Producing Oil & Gas Shales

Photographs of siliceous mudstone lithofacies from Loucks and Ruppel, AAPG, 2007

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July 19, 2011
Acknowledgement

This research has been supported in part by a grant from the Sloan Foundation to the Bureau of Economic Geology at the University of Texas in Austin and Rice University in Houston, Texas.
Motto

It ain’t what you don’t know that gets you into trouble – it’s what you know for sure that just ain’t so...
Multi-scale shales

Classical depositional models will not work: We are cursed with 7 orders of magnitude of grain sizes and irregular grain shapes. Also, interesting phenomena occur at scales 2–4 orders of magnitude larger than the 1 cm scale depicted here.

Source: André Kempe et al., PNAS, 99(14), 9117, 2002
Important features of shale rock

Natural fractures are omnipresent; serve as multiscale conduits for macroscale flow.

Mineralized fractures are permeable relative to matrix. The higher porosity and permeability make microcracks effectively open.

Flow can also occur along the grain boundaries.

Image source: Taylor Walsh, The University of Rochester and GeoMed Analytical LLC.
The cumulative 1-sided area of hydrofractures in the 1997 Denton County well
The cumulative wing length for assumed fracture height of 1,000 ft
All Wells in Denton County

\[ \mu = 1.05, \text{ median } = 0.85, \sigma = 0.77 \text{ million m}^2 \]
All Wells in Wise County

Fracture area in $\text{m}^2 / 10^6$

Probability distribution function

$\mu = 1.12$, median $= 0.98$, $\sigma = 0.79$ million $\text{m}^2$
All Wells in Parker County

Fracture area in m$^2$ / 10$^6$

Probability distribution function

$\mu = 0.86$, median $= 0.74$, $\sigma = 0.70$ million m$^2$
All Wells in Tarrant County

\[ \mu = 1.90, \text{ median } = 1.68, \sigma = 1.24 \text{ million m}^2 \]
$\mu = 1.62$, median $= 1.46$, $\sigma = 0.95 \text{ million } m^2$
All Wells in Core Counties

$\mu = 1.39$, median $= 1.19$, $\sigma = 0.70$ million m$^2$
Possible Project with Pioneer?

- We can apply our method to particular field projects at different locations (e.g., in the Barnett and Eagle Ford shale)
- We can draw better conclusions if we know the formation geology near a well, the well layout, details of frac jobs, dates of refracturing, history of the downhole well flowing pressure, etc.
- Consequently – if we also get more frequent production volumes – we will be able to say many more things about quality of a well and the formation properties around the well