AV Geology of the Piceance Basin Mesaverde Gas Accumulation*

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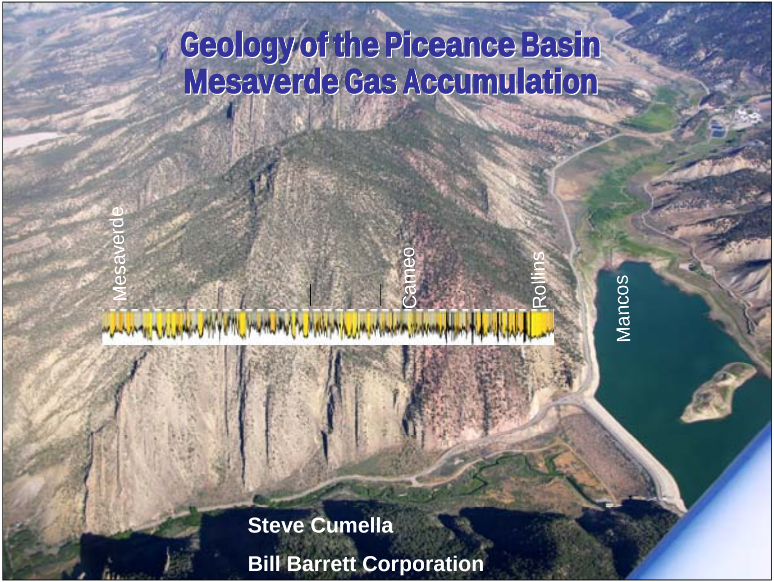
Abstract

A regionally extensive tight-gas accumulation in the Mesaverde Group of the Piceance Basin is currently being actively developed. Daily production has increased from under 200 MMCFD in the year 2000 to over 1 BCFD currently. Most gas production in the Piceance Basin is from discontinuous fluvial sandstones of the Williams Fork Formation of the Mesaverde Group. In some areas of the southern Piceance Basin, 10-acre well density has proven successful. EURs of typical wells in these areas range from 1 to 2 BCF per well, resulting in reserves of about 60-120 BCF per section. The depth limits to the commercial gas accumulation are poorly defined, but it is possible that much of the deeper part of the basin may have commercial gas reserves. Within the area of commercial gas production, most gas is produced from a continuously gas-saturated interval in the Williams Fork. Productive intervals can attain gross thicknesses of over 3000 ft (900 m). The gas-saturated interval thins toward the basin margins where the Williams Fork gas reserves become sub-economic. This tremendous gas resource exists because of several important geologic circumstances. Large volumes of gas were generated from thick Mesaverde coals as they achieved high thermal maturity. Migration of this gas was inhibited by the very low permeability and discontinuous nature of the Mesaverde sandstone reservoirs. The rate at which gas was generated and accumulated in the reservoirs outpaced the rate at which gas could escape, resulting in overpressure. Eventually, the pressure of the gas phase in the pore system exceeded the capillary pressure of the water-wet pores, and water was expelled from the pore system, resulting in the development of an overpressured, gas-saturated reservoir with little movable water.

References

Johnson, R.C., 1989, Geologic history and hydrocarbon potential of Late Cretaceous – age, low-permeability reservoirs, Piceance basin, western Colorado: U.S. Geological Survey Bulletin, v. 1787-E, 51 p.

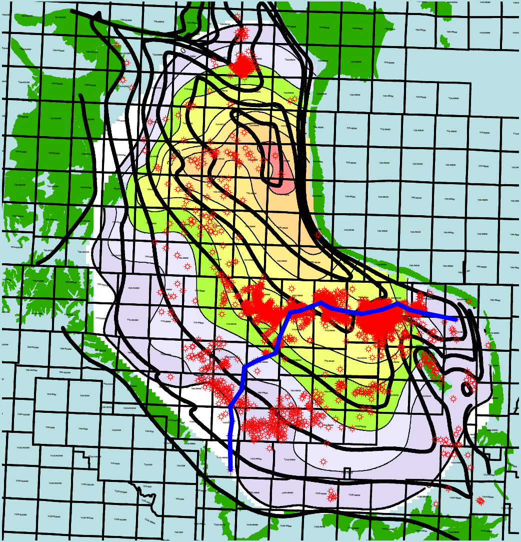
Yurewicz, D.A., 2005, Controls on gas and water distribution, Mesaverde basin center gas play, Piceance Basin, Colorado (extended abstract): Search and Discovery Article #90042 (2005) (http://www.searchanddiscovery.net/documents/abstracts/2005hedberg_vail/abstracts/extended/yurewicz/yurewicz.htm).



