[PS]Geologic Evaluation of the Newburg Sandstone as a CO_2 Sequestration Target*

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Abstract

The West Virginia Division of Energy is currently in phase II of an evaluation of several deep saline formations in the Appalachian Basin of West Virginia that may be potential CO_2 sequestration targets. Phase II focuses on the storage capacity of selected zones including the Oriskany, Tuscarora, and Newburg sandstones. The Silurian Newburg Sandstone is present across central WV and separates the Salina evaporites from the Lockport Dolomite. As a high energy marine deposit, most of the hydrocarbon fields in the Newburg saline formation are combination structural/stratigraphic traps separated by down-dip salt water contacts or dry holes. The Newburg is uncharacteristically over-pressured compared to most gas fields in the basin. Six to seven years appears to be the average life span of Newburg wells which suggests well-developed porosity and permeability, especially in the pay zone, which is in the upper 3-10 feet of the interval. Due to the large number of CO_2 point sources in the region and the obvious reservoir properties of the unit, a serious evaluation of the Newburg Sandstone will serve to expand our knowledge about potential for sequestering CO_2.

References

Dalrymple, R.W., B.A. Zaitlin, and R. Boyd, 1992, Estuarine facies models: conceptual basis and stratigraphic implications: Journal of Sedimentary Petrology, 62, p. 1130–1146

Jarrell, P.M., C. Fox, M. Stein, and S. Webb, 2002, Practical Aspects of CO2 Flooding: SPE Monograph Series Vol. 22, ISBN:978-1-55563-096-6 Society of Petroleum Engineers, p. 200

Patchen, D.G., 1996, in The Atlas of Major Appalachian Gas Plays, V-25, p. 139-144

Patchen, D.G., 1967, Newburg Gas Development in West Virginia – Preliminary Report: WVGS Circular Series Number 6 - revised p. 37

Rosenbauer, R.J., 2002, Dioxide Sequestration in Saline Aquifers: USGS web page, http://soundwaves.usgs.gov/2002/research2.html

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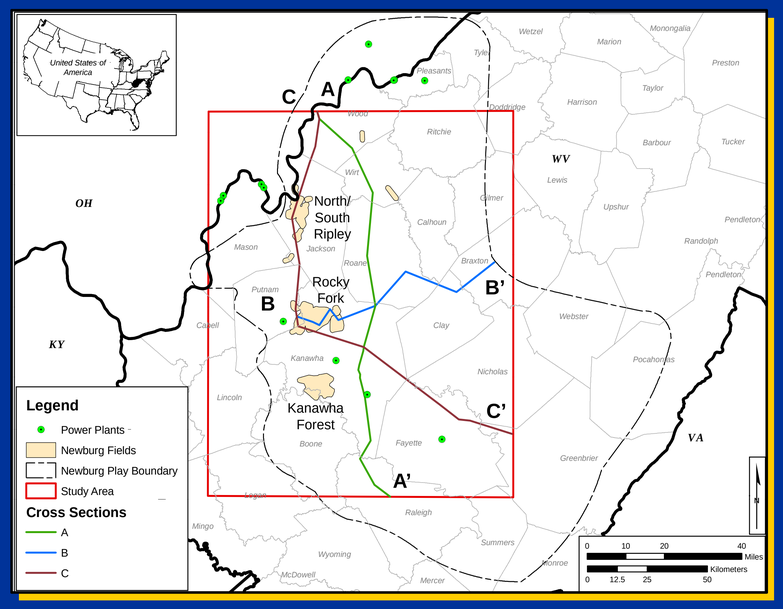
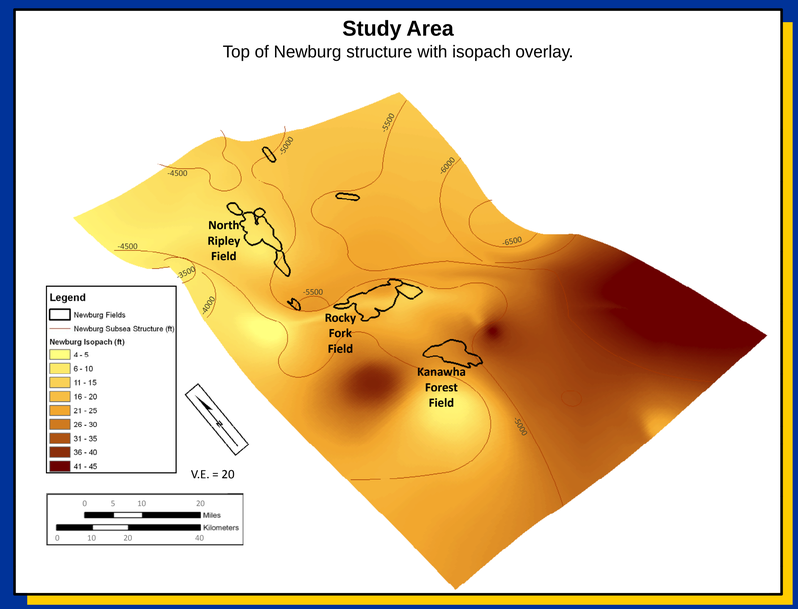
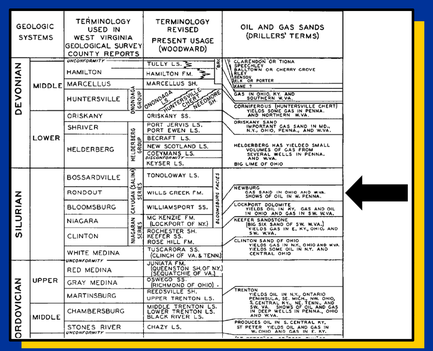


