Evaluation of Thin Limestone Interlayers within Marcellus Shale in Southwestern Pennsylvania*

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Search and Discovery Article #11219 (2019)**
Posted May 27, 2019

*Adapted from poster presentation given at 47th Annual AAPG-SPE Eastern Section Joint Meeting, October 7-11, Pittsburg, Pennsylvania, 2018

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Abstract

Marcellus Shale consists of organic-rich mudrocks with several thin limestone interlayers. The thickest interlayer is named Purcell Limestone, which separates the Marcellus Shale into the Upper Marcellus Shale (Oatka Creek Member) and Lower Marcellus Shale (Union Spring Member). The thickness of these limestone interlayers varies by location within the Appalachian Basin. Limestone interlayers can have an influence on hydraulic fracturing and production in the Marcellus Shale. Identifying the thin limestone interlayers within the Marcellus Shale is important to correctly estimate the thickness of the organic-rich zone within Marcellus Shale. The effects on hydraulic fracturing and production can be investigated by analyzing whether the mechanical properties change within the Marcellus Shale.

Hydraulic fractures through the Purcell Limestone is an important area of study in which the thickness of the limestone layer can play a part in some effects. Understanding the varying thickness of the Purcell Limestone will be useful in order to further evaluate the Marcellus. In southwestern Pennsylvania (including Westmoreland, Fayette, Washington and Greene counties), the Purcell Limestone varies in thickness. Analyzing wells that have been drilled in the Marcellus Shale Formation will allow to pick formation tops and consequently make isopach maps for these thin limestone layers and Marcellus Shale. The log data used in this research include gamma ray, bulk density, neutron, PE and resistivity. The thin limestone interlayers may be further analyzed in different wells to determine the effects on hydraulic fracturing and production for this area. A 3-D structural model will be constructed based on the formation top data and the built maps of structure and isopach of the thin limestone layers and Marcellus shale.
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Introduction
Marcellus Shale consists of organic-rich mudrocks with several thin limestone interlayers. The thickest interlayer is named Purcell Limestone, which separates the Marcellus Shale into the Upper Marcellus Shale (Oatka Creek Member) and Lower Marcellus Shale (Union Spring Member). The thickness of these limestone interlayers varies by location within the Appalachian Basin. Limestone interlayers can have an influence on hydraulic fracturing and production in the Marcellus Shale. Identifying the thin limestone interlayers within the Marcellus Shale is important to correctly estimate the thickness of the organic-rich zone within Marcellus Shale. The effects on hydraulic fracturing and production can be investigated by analyzing whether the mechanical properties change within the Marcellus Shale. Hydraulic fractures through the Purcell Limestone is an important area of study in which the thickness of the limestone layer can play a part in some effects. Understanding the varying thickness of the Purcell Limestone will be useful in order to evaluate the Marcellus further.

In southwestern Pennsylvania (including Westmoreland, Fayette, Washington and Greene Counties), the Purcell limestone varies in thickness. Analyzing wells that have been drilled in the Marcellus Shale Formation will allow to pick formation tops and consequently make isopach maps for these thin limestone layers and Marcellus Shale. The log data used in this research include gamma ray, bulk density, neutron, PE and resistivity. The thin limestone interlayers may be analyzed further in different wells to figure out the effects on hydraulic fracturing and production for this area. A 3-D structural model will be constructed based on the formation top data and the built maps of structure and isopach of the thin limestone layers and Marcellus shale.

Study Area and Dataset
229 Wells with log data were shown above
Wells located in the Allegheny, Fayette, Greene, Washington and Westmoreland Counties in Pennsylvania were used in this research.

Methodology
This research was done using the Petrel E&P Software. Petrophysical analysis was used in order to pick formation tops and determine the lithology. First, the log data was collected and digitized if needed. Next, well correlation was completed to pick the formation tops in all wells. Based on the formation tops of the Marcellus Top, Purcell Top and Onondaga Top, we built a structure model with grid size 500 by 500 feet and 75 vertical layers. Finally, Sequential Indicator Simulation algorithm was used to build lithology model of Marcellus Shale formation (limestone and shale).

Result: Mapping of Number of Limestone Interlayers
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Conclusion
In this research, 229 wells with log data located in five counties in Southwestern Pennsylvania were analyzed. Mapping of formation data was completed. Based on the 2-D and 3D models created, limestone interlayers in the Marcellus Shale can be examined and compared to previous models created. Limestone interlayers vary in thickness and can affect the mechanical properties of the Marcellus Shale.

Acknowledgement
Thank you to EDWIN database for providing the log data. Thank you to the Petroleum and Natural Gas Engineering Program at Saint Francis University for offering the software and funding this trip.
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