Presenter's Notes: Piceance is fortunate to have, surrounding the basin, MV outcrop that can be correlated to the subsurface. This photo is of the Grand Hogback which forms the east side of the basin. The canyon is Rifle Gap north of Rifle. The MV is near vertical and the entire MV section is exposed along Rifle Gap. The WF is about 4000' thick here. The well log superimposed is only 3 miles to the SW. The Mancos forms the valley and the Rollins is the thick ss here. The coals in the lower WF commonly burn in outcrop and that's what causes the reddish color. The top of the MV is shown. The thick resistant intervals are amalgamated fluvial ss that appear to have some lateral extent.

Outline for Talk

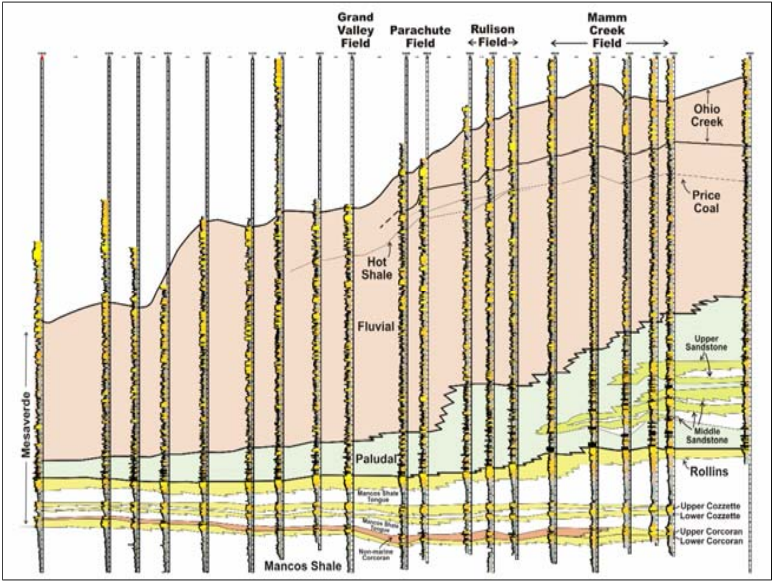
- Stratigraphic overview of Mesaverde Group
- Geology of Williams Fork gas accumulation
- Permeability distribution in Williams Fork
    - Shallower sands have better reservoir quality
- Open-hole logs identify wet versus gas sands much better than cased-hole logs
- Low porosity sands not traditionally completed can contribute significant gas volumes



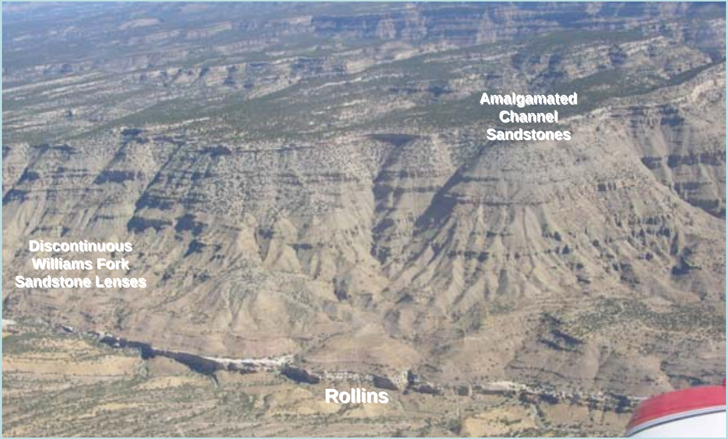
Structure Contours Top Rollins (Johnson, 1989)

Isopach Williams Fork Continuous Gas Shows (Yurewicz, 2005)