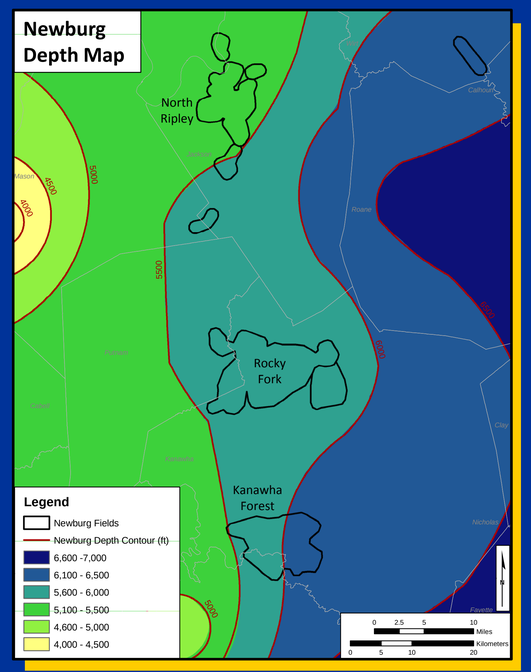
The Newburg Play Boundary designates the study area. This map shows all Newburg gas fields and cross sections used in the initial stages of this study.



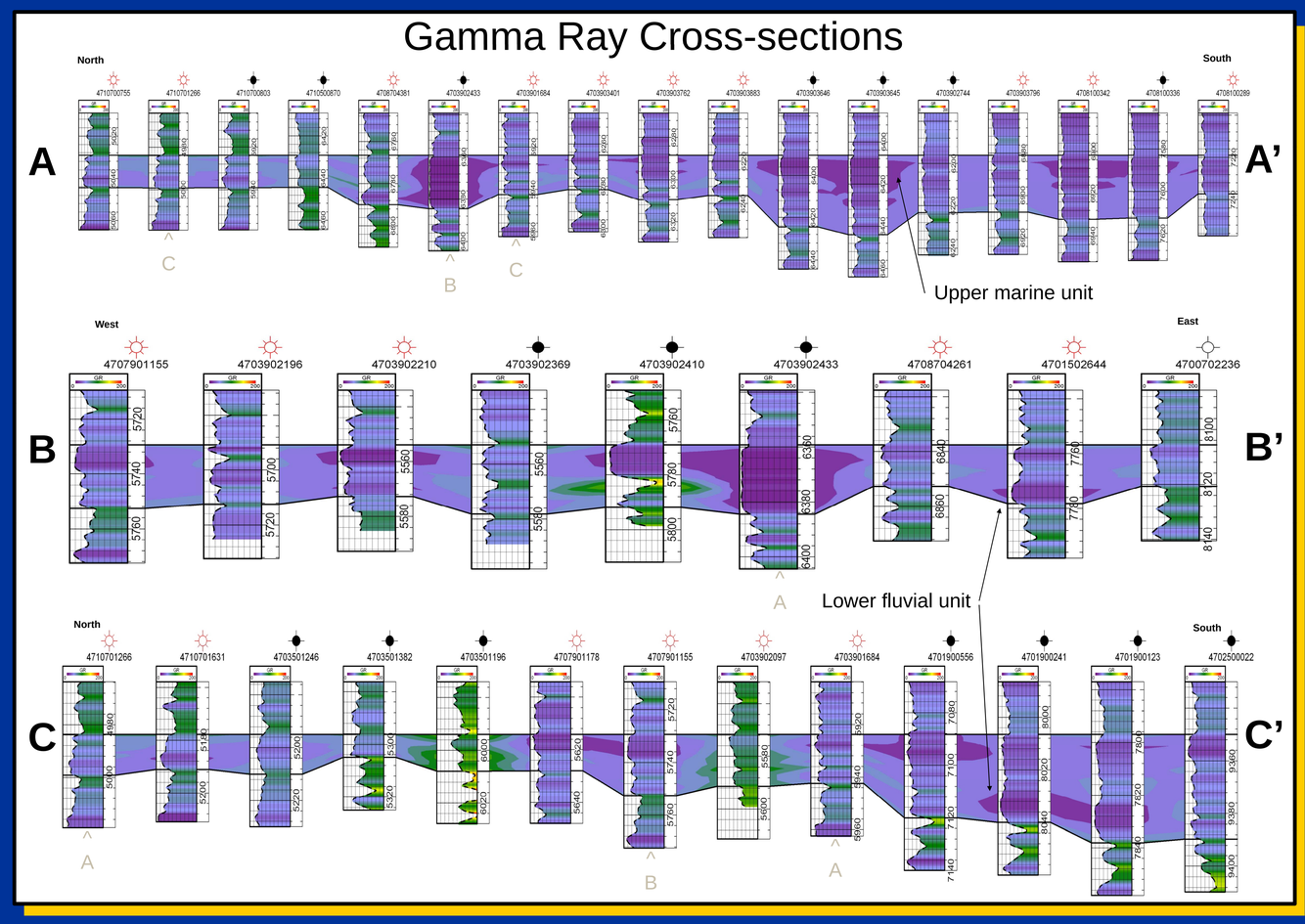
Three-dimensional subsea structure with isopach overlay developed from cross-sections A, B, and C. The Rocky Fork Field sits on a structural high.



