Discussion of the Upper Cretaceous Baxter Shale Gas Reservoir, Vermillion Basin, Northwest Colorado and Adjacent Wyoming

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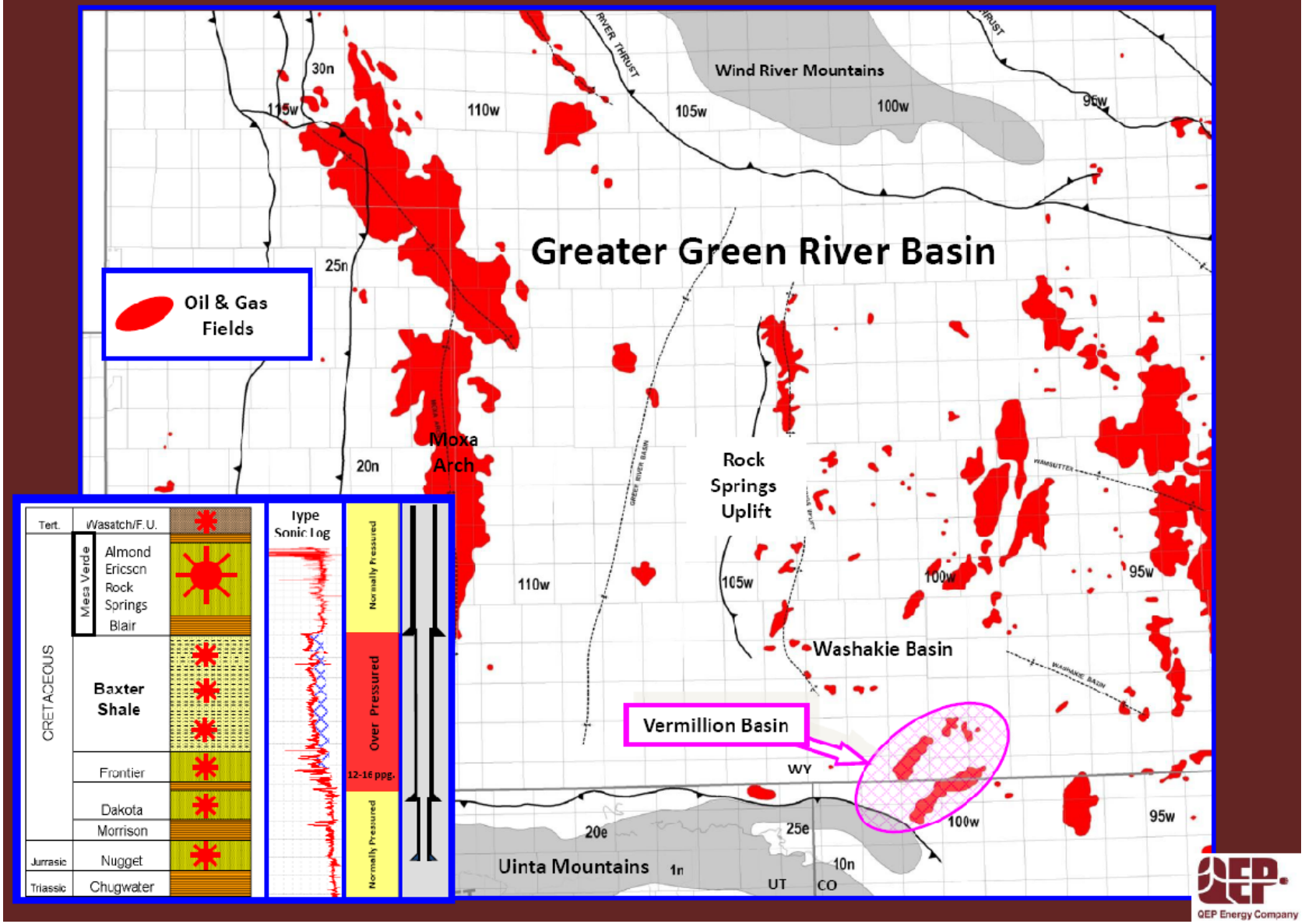
Gas production has been established from the Baxter Shale in 22 vertical wells and 3 horizontal wells in the Vermillion Basin of northwestern Colorado and adjacent Wyoming. The Baxter Shale is stratigraphically equivalent to the Mancos, Cody, Steele, Hilliard, and Niobrara/Pierre formations. It was deposited in hundreds of feet of water in the Western Interior Seaway from about 90 to 80 million years ago (Coniacean to lower Campanian) and consists of about 2500 ft of dominantly siliceous, illitic, and calcareous shales that contain regionally correlative coarsening-upward sequences of quartz- and carbonate-rich siltstones several tens of feet thick. Production comes mainly from the silt-rich intervals as determined by production logs. The productive area in the Baxter Shale has vitrinite reflectance values approaching 2% and is in the dry gas generation window. Total organic carbon content ranges from 0.5 to 2.5% in the shales and from 0.25 to 0.75% in the siltstones. Measured porosities in both the shales and siltstones typically range from 3 to 6% with matrix permeabilities of 100 to 1500 nanodarcies.

