Reservoir Characterization of the Upper Cretaceous Woodbine Group in Northeast East Texas Field, Texas*

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Abstract

East Texas field, a giant U.S. oil field, produced 5.42 billion stock-tank barrels from discovery in 1930 through mid-2007. The lower part of the siliciclastic Upper Cretaceous Woodbine Group is reservoir rock, and almost all production comes from the upper unit, the operator-termed Main sand. The field could produce 70 million stock-tank barrels (MMSTB) using current strategies, whereas 410 MMSTB of remaining reserves from the Stringer zone (lower unit), along with bypassed pay in both units and unswept oil, is possible. These favorable statistics have increased interest in reservoir characterization of the Woodbine, especially the Stringer zone. This study delineates sandstone geometry and interprets reservoir facies and heterogeneity of the Stringer zone and Main sand in northeast East Texas field. Additional objectives are to define key chronostratigraphic surfaces, such as flooding surfaces and unconformities, and to establish a realistic depositional model for the reservoir succession. To achieve these objectives, well log analysis, core description, and net-sandstone mapping of the Stringer zone and Main sand were conducted. According to sequence-stratigraphic and depositional-system analysis, the Woodbine Group is divided into two genetically unrelated units: (1) the highstand deltaic Stringer zone and (2) the lowstand incised-valley-fill Main sand. Principal reservoir units are Stringer 1 and Stringer 2 sands within the Stringer zone and the Main sand. Stringer 2, best developed in the southwest study area, is the most promising reservoir unit for new production. Well deepening and water flooding in this more continuous and thicker sand are proposed to increase production in East Texas Field.

References


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ABSTRACT

East Texas field, a giant U.S. oilfield, produced 5.42 billion stock-tank barrels from discovery in 1930 through mid-2007. The lower part of the siliciclastic Upper Cretaceous Woodbine Group is reservoir rock, and almost all production comes from the upper unit, the operator-termed Main sand. The field could produce 70 million stock-tank barrels (MMSTB) using current strategies, whereas 410 MMSTB of remaining reserves from the Stringer zone (lower unit), along with bypassed pay in both units and unswept oil, is possible. These favorable statistics have increased interest in reservoir characterization of the Woodbine, especially the Stringer zone. This study delineates sandstone geometry and interprets reservoir facies and heterogeneity of the Stringer zone and Main sand in northeast East Texas field. Additional objectives are to define key chronostratigraphic surfaces, such as flooding surfaces and unconformities, and to establish a realistic depositional model for the reservoir succession. To achieve these objectives, well log analysis, core description, and gross-sandstone mapping of the Stringer zone and Main sand were conducted. According to sequence-stratigraphic and depositional-system analysis, the Woodbine Group is divided into two genetically unrelated units: (1) the highstand deltaic Stringer zone and (2) the lowstand incised-valley-fill Main sand. Principal reservoir units are Stringer 1 and Stringer 2 sands within the Stringer zone and the Main sand. Stringer 2, best developed in the southwest study area, is the most promising reservoir unit for new production. Well deepening and waterflood in this more continuous and thicker sand are proposed to increase production in East Texas field.

INTRODUCTION

To delineate sandstone-body geometry and interpret reservoir facies and reservoir heterogeneity in the Stringer sand and the Main sand reservoir facies.

To define and interpret prominent chronostratigraphic surfaces.

To establish a realistic depositional model for the reservoir succession.

DATA AND METHODS

- 500 well logs (GR, SP, and resistivity)
- 3 cores
- Well log analysis
- Core description
- Gross-sandstone mapping

OBJECTIVES

STUDY AREA

Figure 4: Location of the study area in East Texas field (SNP: north pilot area of Ambrose et al., 2009; Hentz, 2010). Map also identifies location of cored wells: (i) Citizen Service No. 82 Holloway Court; (ii) Area No. B142 King, and III: Shell No. 35 Woman used in this investigation.

SEQUENCE-STRATIGRAPHIC FRAMEWORK

Figure 2: (a) Regional lithostratigraphy of Lower and Upper Cretaceous units of the East Texas Basin (Salvador and Menenez, 1993). (b) Austin Chalk directly overlies strata of the Woodbine Group in East Texas field because the entire Eagle Ford Group and all of the upper and most of the lower Woodbine Group were eroded away to contemporary rise of the Sabine Uplift (Halbouty and Halbouty, 1982, Ambrose et al., 2009).

Figure 3: Distribution of cumulative oil production, residual oil, remaining mobile oil, and remaining reserves in East Texas field (Wang, 2010). Almost all production from East Texas field has been from the Main sand (upper Woodbine Group). On the other hand, recent evaluations indicate that remaining reserves are in bypassed pay in the Main sand, deeper pay in the Stringer sand (lower Woodbine Group), and poorly swept oil (Wang, 2010).

Figure 5: Type log showing system tracts (TST: transgressive system tract, HST: highstand system tract, and LST: lowstand system tract) and significant chronostratigraphic surfaces (FS: flooding surface, MFS: maximum flooding surface, HST: highstand system tract, and LST: lowstand system tract). (a) Base map shows depositional units. Arrows show general grain-size trends of depositional units.

Figure 6: (a) North-south sequence-stratigraphic cross section A-B along the depositional dip of the Woodbine Group indicates minimal thickness changes where depth of incision by the incised valley varies. (b) West-east sequence-stratigraphic cross section C-D along the depositional slope of the Woodbine Group exhibits a gradual eastward structural updisplacement decrease in thickness of the overall Woodbine section because of progressive updip truncation of the interval below the base-of-Austin unconformity. Sequence 1 also diminishes in thickness toward the east edge of the field from about 110 ft (33 m) to about 20 ft (6 m). On the other hand, Sequence 2 decreases only slightly in thickness updip. However, flooding surface FS3 is truncated at the base of incision of the overlying incised-valley fill. (c) Base map shows location of control wells used in the study and lines of representative cross sections.

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DEPOSITIONAL SYSTEMS

RESERVOIR FACIES

CONCLUSION

- The Woodbine Group in the north part of East Texas field comprises two fourth-order sequences (Sequences 1 and Sequences 2), consisting of transgressive, highstand, and lowstand systems tracts.
- The lower part of the Woodbine Group, the Stringer zone, is defined as a highstand deltaic unit that contains preserving reservoir-sandstone bodies (Stringer 1 and Stringer 2) that represent distributary-channel fills, crevasse-splay deposits, and delta-front facies.
- Reservoir heterogeneity is relatively high in the Stringer sand owing to the existence of narrow distributaries.
- The upper part of the Stringer sand, Stringer 2, has thicker and relatively well connected sandstone bodies.
- The southwest part of the study area contains well-developed, thicker reservoir Stringer sand.
- Although the Main sand has better reservoir properties, such as well-developed lateral and vertical continuity of stacked fluvial sandstone bodies and high porosity and permeability values, it is suggested that the Stringer sand also has the potential to be a prospective reservoir unit.
- Production in East Texas field can be increased by application of proper field strategies, such as well deepening and waterflooding, with polymer gel flooding in the southwest part of the field, where the Stringer sand is thicker.
- The Stringer zone should be considered as another Woodbine reservoir in East Texas field. Therefore, future studies should include detailed regional mapping of the Stringer zone to develop a better understanding about depositional trends and remaining oil in East Texas field.

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REFERENCES