[PS]Reservoir Characterization, Depositional System, and Diagenesis of the Atokan Grant Sand, Fort Worth Basin, Texas*

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Abstract

The Atokan Grant Sands are a tight gas sand play that would add new reserves to the Fort Worth Basin. The Fort Worth Basin is located in north-central Texas just west of Dallas, Texas. Within the basin, the study area consists of Denton, Wise, Tarrant, and Parker Counties in Texas. The basin is bounded to the north by the Red River Arch, to the west by the Bend Arch, to the south by the Llano uplift, to the east by the Ouachita structural front, and to the northeast by the Muenster Arch. The Grant Sands are approximately 1,500 feet stratigraphically above their source, the Barnett Shale, and were discovered and mapped from early Barnett vertical drilling. This play evolved from a vertical to a horizontal drilling program with Grant wells being drilled alongside Barnett wells. The sands are divided into “upper” and “lower” units with a shale unit between the two. The purpose of this study is to determine the key performance drivers of both the “upper” and “lower” Grant Sands to improve the geologic understanding for enhanced exploration potential. It is a consensus by previous investigations that the Grant is comprised of shallow marine sands from fluvial to deltaic deposition. Although the broad depositional environment is generally agreed upon, the source of sediment is an issue of disagreement in previous works. This study analyzes core data and regional subsurface mapping to determine an interpretation for the depositional environment and diagenesis of the Grant Sand interval.

Reservoir Characterization, Depositional System, & Diagenesis of the Atokan Grant Sand, Fort Worth Basin, Texas

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1 INTRODUCTION

The Fort Worth Basin is located in north-central Texas just west of Dallas, Texas. The basin is bounded to the north by the Red River Arch, to the west by the Bend Arch, to the south by the Llano uplift, to the east by the Ouachita structural front, and to the northeast by the Muenster Arch. The sedimentary sequence in the Fort Worth Basin includes up to 12,000 ft thicknesses (Turner, 1957) of Cambro-Ordivician, Devonian, Mississippian, and Pennsylvanian strata. In the Fort Worth Basin the Atokan and Morrowan rocks range in thicknesses from approximately 200 ft to more than 6,000 ft. The Atoka Group, also termed the Boonsville Field, overlies the unconformity at the top of the Morrowan-age Marble Falls Limestone.

The Atokan Grant Sands are a tight gas sand play that would add new reserves to the Fort Worth Basin. The Grant Sands are approximately 1,500 feet stratigraphically above their source, the Barnett Shale. The Mississippian Barnett Shale is a highly productive play and stands as the prototype for shale plays in North America. The Grant Sands were discovered and mapped from early Barnett vertical drilling. This play evolved from a vertical to a horizontal drilling program with wells being drilled alongside Barnett wells. The sands are divided into “upper” and “lower” units with a shale unit between the two at drilling depths from 4,000 to 6,000 ft drilling depths in the study area. Both “upper” and “lower” sands have been horizontally drilled and are productive.

2 OVERVIEW

The overall purpose of this study is to improve the geologic understanding for enhanced exploration potential. The use of log data was used to map the regional extents and production variations of the Grant Formation. A lithostratigraphic analysis of core data is used to constrain the sequence stratigraphy. The sequence stratigraphy in conjunction with mineralogy is used to constrain the depositional environment and diagenesis of the Grant Sands. A reservoir characterization with a model for depositional setting and diagenesis will contribute to the current geologic understanding of the Grant Sand Formation.

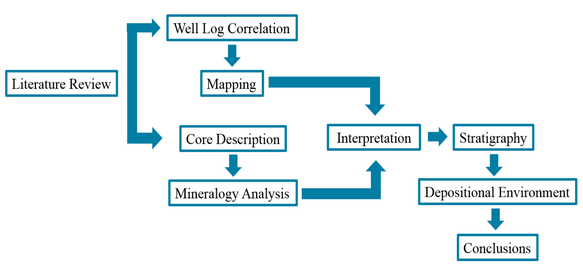

Figure 1: *Work flow for this study. The project began as an industry interest in the Grant Formation for further development potential. It is now being continued to include interests of a more academic nature to fulfill a Master’s of Science thesis.*

The deliverables for this study will include:

- Type log for the Grant Sands
- Boundaries for the regional extents of the units
- Structure maps of the producing units
- Gross Sand Isopach maps of the producing units
- Net Sand Isopach maps of the producing units
- Bubble maps for the Initial Production and Cumulative Gas of Devon wells
- Core descriptions of whole cores Devon owns
- Mineralogical analysis of samples from core
- Stratigraphic description of the Grant Sands
- Model for depositional environment of the Grant Sands

3 AREA OF INVESTIGATION

The Fort Worth Basin is a foreland basin located in north-central Texas, just west of Dallas, TX. The basin is a late Paleozoic structural and depositional feature on the southern margin of North America formed in response to a collision of continental masses. Previous to Pennsylvanian time the area that would become the Fort Worth Basin was located on the eastern side of the Texas Arch in the southern section of the Oklahoma basin.

