Int. J. Chem. Sci.: 12(4), 2014, 1305-1310
ISSN 0972-768X
www.sadgurupublications.com

EVALUATION OF THE PETROLEUM POTENTIAL OF THE JURASSIC AND JURASSIC SEDIMENTS TURGAY BASIN

SMABAYEVA RAIGUL KULBEKOVNA*

Institute of Geology and Oil Gas Business after K. Turysova, Kazakh National Technical University after Name of K. I. Satpayev, ALMATY, REPUBLIC OF KAZAKHSTAN

ABSTRACT

The Turgay sineclise in central Kazakhstan covers about 140,000 sq Km, out of which about 60,000 sq Km of is favorable for oil and gas. The area`s first oil and gas field, Kumkol, was discovered in 1984. The other fields include Maybulak, Aryskum, Kyzylkiya, Nuraly, Aksay, Konus, Bektas and Akshabulak. All of the discoveries are in the Aryskum downwarp.

Key words: Turgay, Jurassic, Sediments, Petroleum, Central Kazakhstan.

INTRODUCTION

The Turgay, also spelled Turgai, or Turgaj, region and former *oblysy* (administrative region) is in central Kazakhstan. The administrative unit was created in 1970, though a larger unit of the same name existed in tsarist times, and it embraced the western fringes of the Kazakh Upland and part of the Turgay Steppe. The main rivers are the Ishim, flowing north, and the Turgay, south. The climate is continental, and annual precipitation varies from 8 to 12 inches (200 to 300 mm). There are important bauxite mines at Arkalyk, and large fire-clay deposits in the same area are exploited. Crops, chiefly grain, are grown in the north, while the arid, sparsely inhabited south is given over mainly to sheep. The Tobol-Tselinograd railway traverses the region, with a branch line from Yesil to Arkalyk. Other cities include Oktyabrsky, Zhaksy, Derzhavinsky, and Amangeldy. The Turgay *oblysy* was divided between Atmola and Kostanay *oblysy* in an administrative reorganization in 1997[1].

EXPERIMENTAL

General view of the Turgay region

Western interests in the area are growing. RWE-DEA AG and Erdol-Erdgas Gommern

*Author for correspondence; E-mail: smabaevar@yahoo.com

GmbH, a joint venture of Gaz de France and Bayernwerk AG, secured a $106.7 million loan in late 1997 to develop Akshabulak oil field. They foresee a $320 million stage development. Production was to start in mid-1998 and continue 20 years from reserves estimated at 110 million bbl. Crude was to be shipped 800 km to the Kazak refinery in Chimkent. That oil would be swapped for a similar volume produced in western Kazakhstan and shipped through Russia, Belarus, and Poland for refining in Germany. A Calgary company, Hurricane Hydrocarbons Ltd., acquired Kazakhstan`s Yuzhneftegaz in the closing days of 1996 for $120 million. That organization produced about 50,000 b/d of oil from Kumkol field and had 317 million bbl of proved and probable reserves. Hurricane has a further 23 million bbl of reserves in the country through its interest in the Turan petroleum project, a joint venture that holds rights to Kizyl-Kiya, Aryskum, and Maybulak fields and the South Kumkol exploration area.

Korchagin, Karpov, and Puzanova described Turgay`s oil and gas potential in an article in geology of oil and gas No. 5 in 1996, reprinted in Petroleum Geology. They wrote that three oil and gas bearing complexes are recognized at Turgay: Middle Jurassic, Upper Jurassic, and Lower Neocomian. The Middle Jurassic complex consists of inter bedded sandstone, siltstone, and clays with thickness up to 90 m. Upper Jurassic is composed of sandstone, siltstone, and clays less than 100 m thick. The Lower Neocomian clastic complex is represented by alternating members of sandstone, siltstone, and clay. It is host to two productive horizons. Thickness of this complex does not exceed 30 m. About three fourths of Turgay petroleum resources are in the Jurassic complexes, and about one fourth is in the lower Neocomian. Depth to pay is generally no more than 8,200-9,800 ft.

