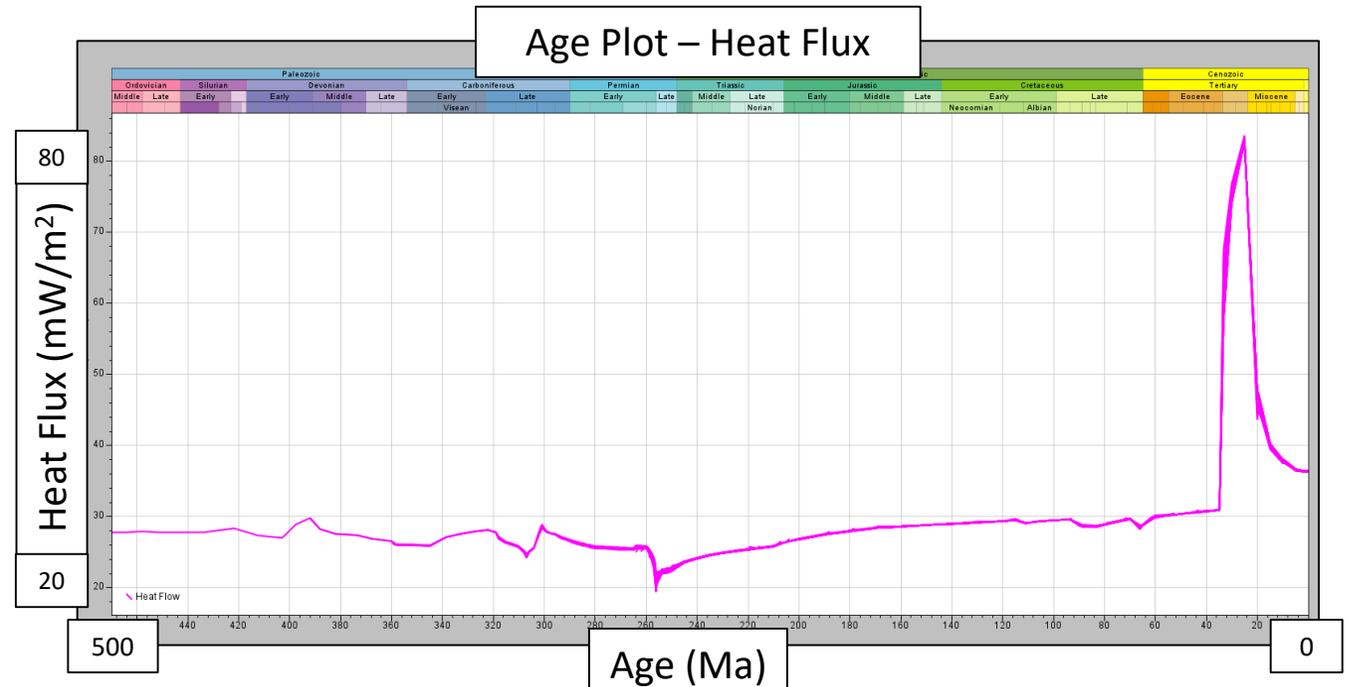
(Gao et al., 2004; Humphreys et al., 2010)

Western Delaware Basin Conclusion

Depth Plot - Thermal and Geochemical Calibration



- Higher paleo heat flux in western basin required for observed thermal maturity
- Requires peak heat flux of 81 (mW/m²), likely occurred during RGR (*Manos and Perez, 2018*)
- Maximum paleo geothermal gradient is **much lower today**

