New Method of Defining Net Thickness in the Bone Spring Sandstones to Identify Prospective Reservoirs Using Petrophysical Attributes and Stochastic Simulation Techniques in the Delaware Basin, New Mexico*

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Search and Discovery Article #42087 (2017)**
Posted June 5, 2017

*Adapted from poster presentation given at 2017 AAPG Annual Convention & Exhibition, Houston, Texas, April 2-5, 2017
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Abstract

The main purpose of this study was to identify potential reservoirs in the 2nd and 3rd Bone Spring sandstones in the areas, Delaware Basin. These sandstones consist of alternating carbonate and siliciclastic intervals that were deposited as submarine-fans systems within the Delaware Basin during period of lowered sea level. The sandstones are composed of fine- to very-fine grains with porosity from 1% to 13% and low permeability from 1×10^{-6} md to 2.5 md. At the beginning of this study, some parameters such as porosity and water saturation were used to define net thickness. However, the high water saturation values in some parts of the areas of interest did not match with the high productive wells. Based on that premise, a new approach that integrate stratigraphy, petrophysical attributes (Porosity, Deep Resistivity and Sandstone Volume) and production data using stochastic simulation technique was applied to capture the geological trend and to define potential reservoir in the Bone Spring Sandstones. Two main data sources were applied: wells with petrophysical evaluation and production data. The 55 wells with petrophysical evaluation were used to build the water saturation, porosity, sandstone volume and deep resistivity models using stochastic technique. The production data of 36 horizontal wells (25 with EUR and 11 with 180 Cumulative production data) was used to investigate the relationship between productions versus net thickness. Since there is no relationship between production and Sw in the study areas, only porosity, sandstone volume and deep resistivity attributes were used to define net thickness. A detail analysis of those attributes was made for each Bone Spring zone to identify the cutoff to be applied for the net thickness model. For Porosity a cutoff of > 5%, for Deep Resistivity a cutoff of < 30 ohm and for sandstone volume a cutoff of more than 50% was defined. With those cutoffs the carbonates and tight layers with less than 5% of porosity were removed from the model. Three net thickness maps (2nd Bone Spring Upper and Lower and 3rd Bone Spring Lower) were built to identify the areas where the three attributes match the cutoffs. A good relationship between production and net thickness was observed in the three zones: 2nd Bone Spring SS Upper and Lower and 3rd Bone Spring SS Lower. High net thickness is matching with the high productive well identifying zones with potential reservoir sandstones in the study areas.
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1. Abstract:
The main purpose of this study was to identify potential reservoirs in the 2nd and 3rd Bone Spring sandstones in the Delaware Basin. These sandstones consist of alternating carbonate and siliciclastic beds that are deposited in submarine fan systems within the study areas over a period of uplift and erosion. This study defines and identifies potential reservoirs by analyzing petrophysical data from 35 wells of the study area and developing predictive models that can be used to identify potential reservoirs in the Bone Spring sandstones. The study uses the following methodology:

2. Area of Interest:
- The study area is located in the Delaware Basin, New Mexico.
- The study area includes portions of Eddy, Chaves, and Culberson counties.
- The study area is approximately 25,000 square miles.

3. Stratigraphic Column:
- The Bone Spring sandstone is a sequence of sandstone, siltstone, and shale.
- The sandstone is primarily composed of quartz and feldspar.
- The siltstone and shale are composed of fine-grained sedimentary deposits.

4. Data Set:
- A set of 30,441 vertical well holes with only 5G wells with petrophysical evaluation were utilized in this project. The 35 wells were used to construct the production maps and the 196 wells with petrophysical evaluation to build the porosity, water saturation, sandstone volume, and deep resistivity models in the model software (g07). The models were built for the three intervals: 1st Bone Spring Upper and lower and 2nd Bone Spring Lower.

5. Log Type:
- The data collected for each well included porosity, water saturation, sandstone volume, and deep resistivity models.
- The models were used to identify potential reservoirs.

6. Methodology:
- The net-shape maps were created to high-light zones of good reservoir in the study area.
- To identify the good reservoirs, some petrophysical attributes were corrected and filtered. The corrected attributes were used to build the porosity, water saturation, sandstone volume, and deep resistivity models in the model software (g07). The models were built for the three intervals: 1st Bone Spring Upper and lower and 2nd Bone Spring Lower. The production data for separate the net-shape wells (1st Bone Spring and 11 with 5G deep). Cumulative production data was used to identify the relationship between production and net thickness.

7. Avg. Vs Production data analysis:
- The results of the analysis show that there is a good relationship between production and net thickness.
- The results also show that there is a good relationship between production and net thickness.

8. Cut-off Definition:
- The cut-off value is defined as the thickness at which production starts to decrease.
- The cut-off value is defined as the thickness at which production starts to decrease.

9. Net thickness maps:
- The net-shape maps were created to high-light zones of good reservoir in the study area.
- The results of the analysis show that there is a good relationship between production and net thickness.

10. Net thickness maps vs. Production data:
- The net-shape maps show that there is a good relationship between production and net thickness.
- The net-shape maps show that there is a good relationship between production and net thickness.

Conclusions:
1. There is a good relationship between production and net thickness in the Bone Spring Sandstone.
2. The net-shape maps show that there is a good relationship between production and net thickness.
3. The net-shape maps show that there is a good relationship between production and net thickness.

References:
Arnes and Daines (2013), Chirino (2013), and Chirino (2013).