Analysis of Hydrocarbon Prospectivity of Low Resistivity Low Contrast Ardol Sands of Matar Field, Cambay Basin-A Case study.

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Keywords

Low resistivity Low Contrast, CMR Log, Core, Matar, Cambay Basin.

Summary

Matar is one of the promising onland oil and gas field in South Cambay basin, lies in the eastern rising flank of Jambusar-Broach Tectonic block. Hazad sands of Middle Eocene age is an established play and major hydrocarbon producer in Jambusar-Broach Block, which remained the focus of exploration and development since its discovery. However, at the mature stage of exploration of Cambay Basin, thrust area of exploration lies in deeper and shallower plays apart from Hazad play. Ardol sands of upper Eocene age is an upcoming play which has been proved to be hydrocarbon bearing pay in Matar area. So far 26 wells were drilled in Matar Field out of which 13 wells yielded oil and gas.Presence of hydrocarbon in Ardol Pays of Matar area was established during the year 2012 by drilling A-13 well.

Subsequently, development wells for Ardol Sand pays in Matar area have proved the commercial accumulation of hydrocarbon reserve. Production of substantial quantity of clean oil with negligible water cut had brought new dimension to explore prospectivity of Ardol sands as upcoming play in addition to Hazad play.

Recent wells A-21, 23, 24, and 27 were drilled to exploit hydrocarbons from Ardol sands. Low resistivity Low contrast character of sands in Matar Field are analysed with CMR log along with core data indicated the reason as high capillarity bound water coupled with high salinities of formation water in the reservoir section created low reisitivity low contrast between water and hydrocarbon zones. Systematic outward field development technique was used for field development without disturbing the drainage areas of drilled wells was major concern. In this study log signatures of Ardol sands are analysed in the block of W-13 & W-11. Geological data along with log data & pressure data are correlated in wells A-13, 14, 19, 20, 21, 23, 24, 27.Log correlation along the strike and dip direction clearly shows the increase in sand thickness to south of Matar Field.

Introduction

First well Matar-1 was drilled with an objective to explore Hydrocarbon prospectivity in Tertiary rocks which yielded commercial hydrocarbon from Hazad pay and subsequently twenty six wells were drilled in Matar, out of which, the wells A-11, 12, 13, 14, 18, 19, 20, 21, 23, 24, 25, 26, 27 yielded hydrocarbons (13 wells out of a total of 26 wells yielded oil and gas). Established Mid Eocene play of Hazad & Ardol Member have hydrocarbon accumulation in structure bounding faults/ N-S longitudinal faults. Structural entrapment has been observed in Matar area as fault closure prospects. Discrete nature of Ardol pays are entrapped strati-structurally.

Presence of hydrocarbon in Ardol Pays of Matar area was established during the year 2012. Subsequently, development wells for Ardol Sand-I & II pays in Matar area have proved the commercial accumulation of hydrocarbon reserves. Production of substantial quantity of clean oil with negligible water cut had brought new dimension to explore prospectivity of Lower & Upper Ardol sands as upcoming play in addition to Hazad play.

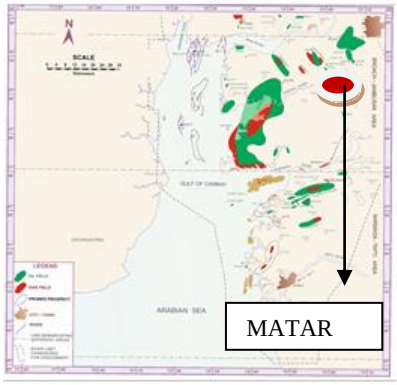

Fig-1: Location map of the study area.

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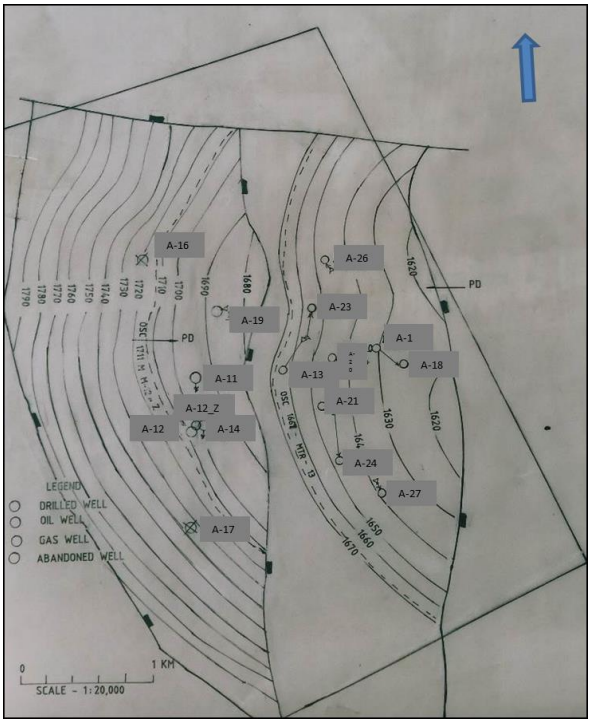

Fig-2: Structure map and oil isopay map of Ardol sand-1 in the block of W-13 & 11.