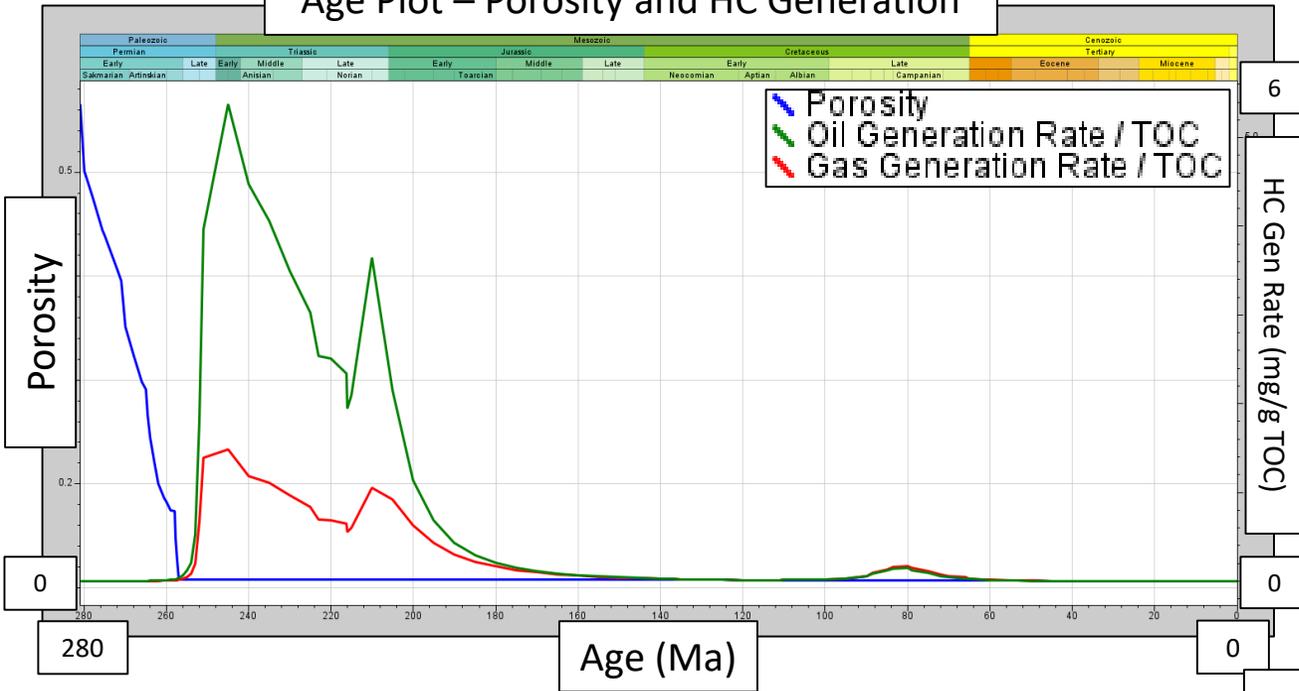


Outline

- Introduction to Delaware Basin
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- **Conclusions**

