Innovating For Efficiency In Shale Gas: What's Next?

Chris Hopkins, Schlumberger

Introduction

Shale gas is no longer strange to industry—NOCs, IOCs and independent operators are all intensely interested in its potential, but they are understandably cautious about the media hype and the real economic value of shale plays. The next major challenge for shale gas producers seeking greater production efficiency is to understand and deal with vertical and lateral heterogeneity, especially as new shale plays are pursued outside North America (Figure 1). As it always does, industry can use the lessons of the past to increase efficiency from shale gas reservoirs.

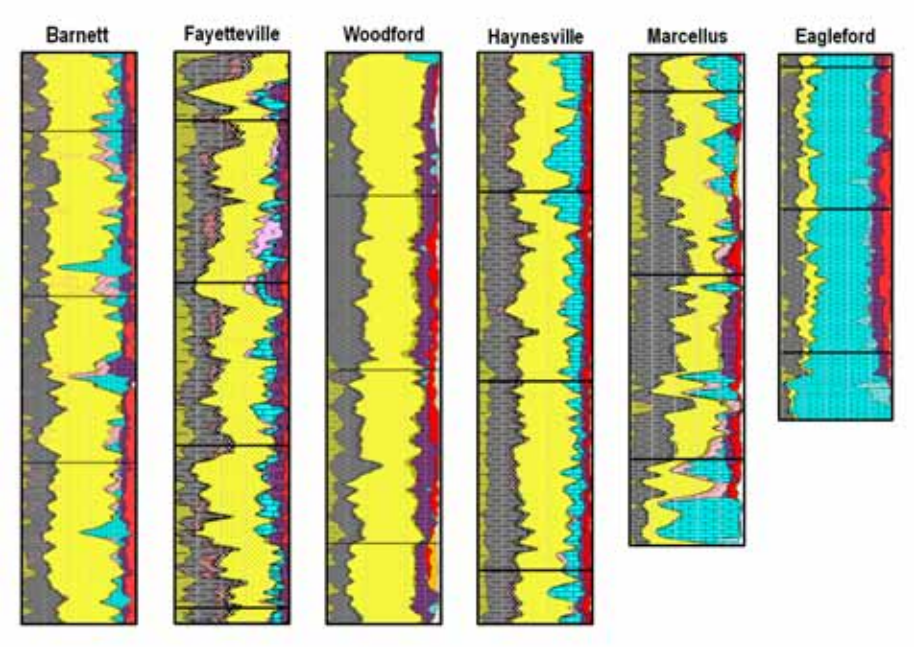

Fig. 1. Vertical logs showing differences in lithology between shale reservoirs.

While the more developed shale plays, such as the Barnett Shale of Texas, have seen relatively little change in the way wells are drilled since the earliest wells in the 1980s, it was not until the explosion in the volume of horizontal drilling around 2003 that dramatic changes in production in the unconventional gas industry were realised. Multi-stage completions and hydraulic fracturing operations with water-base fluids were used to increase production. High drilling volumes meant that costs per well could be reduced through lean techniques, pad drilling, and other efficiency gains. From the mid-1980s to the 1990s, well costs in the US dropped from US$7.5 MM to US$4 MM.

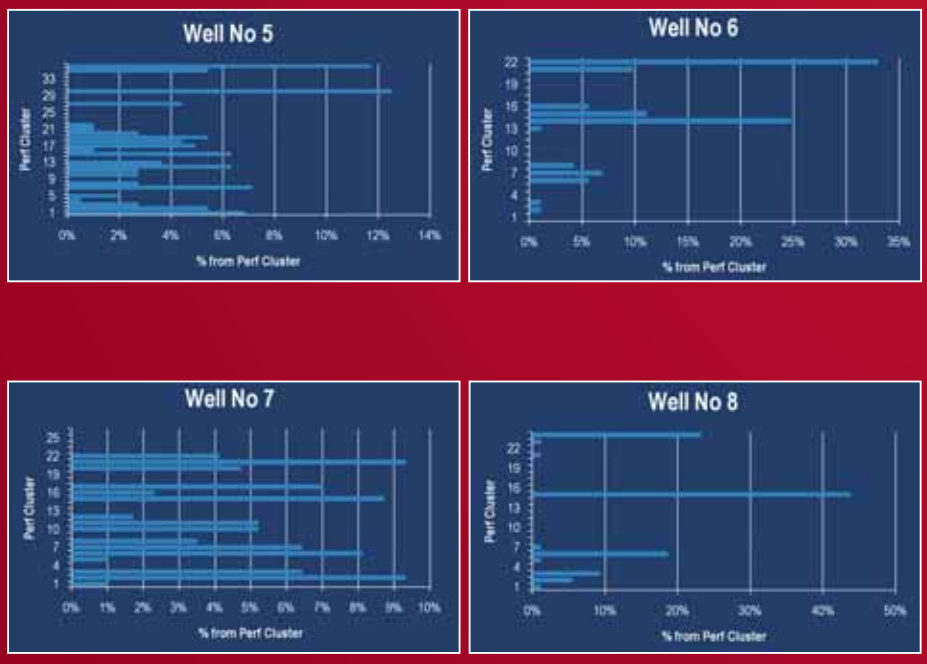

Fig. 2. Production from perforation clusters along a horizontal well demonstrates lateral variability of shale reservoirs.