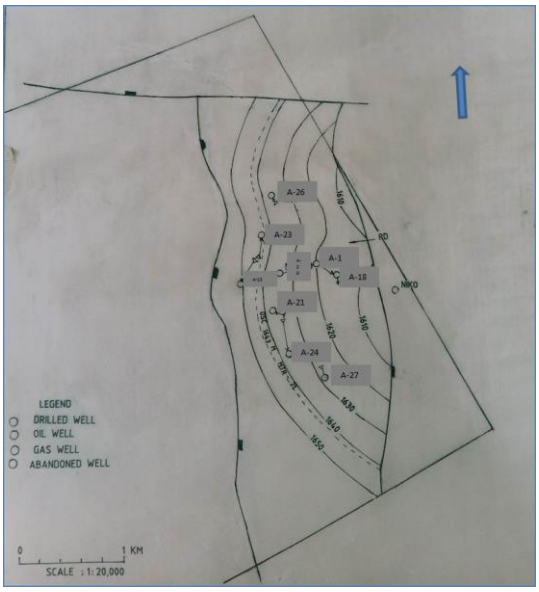

Fig-3: Structure map and oil isopay map of Ardol sand-2 in the block of W-13.

In the block of W-13, oil was established from Ardol sand-I by testing of exploratory well A-13 during December' 2011. The development well A-20 was drilled during October' 2013 for Ardol sand-1 and was completed as OP from Ardol sand-1. Another development well A-21 was drilled during April' 2016 for Ardol sand-1 and was completed as OP from Ardol sand-I & II. Ardol sand-1 was tested in A-1 and is flowing intermittently after HF. In A-18 Ardol sand-1 is very poorly developed. A-23 & 24 were drilled during October & November 2017, respectively and are completed as OP from Ardol sand-1.A-26 was drilled for Ardol sand but comleted in GS-8 and A -27 was drilled and completed in Ardol sands. From recently generated G & G data A-27 produced Qo: 48m3/d, WC:10.84% (8mm), FTHP:10KSC from Ardol sand-1.Hence a systematic outward development of the field lead to spell bound incremental gain of production in FY2018-19 (Shown in Fig-4).

Matar field was put on production in March 2009. The first oil peak oil production rate of 61m3/d was reached in January 2010 when A-11 was producing from GS-9 before being zone transferred to GS-8.

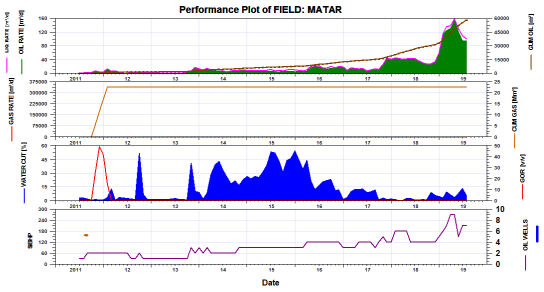

Fig-4: Production performance of the Matar field.

The second and the highest peak oil production rate of 142m3/day has been achieved recently in February 2019 with the drilling of two new development wells A-26 (producing from GS-8) and A-27 (producing from Ardol-I sand) and the side tracking of well A-12 to produce from Ardol sand.

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With the onset of production from Ardol sand, the performance of the field has been improving over the past few years. The field performance shows incline in production rates.

Currently, the field is producing oil @142m3/d with 7% W/C, out of which 113m3/d of oil is being produced from Ardol sand alone. Most of the wells on production are on SRP.

Method

26 wells G&G data is collected, log motif's and log correlations in strike and dip direction are prepared. Analysis of the log correlations clearly demonstrated the trends and sand dispersal patterns. Core data along with advance log data are analysed simultaneously to justify the reason for low resistivity being domination of capillary bound porosity. In addition reservoir pressure data and productions trends clearly defined the productivity of Ardol sands. Elaboration of each analysis is further mentioned below with substantial information.

