Engineers Need to Draw Better Maps: Importance of Multidisciplinary Studies for Resource Estimates in Unconventional Reservoirs

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Major Concepts

• Too often engineers assume the only thing geologists quantify is $\phi_h$… and maybe area.

• But… the same geostatistical tools used to make stochastic reservoir models can be used to examine production parameters (such as initial rate, estimated frac length, and EUR).

• These tools are numeric so both the best estimate and the uncertainty can be honoured.

• For simplicity, this presentation will concentrate on just one parameter, gas EUR.
How an Engineer Plots EUR (Gas Wells in N. America)
How a Statistician Plots EUR
(Gas Wells in N. America with IP≈500Mcf/d)

There can be an order of magnitude uncertainty if EUR is estimated by Peak Rate.
How a Geologist Plots EUR (Gas Wells in WCSB)
Three Plots and Three Views

- Each presentation of the data honestly compares two variables.
  - EUR vs initial rate
  - Average and variability of EUR
  - EUR vs location
- None of the previous presentations shows a single average type–well.
- In all the maps that follow, all known producing wells in a given reservoir are individually declined by two different computer algorithms. Next, the total map area is divided into 4 mi$^2$ blocks and the EURs of all wells within each block are added up together to give an estimate of producing MMcf/section.
Horseshoe Canyon
EUR Method 1
In this example, both methods of calculating EUR show that the highest gas recoveries are in the middle of the play.
The variability between EUR methods can be large, especially if there is not much production data.
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.
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.
Eagleford Variograms

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
Montney
EUR Method 2

Less Development and Production

Earliest Area of Development
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.
Computer Contours w/ Variance

Montney

But estimates in these areas are less certain... as shown by the contour lines.

Computer estimates of EURs in these areas are lower.
Is Your Database Accurate and Complete? (What’s the Matter with Kansas?)

Well Locations Were Stored in a Different DB Table
Major Conclusions

• 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.

• This is a very developed concept to geomodelers, but weakly accounted for in industry guidelines such as SPEE Monograph 3 and reduced to simple log-normal Excel plots by most investment bankers.

• The same tools used to geo-model rock matrix properties can model performance indicators such as EUR, frac length, SRV, etc.

• Best of all, these tools can model estimates of both the average performance and the variability in performance.

• Even better, some of these tools are free... like the ones I used in every example in this presentation.
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