In the north of the Turgay downwarp oil shows have been recorded in Upper Devonian-Carboniferous carbonates. Noncommercial flows or films of oil were found in Carboniferous sediments during drilling of 13 wells in the Shcherbakov, Lesnoy, Ospanov, and Silant'yev areas. Novonezhin well 119 yielded 1.5 tons of oil from Visean limestone. Early explorers quickly evaluated the anticlines, so the main thrust of exploration is now for stratigraphic and fault traps in the border zone of the graben-synclines and in structural saddles.

Structure, evolution, and oil & gas potential of the South Turgay Basin, Kazakhstan

The South Turgay Basin is part of the larger Turgay depression located in Central Kazakhstan. The basin originated as a continental rift during the Jurassic. The stratigraphic section of the Basin is divided into –

(i) The Proterozoic metamorphics,

(ii) Pre-rift Devonian to Carboniferous volcanic and sedimentary rocks,

(iii) Terrigenous Jurassic sediments, mainly lacustrine but partly alluvial, associated with the rifting and

(iv) Post-rift continental and marine Cretaceous to Cenozoic deposits. Structurally, the Basin is divided into three tectonic elements: the Zhylanshik Trough (300 x 200 Km) to the north, the Aryskum Trough (300 x 175 Km) to the south, and the Mynbulak arch, which separates the two. Displacement along normal boundary faults is as much as 4 Km[2].

All hydrocarbon accumulations found to date are in the Aryskum Trough, mainly within the Jurassic and Neocomian section, where high quality source rocks, reservoirs and traps are in dose proximity (10 to 25 Km). TOC reaches 15% in the combustible Jurassic shales. The thermal history of the Jurassic rocks is optimal for hydrocarbon generation. Reservoir porosity reaches 30% with maximum permeabilities of up to 2.5 darcies. The largest traps are drape folds over horsts. Hydrocarbons also occur in the pre- and post-rift formations and weathered basement. The basin contains 51 thousand cubic kilometers of sediments, which are calculated to have generated 2737 million tons of oil (820 million tons recoverable). Drilling has confirmed 200 million recoverable tons, the main fields being Kymkol, Aryskum, Konis, Kyzilka and Akshabulak[2].

Formation and hydrocarbon distribution of Turgay Basin

A structural framework of juxtaposed horsts and grabens was formed under the control of the strike-slip Karatau fault in the Early-Middle Jurassic, and the present status was formed under the control of inversion movements of the strike-slip fault in the late Jurassic and late Cretaceous. After experiencing intense compression during the inversion period, large area and high amplitude anticline traps were formed in the horst area, and faulted noses and faulted anticlines were formed on both sides of the strike-slip fault[3]. These traps provided effective reservoir spaces for petroleum accumulation, and host the oil and gas discovered so far in the South Turgay Basin. Two compressive events occurring in the late Jurassic and late Cretaceous formed a series of faulted anticlines and faulted nose structures along the strike-slip fault zone, which provided effective reservoir space for hydrocarbon accumulation (Fig. 1).

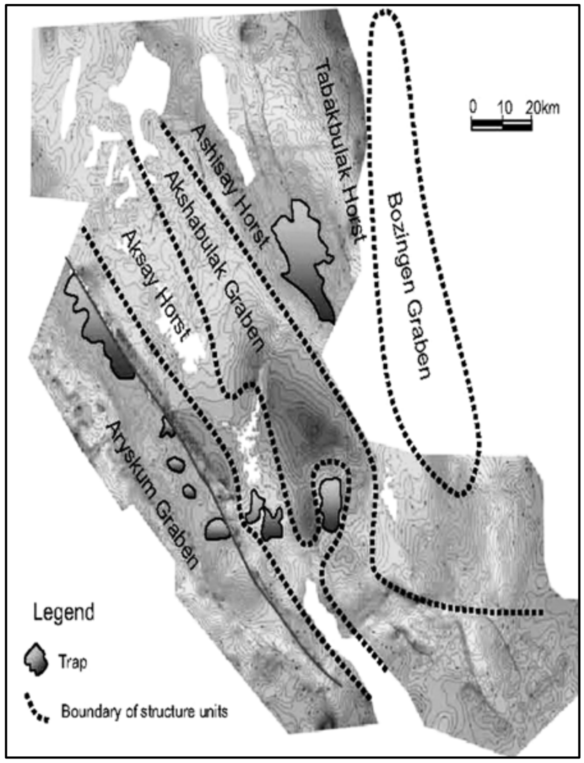

Fig. 1: Structure map of the South Turgay Basin[3]

