

Thermal Maturity of the Mancos Shale within the Uinta Basin, Utah and Colorado

This presentation is part of a study of the shale-gas potential of the Mancos Shale in the Uinta Basin, conducted by the Utah Geological Survey in partnership with the University of Utah and Halliburton Corporation. Material presented here will be posted on the project website, http://geology.utah.gov/emp/shalegas/cret_shalegas/index.htm, where additional information about the project is available.

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Additional Information

1. Objective: Evaluate the thermal maturity of the Mancos Shale in the Uinta Basin.

Approach: Multivariable regression, where vitrinite reflectance (% Ro) is predicted from sample location and elevation; compare regression results with maturity estimated by burial history models.

 Abstract:
 The Upper Cretaceous Mancos Shale is an emerging shale-gas play in the Uinta Basin of eastern Utah and western Colorado. This study evaluates the thermal maturity of the Mancos as part of a larger effort to identify prospective areas for shale-gas development. We use a multivariable regression to derive an equation that predicts vitrinite reflectance (% Ro) from elevation (MSL) and geographic coordinates (UTM easting and UTM northing). Data used for this analysis include %Ro measurements for 276 samples of the Mancos and surrounding strata, collected from 97 outcrops and 71 drill holes. Reflectance values range from 0.3 to 2.4% (median 0.7% Ro); most were compiled from the published literature. Regression analysis with these data gave an eight-variable, second-order equation with an adjusted r² of 0.87 and a standard error of 0.13% Ro; one non-significant variable (t-statistic < 2) was ignored. Besides showing where the Mancos Shale is within the gas window, the model can be used to predict depth to the oil or gas window, as well as the maturity at any depth and location within the basin. Our current efforts are directed towards identifying locations where the model fails to accurately predict vitrinite reflectance, and ultimately, the causes of these local departures from the regional trend.</td>

Results from the regression model were compared to measured reflectance as well as maturity indicated by burial history models for five wells (Genesis 5.1 software). Stratigraphic data for these wells were from the Utah Division of Oil, Gas, and Mining. We calculated the amount of section removed during periods of erosion by using the deposition rate of the underlying preserved unit, and denudation rates ranging from 59 to 150 ft./m.y., by analogy to modern drainage basins in settings similar to the paleogeography of Utah, and by comparison to preserved strata in nearby outcrops and wells. We used a heat flow of 50 mW/m² for the pre-Cretaceous, increasing it to a continental average of 57 mW/m² in the Cretaceous, then increasing it in the Tertiary to the modern (observed) heat flow.

2. Vitrinite Reflectance Data:





179 drill hole samples (71 drill holes)

Utah Index Map



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3. Calculation:

variables x = UTM Easting y = UTM Northing z = elevation

transformed variables X = x / 100,000 Y = y / 100,000Z = 1,000,000 / (300,000 + z)

Regression model for 2nd order polynomial expansion using transformed variables to predict % Ro.

Regression Statistics

| Multiple R | 0.93 |
|-------------------|------|
| R Square | 0.87 |
| Adjusted R Square | 0.87 |
| Standard Error | 0.13 |
| Observations | 276 |

ANOVA

| | degrees of freedom | Sum of Squares | Mean Square | F | Significance F |
|------------|--------------------|----------------|-------------|-------|----------------|
| Regression | 8 | 31.94 | 3.99 | 230.7 | 3.4E-115 |
| Residual | 267 | 4.62 | 0.02 | | |

Total

36.56

Output

| Variables | Coefficients | Standard Error | t Stat | P-value |
|----------------|-----------------|----------------|--------|---------|
| Intercept | -642.28 | 102.59 | -6.26 | 0.000 |
| X | 14.95 | 2.49 | 6.00 | 0.000 |
| Υ | 33.23 | 4.36 | 7.61 | 0.000 |
| Z | -80.10 | 23.42 | -3.42 | 0.001 |
| X ² | 0.08467 | 0.04 | 2.16 | 0.032 |
| Y ² | -0.2637 | 0.05 | -4.81 | 0.000 |
| Z^2 | 29.30 | 2.37 | 12.35 | 0.000 |
| XY | -0.3641 | 0.06 | -6.59 | 0.000 |
| XZ | not significant | | | |
| YZ | -2.478 | 0.57 | -4.36 | 0.000 |

275

4. Application:

Maturity at base of the Mancos Shale









Maturity at Uinta Basin surface



Maturity at 10,000 ft depth



more applications



Depth (ft) to dry gas (1.3 %Ro)



5. Comparison: Maturity predicted by regression model is compared to maturity from burial history

models and measured % Ro for five drill holes.



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