Depositional and Structural History of the Sedgwick Basin, South Central Kansas in Relation to Petroleum Entrapment

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Abstract. The Sedgwick Basin is an important hydrocarbon-producing area in Kansas. Subsurface structural and isopach (thickness) maps and cross-sections illustrate the depositional and tectonic history of the area. It has undergone several episodes of compression followed by tensional deformation during the Paleozoic, which formed anticlinal and fault-bounded structures that were conducive to hydrocarbon accumulation. Also, there were several episodes of sea-level fall and attending subaerial exposure that produced unconformities and reservoir porosity. Approximately 110 million barrels of oil and 118 MCF of natural gas have been produced over the last 92 years in the area. The structural and stratigraphic mechanisms important in hydrocarbon entrapment and future potential in this area are assessed.

Introduction

The Sedgwick Basin was an embayment of the epicontinental Permian sea. It was bound by the southern Nemaha uplift to the east and the southern Central Kansas Uplift to the west (Fig. 1). This is an important area of petroleum production and was intensely drilled in the early 20th century into the late 1950s.

The purpose of this study is to conduct a detailed investigation of subsurface geology in the eastern Sedgwick Basin in order to: (1) describe the geology of the area; (2) identify reservoir ages and types; (3) model the depositional and structural history of the area; (4) relate the geologic history of the area to petroleum entrapment.

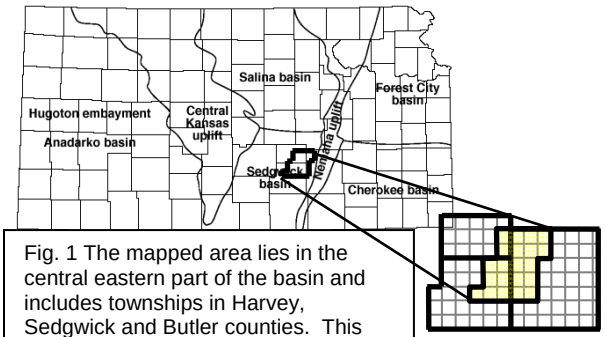

Fig. 1 The mapped area lies in the central eastern part of the basin and includes townships in Harvey, Sedgwick and Butler counties. This area contains 102 fields which produce mainly from Pennsylvanian, Mississippian, and Ordovician rocks

Methodology

Subsurface mapping is the main focus of this project. Many wells did not penetrate deeper than the Mississippian, which results in less control on maps of older formations. Collecting information from scout cards and well logs is essential to begin the mapping process. Careful correlation of available logs provided a basis for the maps that were generated. Hydrocarbon entrapment can be effected by the structure and thickness of a unit. After correlation, structural and thickness maps were created on these horizons to evaluate specific attributes of the area that would result in entrapment of hydrocarbons.

Regional as well as local cross sections were produced to understand the depositional history. They aided in the recognition of the structural and stratigraphic controls of petroleum accumulation in the area. A core sample of the #31 Lathrop well in the northeast part of the study area was examined to further study the lithology of the formations found in the Sedgwick Basin.

Results

The area mapped dips regionally to the southwest and is interrupted by minor uplifts. There are two large structures in the area; the Elbing anticline and the Valley Center anticline (Fig. 3) [1]. Hydrocarbons appear to have accumulated on the crest of these structures in multiple horizons. Each horizon has unique characteristics that enable them to hold hydrocarbons.

The main reservoirs are the Burgess sandstone, rocks underlying the Mississippian unconformity including the Warsaw Limestone and rocks of the Osagian stage, Hunton limestone/dolomite, and Viola dolomite.

Pennsylvanian

The Burgess sand overlies the Mississippian unconformity and is generally thought to be remnants of erosion [2]. The thickest parts of the sand body were deposited in Mississippian lows. The Burgess is a

conglomeratic sand consisting of poorly sorted quartz grains and chert fragments [2].