The lower Jurassic source rocks of the South Turgay basin started generating much hydrocarbon in the late Jurassic, and the first hydrocarbon accumulation occurred in the tectonic inversion period also in the late Jurassic[3]. The middle Jurassic source rocks started generating hydrocarbon in the late Cretaceous, and the second hydrocarbon accumulation occurred in the tectonic inversion period in the late Cretaceous, during which the previously formed reservoirs were adjusted and transformed. The dominant migration directions of oil and gas were:

(i) Lateral migration in the horst area and graben slopes; thus, forming anticline pools in horsts and lithologic-stratigraphic reservoirs in graben slopes.

(ii) Lateral-vertical migration on both sides of the strike-slip fault belt, forming fault nose (faulted block) reservoirs. Therefore, the two stages of tectonic inversion in late Jurassic and late Cretaceous facilitated secondary hydrocarbon migration and adjustment. Then the reservoir shapes were finally set and the hydrocarbon distribution was stabilized (Fig. 2)[3].

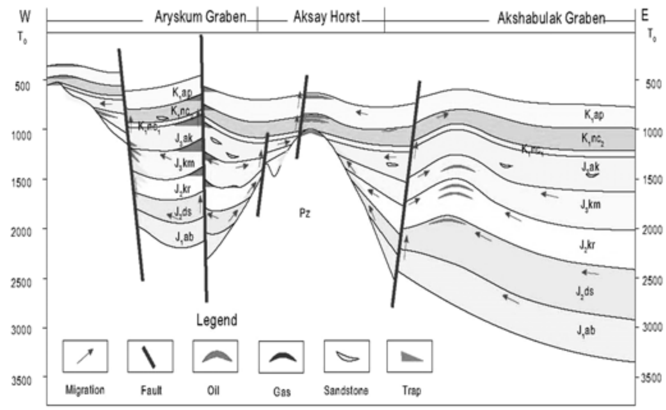

Fig. 2: Diagram of petroleum migration in the South Turgay Basin[3]

Horsts are better hosts for petroleum accumulation than grabens. Horsts were formed early in the strike-slip pull-apart period of the early-middle Jurassic, and reservoir properties were improved through long weathering and erosion. Moreover, anticlines on horsts are suitable for the long-term petroleum accumulation. Therefore, the explanation of why horsts are better for petroleum accumulation than grabens is the strike-slip pull-apart of the South Turgay basin.

Four grabens of the South Turgay basin have great differences in the degree of accumulation of petroleum, and the West graben is better than the East one. This is caused by the difference in the degree of structure inversion in the South Turgay basin. With the highest inversion degree, the Aryskum Graben accumulated the maximum petroleum. From West to East, the inversion degree reduced, and thus, the petroleum accumulation reduced[3]. Therefore, the explanation of why the west graben is better than the east one is the structure inversion of the South Turgay basin (Fig. 2).

CONCLUSION

A geologic structure characterized by the juxtaposition of horsts and grabens was formed under the action of the strike-slip pull-apart Karatau fault. The formation of the horsts provided favorable reservoir spaces for later hydrocarbon accumulation, while different filling stages controlled different reservoir-forming factors in grabens. The hydrocarbon generation and expulsion amount and the migration direction were changed by tectonic inversion, which also created the final form of the hydrocarbon-bearing traps. Three types of hydrocarbon-bearing structure formed in the South Turgay basin. Anticline traps formed in the horst area, lithologic-stratigraphic traps in the graben slope area, and fault nose or fault block traps on both sides of the strike slip fault zone. The strike-slip pull-apart of the South Turgay basin explains why horsts are better for petroleum accumulation than grabens, and the structure inversion of the South Turgay basin explains why the west graben is better than the east one.

REFERENCES

1. http://www.britannica.com/EBchecked/topic/689204/Turgay.
2. http://www.searchanddiscovery.com/abstracts/html/1997/annual/abstracts/0090b.htm.
3. W. Yin, Z. Fan, J. Zheng et al., Characteristics of Strike-slip Inversion Structures of the Karatau Fault and their Petroleum Geological Significances in the South Turgay Basin, Kazakhstan, Pet. Sci., **9**, 444-454 (2012).

Revised : 28.08.2014 *Accepted : 31.08.2014*