GEOLOGY AND ENGINEERING CHARACTERISTICS OF SELECTED LOW-PERMEABILITY GAS SANDS: A SURVEY (ADDENDUM)

Final Report

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(Finley,1982)

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INTRODUCTION

This addendum to a survey of blanket-geometry tight gas sands was primarily prepared to include data on the "Clinton"-Medina Sandstone. The review of the "Clinton"-Medina and some data used in the review of the Berea Sandstone were provided by the West Virginia Geological Survey under subcontract to the Bureau of Economic Geology. CER Corporation and the Gas Research Institute (GRI) will utilize the results of this complete survey to identify a smaller number of stratigraphic units, geologic basins, or depositional systems that can be investigated in a future, more detailed study.

CHARACTERISTICS OF SELECTED BLANKET-GEOMETRY TIGHT GAS SANDS

Berea Sandstone, Appalachian Basin

Introduction

The Berea Sandstone of the Lower Mississippian Pocono Group is the lowermost Mississippian sandstone in the Appalachian Basin. The Berea varies from a medium- to fine-grained sandstone (Fayette and Raleigh Counties, West Virginia) to siltstone and fine-grained sandstone which may be interbedded with shale (Plateau Region, western Virginia). Data base for this review of the Berea is fair, with some data from each of 4 applications for tight gas formation designations (table 1). Specific engineering data are very limited; unstimulated flow rates are almost totally lacking, and permeabilities are generally inferred to be below 0.1 md largely by comparison to few porosity values which have coexisting permeability values. The Berea Sandstone has also been applied for and has been state-approved in Ohio (Hagar and Petzet, 1982b), and is likely to be applied for by operators in Kentucky (K. L. Avery, personal communication, 1982). Other formation characteristics are summarized in table 2.

(Finley,1982)

Depositional Systems

The Berea Sandstone is part of a Lower Mississippian progradational clastic wedge that includes major sand-filled fluvial channels, a delta plain, and a delta front. The system has characteristics suggesting that it was wave-dominated (Shumaker and Donaldson, 1981). Two major fluvial axes are known as the Gay-Fink and Cabin Creek Channels (Pepper and others, 1954); these channels are located approximately 50 miles apart in north-central and south-central West Virginia, respectively. The Berea occurs in the subsurface of parts of eastern Ohio, western Pennsylvania, western West Virginia and northeastern Kentucky, and contains elements of both deltaic and barrier depositional systems. In outcrop and in quarries in Ohio, Berea sandstones are highly lenticular and are surrounded by the red Bedford Shale; these sands probably represent a fluvial channel facies. In other areas barrier islands backed by lagoonal facies developed in an inferred delta-margin position. The Second Berea Sandstone of southeastern Ohio is such a barrier facies, and, although occurring entirely in the subsurface, is well known as the result of extensive gas production (Pepper and others, 1954).

Larese (1974) found that the Cabin Creek and Gay-Fink channel trends grade westward in central West Virginia into an extensive "sheetsand facies" representative of a regressive marine environment. Barrier island and distributary mouth bar facies were found to be part of the Berea deltaic complex. In addition, in the undifferentiated Pocono-Maccrady Group formations, Williamson (1974) noted shoreface and strandplain facies. Massive sandstone units with relatively sharp upper and lower contacts are interpreted as reworked, abandoned deltaic lobes (Williamson, 1974). Deposition of the Berea Sandstone was followed by a marine transgression which resulted in the deposition of the carbonaceous Sunbury Shale. The latter acts as an excellent subsurface marker in the delineation of the Berea; the extent to which the Berea was reworked during transgression was not noted by either Williamson (1974) or Larese (1974).

(Finley,1982)

Extrapolation Potential

The Berea Sandstone would be classified with deltaic systems and deltas reworked by transgression among the blanket-geometry tight gas sands evaluated in this survey. The Carter Sandstone, the Davis Sandstone, the Olmos Formation, and the Blair Formation are within this group (table 103). However, more of the Berea probably represents fluval facies than the literature suggests is present as part of these other stratigraphic units. In addition to the Gay-Fink and Cabin Creek channel trends, points of fluvial input to the marginal marine depositional systems have been identified in southern West Virginia (Virginia-Carolina Delta) and in northern Ohio (Berea Delta) (Pepper and others, 1954).

The extrapolation potential of the Berea to the other deltaic systems listed above and to the Frontier deltaic system would be expected to be fair to good. The extent to which progradational deltaic and barrier-strandplain facies are preserved in comparison to fluvial facies will determine the balance of blanket-geometry to lenticular-geometry sandstones present in the Berea.

(Finley,1982)

Table 1. Tight gas sand areas for the Berea Sandstone, Virginia, West Virginia and Ohio (Virginia Tight Sand Committee, 1981; West Virginia Tight Formation Committee, 1981a, 1981b and 1982; Hagar and Petzet, 1982a and 1982b).

Counties	Total Gross Area (acres)	Depth (ft)	Permeability (md)
Virginia			
Dickenson, Lee, Scott, Wise, Russell, Buchanan Tazewell	768,000	3,356-6,028	<0.1
West Virginia			
Fayette, Raleigh	1,024,000	2,766	<0.1
Mercer, McDowell, Wyoming	832,000	2,766	<0.1
Boone, Cabell, Kanawha, Lincoln, Logan, Mingo, Putnam, Wayne	-	-	<0.1
Ohio			
Athens, Gallia, Meigs, Morgan, Muskingham, Perry	2,580,000	1,200-2,000	0.012-0.215

(Finley,1982)

Table 2. Selected characeristics of the Berea Sandstone in Virginia and West Virginia (Virginia Tight Sand Committee, 1981; West Virginia Tight Formation Committee, 1981a, 1981b and 1982).

Virginia

Porosity: 2-8%, average 4%

Permeability: <0.1 md

Water saturation: 8-50%, average 35%

Oil production: none in application area

Excluded areas: selected parts of 4 existing fields

West Virginia

Porosity: average 7-8%, or less

Permeability: <0.1 md

Water saturation: no data

Thickness: 5-100 ft, mostly 55 ft or less

Oil production: none in application area

Excluded areas: field areas with >7.7% porosity or unstabilized flows over 91 Mcfd.

(Finley,1982)

CONCLUSIONS

The Lower Mississippian Berea Sandstone is a wave-dominated delta system including major sand-filled fluvial channel trends, delta front and delta plain facies. It would probably be similar to parts of the Carter Sandstone, Davis Sandstone, and the Olmos Formation and possibly be similar to parts of the Mesaverde Group. The latter statement is speculative, however, since better strandplain development is likely associated with blanket-geometry tight gas sands of the Mesaverde Group. Lack of more detail on depositional systems, on operator interest, and on potential reserves makes assessment of the Berea incomplete relative to potential research interest on the part of GRI.

The "Clinton"-Medina is highly productive from tight gas sands and does not appear to be a stratigraphic unit requiring major research and development efforts to encourage further development. Its eastern equivalent, the Tuscarora Sandstone is not developed and is relatively poorly understood. It seems likely that research and development of a similar fan delta system, such as the Travis Peak Formation, would have beneficial effects on the understanding of the entire "Clinton"-Medina Tuscarora system within the Appalachian Basin.

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This addendum was compiled as a supplement to the main body of this survey, and was prepared by the same staff of the Bureau of Economic Geology as listed therein. However, all drafting contained in this addendum was originally prepared by the West Virginia Geological and Economic Survey.