The Fort Worth Basin is bounded to the north by the Red River – Electra Arch, to the west by the Bend Arch, to the south by the Llano uplift, to the east by the Ouachita structural front, and to the northeast by the Muenster Arch. These regional structural elements were formed with the occurrence of the Ouachita Orogeny.

Figure 2: *Location map for the Fort Worth Basin in Texas.*

The basin is an asymmetric wedge-shaped regional feature that was downwarped during the early Pennsylvanian time by the transpression that produced the Ouachita structural belt (Johnson et al., 1989). Striking north-south, the basin is approximately 20,300 square miles in size at 200 miles long and ranging from 10-100+ miles wide. The width ranges from a few miles in the southern end adjacent to the Llano uplift to approximately 100 miles in the north near the city of Fort Worth, TX. The deepest part of the basin is a deep axial trough adjacent to the Ouachita structural belt with a maximum known thickness of 12,000 ft of Paleozoic sedimentary rocks (Thompson, 1982; Johnson et al., 1989). The clastic wedge that filled the trench overlies early to middle Paleozoic shelf carbonates that spread and thin westward onto the margin of the Bend Arch and is unconformably overlain by outcropping Cretaceous strata (Walper, 1982).

The study area for this investigation is located in the north-east section of the Fort Worth Basin. It covers the south-west corner of Denton County, the southern portion of Wise County, the north-east corner of Parker County, and the north-west corner of Tarrant County in Texas.

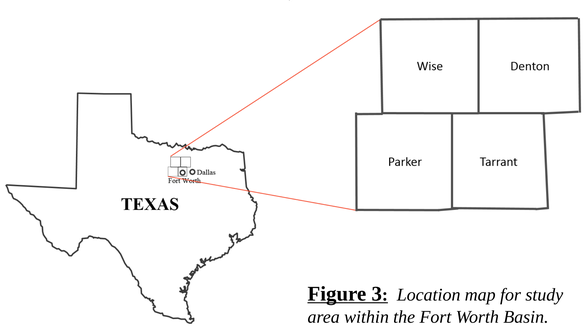

Figure 3: *Location map for study area within the Fort Worth Basin.*

4 STRATIGRAPHY

The Atoka Group, also termed the Boonsville Field, overlies the unconformity at the top of the Morrowan-age Marble Falls Limestone. The Boonsville Field of the Fort Worth Basin thins to the northwest and is comprised of sandstones, conglomerates, interbedded shales, and thin limestones (Maharaj and Wood, 2009; Johnson et al., 1989). The conglomerates and coarse sandstones are usually composed of subrounded to subangular quartz clasts with feldspars and some chert. Both carbonate and silica cements are commonly found in the sandstones and conglomerates. Dissolution of detrital feldspar grains often creates secondary porosity. The lower portion of the Boonsville Field is the Bend Conglomerate Group. The Bend Conglomerate Group is comprised of sands interbedded by shales with the “upper” Grant sand at the top.

