

Orientation of Hydrocarbon Pools in Supergiant Fields for Prognostication and Planning of Exploration Strategy

Kiran S. Misra, Mohit Agarwal and Mrinal Anand

College of Engineering Studies, University of Petroleum and Energy Studies, Dehradun-248007, Uttarakhand, India

Presenting Author Email Id: drksmisra@gmail.com

Abstract

We demonstrate an intricate relationship between hydrocarbon pools and tectonic elements along with certain geomorphological anomalies. High resolution satellite imagery are interpreted to map lineaments, lithological trends and geomorphological features. Case studies from the Iran-Iraq fields in Middle East, Coastal California, Bombay Offshore and Krishna-Godavari (K-G) basins are presented. It has emerged that the elongation of the hydrocarbon pools are remarkably coinciding with the prominent tectonic trends. In Middle East and California certain pools are parallel to the lithological trends while others follow the lineament trends. Some very conspicuous geomorphological anomalies, such as sand bars and paleo-channel complexes also host huge amount of hydrocarbons. In Barmer-Cambay basins, the oil fields are parallel to the graben boundaries in the northern part and preferential accumulation of hydrocarbons is by both stratigraphic and tectonic controls. In the southern part of the Cambay basin the orientation of oil pools is parallel to E-W trending Narmada-Tapti Tectonic Zone. The multitier oil pools of Bombay offshore have preferred orientation along tectonics, which has controlled development of N-S rift during Paleocene-Eocene, submerged sand bars during Oligocene and marine transgression during Miocene. Interestingly in K-G basin the Cretaceous and older pools are found to be parallel to coastal geomorphological features such as paleo-beach ridges, while Tertiary pools are largely confined within the extension of Pranhita-Godavari graben and are related to anastomosing paleo-channel complexes.

Introduction

It was generally believed earlier, that the preferential accumulation of hydrocarbons is related to either structural or stratigraphic control. Many a times it is not possible to categorize them into either of the two distinct groups. Regional orientation and elongation of hydrocarbon pools has emerged as an important consideration for planning the exploration strategy. Misra et al 1992 demonstrated in Western sedimentary Province of Canada, that Mississippian and younger pools, oriented in NNW-SSE direction, are associated with the anticlines and thrusts, developed during Rocky mountain orogeny. On the other hand, older oil pools are related to the Devonian reef complexes; evolved along gradually subsiding basement blocks. Misra and Misra 2010 illustrated unique distribution in K-G basin. Here Cretaceous pools are curvilinear and coincide with the coastal beach ridges, while offshore Tertiary pools are oriented in NW-SE direction corresponding with the Pranhita-Godavari graben.

Orientation of Hydrocarbon Pools

The findings of four areas are reported here - the Persian Gulf, California coast, Krishna-Godavari and Bombay offshore region. In Persian Gulf region the younger Tertiary pools are trending in NW-SE direction which corresponds with the Zagros mountain ranges. The older oil pools such as Ghawar and

Burgan have NNE-SSW trend which matches with the trend of rift and grabens. The structural trends and lineaments interpreted from the satellite imagery and hydrocarbon pools are depicted in Fig. 1.

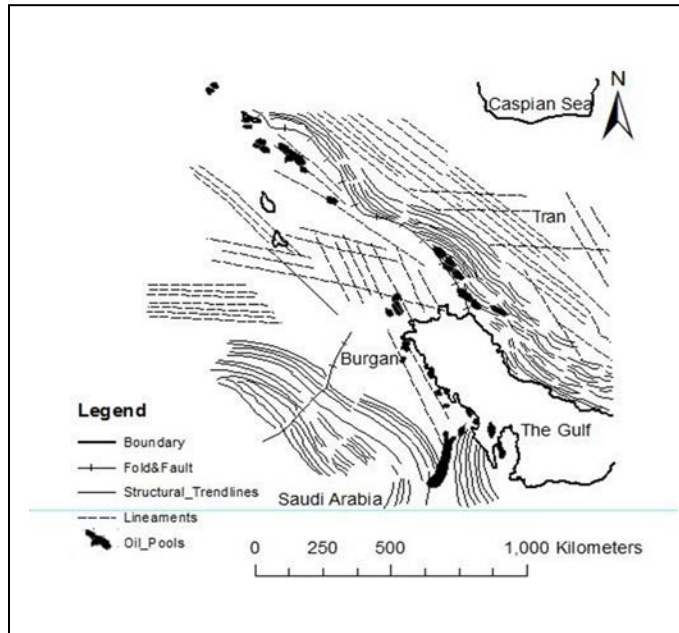


Fig.1. Map showing structural trends and disposition of hydrocarbon pools in Persian Gulf region. The elongation of hydrocarbon pools can be seen along the structural trends

