Are Rescaled Decline Curves A Solution for Shale Gas Assessment?

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The intent of the study has been to find a reliable way to predict ultimate recoveries as soon as possible after the start of production in an unconventional gas well.

The production history of over 160,000 tight sands and shale gas wells has been studied using statistical methods (Chatellier 2010). Prediction of long term production behaviour has been defined using two traditional parameters: cumulative production and production per day. Whereas both are adequate for historical reviews, they are not of great help when an early prediction of ultimate recovery is needed. The study of these numerous producers has nevertheless allowed a comparison between tight sand formations within a basin and across basins (Figs. 1 and 2).

In order to create single decline curves that combine many wells, our approach has been to rescale the data by using the logarithm of the cumulative production instead of the traditional production parameter (Mcf or Bcf). In our graphs we refer to this parameter as the “normalized production index”. The advantage of this rescaling is to be able to inspect the behaviour of the production rate (the proxy being the log of production divided by the number of days). Many wells can thus be plotted at once and the curve is typical of an inverse function (harmonic behaviour) that is a simple and very reliable mathematical function. Proxy type curves for the Mesaverde and Dakota data sets from the San Juan Basin have been displayed in figures 3 and 4; they exhibit a harmonic behaviour reminiscent of traditional single well decline curves. The calculated inverse functions of a few formations have been graphed in figure 4; the relative position of each curve is in total agreement with the results obtained from our conventional statistical analysis (Fig.2b).

Whereas the match between the results from both methods indicates that the rescaled type curve has some merits, our study went further to do a sensitivity analysis and compared the Mesaverde in two basins using progressively less and less data. The aim was to see if we could obtain similar results with little data and to define how much data was really needed. We used data sets comprising production figures from 20 years down to one year. In every case the calculated inverse functions for both basins were extremely close to each other and plot on top of each other when using the same consistent number of months of production in the comparison between data sets (Figs. 4b). Our conclusion is that when dealing with most tight sands, one year or less of production data is deemed to be sufficient to predict with some certainty the “ultimate” cumulative production of a well, assuming constant economic conditions.

The remaining and most important question to address is the robustness of the method for shale gas. The first problem is the very limited amount of data for any shale plays except the Barnett. The second major problem is the constantly evolving completion technique, the increasing length of the borehole and the variable number of frac stages.

The question that we may want to address now is how much could shales decline curves differ from tight sands and why.

In the near-future some other questions need to be addressed:

- Will non-Darcy contributions (diffusion and desorption) be significant in shale gas?

- Complex porosity systems in shale are influenced by three main parameters: main fracture wings dimension, stimulated rock volume and nature of the formation. Will these complex porosity systems created by evolving completion practices change the behaviour profile?

- Lastly, is one year of production data, a long enough time to predict the ultimate cumulative production for a shale gas well?

Reference

Chatellier, J-Y., 2010, Early Prediction of Ultimate Production Calibrated to Historical Data, Method for Unconventional Gas, CSPG Geocanada convention, Calgary, abstract only