Increasing efficiency by understanding heterogeneity

From a technology efficiency point of view, average gas prices over US$6 in the early 2000s drove technology development and helped to make horizontal drilling part of the standard production-enhancing procedure the industry now enjoys. However, while efficient practices may have standardised well construction to some extent, the outcome of these wells has been far from standard, with average production varying by an order of magnitude in Barnett Shale wells. Variations in production result from the differences in reservoir and rock mechanical properties between shales (Figure 2). Geologists appreciate the tremendous variation in the rocks, and producers recognise the need to incorporate geomechanics to help well designers determine the best location to kick off horizontal wells and to best place wells within producing zones.

While many producers understand that vertical formation variations can significantly affect the overall production of a well, lateral variability in the formation also affects ultimate production success and is less well understood. Production logs reveal significant differences in production contribution from perforation clusters along horizontal wellbores within the same shale.

More detailed knowledge of the lateral heterogeneity, better informed decisions on where and when to land wells, and well placement and completions become more efficient and more productive, providing the strongest likelihood for every perforation cluster to produce gas. As with most operations, the key is to acquire the right data and interpret it in time to benefit from it.

Applying old lessons in new places

Knowledge gained in the last few decades in the US can help guide the increasing interest in shale gas around the world. The Barnett Shale covers approximately 13,000 km^2 and contains 11,000 producing wells. The Baltic Shale in Poland extends over 100,000 km^2, but currently has only five wells drilled, so lessons learnt from the US shales could help improve efficiencies during the exploration phase of such plays. The expertise gained in the US fields can be applied to deploy the right technologies to improve the economics and production of these newer fields, from exploration to appraisal and development to production (Figure 3). Integrating seismic data with a range of subsurface measurements, including accurate core analysis performed by companies such as TerraTek for shale gas evaluation, will lead to more accurate models that incorporate both vertical and lateral heterogeneities. This information can then be used to plan optimal development and completions specifically for each field to improve production, effectively manage water resources, minimise operating footprint, and optimise surface infrastructure (Figure 4). ■

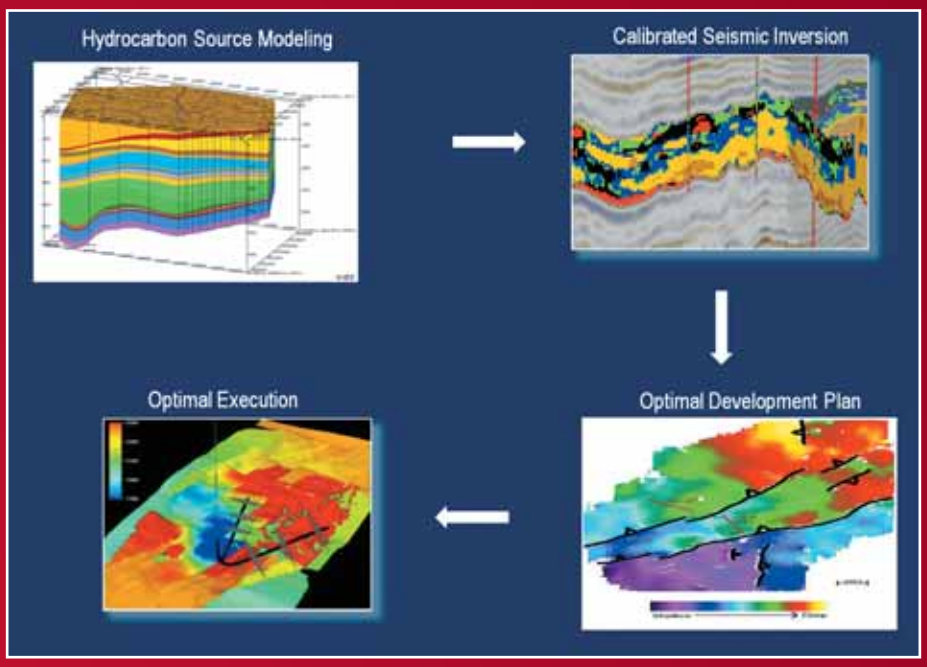

Fig. 3. Workflow for identifying and producing from sweet spots.

Fig. 4. Opportunities to improve production by applying advanced technology.