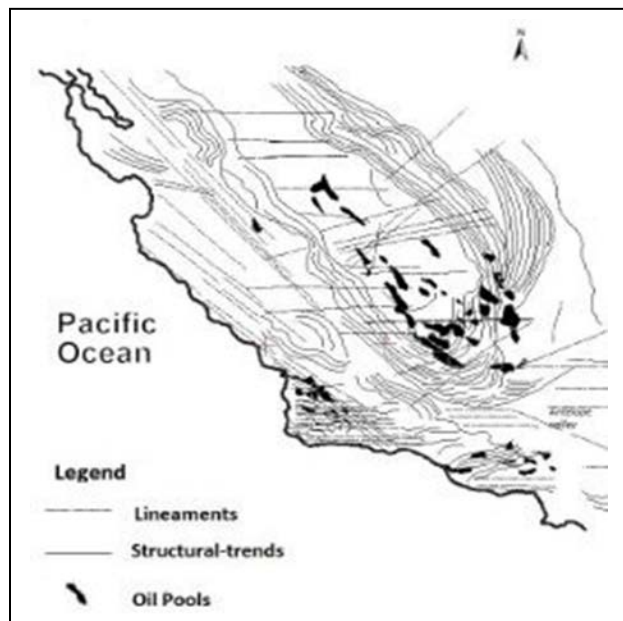


Fig.2. Disposition of hydrocarbon pools of California coastal region .Here oil pools can be seen oriented along the structural trend lines and lineaments.

The interpretation of satellite imagery of California coastal region of USA has shown a broad synformal structure plunging in N-W direction. The hydrocarbon pools are along both the limbs of this structure. The southern part is dominated by pronounced E-W trending lineament zone and here the pools as well as their elongation match exactly with them Fig.2.

The hydrocarbon pools of Krishna-Godavari basin are shown in Fig.3. The older pools producing from the Cretaceous volcano-sedimentary sequence are curvilinear and are roughly parallel to the coast and related geomorphological features such as beach ridges. The younger pools of upper Tertiary are associated with the fossilized paleo-channels complexes. These paleo-channels are carved by the SE flowing Godavari and Krishna and their distributary channels. These highly meandering channels, composed of sand are encased in fine silt and clay material.

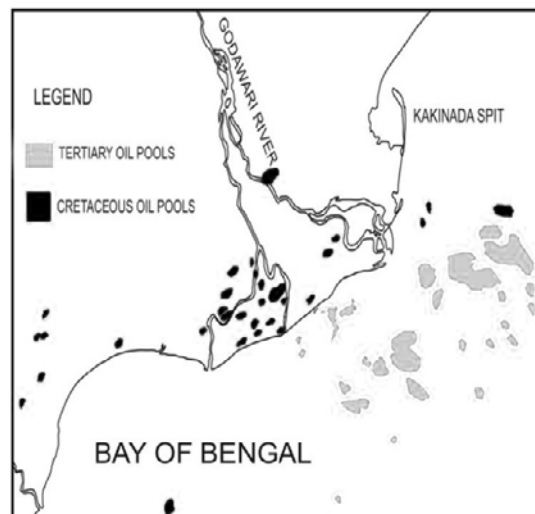


Fig.3. Disposition of hydrocarbon pools in Krishna-Godavari basin is shown as per the geological ages of reservoir rocks

In offshore Bombay, the Paleocene, Eocene, Oligocene and Miocene pools have distinct relationship with geological setting Fig.4. Paleocene pools such as Panna and surrounding pools are elongated in N-S direction and appear to have developed due to subsidence along normal faults parallel to the extension of Cambay Structure. This succession started with the development of nearly N-S trending rift, on top of the Bombay platform. The presence of Paleocene rocks and hydrocarbon pools largely in southern part, suggests that the initiation of rifting started from south to north. Later, during the Eocene, this rifting became more prominent and continued in northerly direction right through the Cambay into Barmer region. This resulted in deposition of thick Eocene sequence in this basin. Ratna, Heera, Neelam, Bassein, Panna and surrounding smaller pools are associated with this sequence. Oligocene pools comprise cluster of north Tapti, mid Tapti and south Tapti fields, mainly localized in the southern part of Gulf of Cambay. These elongated pools correspond with the directionally similar submerged sand bars. These linear bars are affected by both longitudinal as well as transverse faults. Although they are submerged, even then their attitude can be ascertained from the satellite imagery. The unique crescent shaped Bombay high super giant hydrocarbon pool is also associated with lower Miocene carbonate reef

complexes. Furthermore, a number of surrounding pools, as well as new findings in southern offshore of Saurashtra are also located in lower Miocene Gaj formation.