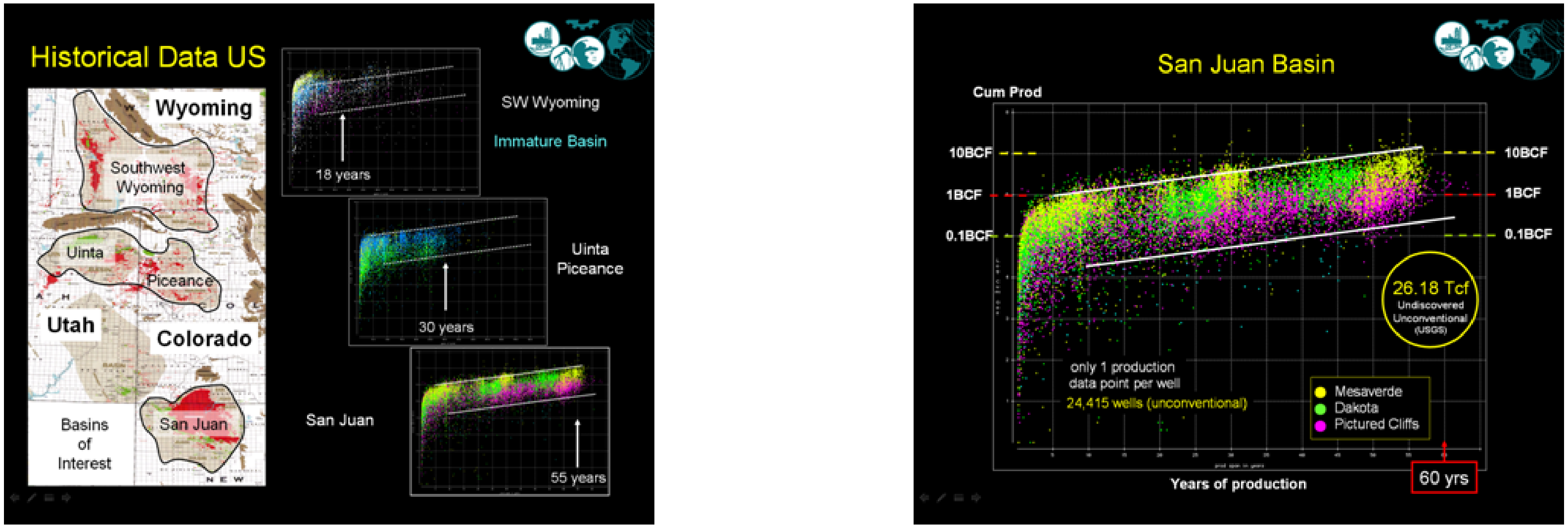


Fig.1 Large amount of production data is available for many tight gas plays

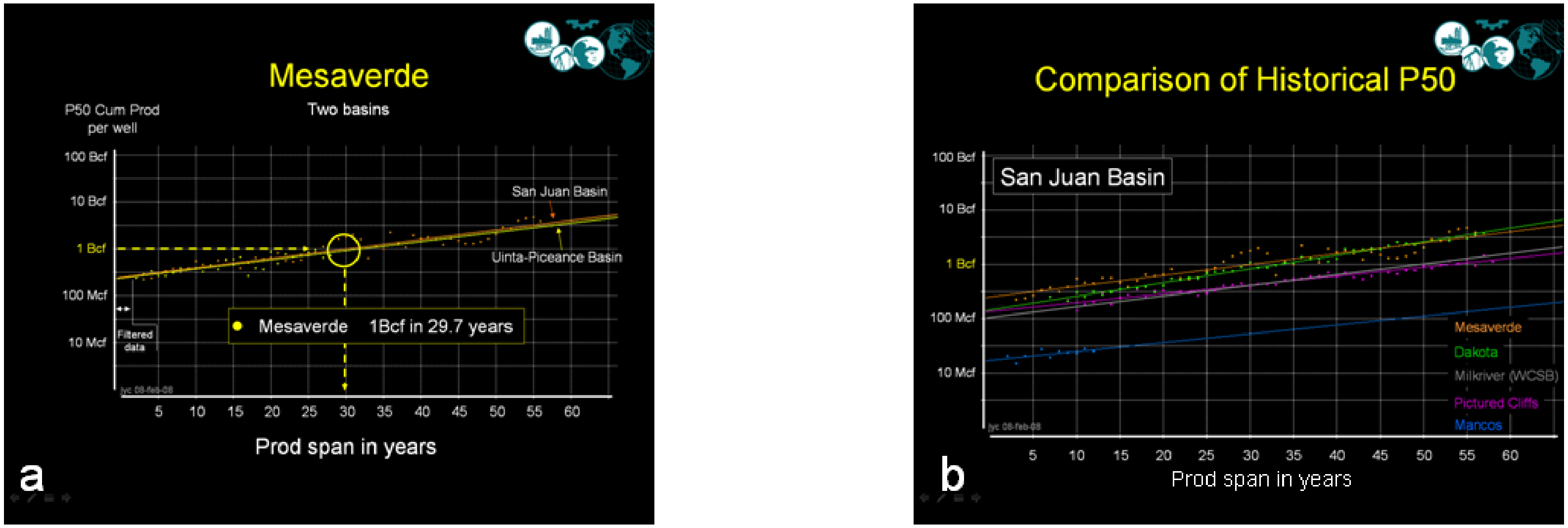


Fig.2 A quick comparison of production through time is obtained with the use of statistics