Wolfcamp Hydrocarbon Generation

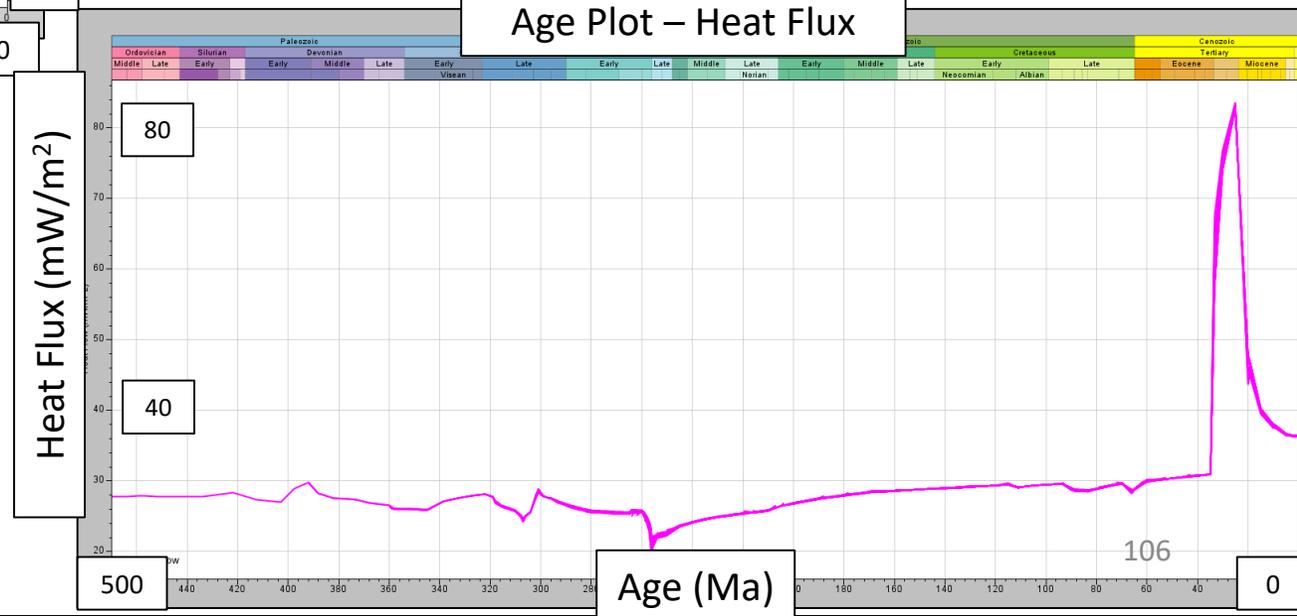
Age Plot – Porosity and HC Generation



- Late-stage heating drove Wolfcamp into gas window in western basin
- Western basin requires heat pulse capable of generating roughly 40 (mW/m²)
- Heat source **not present today**

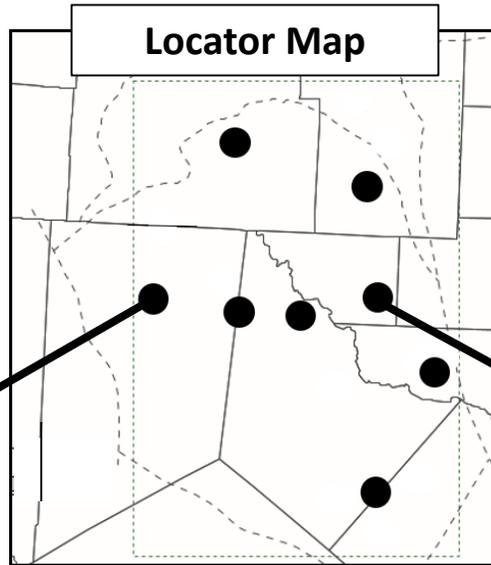
- Wolfcamp HC Generation peaked in Triassic
- Wolfcamp reached maximum mechanical compaction prior to onset of hydrocarbon generation
- Supports higher geothermal gradient explanation for thermal maturity, higher Gas-Oil-Ratio in west

