Emelda Orakwue

Reservoir characterization of West Waha and Worsham-Bayer Fields

Southeastern Delaware Basin, West Texas Using integrated data source

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RESERVOIR CHARACTERIZATION OF WEST WAHA AND WORSHAM-
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RESERVOIR CHARACTERIZATION OF WEST WAHA AND WORSHAM-BAYER FIELDS, SOUTHEASTERN DELAWARE BASIN, WEST TEXAS USING INTEGRATED DATA SOURCE

BY

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**ABSTRACT**

West Waha and Worsham-Bayer fields are located in the Southeastern Delaware Basin, West Texas. For several decades, these fields have been experiencing problem of low natural gas recovery in contrast to their large estimated reserves. This study involved the integration of interpreted three data sets namely; 10 well logs, 20-sq-miles 3D seismic and production data. The principal objectives for this study were to determine the impact of thin-beds on reservoir petrophysical analysis and to assess the impact of estimated recoverable reserve on the interpreted reservoirs (R1 [Lower Ordovician Ellenburger group], R2 [Silurian Fusselman formation], R3 [Devonian Thirtyone Formation] and R4 [Undifferentiated Mississippian Limestone].

Reservoir characterization method employed were: well log correlation, petrophysical analysis to calculate porosity and Movable Hydrocarbon Index (MHI), reservoir attribute analysis for thickness estimation, seismic-to-well ties to detect the reservoirs of interest, fault mapping, 3D seismic interpretation, generation of time-depth structure maps for prospect mapping, volumetric analysis for recoverable reserve estimation and production record interpretation.

Well log correlation revealed complex thrust faulting, structural rotation and left-lateral strike-slip which serves as major traps in some areas of the fields. The reservoirs were thickening to Northeastern direction towards Texas arch and thinning Northwestern and the log motifs depict carbonate depositional environment type. The mean porosities for R1, R2, R3 and R4 reservoirs are 23.7%, 16.3%, 26.1% and 26.0% respectively, while the fields' mean porosity value is 23.1% showing excellent porosity value for natural gas flow. Wells 29, 36, 37 and 38 have MHI of >20%. R1 reservoir had the highest thickness value (146 ft) at well log 29. F1 and F2 are major faults and F3, F4, F5, F6, F7 and F8 and F9 are minor faults. F3, F2, F4, F5, F6, F7 and F8 dip north, while F1, F3 and F9 dip south. The total Gas in place (BScf) and...
the total Recoverable reserve (Tcf) calculated were 359.73 and 636.62 respectively. Production records interpretation showed decrease in reservoirs' productivity as a result of decline in the natural pressure of the reservoirs. From analysis results, it was deducted that the thin beds positively impact the reservoir petrophysics and the calculated recoverable reserve also impact reserve.

This work showed that the studied fields have large amount of natural gas volume and that R1 is the major producing reservoir. The method used may also be applied in Nigerian fields towards enhancing hydrocarbon recovery.
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Dedication

This research work is highly dedicated to the Almighty God. Thank You for the knowledge and wisdom given to me during the course of this research. Thank You for the journey so far. I love You.

I do dedicate this to the blessed memory of my lovely eldest brother, Evangelist Chukwuemeka Evaristus Ubaka, who slept in the Lord on Wednesday night (10.30pm) 19th August, 2009. Also to the blessed memory of my dearest and ever caring daddy, Joseph Nwabuze Orakwue, who departed on Thursday morning [10.00am] 11th March, 2010. May your gentle souls rest in peace, miss you so much. Daddy you would have waited to give me a warm embrace at the completion of my master’s degree, but it is well.
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CHAPTER ONE

INTRODUCTION

1.1 General Statement

Reservoir characterization and subsurface geological maps is perhaps the most important vehicle used to explore for undiscovered hydrocarbons and to develop proven hydrocarbon reserves. However, the subject of reservoir characterization and subsurface mapping is probably the least discussed, yet most important, aspect of petroleum exploration and development. As a field is developed from its initial discovery, a large volume of well logs, seismic, and production data are obtained. With the integration of these data, the accuracy of the subsurface interpretation is improved through time (Tearpock and Biscake, 2003).

A decade ago, approximately 800 trillion cubic feet (Tcf) of natural gas existed or was estimated to exist in conventional reservoirs in United States, yet only 538 Tcf of this gas is economically recoverable at prices of less than $3 per thousand cubic feet (Mcf) in 1987 dollars (Finley et al., 1988). More recently, considering only the largest 580 gas reservoirs on Texas State Lands, only half of an original 20 Tcf of natural gas in place has been recovered (Holtz and Garrett, 1997). One of the most promising new technologies for imaging gas reservoirs for reserve-growth studies is three-dimensional (3-D) seismic reflection data. The recent rapid increase in the use of 3-D seismic data in the oil and gas industry has vastly improved the level of detailed resolution of subsurface reservoir parameters such as petrophysical features (porosity, permeability, water saturation and so on), structural features interpretation (faults and folds), stratigraphic features (erosion and truncation features, karsting etc), and in some cases, even direct hydrocarbon