The play area is defined by numerous wells with gas shows and overpressuring in the Baxter with gradients ranging from 0.6 to 0.8 psi/ft at depths greater than 10,000 ft. The vertical wells had initial production rates ranging from 0.5 to 9.1 MMCFD and the horizontal initial rates ranged from 3.3 to 6.4 MMCFD following fracture stimulation. The best well in the area is a vertical well that apparently encountered a swarm of natural fractures and was completed for over 9 MMCFD. It has an estimated ultimate recovery of over 8 BCF from the shale. Thus, these initial tests of the Baxter are promising and define a large shale gas resource with as much as 400 BCF of gas-in-place per square mile.

A challenge within this reservoir is the ability to economically access this large unconventional gas accumulation. This is not a classic 100- to 300-foot-thick organic-rich shale gas reservoir. Instead it is a very large hydrocarbon resource stored in 2500 ft of shale with interbedded siltstone intervals. Attempts at horizontal development have not shown the increased reserve multipliers seen in other shale plays. Yet there is opportunity as shown by the one outstanding vertical well expected to produce over 8 BCF.

3-D seismic data have proved useful in helping define potential fracture networks in the Baxter Shale that can be targeted with horizontal wells. Wells located based on interpretation of the 3-D seismic encountered several fractured zones that flowed gas and had flares over 100 ft high. These laterals required mud weights in excess of 17lb/gal to control the wells, but upon completion and stimulation of the reservoir, did not produce significantly better than the vertical wells. Thus, much remains to be learned about how to optimize development of this tantalizing resource play.

Figure 1. The Vermillion Basin lies northeast of the Uinta Mountains Uplift.