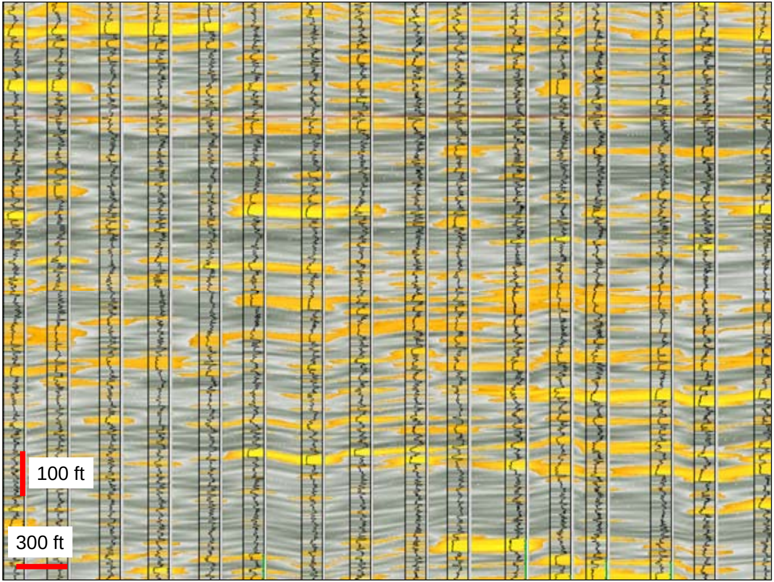
Current Daily Production ~1.3BCF/D



Grand Valley Field
Parachute Field
Rulison Field
Mamm Creek Field
Ohio Creek
Price Coal
Hot Shale
Fluvial
Upper Sandstone
Middle Sandstone
Paludal
Rollins
Mesaverde
Mancos Shale Tongue
Mancos Shale Tongue
Non-marine Corcoran
Upper Cozzette
Lower Cozzette
Upper Corcoran
Lower Corcoran
Mancos Shale

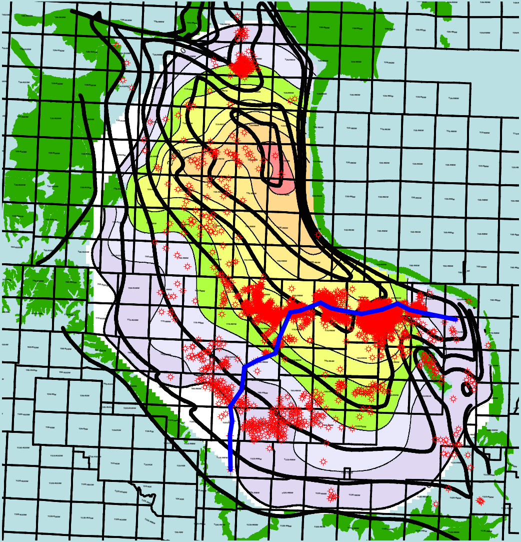


Presenter's Notes: This photo is from the southwest part of the basin near Grand Junction. Rollins is the continuous white ss near bottom of photo. Lower part of WF contains low sand content with discontinuous ss. Higher in WF, amalgamated ss are thicker and more laterally continuous. Correlations indicate that the amalgamated ss are the strat equiv of the Upper marine ss.


100 ft
300 ft

Williams Fork Reservoir Factors

- Discontinuous Sands and Very Low Permeability
  - Restricted fluid movement
- Gas Generation and Overpressuring
  - Abundant gas generation from coals creates overpressuring because gas can't migrate out of basin center as fast as it is generated
- Natural Fracturing
  - Extensive natural fracturing results from widespread overpressured conditions



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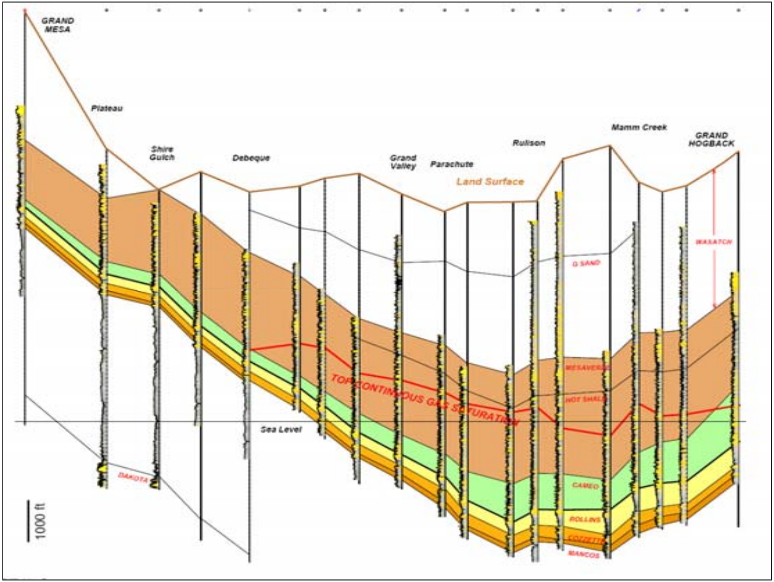


