

Reservoir Quality and Net Pay Determination in the Bioturbated (Shaly Sand) Viking Formation of Western Canada*

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Abstract

The Lower Cretaceous Viking Formation of Western Canada has been producing oil and gas conventionally for over 60 years. The finer grained, bioturbated and lower permeability oil-bearing sand and finely interlaminated shale deposits of the transitional to offshore geological setting hold vast quantities of unexploited oil. The question is: how much?

The Viking oil resource play extends from the Redwater area of Central Alberta through Provost and across the border into West Central Saskatchewan ([Figures 1](#) and [2](#)). Vertical oil producers have been drilled in areas along this trend but have typically been low rate wells requiring fracture stimulations to be marginally economic. Initial rates average less than 40 bopd. Drainage areas are not extensive and recovery factors are only 5-7%. The remaining oil-in-place in the undrained portions of the reservoir represents a very large and worthwhile target to pursue with today's advanced drilling, completion, and production practices.

With the advent of horizontal fracture stimulation technology, these resources can be better accessed and economically produced. Due to the finely-laminated and bioturbated nature of the sand and shale interbeds, the net to gross reservoir ratio cannot be determined from log evaluation. Resolution of the geophysical well logs is not advanced enough to accurately quantify net pay in this type of reservoir. The question becomes what is the OOIP and to answer that you have to quantify the net pay.

WestFire Energy and many other operators have been drilling and fracing horizontal Viking wells for the past four years in Alberta and Saskatchewan with varying results. There have been a number of technologies used and extensive research done on stimulating the Viking; but reservoir quality has always been taken from conventional industry log and core analysis.

Understanding the reservoir is paramount to developing a successful horizontal drilling and stimulation program. Combining the best reservoir quality and thickest net pay areas focuses horizontal drilling to the most prospective areas.

The Viking sands represent a transitional to offshore shallow-marine environment. The reservoir consists of centimeter-scaled parallel-laminated and bioturbated oil-bearing sands and interbedded tight shales ([Figure 3](#)). Porosity ranges from 15-20%, permeability 20-80md from conventional core analysis and oil API gravity is 36+/- degrees.

Taking plugs to perform core analysis can be difficult because of the laminated nature of the reservoir. The sands themselves can have varying degrees of bioturbation. Sands can range from very fine-grained to coarse cherty storm deposits and the friable nature of the reservoir makes it physically difficult to cut plugs for analysis. So how does one estimate net pay and quantify the reserves?

Calculating Net Pay: Methodology

WestFire Energy teamed up with Digital Resource Solutions (DRS) in 2008 to develop a process to tackle this problem. A number of existing industry cores were evaluated in the early years of the program. Nine core hole wells were then drilled from 2010-2011 in the Redwater area of Alberta and 14 in the Plato and North Dodsland areas of Saskatchewan. These wells were drilled specifically to cut and retrieve whole core and analyze the cores for reservoir quality and net pay thickness. The cores were sent to AGAT labs and photographed under white light and UV light. Under UV, light the oil-bearing sands can be differentiated from the shalier sections of the core. The UV light photos were then evaluated by Digital Resource Solutions (DRS) using proprietary digital point-counting software. Oil-filled reservoir fluorescence can be quantified using sophisticated pixel counting to give a Volume of Fluorescence, or more simply a net pay-to-gross interval ratio. This process results in a highly accurate estimate of net pay. When a number of cores are evaluated in the same manner within a prospect area, a net pay trend map can be generated and original oil in-place can be calculated more accurately. Industry core photos have also been utilized for digital core processing. When UV photographs are not available, visual estimates of pay thickness and reservoir quality have also been added to the data set. The age of a core affects its ability to fluoresce; so it is important to photograph the core as soon after cutting as possible. Consistent photographic exposure is also important.

Conclusions

Determining net pay and original oil in-place from logs is difficult. WestFire Energy and DRS worked together to develop a process and applied the process to 23 wells drilled and cored in 2011.

By utilizing digital pixel point counting technology on UV photos of Viking oil-bearing sands in the Redwater area of Alberta and the Plato and Dodsland areas of Saskatchewan, the net pay and original oil in-place can be more accurately calculated and mapped across large areas. The core evaluation also defines areas of better reservoir quality and thickness. This helps to quantify the oil in-place volumes and focus horizontal drilling activities in the most prospective areas.

