Geologic Controls on "Type Producing Areas" (TPAs) in the Fruitland Coal Bed Gas Field, New Mexico and Colorado

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Variations in thermal maturity exert a fundamental control on reservoir quality in the (Upper Cretaceous) Fruitland Coal gas field in the San Juan Basin, New Mexico and Colorado. Four northwest-southeast-trending "type producing areas" (labeled TPA1 through TPA4 from SW to NE) can be delineated, based primarily on gas production parameters (cumulative gas production per well, peak and present-day gas production rates, cumulative water production, gas to water ratio, composition of produced gas, and cumulative oil production). Production characteristics are broadly consistent within each TPA, but change dramatically across the TPA boundaries (labeled B1/2, B2/3, B3/4, from SW to NE).

Important geologic factors influencing coal gas production in the San Juan Basin include thermal maturity, petrographic composition of the coals, coal thickness, structural geology, and hydrodynamics, among others. These variables influence the: composition and quantity of sorbed gases (and oil), reservoir fluid pressure, sorption isotherm shape, water saturation, and cleat permeability. Geological controls are difficult to interpret, as multiple effects may be overprinted in any given area. Of the factors identified, however, thermal maturity appears to have the dominant influence. Vitrinite reflectance (mean, random) increases from 0.45% in TPA1 to 1.6% in TPA4 (based on Fassett, 2000). The highest gas production rates occur within TPA3 (a.k.a. "The Fairway"). The sinuous, but extremely sharp (less than one km wide) southern boundary of TPA3 (B2/3) is associated with a coal rank transition occurring at around 0.75 to 0.80% $R_{o,vit}$. This corresponds approximately the boundary between high volatile B bituminous and high volatile A bituminous. Peak gas rates increase by a factor of 10X to 20X across this transition. In TPA 2, which is equivalent to high volatile B bituminous coal rank, the reservoir is underpressured and permeability is low. Wells produce high BTU gases rich in C_{2+} and, in some cases oil, but very little or no water. North of B2/3 the reservoir is overpressured, permeability is high, and wells produce dry CH_4 with >10% CO_2 and high initial water rates. Overpressuring within TPA3 is empirically associated with the transition from wet gas to dry gas across B2/3, although the details of this mechanism remain elusive. In any case, overpressuring is more readily interpreted as related to hydrocarbon generation rather than to regional hydrodynamics.

Boundary B1/2 may also be related to thermal maturity, but the boundary is less sharp than B2/3, and the effect on reservoir quality is more subtle. B2/3 is more-or-less coincident with the 0.60% Ro,vit contour of Fassett (2000), which corresponds approximately to the transition from high volatile C bituminous to high volatile B bituminous. The Fruitland coals within TPA 2 appear to have entered the rank window of petroleum expulsion, as indicated by oil and condensate production. To the south of B1/2, the C_{2+} fraction is substantially less or absent.

The influence of hydrogeology is greatest in TPA4, but is minor elsewhere. Wells in TPA4 have very low gas to water ratios, many wells producing less than 1 MCFG per BBL water. Some wells near the coal outcrop have produced over 6 million barrels of water, with G/W ratios as low as 0.2. The proximity of these wells to the outcrop and their very long dewatering times indicates that there is a probable connection of the coal gas reservoir to the outcrop where meteoric recharge is taking place. Published water chemistry data support meteoric recharge for coals within TPA4 (Kaiser et al, 1990). In contrast, wells in TPA3 dewater relatively quickly. Based on production and regional stratigraphic trends, the major coals in TPA3, appear to be hydrologically isolated from TPA4. B3/4 is inferred to be a hydrodynamic boundary.

Structural geology has little discernable influence on gas production in the Fruitland Coal Field, except along the northwestern basin margin, where beds are dipping at high angles toward the basin center. Previous interpretations that production is influenced by structural features such as fracture swarms, hingelines are difficult to substantiate..

Interpretation of regional variations in reservoir quality is complicated by the coals of the Lower Fruitland apparently having significantly different petrographic composition from coals of the Middle and Upper Fruitland. Lower Fruitland coals are apparently more oil-prone, containing much higher proportion of fluorescent materials and oil exudations (Levine, 1991; Gurba and Fassett, 2000). Interpretation of organic petrologic controls on reservoir quality is also hampered by an extreme shortage of relevant data, which is ironic considering that the Fruitland Coal gas field has been one of the most prolific in North America, with thousands of wells having been drilled and completed in the coals.

Fassett, J. E, 2000, Geology and coal resources of the Upper Cretaceous Fruitland Formation, San Juan Basin, New Mexico and Colorado, In: Kirschbaum, M.A. et al., eds., Geologic Assessment of Coal in the Colorado Plateau: Arizona, Colorado, New Mexico, and Utah: US Geological Survey Prof. Paper 1625-B, Chapter Q (CD-ROM).

Levine, J.R., 1991, The impact of oil formed during coalification on generation and storage of natural gas in coal bed reservoir systems: 3rd Coalbed Methane Symp. Proc., Tuscaloosa, AL, May 13-16, 1991, p. 307-315.

Gurba, L. W. and Fassett, J.E., 2000. Depositional effects on coal rank indicators in the San Juan Basin (USA) - Comparison to Australian coal basins. In: Skilbeck, C.G. and Hubble, T.C.T. (Editors). Understanding Planet Earth: Searching for a Sustainable Future. Abstracts of the 15th Australian Geological Convention, University of Technology, Sydney, NSW, Australia, July 3-7, No 59: p. 198.