GRAND MESA
Plateau
Shire Gulch
Debeque
Grand Valley
Parachute
Rulison
Mamm Creek
GRAND HOGBACK
Land Surface
WASATCH
G SAND
MESAVERDE
HOT SHALE
TOP CONTINUOUS GAS SATURATION
Sea Level
DAKOTA
CAMEO
ROLLINS
COZZETTE
MANCOS
1000 ft

Vertical Variation of Reservoir Quality in Williams Fork

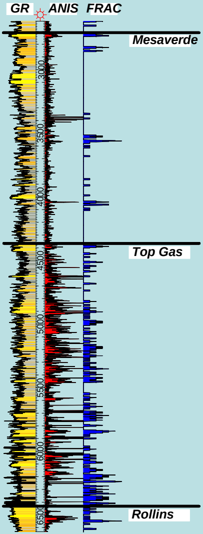
- Sands in the lower Williams Fork have microdarcy perm and very little relative permeability to water, resulting in very low water production rates
- Sands in the upper part of the gas producing interval can have much better reservoir quality; they can be prolific gas producers, but sands with high water saturation can produce very high water rates

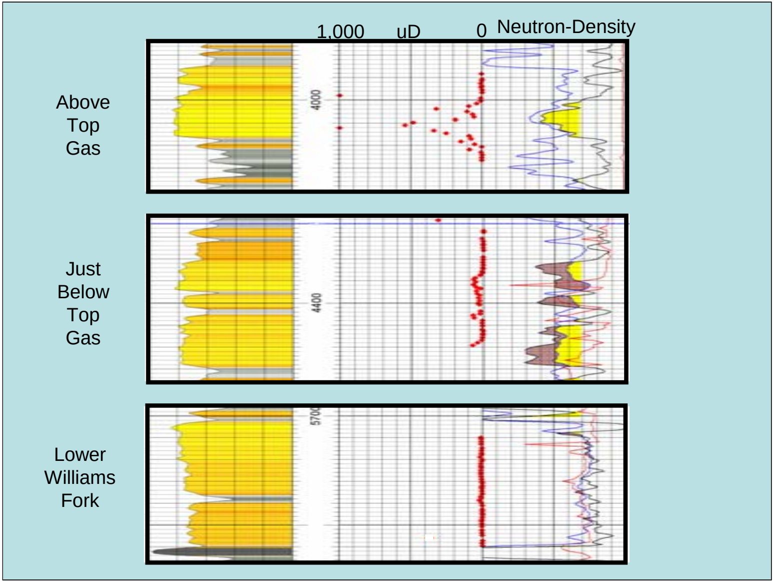
Shallower Sands Commonly Have Better Permeability

