geoconvention
Calgary • Canada • May 13-17 2019

# Collisional Tectonics and Its Effects on Hydrocarbon Entrapment and Progression: A Model from Potwar Plateau, NW Corner of Indian Plate

*Rana Faisal Shahzad, Muhammad Akram, Uzair Hamid Awan, Shakeel Ahmad, Shabeer Ahmed Abbasi, Sajid Sharif, Muhammad Shahid, Imran Khan*

*Oil and Gas Development Company Limited, Islamabad. Pakistan.*

## Summary/Abstract

Regions characterized by collisional/compressional tectonics are important in the context of entrapment and progression of hydrocarbons. Faults formed in a collisional tectonic settings are contributing in the migration and entrapment of hydrocarbons (Allan, 1997; Halbouty, 2001; Klett and Schmoker; 2001). Mann et al., (2003) identified five classes of tectonic settings after studying 877 hydrocarbon fields as continental passive margins (304 fields), continental rifts (271 fields), collisional margins produced due to collision between two continents (244 fields), strike slip margins (50 fields), and subduction margin (8 giant fields).

Potwar Plateau, part of foreland fold-and-thrust belt of northern Pakistan is positioned south of the Himalayan arc and NW corner of Indian plate, is characterized by ongoing northward convergence of Indian Plate with Eurasian. It is the second important hydrocarbon producing region of Pakistan. Seismic and well data have been incorporated for the study of entrapment mechanism provided by collisional tectonics in the study area. Salt Range thrust of around 5 Ma is the main frontal thrust, along which the Potwar Plateau has been voyaged southward away from the main collisional zone. Deformation within Salt Range thrust and Khairi Murat thrust is dated between 5 to 1.2 Ma revealing younger out-of-sequence deformation (Jadoon et. al., 2008).

Kinematics of Indian plate have been studied with the help of GPlate software and nine major tectonic evolutionary stages of the Indian Plate during its 9000 Km voyage from Gondwanaland to Asia are summarized.

The Pre-Cambrian basement disturbed by normal faults having small throw and shows an upward rising trend in the south towards the Sargodha High.

Evaporite of Salt Range Formation of Infra-Cambrian are mainly providing regional detachment level for northeast-southwest trending Thrust faults along which various anticlines have been developed as a result of collisional tectonics suggesting thin-skinned deformation. These faults also might have acted as conduits for updip migration of hydrocarbons into the neighboring reservoirs.

Timing and maturity of the petroleum system is based on theories on basal heat flow.

## Theory / Method / Workflow

The generalized methodology use for this study is given as: Generation of synthetic seismogram, identification and marking of prospective horizons and faults on seismic data of the area, modelling of major entrapment structures to study the effects of collisional tectonics in the progression of traps of area with the help of GPlates. This fascinating tectonic of Indian Plate has greatly facilitated the petroleum system of the study area (NW Corner of Indian Plate/Potwar Plateau, Pakistan). Thrusted faults were generated while NW corner of Indian Plate collided with Eurasian Plate around Miocene. The structural style of fields has been associated with thrusted anticlinal structure, fault related folds, pop-ups, and triangle zones. Thrust faults have provided trapping mechanism to the major reservoir rocks of Eocene carbonates and on the odd occasions to Permian and Cambrian sands vas well.
Maturity modeling suggesting that generation of hydrocarbon may started in Late Cretaceous time for Cambrian to Early Cretaceous source rocks and from Mid Pliocene to recent for Paleocene and younger source rocks. Hydrocarbons were initially migrated updip to immediate reservoirs and secondary migration was also facilitated vertically into neighboring structures progressively having multiple reservoirs through number of thrusts, back-thrust faults and fractures. The various thrust bounded structures looks like to getting younger in the south progressively at close to from 5 to 1 Ma.

## Results, Observations, Conclusions

Keeping in view extensive literature review on tectonic history of Indian Plate and its effects on hydrocarbon entrapment and progression on NW corner of Indian Plate, kinematic parameters by Gplates, **1D source rock maturity modeling** and seismic data interpretation, following conclusions can be drawn:

- The area is characterized by collisional episodes of Indian plate had greatly facilitated the trapping mechanism to the hydrocarbons on NW corner of Indian Plate.
- **Oil window prevailed from Early Miocene to Recent.**
- The age of structuration (trap formation) is younger than Miocene.

## Novel/Additive Information

This fascinating tectonic of Indian Plate has greatly facilitated the petroleum system of the study area (NW Corner of Indian Plate/Potwar Plateau, Pakistan). Thrusted faults were generated while NW corner of Indian Plate collided with Eurasian Plate. The structural style has been interpreted as pop up anticlinal anticlines. Thrust faults has provided trapping mechanism to the major reservoir rocks of Eocene Carbonate.

Due to collisional tectonics between Indian and Eurasian Plate. The study area which is located on the NW corner of Indian plate exhibiting second one important region of Pakistan producing hydrocarbons as shown by the results in the above figures.

## Acknowledgements

We are very grateful to Oil and Gas Development Company Limited (ODDCL) for providing data and are also grateful to Mr. Nazir Ahmad (Senior Geologist) of OGDCL, for his helps in defining burial history towards full length manuscript of the study.