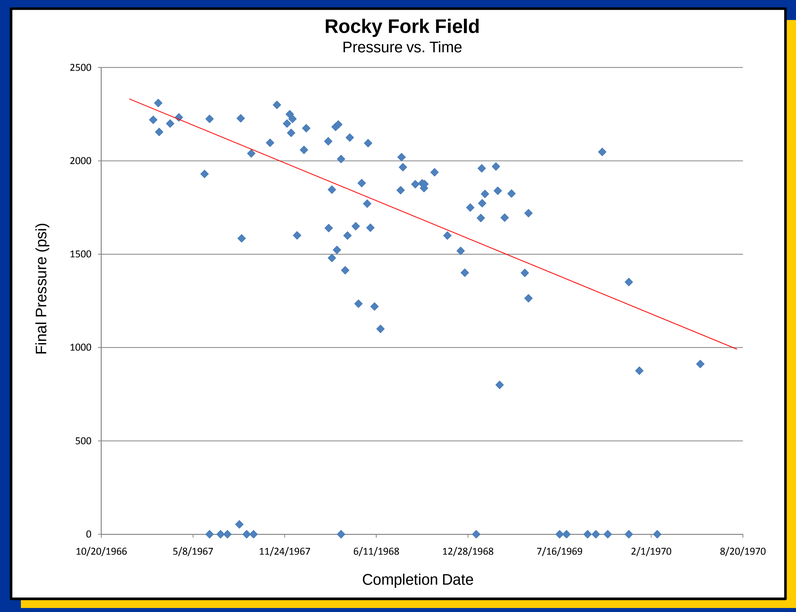
Generalized Stratigraphy (adapted from Patchen, 1967)