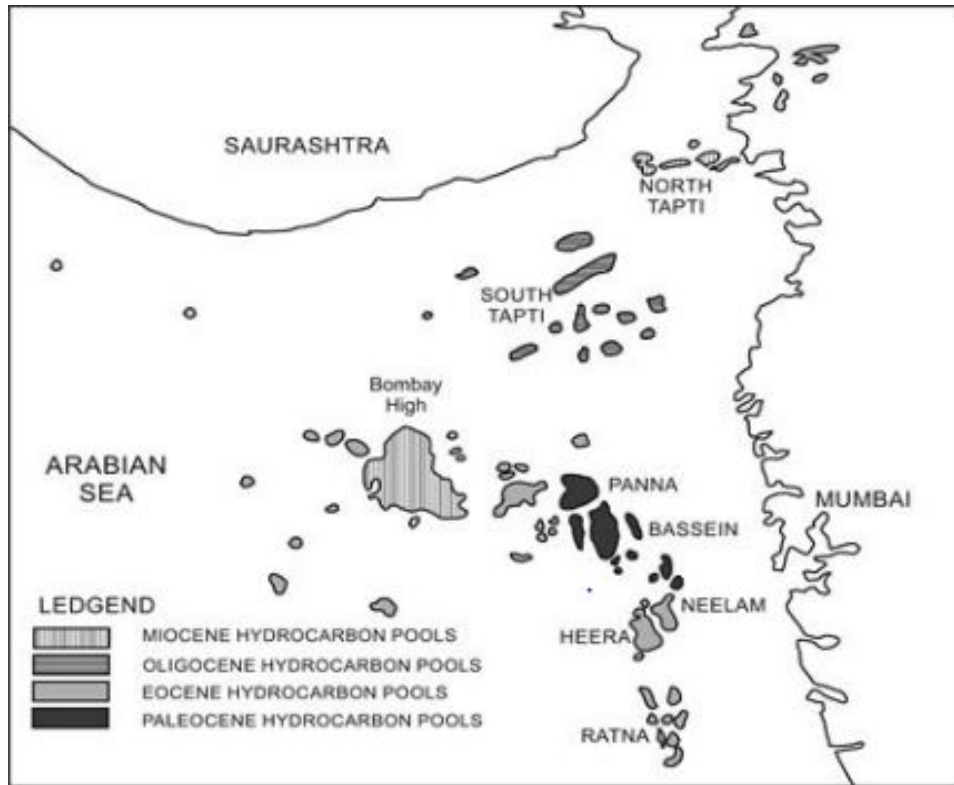


Fig.4. Disposition of Hydrocarbon Pools in Bombay offshore basin is shown as per the geological ages of reservoir rocks

Conclusions

Study has led us to arrive at following conclusions.

- 1) Distribution of hydrocarbon pools in space and time can be utilized as an additional tool for prognostication of areas for detailed exploration. Various patterns of distribution have also complimented our understanding of complex geological processes which were involved during their formation.
- 2) Preferential accumulation of hydrocarbons is not only controlled by trapping mechanism but also innumerable factors associated with deposition of reservoir rocks. Tectonics has emerged as the most important factor from basin formation to the accumulation of hydrocarbons.
- 3) Hydrocarbons hosted by geomorphological features such as fossilized channel complexes, beach ridges and sand bars are subtle manifestations of tectonic activity.

References

Misra K S, Slaney VR, Graham D and Harris J (1992) Mapping of Basement and other Tectonic features using SEASAT and Thematic Mapper in Hydrocarbon producing areas of the Western Sedimentary Basin of Canada. *Canadian Journal of Remote Sensing*, 17, (2):137-151.

Misra K S, Misra A (2010) Tectonic Evolution of Sedimentary Basins and Development of Hydrocarbon Pools along the Offshore and Oceanic Regions of Peninsular India. *Gondwana Geological Magazine*, 12:165-176.