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Petroleum system analysis of Walrus area in the Deepwater US Gulf of Mexico

***Y. Tkachenko, V. Shabanov, A. Drozdova, V. Yemets, O. Prokopenko, I. Virshylo** (*Taras Shevchenko National University of Kyiv, Institute of Geology*)

SUMMARY

In this paper results and conclusions of petroleum system analysis for the Walrus Project in the Deepwater US Gulf of Mexico are presented. One main petroleum play (Miocene Turbidites) was defined and described. The generation potential of Albian source rocks was proved. A high hydrocarbon perspective of the studied part of the basin was proved.

Introduction.

This paper represents the petroleum system analysis of the Walrus Project area in the Deepwater Gulf of Mexico. Study is based on the Imperial Barrel Award competition and was provided using well (well logs and well tops) and seismic (3D cube (depth, velocity)) data of Walrus Project in the Deepwater Gulf of Mexico received within competition.

Source rock within studied area are of Mesozoic age and the problem of petroleum system analysis is related to unexplored deposits beneath Cenozoic. According to this, there are no accurate information about presence and location of them.

Methods of analysis.

In current study, for the petroleum system analysis of Walrus area we used: 1) paleogeographic maps for understanding the geological settings and depositional environment of sequences 2) well log interpretation to indicate the presence of play elements (seals, reservoirs and etc.); 3) seismic interpretation to understand the geological structure; 4) definition of the exploration play areas.

Geological and depositional settings.

Walrus sits in area characterized by unconfined Upper and Middle Miocene turbidites disrupted locally by salt tectonism. The Miocene deposition can be characterized as varying between amalgamated channel deposits to less laterally extensive channel/levee complexes.

The geological information was researched using a variety of sources in order to enable an accurate interpretation of the data through increased knowledge of the region. Walrus Project is located on the margin of the continental slope and shelf of the US Gulf of Mexico at a depth of 2900-4000 feet (Figure 1).



Figure 1 Schematic map of the principal physiographic elements of the Gulf of Mexico basin and adjacent North America. White outline shows approximate geological limits of the Gulf basin. Yellow square – approximate Walrus Project area location (William E. Galloway, 2008)

The lithostratigraphic chart of the studied area represents sediments of the Middle Jurassic – Quaternary age and mainly consists of terrigenous rocks (Figure 2).

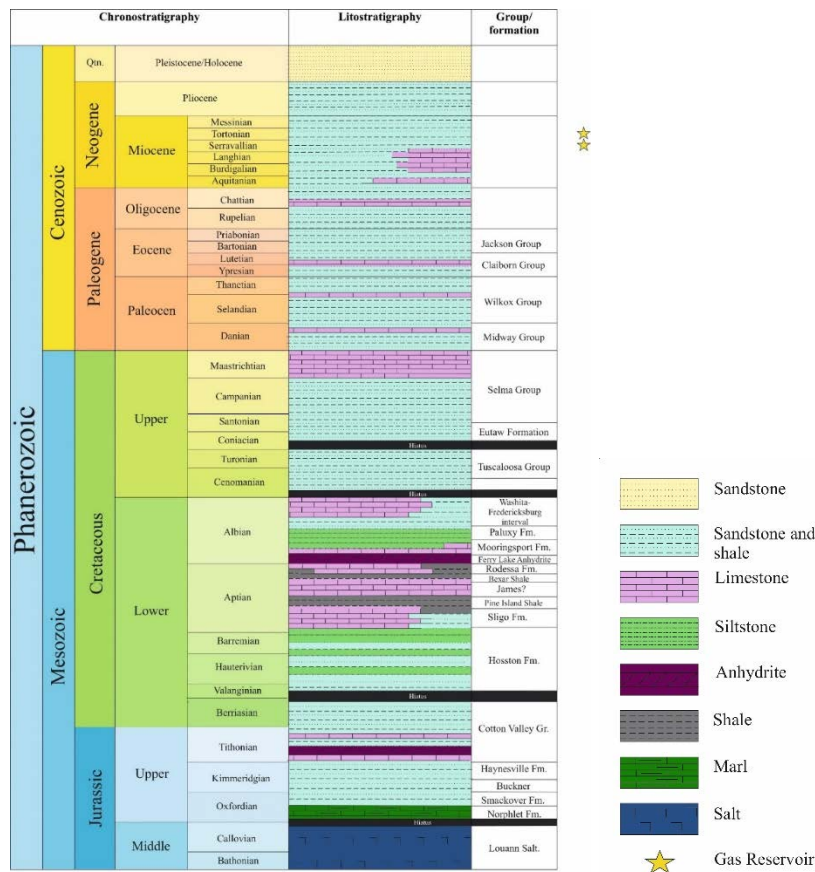


Figure 2 Lithostratigraphic chart of the Walrus Project area.