Mississippian

Limestone and chert of Mississippian age lie below an erosional unconformity representing a drop in relative sea level. Hydrocarbons appear to have accumulated in buried hills as well as along the flanks of the Elbing anticline where Mississippian rocks pinch out over the crest of the structure

Silurian

The Hunton Group of Silurian age consists of either limestone or dolomite in the study area. This unit mainly produces in areas where the Mississippian is eroded, as it is the next reservoir quality rock underlying the Mississippian.

Ordovician

The main Ordovician reservoir rock in the area is the Viola. The Viola is typically a dolomite in the study area, and also produces from structural highs particularly where the Mississippian sees significant erosion.

Discussion

The tectonic compression occurred during Mississippian time, when the large scale anticlines were formed (Fig. 2). Following compression, a relaxation occurred which caused normal faulting on the flanks of these large anticlines. As the Mississippian was uplifted, the crest of the Elbing anticline was subaerially exposed, subjecting the Mississippian to complete erosion. The Mississippian also was eroded on the crest of the Valley Center anticline as well.

The source rock for the area is the Woodford shale in Oklahoma [3]. Hydrocarbons migrated up dip into the Sedgwick Basin and have mostly been trapped in structural anticlines throughout the study area. Stratigraphic trapping has occurred in the Burgess sandstone.

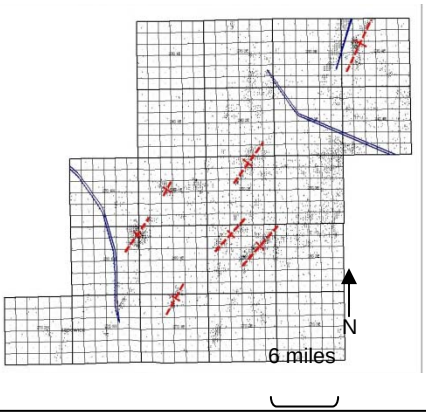

Fig. 2 Map of structural trends in the study area. Northeast trending dashed lines indicate anticlinal structures. Fault zones are indicated by solid lines.

This is an area that was extensively drilled in the early 1900s at the height of petroleum exploration in Kansas. According to the Kansas Geological Survey, about 5,000 wells have been drilled in the study area, over half of those being productive.

Since this area has not been reviewed in recent years, the application of new technologies can be advantageous for reviewing old fields and traps. With the use of Geographix software, cross sections and maps can be produced. Providing a modern view on an old area will be beneficial for understanding the history of the Sedgwick basin. This study is being done to place the entrapment of hydrocarbons in context with the structural and depositional history of the basin. There has yet to be a full study on the Sedgwick Basin, this study intends to initiate further basin analysis.

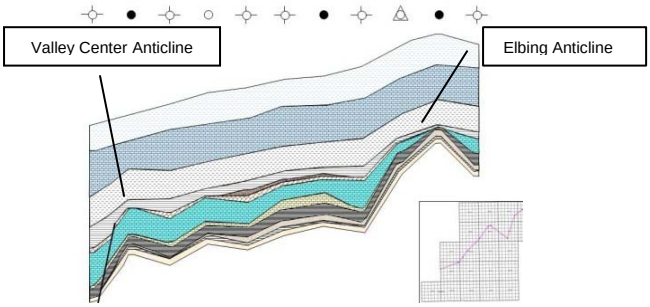

Figure 3. Cross sectional view of present day structure across the study area from the southwest to the northeast. The Valley Center and Elbing anticlines can be seen, as well as normal faulting to the west of the Valley Center anticline.

Conclusions

The structural maps, isopach maps, cross sections, and core examination have: 1) provided several regionally extensive subsurface maps within the basin that describe the regional geology and also identify reservoir ages and types; (2) identified the structural and stratigraphic mechanisms for petroleum entrapment; and (3) demonstrated how tectonic activity has influenced the trapping of petroleum. This study provides a better understanding of the basin geology and its productive nature.

Acknowledgements

I would like to thank Murfin Drilling Company, Inc. for their assistance on this project through providing software, scout cards, and their support.

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