Considering The Full Production History Of Five Key Resource Plays

October 30, 2013
Calgary

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Major Concepts

• With over a decade of commercial deployment, multi-frac’d development is no longer new so why does most analysis still highlight initial rates?

• By analyzing the full production profile and decline behavior, simple diagnostics can help to identify the flow regime.

• If the petroleum industry is going to talk in terms of statistics (P10 reserves, average type wells, top tier acreage) it must talk in terms of geostatistics.

• These results can be used a starting point when trying to build analogs for emerging resource plays.

• Actual decline rates for old fields may be higher than you expected.
Peak Rate is, Mostly, a Good Proxy for EUR (Gas Wells in N. America)
...But This is a Broad Correlation (Gas Wells in N. America with IP $\approx 500$Mcf/d)

There can be an order of magnitude uncertainty if EUR is est. by Peak Rate
We Can Restrict Our Set of Wells
(MR/MH Wells in Alberta and Saskatchewan)
...But This is Still a Broad Correlation
(MR/MH Wells with IP≈200Mcf/d)

There is still an order of magnitude uncertainty if EUR is est. by Peak Rate
MR/MH Gas EUR
(from existing wells)

Suffield… we’ll see this later
MR/MH Gas Remaining
(from existing wells)

Suffield… we’ll see this next
Looking at one of Canada’s original resource plays, we can see that 25 years of technology have incrementally added EUR, but have not fundamentally changed the picture.
Decline Rates of MR/MH Gas Wells (after 1, 2, 3, 5, 10, 20, 30 years of production)

P50 decline at 10 years is ≈10%
Alberta Horseshoe Canyon CBM (Rate–Time Plot, by Well Cardinality)
Alberta Horseshoe Canyon CBM (Pseudo–Blasingame Plot)

Clear boundary dominated flow

Near wellbore perm improvement?

Only Rates Greater than 1 Mcf/d are Plotted
Alberta Horseshoe Canyon CBM
(Decline at 1, 2, 3, 5, 10 years of production)

P50 decline at 10 years is ≈7%
Horseshoe Canyon
Variability in EUR Between Wells

The variability between wells can be large, which has prompted analysts to label these “statistical plays”, but we saw that average EUR per section was well defined, at least on a regional scale.
Horseshoe Canyon
Variograms

The variance is roughly 1.5 at a distance of 100 km.
Horseshoe Canyon
Computer Contours w/ Variance

EUR estimates can vary...

...and there are enough wells to be sure, even on the fringes.
Eagleford
EUR Method 2

Look, the Eagleford magically disappears in Mexico!
Eagleford
Variability in EUR Between Wells

EUR per well does vary, but we can quantify this variability.
The variance N/S is roughly 6.0 at a distance of 100 km.

EUR per well does vary more than in the HSC example, by about a factor of 2-4.

The variance E/W is roughly 3.0 at a distance of 100 km.
Eagleford
Computer Contours w/ Variance

Ordinary Kriging Prediction

Ordinary Kriging Variance
Montney Gas in NE British Columbia (Rate–Time Plot)

-1/2 Slope
Montney Gas in NE British Columbia
(Pseudo–Blasingame Plot)

If analytical rate/transient techniques are used for our “type-curves”, damage/skin/clean-up effects start to become apparent.

Only Rates Greater than 100 Mcf/d are Plotted
Montney Wells in NE British Columbia
(Decline at 1,2,3,5,10 years of production)

P50 decline at 10 years is \( \approx 6\% \), but these are widely spaced verticals.
Montney
Variability in EUR Between Wells

Multiple horizons
High CGR
Mixed vertical and horizontal development
High CGR
Montney Variograms

These variograms don’t look like textbook examples… the play is still being delineated.
Decline Rates of N. American Gas Wells (after 1,2,3,5,10,20,30 years of production)

P50 decline at 20-30 years is \(\approx 8\%\)
Multifract'd Cardium Oil in Alberta
(Rate–Time Plot)

Early well performance is pulling-up the averages.
Multifract’d Cardium Oil in Alberta (Pseudo–Blasingame Plot)

Maybe some wells are seeing boundary dominated flow, but most are not… suspect frac’s are interfering… wells are probably only interfering weakly… more work needed.

Only Rates Greater than 0.1 bbl/d are Plotted
Multifract’d Cardium Oil in Alberta (Decline at 1,2,3 years of production)

P50 decline at 3 years is steeper than both the Montney and overall N. American gas declines
Major Conclusions

- Many current plays are still in infinite acting flow and so it is difficult to verify DPIIP assumptions from production data.

- Good areas are developed first and will be drilled until there is enough interference, hopefully not too much!

- Smart operators will delineate the expected economic outcome, which may take over a decade... and make sure they don’t miss anything.

- Typical long term decline rates may be steeper than you expect: median decline rates for gas wells after 30 years of production are approximately 5–10%. A minority of wells have much shallower declines.

- Many important parameters, such as EUR and decline rates, can be neither normally nor log–normally distributed.
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Sample EUR Match 1

Production to Date = 3,292 MMcf

Exponential URR = 4,150 MMcf

Harmonic URR = 8,600 MMcf

Pseudo–Blasingame Plot

Radial Flow Identification

Linear Flow Identification

Only Rates Greater than 100 Mcf/d are Plotted
Sample EUR Match 2

Production to Date = 1,704 MMcf

Exponential URR = 2,000 MMcf

Harmonic URR = 3,150 MMcf

Pseudo–Blasingame Plot

Radial Flow Identification

Linear Flow Identification
Sample EUR Match 3

Production to Date = 3,250 MMcf

Exponential URR = 12,750 MMcf

Harmonic URR = 18,000 MMcf

Pseudo-Blasingame Plot

Radial Flow Identification

Linear Flow Identification
In this example, both methods of calculating EUR show that the highest gas recoveries are in the middle of the play.
Horseshoe Canyon EUR2–EUR1

The variability between EUR methods can be large, especially if there is not much production data.
The variance N/S is roughly 2.5 at a distance of 100 km.

The variance E/W is roughly 1.5 at a distance of 100 km.
MR/MH Gas Wells
Computer Contours w/ Variance
Gas Wells in WCSB
Gas Wells in N. America

Well Locations Were Stored in a Different DB Table