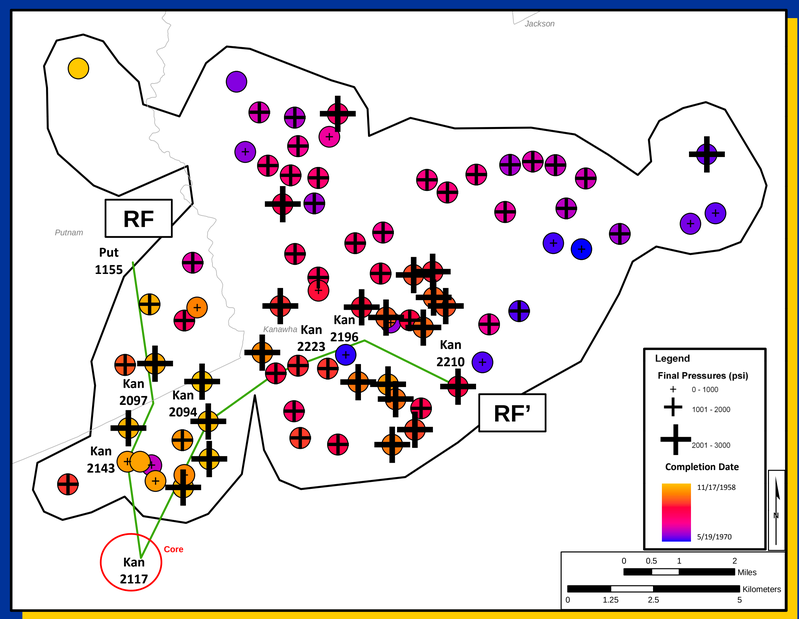


The WVDOE work plan defines a deep saline aquifer as a salt-water bearing unit “below 2,600 ft (780 m)”. When injected at these depths, CO_2 remains in a supercritical state allowing it to react with the salt and form carbonate minerals which adhere to the surface of the grains (Rosenbauer, 2002).

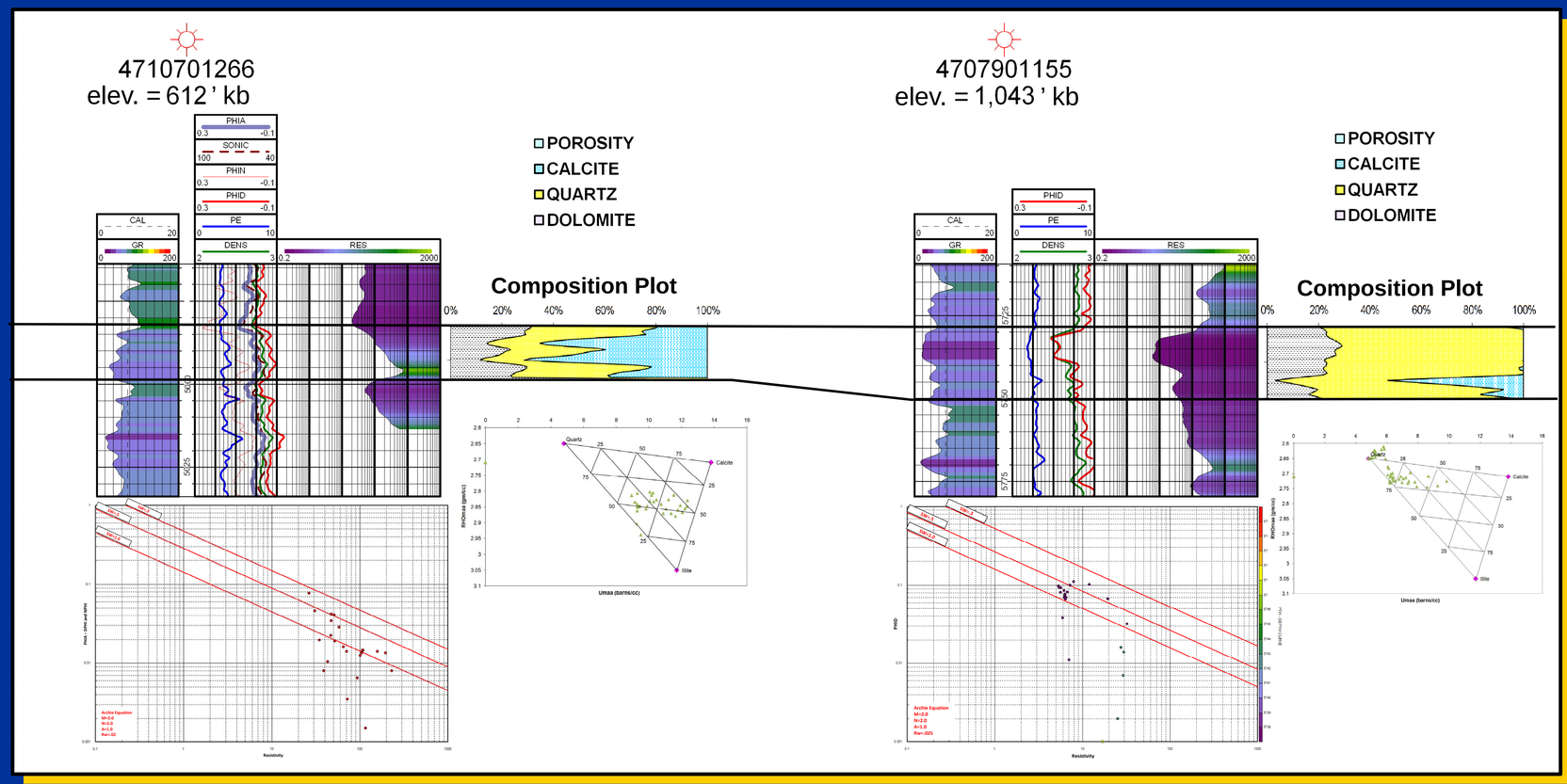


Correlations from cross-sections were used to create the structure, isopach and depth maps shown (Datum at top of Newburg). Using the Dalrymple et al. (1992) estuarine facies model, the Newburg appears to be a transgressive sequence comprised of two quartzose sandstone sections (a lower fluvial unit and an overlying marine unit) overlain by a shale zone. Tie wells denoted in light grey.