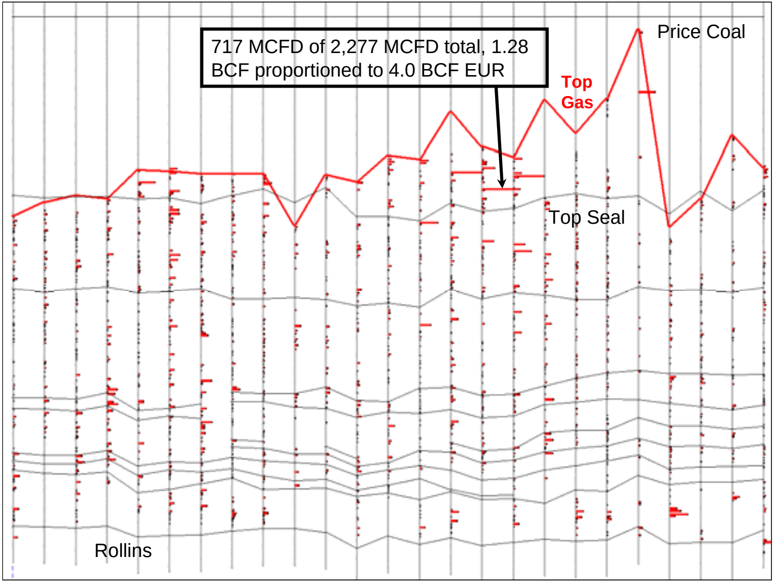
500 uD

60 uD

10 uD



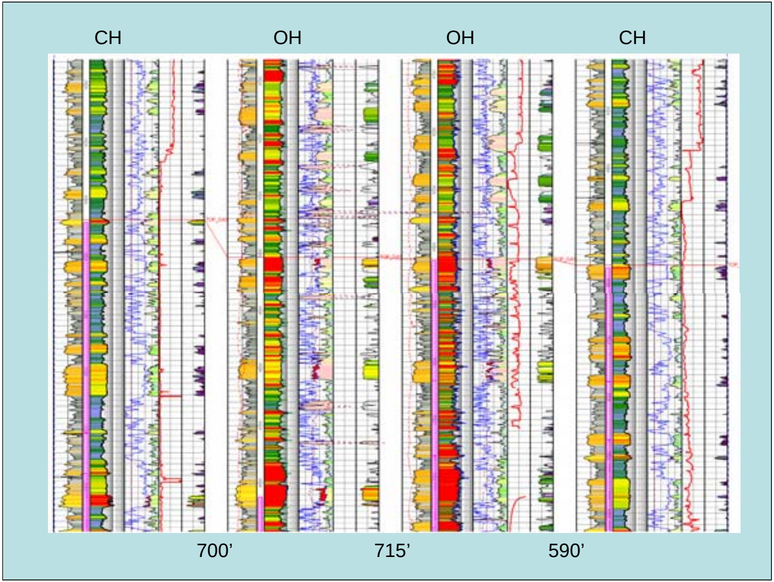

1,000
uD
0
Neutron-Density
Above Top Gas
4000
Just Below Top Gas
4400
Lower Williams Fork
5700



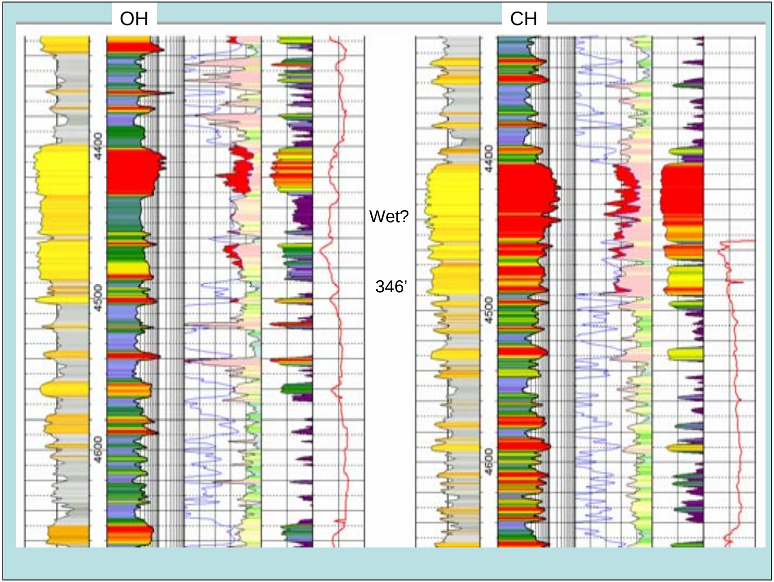
717 MCFD of 2,277 MCFD total, 1.28 BCF proportioned to 4.0 BCF EUR
Price Coal
Top Gas
Top Seal
Rollins

Emulated Open-Hole Curves from Pulsed Neutron Logs Don't Identify Pay As Well As Open-Hole Logs

- Numerous examples of CH logs from all logging companies show different log responses compared to OH logs
- These differences can cause completion of wet zones or skipping of highly productive zones
- Williams Fork fluvial sands are discontinuous; therefore it may not be possible to correlate a sand in a cased-hole well to an open-hole well, even at 10-acre density

