[PS]Reservoir Characteristics of the Codell Sandstone Tight Oil Play, Northern DJ Basin, Wyoming and Colorado: Extension of Wattenberg into the Oil Window*

Kevin H. Smith[1], Richard J. Bottjer[1], Robert H. Sterling[1], Henry C. Nowak[2], and Daniel R. Wheat[2]

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Abstract

The Cretaceous Codell Sandstone has been producing gas and oil in the Wattenberg Field in Colorado since 1979. Recent advances in horizontal drilling and multi-stage fracture stimulations have facilitated the extension of the Wattenberg Field into the northern DJ Basin in southeastern Wyoming and northern Colorado, where stabilized production rates up to 1300 BOPD are associated with recently completed horizontal Codell wells. This new play area in Laramie County, Wyoming and northern Weld County, Colorado is thermally in the oil window. Codell Sandstone oil producers have gas-oil ratios less than 2000 scf/bbl.

The Codell Sandstone thins from north to south due to erosional truncation beneath an angular unconformity at the base of the Fort Hayes Limestone Member of the Niobrara Formation and ranges from 18 to 33 feet in gross thickness. The Codell Sandstone is a very-fine to fine-grained sandstone and produces oil from two main facies: bioturbated sandstone and laminated sandstone. The laminated facies is parallel to sub-horizontally bedded, has 8 to 15 percent porosity, and .01 to 0.10 millidarcies permeability. The bioturbated sandstone has 8 to 13 percent porosity and .008 to .05 millidarcies permeability. The Codell Sandstone is a low-resistivity pay zone that produces oil with low water cuts from zones with less than 10 ohm-m resistivity. Clay content 15-25% with abundant microporosity as imaged with epifluorescent microscopy, accounting for high bound water content and explaining the low formation resistivity.

Two Codell Sandstone cores provide examples of these facies. The Noble V.O. Child #30-09 core in Laramie County, Wyoming, recovered 26 feet of Codell Sandstone, including 22 feet of bioturbated facies and 4 feet of laminated facies. The Noble Lazy D #03-09 core in Weld County, Colorado, recovered 18 feet of Codell Sandstone, including 10 feet of bioturbated facies and 8 feet of laminated facies. Core oil saturations and fluorescence under ultraviolet light indicate that the Codell Sandstone is oil saturated in both cores. Nearby horizontal wells drilled and completed in the Codell Sandstone indicate that oil can be recovered economically extending Codell production more than 50 miles north of Wattenberg.

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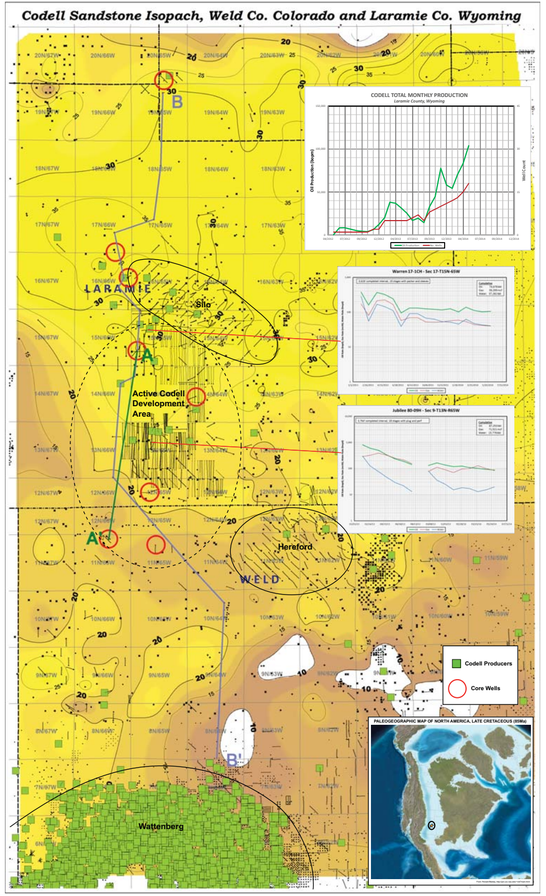
Codell Sandstone Isopach, Weld Co. Colorado and Laramie Co. Wyoming



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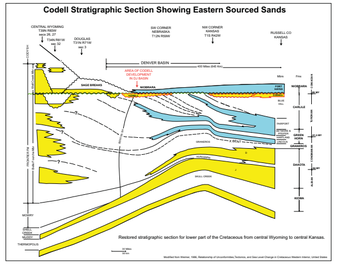
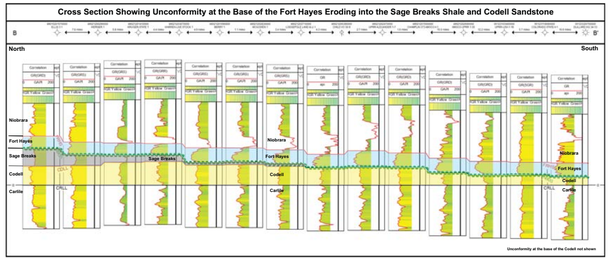
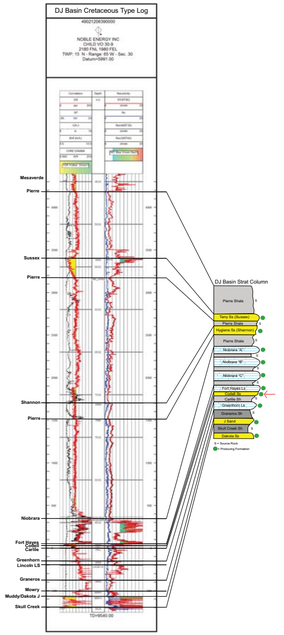
Codell Stratigraphic Section Showing Eastern Sourced Sands