Age Plot – Heat Flux

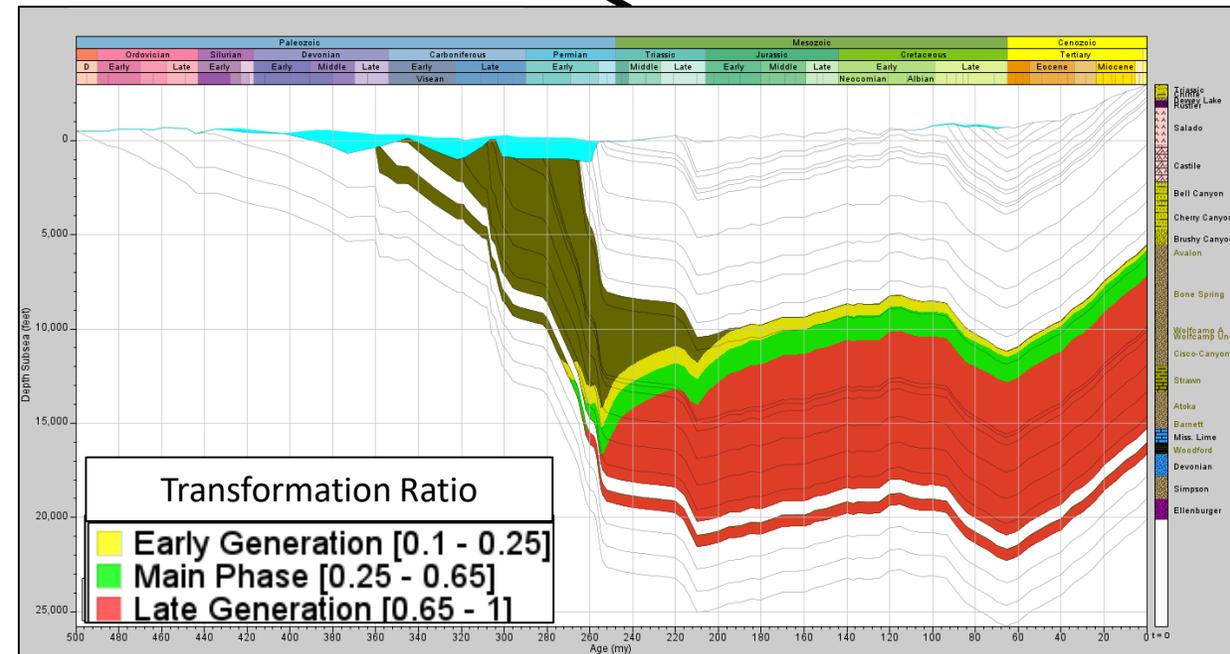
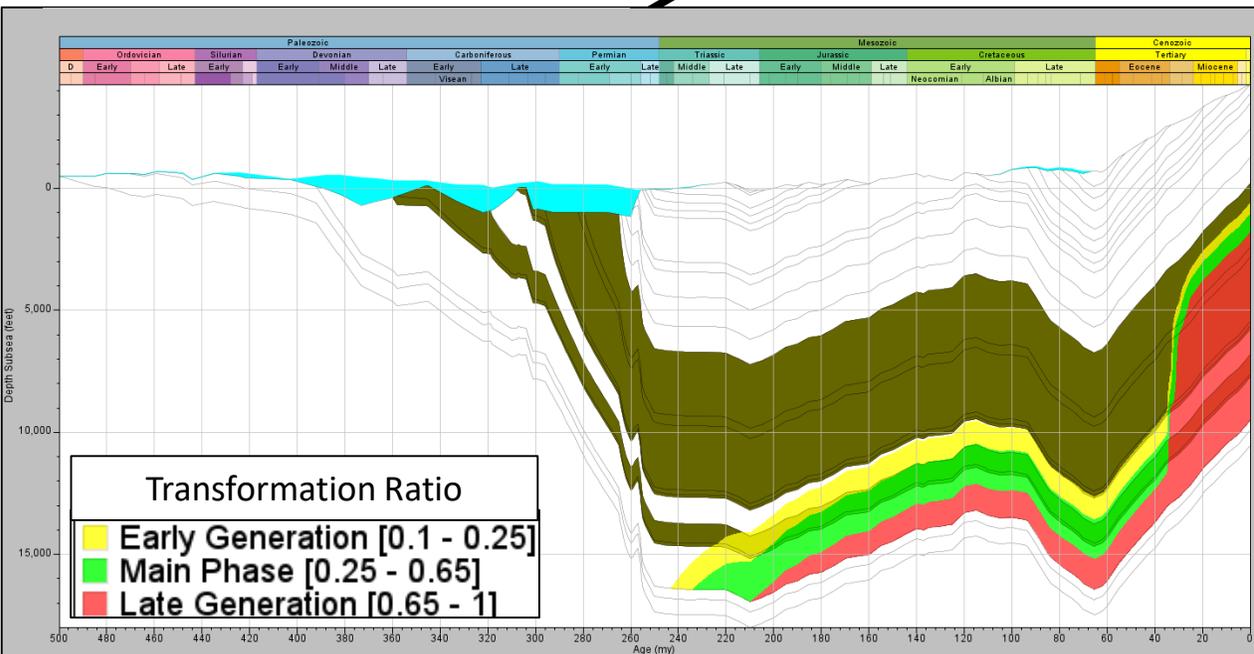


Western vs Eastern Delaware Burial History

- Geothermal controls
- Cenozoic tectonism



- Tectonic controls
- Paleozoic Tectonism



Conclusions and Recommendations

Conclusions	Recommendations
<ul style="list-style-type: none">• Thermal maturity of Wolfcamp most sensitive to heat flux<ul style="list-style-type: none">• Adequate temperature data crucial for calibration• 1D vertical heat flux not sufficient to model western Delaware Basin	<ul style="list-style-type: none">• Calibrate maturity models with DST's, temperature logs, multiple BHT's
<ul style="list-style-type: none">• Oil generation in Wolfcamp sensitive to mechanical properties of rock<ul style="list-style-type: none">• Modeling with representative lithology for thermal maturity, volumetrics	<ul style="list-style-type: none">• Utilize porosity data for calibrant• Detailed analysis of thermal properties of Wolfcamp from cores, cuttings
<ul style="list-style-type: none">• Western Delaware Basin is a separate heat flow province (<i>Blackwell and Birch, 1968</i>)<ul style="list-style-type: none">• Tectonism in the Western Delaware Basin caused a heat pulse of 20 mW/m² not present today	<ul style="list-style-type: none">• 2D/3D Basin modeling to test lateral heat flow scenarios from western heat flow province

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Questions?

Wolfcamp Structure – EIA, 2019

