Geology of the Giant Continuous Gas Accumulation in the Mesaverde Group, Piceance Basin, Colorado*

Stephen P. Cumella[1]

*Abstract from 2010-2011 AAPG Foundation Distinguished Lecture presentation.

[1]Bill Barrett Corporation, Denver, Colorado (scumella@billbarrettcorp.com)

A regionally extensive continuous 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 about 1.3 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. Typical wells' estimated ultimate recoveries (EURs) in these areas range from 1 to 2 BCF per well, resulting in reserves of about 60-120 BCF per section (1 square mile). The 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 lenticular nature of the Williams Fork sandstone reservoirs. The rate at which gas was generated and accumulated in the reservoirs outpaced by 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. Overpressuring resulted in pervasive natural fracturing of the lower part of the Williams Fork and gas migrated vertically through the fracture system.

Many factors are critical to successful development of Mesaverde reserves. Maximum horizontal stress commonly has a very similar orientation to the natural fracture orientation, resulting in highly elliptical drainage patterns. Bottom-hole locations must be placed to avoid interference along fracture orientation. The top of continuous gas saturation is commonly difficult to pick on logs and significant gas reserves are present in the overlying transition zone. Accurate differentiation of wet versus gas-bearing sandstones is much more successful using open-hole versus cased-hole logs. Also, production log data indicates that thin, tight sandstones that have not traditionally been considered pay can contribute significant gas. Hydraulic fracturing technology continues to evolve, with recent large water-volume fracture treatments resulting greatly improved well performance.