Development of the Gulf of Mexico could be divided into 6 stages (Worrell, Matthew R., 2017):

- 1) Late Triassic-Early Jurassic – the breakup of Pangaea created a divergent margin basin characterized by extensional rift tectonics and wrench faulting;
- 2) Middle Jurassic - continued rift tectonics led to the development of multiple basins within the larger GOM basin and widespread deposition of the Louann Salt;
- 3) Late Jurassic basinal subsidence (thermal and isostatic) was accompanied by a regional marine transgression (Mancini and Puckett, 2002) that resulted in the deposition of the Norphlet eolian dune facies, Smackover carbonate and marine sequences, and Cotton Valley sand and carbonate sequences;
- 4) Middle Cretaceous (Valanginian) - extensive erosional period. This was followed in the Upper Cretaceous by several transgressive-regressive sequences;
- 5) Paleocene-Miocene –major influx of Cenozoic clastic sediments followed by transgressions and regressions;
- 6) Pleistocene – high-amplitude sea level fluctuations. This lead to significant shelf edge progradation and extensive submarine canyon incision (Galloway et al., 2000).

Modelling.

The burial history modelling of the studied area was provided using PetroMod® software. All petrophysical or geochemical properties, which must be assigned to the layers (space between maps) according to their lithology (thickness between horizons, which determine discrete time steps) can be

taken from PetroMod® internal data bases, which also provide kinetic data and fluid properties for play elements.

In this area of study we defined, using a variety of sources, four major source rocks of the following age: Turonian, Albian, Tithonian, Oxfordian.

Boundary conditions for basin development, such as Heat Flow and SWI-Temperature also were taken from internal databases. Paleo Water Depth values were taken from paleogeographic data (Figure 3).

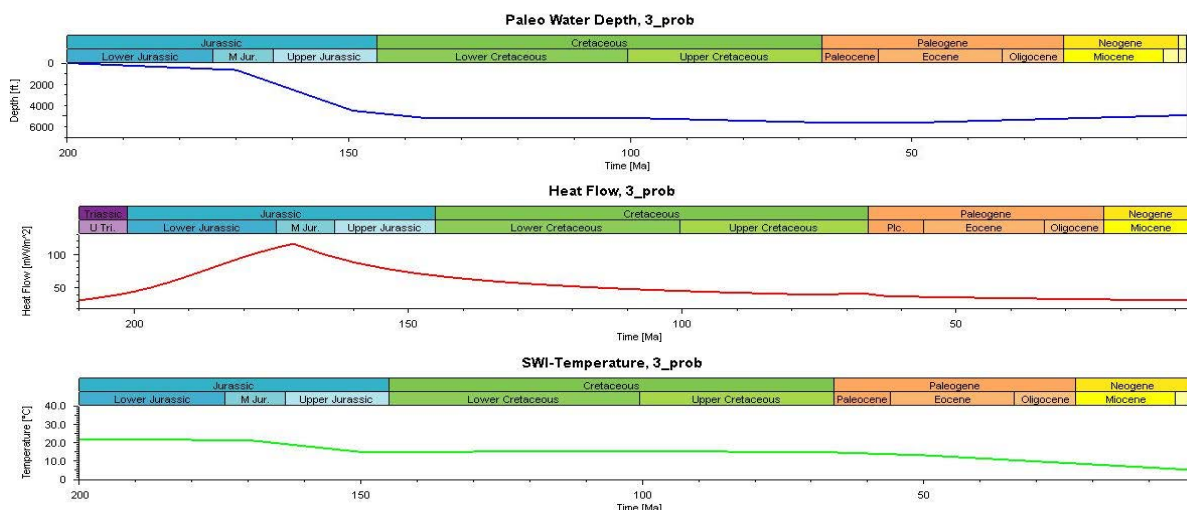


Figure 3 Boundary conditions taken for burial history modelling of Walrus area.

After calibration the simulation results can be used to present the transformation ratio (Figure 4), which shows that, nowadays, in this area, source rocks of Albian age are sufficiently mature to generate hydrocarbons. The burial history diagram represents that Albian source rocks are in gas generation zone (Figure 5).