Acknowledgements

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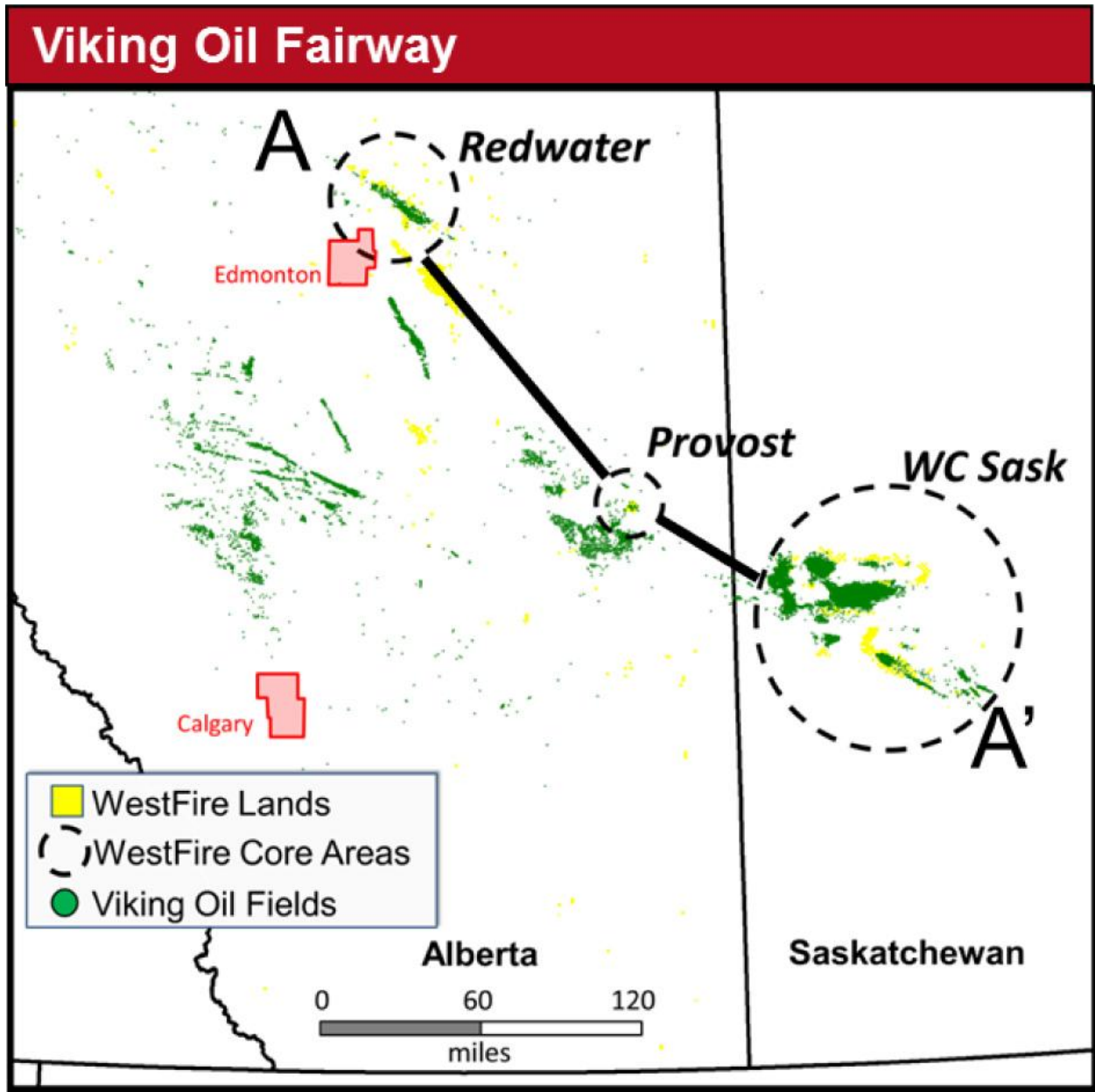


Figure 1: Viking study area.

