

REFINING UNCONVENTIONAL FIELD DEVELOPMENT DESIGN USING TIME-LAPSE GEOCHEMISTRY – AN EXAMPLE FROM THE EAGLE FORD SHALE

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Introduction

Time lapse geochemistry is a relatively inexpensive technique that can be used to monitor the variation or consistency of production streams from different wells or production streams. Initially developed for the surveillance and optimisation of conventional oil and gas fields, this technique is now increasingly applied to optimise production from unconventional resources. In this case study we demonstrate how time-lapse geochemistry was used to optimise development strategies for gas-condensate production from the Eagle Ford Shale.

The Eagle Ford Shale is an organic- and carbonate-rich sequence of Cenomanian and Turonian age and one of the most prolific producers of shale oil and gas in Texas. Phases and gas-oil ratios (GOR) of fluids produced from the Eagle Ford are strongly correlated to thermal maturity of the shales. Fluids in our study area produced with initial GOR values of 10,000 – 20,000 scf/bbl. The Eagle Ford Shale in the study area is stratigraphically sub-divided into an Upper and a Lower Eagle Ford Shale (UEF and LEF), and horizontal wells were landed in pairs in both intervals. We have found that wells in the organic-richer LEF have generally better production rates than wells completed in the leaner UEF. We also found that UEF and LEF well pairs are often in pressure communication, with production rates of well pairs influencing each other. This demonstrates that hydraulic fracturing can connect UEF and LEF well pairs. However, it was unclear if it was possible to efficiently drain a stimulated rock volume across sub-units, e.g. drain the UEF by wells landed in the LEF. To test this, we conducted a time-lapse geochemistry study monitoring geochemical differences of condensates from three well pairs over a time span of four years.

Results

Condensate samples from three sampling campaigns (2013, 2015, 2017) were analysed by high resolution whole oil chromatography, and data were compared using integrated peak areas of known compounds and Kovat's indices of intra-*n*-alkane peaks. Intra-*n*-alkane peak comparisons were conducted using the software ChromEdge ReserView.

Where endmember fluids with sufficient geochemical differences are available, geochemical data can be used to unravel comingled production. A complication when applying production allocation to the development of unconventional resources is that generally endmember fluids are unobtainable, although some studies have sought to overcome this limitation by the use of solvent extracts of core samples (e.g. Jweda et al., 2017). In this study, we have not attempted to allocate fluids in proportions to individual reservoir units using this approach.

On first impression, the geochemical signatures of fluids taken in 2013 from the UEF appear very similar to fluids from the LEF. However, closer inspection revealed small but consistent differences for fluids produced from the two intervals. These differences persist when

monitoring fluids in 2015, and in 2017. This implies no significant mixing of produced fluids over production time frames of well pairs. Where UEF can be produced at economic rates, dedicated UEF wells will create additional value that would not be accessed by LEF wells. Our study demonstrates that stimulated rock volume does not equate to drained rock volume even in well pairs that are in pressure communication.

The geochemical variation within the UEF is greater over time and between locations than for samples from the LEF. Our charge models suggest that the LEF is a fully self-sourced interval, while fluids produced from the UEF probably represent a mixed charge from the underlying LEF and UEF. Interestingly, LEF fluids appeared to be slightly more mature compared to the overlying UEF fluids, which cannot be accounted for by their small vertical separation. This slight maturity difference may be due to earlier generated, less mature fluids from the LEF becoming retained in the UEF and mixing with the indigenous UEF organic matter that continues a regular maturation path on burial.

Conclusion

Time-lapse geochemistry on condensates proved to be a low cost and effective tool for optimising the production of gas-condensates of the Eagle Ford Shale in our study region and added many new potential drill sites for the development hopper.

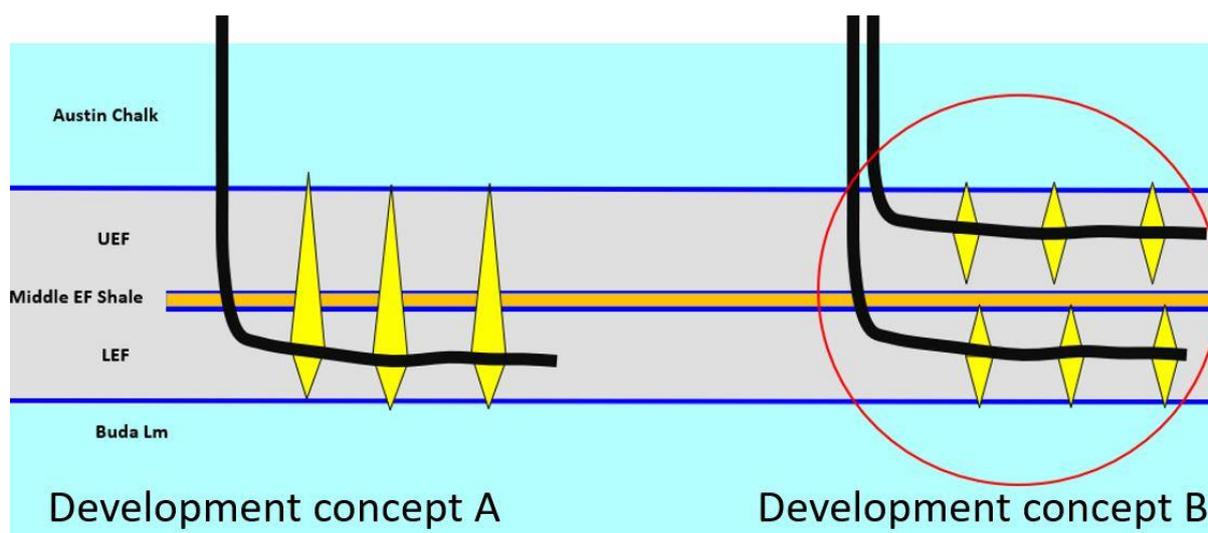


Figure 1 Schematic of two possible development concepts for the Upper Eagle Ford (UEF) and the Lower Eagle Ford (LEF). Time-lapse geochemistry steered BP towards Concept B.

Reference

Jweda, J., Michael, E., Jokanola, O., Hofer, R., Parisi, V. (2017) Optimizing field development strategy using time-lapse geochemistry and production allocation in Eagle Ford. SPE/AAPG/SEG Unconventional Resources Technology Conference 2017: 2671245.