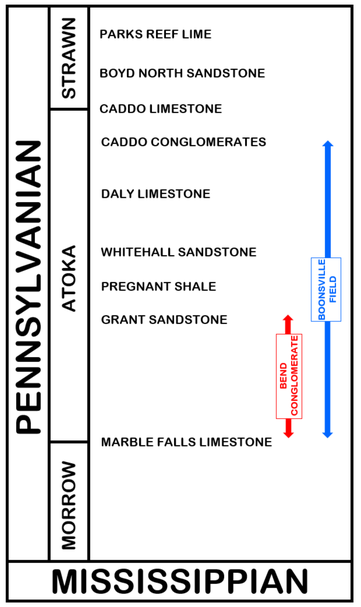

Figure 4: *Stratigraphic column for the Atoka in the study area.*

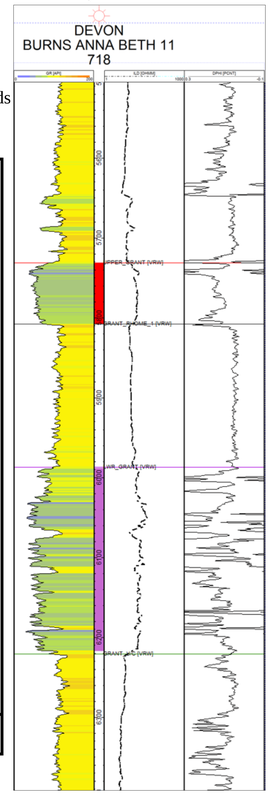

Figure 5: *Type log for the Grant Sands from Denton County, TX*

5 METHODOLOGY

The study area is highly developed with a major quantity of IHS Petra well log data. Well log formation identifications were initially based on previous formation top picks by industry geologists, in particular Gayle Riggs, at Devon Energy. A set of criteria was established for consistent formation top picks for this study based on log characteristics. An organized grid system was set up to consistently map the area by correlating well logs. While completing well log correlations, pay intervals were selected based on a visual interpretation of log curves for “clean” sands. The well log correlations and the pay intervals were then used to produce maps of the Grant Sands.

6 MAPPING

Structure maps and gross sand maps for both the “upper” and “lower” sands were created from the well log correlations. These maps depict the regional extents of the Grant Sands. The “lower” Grant is more widespread regionally and ranges in thickness from a couple tens of feet to more than 650 feet in the southern portion of the study area as can be seen in Figure 6. The “upper” Grant sand is much more regionally constrained and is up to 100 feet thick in the center of the elongate body.

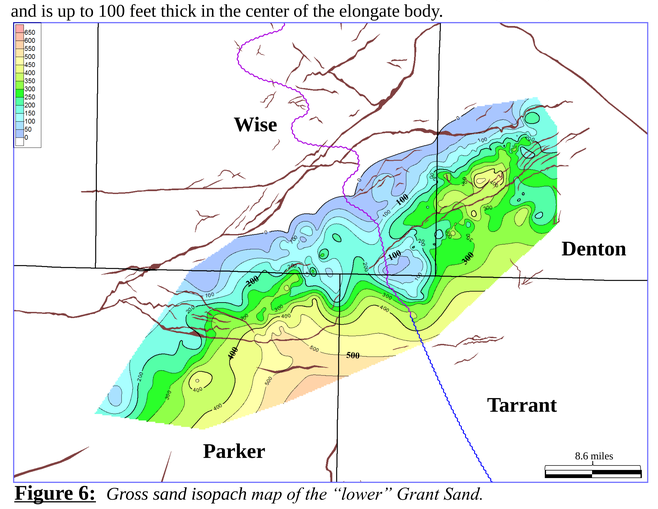

Figure 6: *Gross sand isopach map of the “lower” Grant Sand.*

The pay intervals were used to produce net sand maps for both the “upper” and “lower” sands because the logs were too washed out to use cut-off parameters for a traditional net sand map. Bubble maps of IP and CumGas were overlain on the net maps show the production for each sand. Although the “lower” Grant is thicker and more widespread than the “upper”, the production data represents that the “upper” sand is the better reservoir.

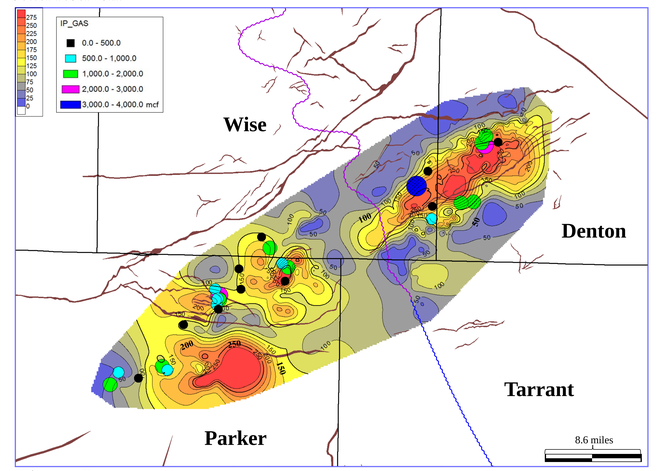

Figure 7: *Net sand map of the “lower” Grant with Initial Production bubble map*

7 CONCLUSIONS

From the results thus far it is concluded that the Grant Sands have future potential both in development horizontal locations and in recompletions in previously drilled Barnett wells. The “lower” Grant sand is thicker and more widespread, but contains intervening shale layers that may act as frac barriers. Future work includes completing core descriptions and mineralogical analysis to construct a description of the Grant Sands stratigraphy and then integrating that information to build a model for depositional environment.

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