The Cretaceous Mowry Shale is an organic rich, siliceous marine shale, and as such is a major source rock in the Western United States. Because the amount of organic material in a rock is linked to its oil and gas generative capability, several studies have outlined the lateral variability of total organic carbon (TOC) on a basin scale, covering large areas with limited sample sets. Little is known about fine-scale lateral variations of TOC on a scale of several miles, however. Over 300 samples from the same 10-cm stratigraphic interval of the Mowry Shale have been collected at regular 10 meter intervals over three outcrops near Lander, Wyoming. Pyrolysis analysis and clay mineralogical characterization of samples shows meaningful fine-scale variations and spatial trends. Average TOC of all samples is 1.65% with a standard deviation of 0.229 and a range of 1.57%, and samples are characterized as either Type III or mixed Type II/III source facies. Based on a 3D spatial model built in Petrel, TOC decreases basinward (southeast) in the study area despite a documented larger regional increasing basinward trend. Additionally, kerogen types become slightly more gas prone in a basinward direction. This suggests important localized trends, often important on a production scale, in both the Mowry Shale and other fine-grained systems can be quite different than larger, generalized basinward trends.

References Cited


Fine-scale Spatial Distribution of Organofacies in the Mowry Shale, Wind River Basin, Lander, WY

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Outline

Problem, Significance

Geologic History
  ◦ Mowry Deposition
  ◦ Stratigraphy
  ◦ Facies

Methods

Results

Conclusions
Focus on Regional variations in TOC

USGS Study
- 17 samples basin wide
- From cuttings
- TOC Increases to Southeast

Are there localized trends that differ from regional ones?

From Finn, 2007
Significance

Long-reach laterals = spatial heterogeneity matters!

In order to build a better paleogeographic understanding, detailed spatial information is key (process sedimentology, predictive power).

From Finn, 2007
Geologic History
Mowry Deposition

Cordilleran Orogeny and associated foreland basin

Mowry Sea: 100 Ma
- No connection to present day gulf
- Earliest phase of Western Cretaceous Interior Seaway

Mowry Shale in Montana, Wyoming, and Northern Utah and Colorado

From Blakey, 2014
Stratigraphy

Jurrasic: Redbeds

Lower Cretaceous:
- Cloverly Formation
- Thermopolis Shale
- Muddy Sandstone

Mid-Upper Cretaceous
- Mowry Shale (250-475 ft thick)
  - Lower: Shell Creek Shale
  - Upper: Hard brittle siliceous shale
- Frontier Formation
- Cody Shale
- Mesaverde Formation

From Finn, 2007
Methods
Methodology

Measure, describe, and sample several vertical sections within a small sub-region of the Wind River Basin for organofacies variability.

Pick a horizon that we feel is traceable across the area, based upon field observations, geochemical characterization, and sample laterally at a very fine spacing (~5 meters).

- ~350 samples across three outcrop localities.
Study Area

From Kirschbaum et al, 2005

KmW Outcrop
Lab Techniques

HAWK Pyrolysis
Results
Facies

**Facies A**

2-10 cm often discontinuous beds of poorly laminated resistant grey-brown silty shale

Often interbedded with 1-5 cm grey-black laminated mudstone beds (Facies B)
Facies B

Well laminated silty black-grey shale beds

Millimeter laminations

Often associated with 2-5 cm lenses of discontinuous resistive grey-brown shale (Facies A)
Facies

Facies C

Well laminated silty grey shale beds

Millimeter laminations

Often associated with 1-2 cm continuous orange-brown bentonite beds
Facies

Other facies include:
- Bentonites (3 major horizons)
- Silty Sandstones
  - 2 major ones (major being a relative term), both capped by a bentonite.
Kerogen Type
Maturity
Scintillometer

KmW Scintillometer

Depth (m)

0 5 10 15 20 25 30 35 40

API

0 50 100 150 200 250

Bentonites

Unit Sampled Laterally
Weathering Profile

TOC in Trench

\[ y = 0.0015x + 1.9729 \]

Depth (inches)

TOC

Surface

Fresh
Lateral Samples

% TOC by Sample

KmW

KmE

Km

%TOC

Sample #

Average TOC: 1.65%
Maximum TOC: 2.10%
Minimum TOC: 1.15%
Range: .95%
St Dev: .20%
Lateral Samples

Average TOC increases to the southeast

KmW 1.57%
KmE 1.61%
Km 1.69%

Study Area

From Finn, 2007
Significant vertical heterogeneity in organic content, temporal variability.

In contrast, very little spatial heterogeneity. Drilling implications...

Lateral homogeneity suggests constant spatial deposition, local basin was not segmented, no structural impediments, consistent oxic conditions, and correlations can be made based on geochemical signature in this area.

TOC at surface is not significantly affected by weathering.

Samples are dominantly Type III with some mixed Type II/III suggesting close proximity to shoreline and/or terrestrial input, consistent with other studies and outcrop location near basin margin.

5 m lateral sample interval is probably overkill.
References


Thank you!