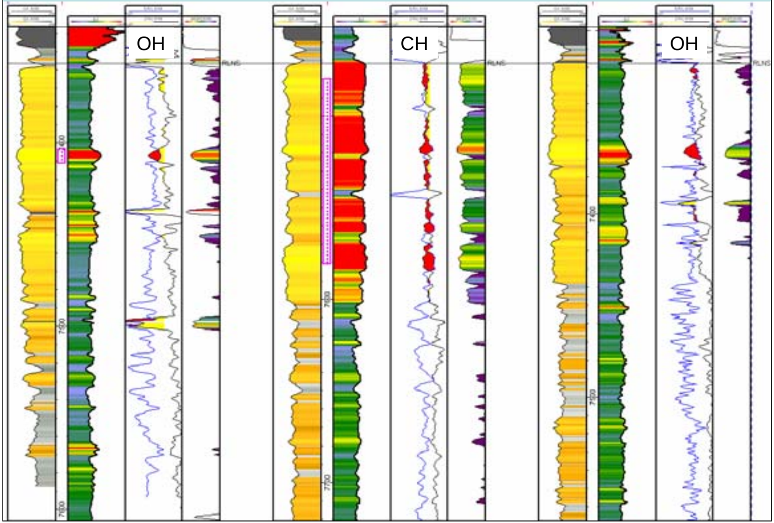


Presenter’s Notes: 32-11C,32-14,32-14D,32-15C



Presenter’s Notes: GM 443-20, 642-20

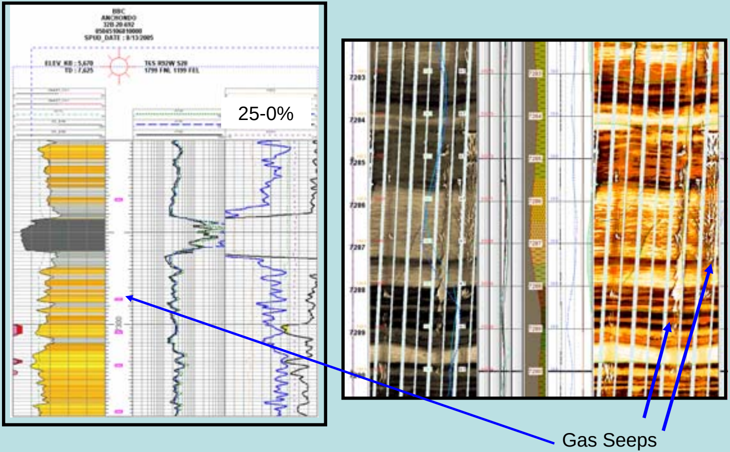
Rollins Pay Example – Mamm Creek Field



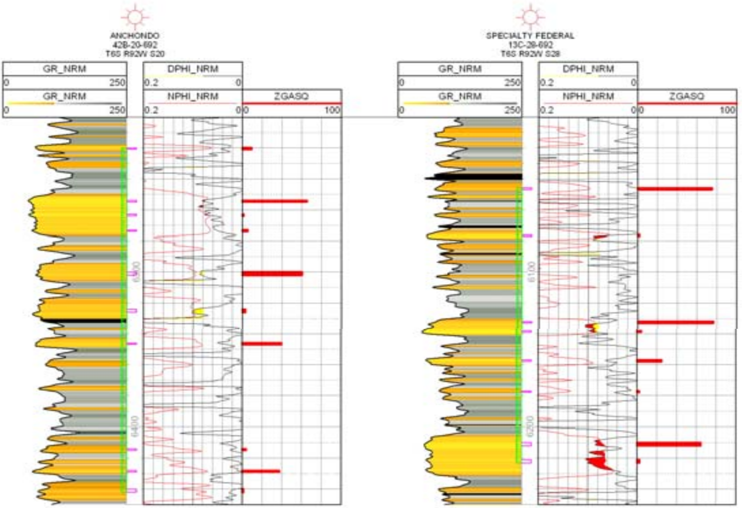
Low Porosity Sands Can Contribute Significant Gas Volumes

- Gas seeps on image logs are commonly seen in very low porosity sands
- These tight, well cemented sands are highly fracture prone
- Production logs show good contribution from tight sands that weren’t usually completed in the past

Image Logs Show Gas Seeping from Thin, Tight Zones That Are Not Usually Considered Pay



Production Logs Show Good Production from Thin, Tight Pay



Conclusions

- The Mesaverde interval in the Piceance Basin is a world class gas resource with very little dry-hole risk, currently producing about 1.3 BCF/D
- Reservoir quality is best in sands in the upper part of the gas-bearing interval of the Williams Fork, but risk of water production is higher
- Wet versus gas sands can be differentiated much better with open-hole versus cased-hole logs
- Very low porosity sands not completed in the past can contribute significant gas