Cross Section Showing Unconformity at the Base of the Fort Hayes Eroding into the Sage Breaks Shale and Codell Sandstone

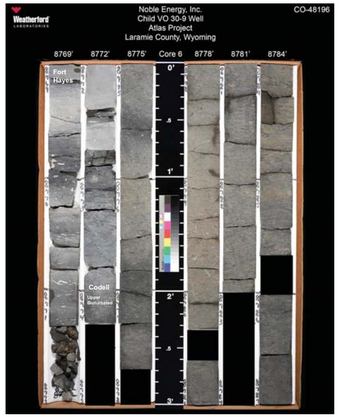


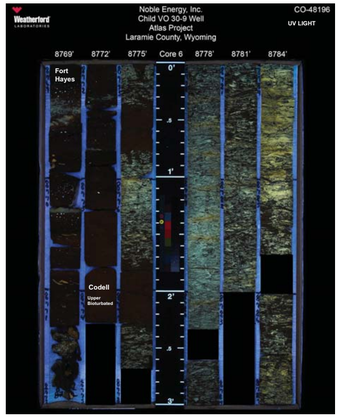
DJ Basin Cretaceous Type Log

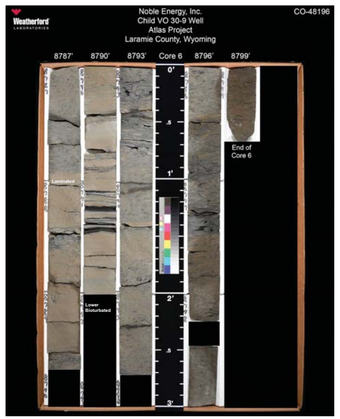


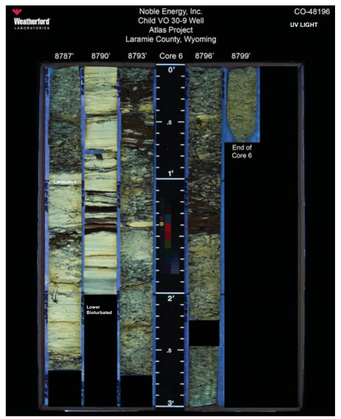
CHILD VO 30-9 CORE PHOTOS

Depth 8769' - 8799.7'





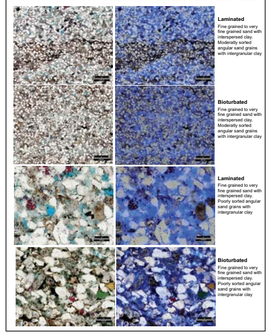




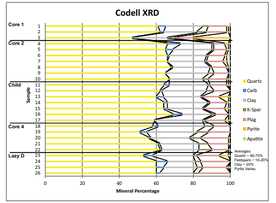
Codell Gross Thickness = 26'
Fluorescing Thickness = 24'
Laminated = 4'

Codell Gross Thickness = 18'
Fluorescing Thickness = 18'
Laminated = 8'

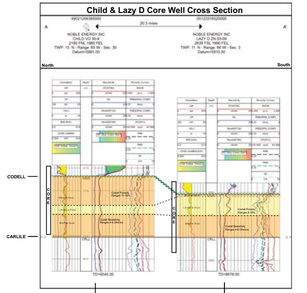
Codell thin section photos show abundant intergranular pores. Epifluorescent light photos show high microporosity accounting for high amounts of bound water in matrix



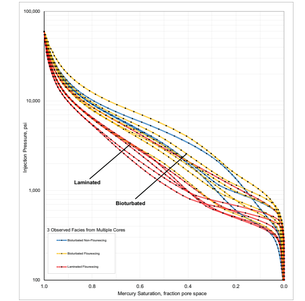
Codell XRD



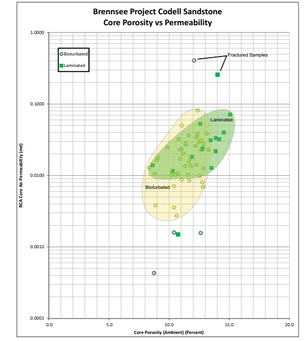
Child & Lazy D Core Well Cross Section



CODELL SANDSTONE Injection Pressure vs Mercury Saturation MERCURY INJECTION CAPILLARY PRESSURE



Brennsee Project Codell Sandstone Core Porosity vs Permeability



Core Porosity vs Core Sw