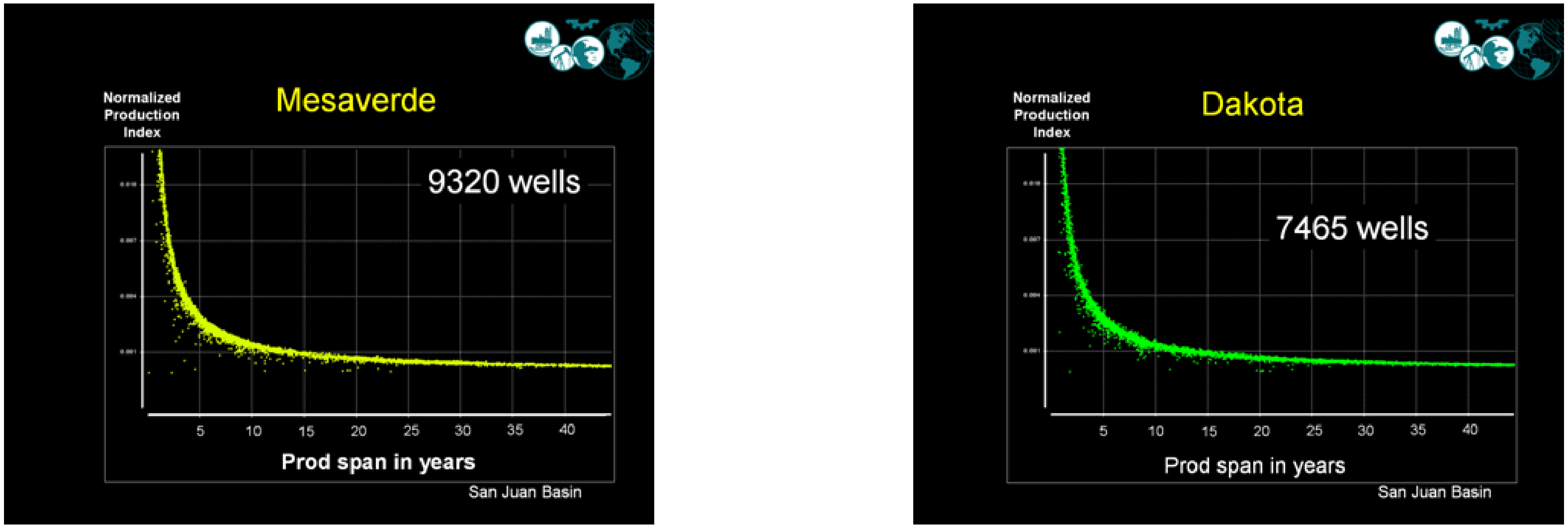
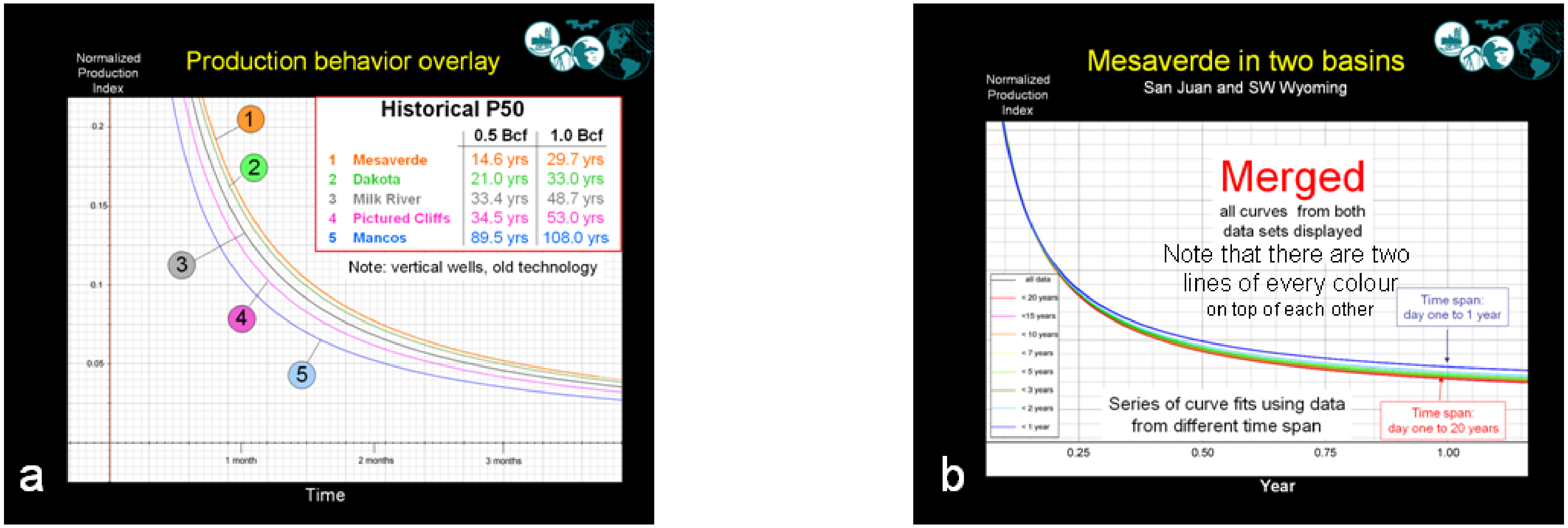


Fig.3 Reservoirs can be characterized using proxy decline curves (rescaled/normalized)



Historical P50

		0.5 Bcf	1.0 Bcf
1	Mesaverde	14.6 yrs	29.7 yrs
2	Dakota	21.0 yrs	33.0 yrs
3	Milk River	33.4 yrs	48.7 yrs
4	Pictured Cliffs	34.5 yrs	53.0 yrs
5	Mancos	89.5 yrs	108.0 yrs

Note: vertical wells, old technology

Merged

all curves from both data sets displayed

Note that there are two lines of every colour on top of each other

Series of curve fits using data from different time span

Fig.4 The inverse function (rescaled decline) allows to differentiate various reservoirs from different basins