- CMR log in wells A-27, 20 & 11 clearly depicts domination of capillary bound porosity.
- Core reports of wells A-11 & 13 shows the presence of micro and meso pores (& high capillarity) in sandy/silty portions.
- The stratigraphic correlation with wells A-12,14,11,13,20,1 & 18 suggests that the sands of Ardol sand-2 are very well developed in W-13 Block as interpreted from log data.(Fig-5)

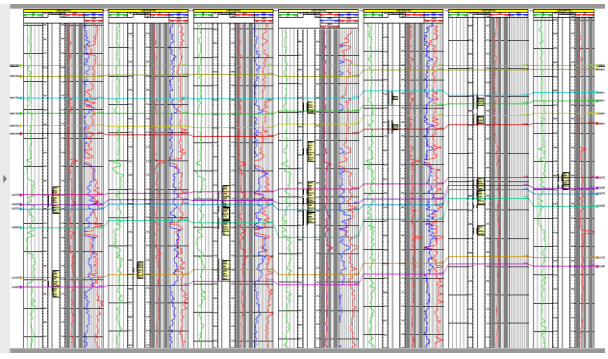


Fig-5: EW (Dip direction) Stratigraphic Log Correlation with nearby wells.

- The stratigraphic correlation with wells A-27,24,21,13,20,23 & 26 clearly shows better development of sands in the southern part of the field as interpreted from log data.(Fig-6)

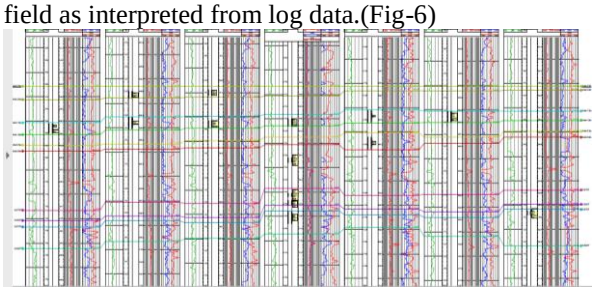
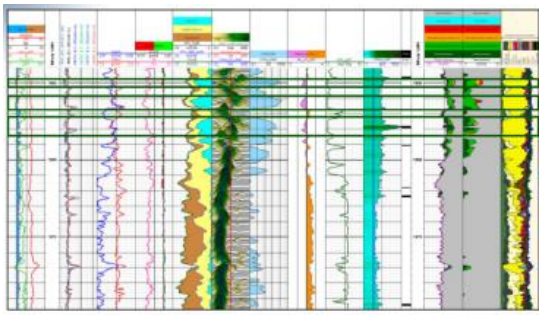
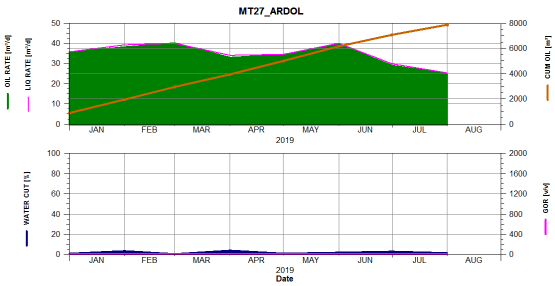


Fig-6: NS (Strike direction) Stratigraphic Log Correlation with nearby wells.



- Fig-7: Log motif of A-27 in the interval 1700-1620m

- A-27 on perforation and testing the objective Ardol Pay (AP-I) in the interval 1681.0-1685.0m produced oil @ 39.85m3/d thru 8mm bean and FTHP: 177.79psi.This sand layer is developed with resistivity in the range of 1.0-10.0Ω-m and GR 30-50API.



- Fig-8: Performance plot of A-27 since inception

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- Sand developed in the interval 1680.5-1682m is shaly. Clean sand is developed in the interval 1683-1686m. The computed effective porosity and water saturation in this sand are 10-18% and 60-70% respectively. On the basis of quantitative log evaluation and nearby wells production history Ardol pay-1 in the interval 1682.0-1685.5m is interpreted as hydrocarbon bearing.
- CMR log was recorded and processed in the interval 1207-1842m by M/S SASL. T2 cutoff of 33ms is used for processing. In the objective pay, Ardol Pay-I in the interval 1681-1686m, CMR free fluid porosity is estimated as 5-10% and permeability varies from 1.5-7mD.

Conclusions and Recommendations

From the studies carried out, it is envisaged that the pay sand Ardol sands are low resistivity-low contrast pay sands. The low resistivity is due to domination of capillary bound porosity. The general trend of the pay with the quality and thickness of sands get better towards south of the field which may lead to increase in the encountering of the sand. But immense hope is also restored in the Block of W-11 where in Ardol establishment is thoroughly proved with the drilling of side track well A-12_Z. Both the Blocks are equally promising to enhance further production of the field. New seismic data acquisition may be planned in the area for better understanding of reservoir and sand dispersal patterns.

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