Well communication map for the Rocky Fork Field. Lighter colors designate earlier completion dates and larger crosses indicate higher pressures. Only wells completed in the Newburg were used. Comingled wells were excluded.

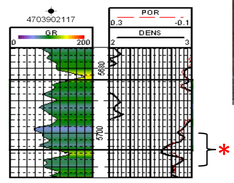


Wood 1266 (API # 4710701266) and Putnam 1155 (API # 4707901155) county wells had the most complete log suites and were used for log analysis. The Newburg sandstone rarely exceeds a thickness of 30 ft (9 m), with the pay zone generally described as "frosted" quartz sandstone in the upper 3-10 ft (.9-3 m) of the interval (Patchen, 1996). Neither of the above wells produced gas from the Newburg lithology. Although both wells have water saturations in excess of 50% throughout most of the interval, only the Putnam County well contains the characteristic porosity anomaly at the top of the formation. Calcite cement may be responsible for the reduction in primary porosity in the Wood County well.

Newburg core (3" dia.) from Kan 2117 (API# 4703902117).

5700.5' – 5701'
Porous quartz sandstone filled with clay. White and clear calcite cement.

5701.5' – 5702.1'
Calcareous quartz sandstone. Carbonate and shale intraclasts. Bioturbation and stylolites.



5703.5' – 5704'
Calcareous quartz sandstone. Calcareous fossil fragments and algal features. Limonite.

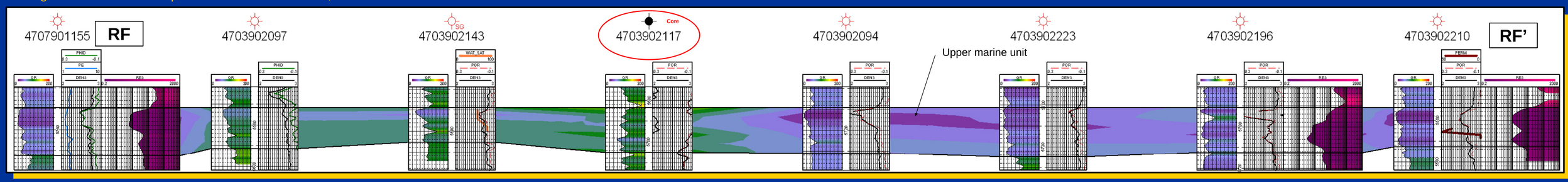
5704' – 5705'
Calcareous quartz sandstone. Dolomite and shale intraclasts.

5706'
Quartz sandstone with silica cement.

5708.5' – 5709'
Carbonate underlain by interbedded dark grey shale and sandy carbonate. Stylolites.

* **All core photos from this interval in lower Newburg.**

Cross-section through southwestern part of Rocky Fork Field. The upper marine sandstone is present throughout this section except where the core is located, which is outside of the field.



Rocky Fork Field CO_2 Storage Potential = 9.045 million metric tons

area = 1.8 billion sq. ft. average thickness = 15 ft. average Φ = 3% average S_w = 50% average temperature = 112.5° F (44.7° C)
(Average thickness is based on isopach. Average porosity is based on wells in cross-section RF (excluding Kan 2117). Average water saturation and temperature is based on log analysis of Putnam 1155 and Wood 1266 wells.)

Calculations
1.8 billion sq. ft. (area of field) X 15 ft. (avg. thickness of interval) = 27 billion cu. ft. (volume of field)
27 billion cu. ft. X .015 (empty Φ (S_w =50%)) = .405 billion cu. ft. (available storage space)
.405 billion cu. ft. X 49.32 lbs./cu. ft. (density of CO_2 at 110° F and 2500 psi (Jarrell et al., 2002)) = 19.9 billion pounds of CO_2
19.9 billion pounds of CO_2 / 2200 lbs./metric ton = .009045 billion metric tons

References

Dalrymple, R.W., Zaitlin, B.A., Boyd, R., 1992. Estuarine facies models: conceptual basis and stratigraphic implications. Journal of Sedimentary Petrology 62, pp.1130–1146.

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