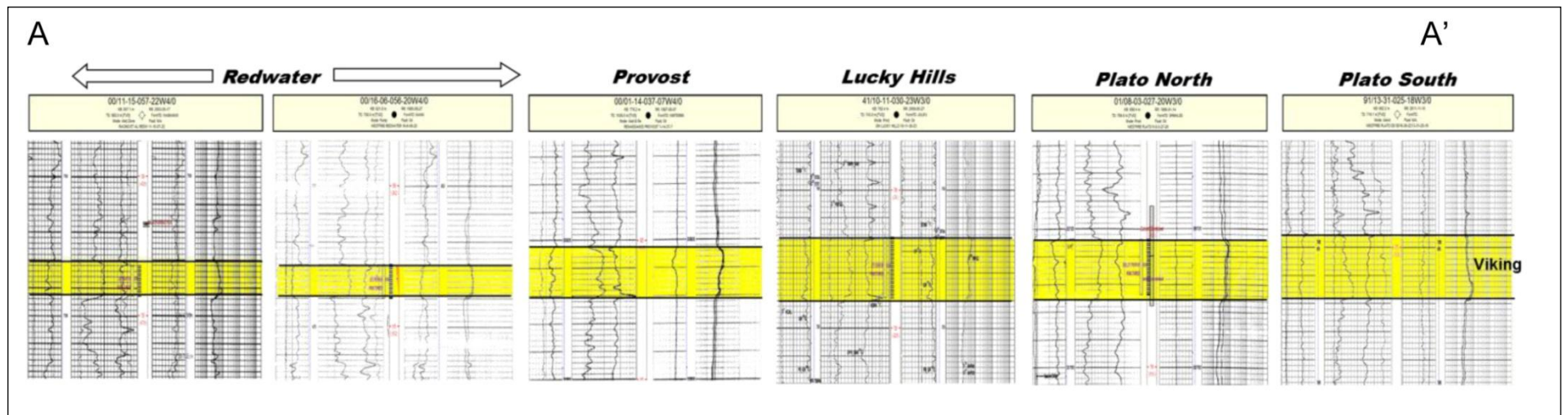


Figure 2: Regional cross section A-A' (location in [Figure 1](#)).

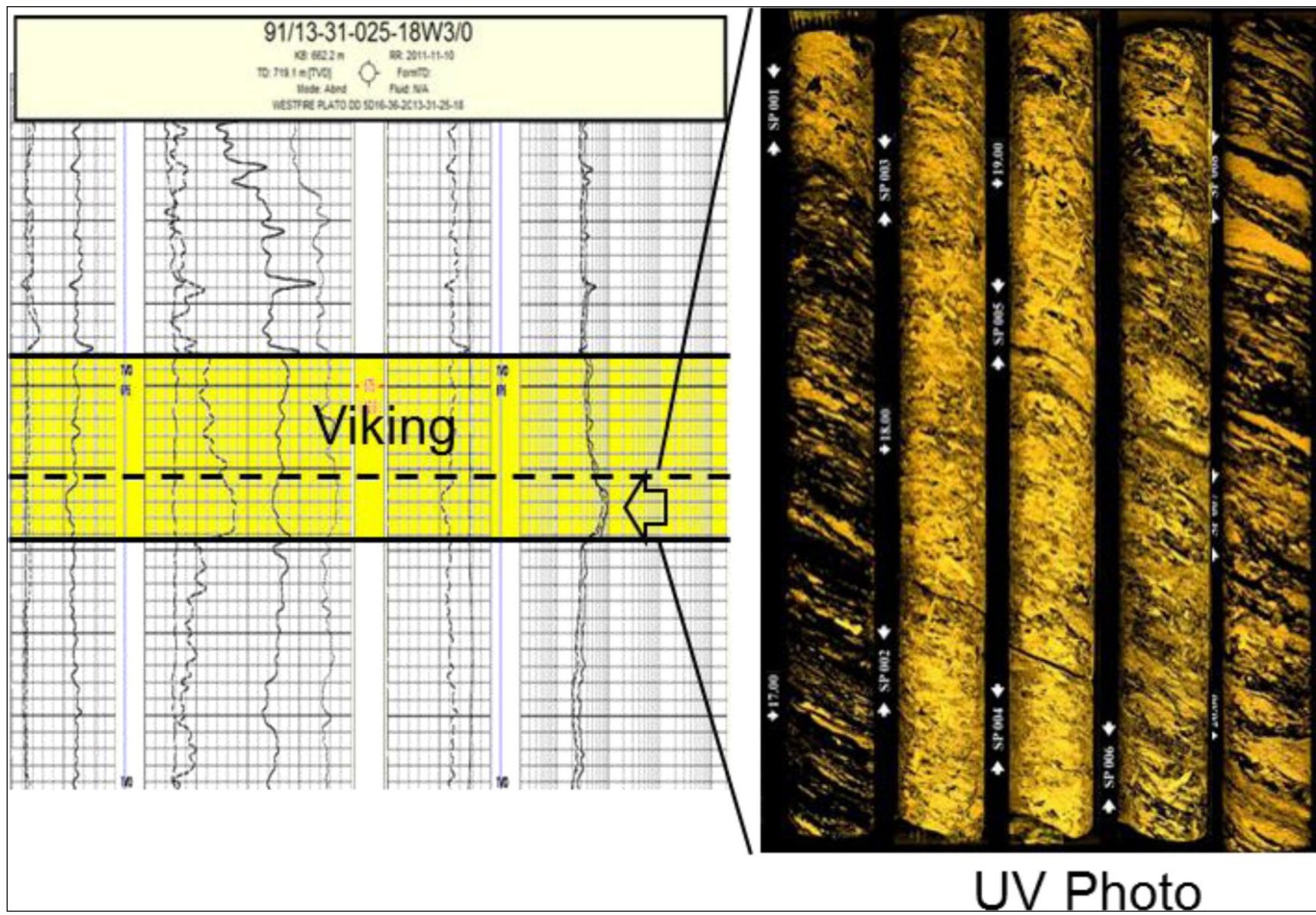


Figure 3: Core UV photo of Viking oil-bearing sands.