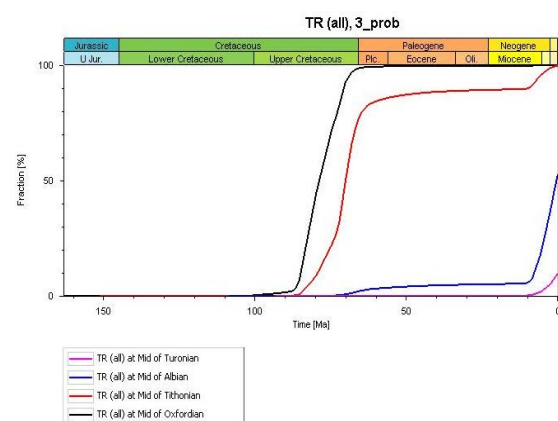


Figure 4 Shows the transformation ratio of the source rocks. Oxfordian – immature, Tithonian and Turonian – over-mature, Albian – mature.

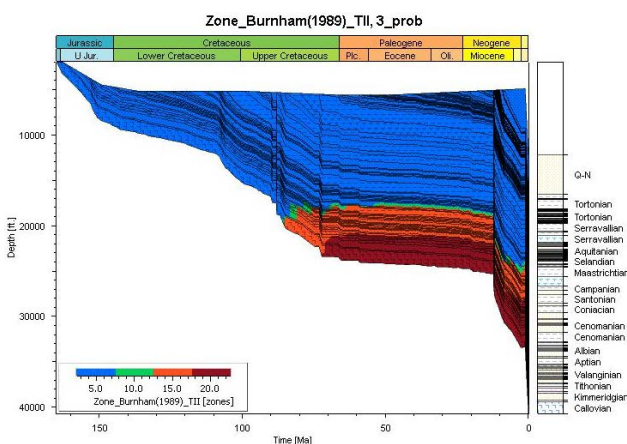


Figure 5 Shows the burial history diagram with hydrocarbon generation zones. Albian source rocks are in gas generation zone.

Burial history plots shows that the beginning of hydrocarbon generation was approximately 80 million years ago, which is confirmed by diagram of temperature (Figure 6).

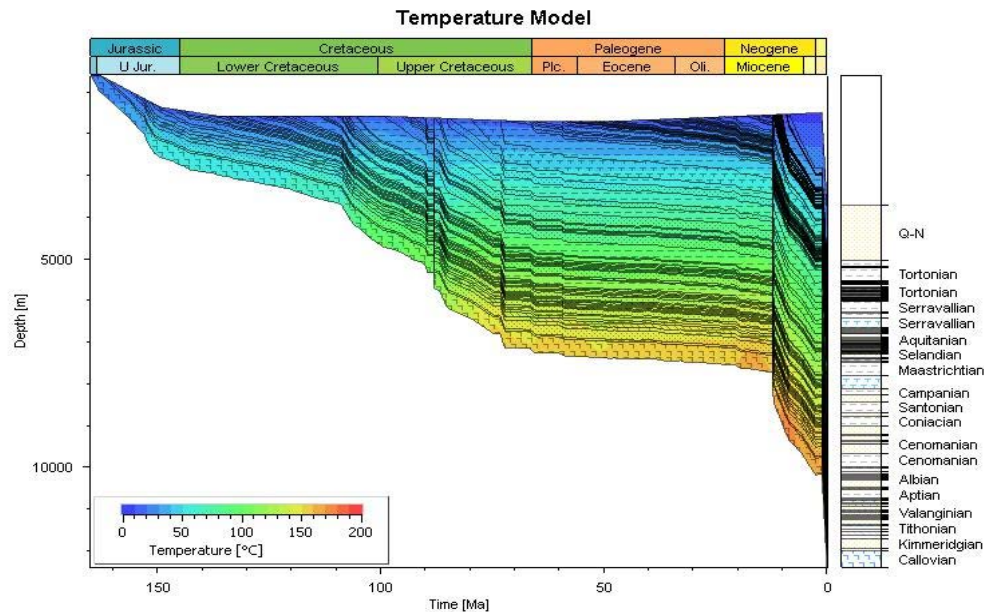


Figure 6 Temperature model of the basin. Represents the temperature increase started 80 mln years ago.

According to the well log data all discoveries are of Serravallian age and produce gas which correlates with our results.

Seismic data has lots of hydrocarbon shows above the levee complexes and migration pathways along faults and salt diapirs.

Recommendations and conclusions.

Walrus Project is a high perspective area for hydrocarbon exploration. The most promising – Miocene Turbidites, which are the area of exploration interest in US Gulf of Mexico. According to the previous studies, there are four main source rocks within our area of study. The petroleum system analysis provided in this paper was shown that only Albian source rocks are potential to generate gas. The remaining three do not match generation parameters. To accurate the results and predictions the deeper exploration of Mesozoic sediments is needed. Seismic data represented hydrocarbon perspectives in Serravallian levee complexes and migration pathways from Mesozoic sediments along salt diapirs and faults.

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