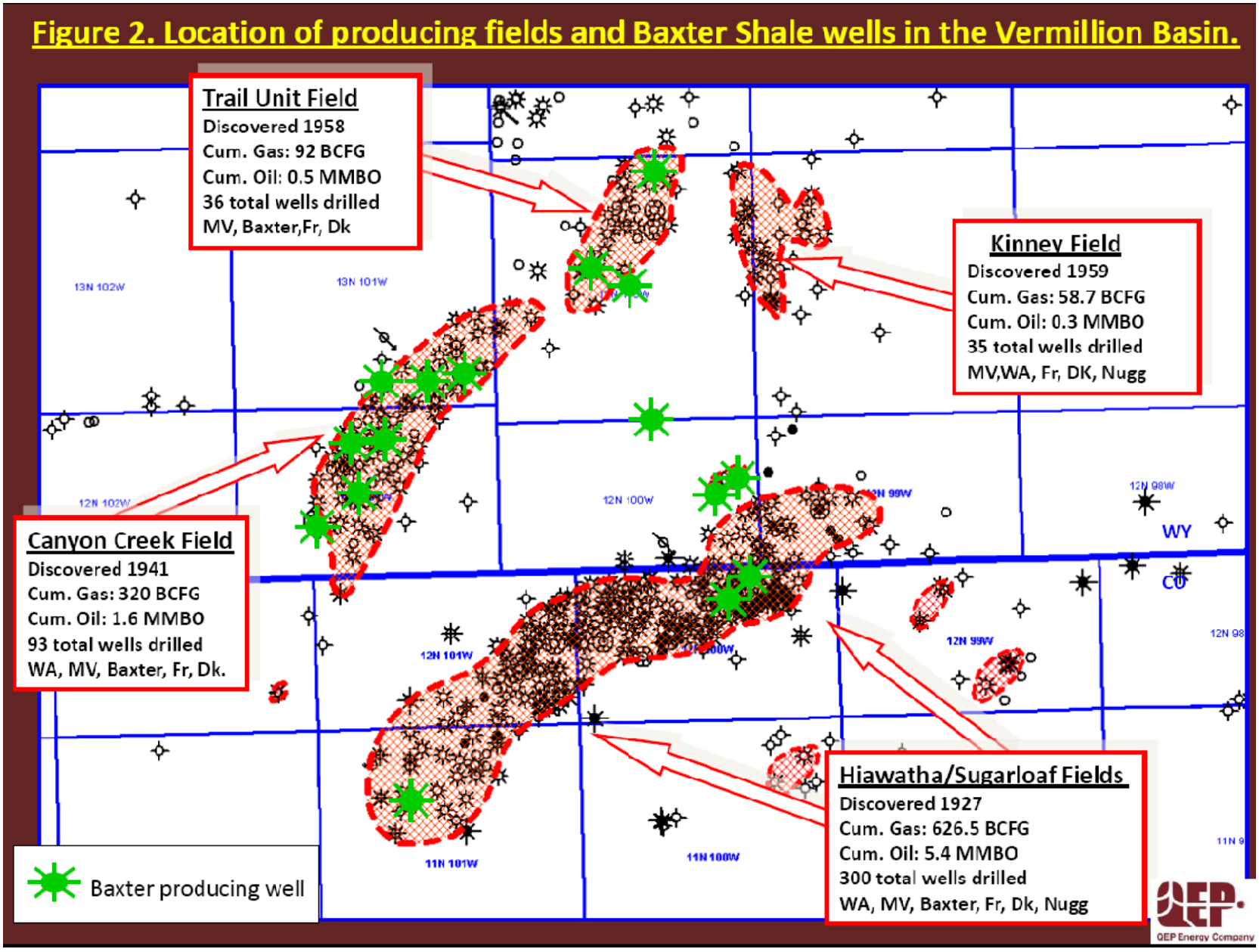


Figure 2. Location of producing fields and Baxter Shale wells in the Vermillion Basin.
Trail Unit Field
Discovered 1958
Cum. Gas: 92 BCFG
Cum. Oil: 0.5 MMBO
36 total wells drilled
MV, Baxter,Fr, Dk
Kinney Field
Discovered 1959
Cum. Gas: 58.7 BCFG
Cum. Oil: 0.3 MMBO
35 total wells drilled
MV,WA, Fr, DK, Nugg
Canyon Creek Field
Discovered 1941
Cum. Gas: 320 BCFG
Cum. Oil: 1.6 MMBO
93 total wells drilled
WA, MV, Baxter, Fr, Dk.
Hiawatha/Sugarloaf Fields
Discovered 1927
Cum. Gas: 626.5 BCFG
Cum. Oil: 5.4 MMBO
300 total wells drilled
WA, MV, Baxter, Fr, Dk, Nugg
Baxter producing well
13N 102W
13N 101W
12N 102W
12N 100W
12N 99W
12N 98W
12N 101W
11N 101W
11N 100W
WY
CO
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