

Reservoir delineation of K-VIII pay sands of Middle Eocene Kalol Formation in and around Wadu-Paliyad Fields of Ahmedabad Block, Cambay Basin

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Abstract

The study area comprising of Wadu-Paliyad-Wadasma Fields and northern part of Kalol Field is located in Mehsana-Ahmedabad Tectonic block of Cambay Basin (Fig.1). The NNW-SSE trending Cambay rift basin, situated in the northwestern part of the Indian pre-Cambrian shield, is segmented into five different tectonic blocks by ENE-WSW trending transverse faults. The Kalol Formation, deposited during post rift thermal subsidence stage, is the main producer of hydrocarbons in Wadu and Paliyad fields. Hydrocarbon reserves are mainly contained in multiple pays of Kalol formation of Middle Eocene age. Present study is focused on delineation of K-VIII pay within Sertha member of Kalol Formation.

In this area, hydrocarbon entrapment has stratigraphic control with stratigraphic component playing the major role in entrapment; hence presence of reservoir facies seems to hold more significance in accumulation of hydrocarbons. The K-VIII reservoir is anticipated to have depositional extent much beyond the existing pool limits in the study area. Therefore; mapping of reservoir facies is critical in delineation of sand bodies for exploitation and further exploration. An attempt has been made to understand the reservoir facies distribution integrating available G&G data with seismic attribute study of 3D seismic data. The sand isolith map for the K-VIII unit was prepared based on available drilled well data, and geological understanding of the area. The map was further fine-tuned with the seismic attributes from 3D seismic data. This study brought out additional prospective areas for exploration of both new pools as well as delineation of existing ones.

Introduction

The Cambay Basin is an intra-cratonic NNW-SSE trending aborted rift forming an integral part of the

western margin rift basin systems of India. The Cambay Basin is considered to be formed during Early Cretaceous time due to rifting along Dharwarian orogenic trends during the northward migration of the Indian plate after its break up from Gondwanaland in Late Triassic - Early Jurassic time (Biswas, 1982). Evolution of the Cambay Rift Basin could be divided into pre-rift, syn-rift and post-rift stages. The basin is divided into five major tectonic blocks from north to south namely Sanchor-Patan, Mehsana-Ahmedabad, Cambay-Tarapur, Jambusar-Broach and Narmada-Tapti Block, separated by pronounced transfer faults (Fig. 1). The Ahmedabad sector extends from the Nandasani cross-trend to the north to the Vatrak cross-trend to the south. The study area comprising of Wadu-Paliyad, Wadasma, North Kalol field is located in Mehsana-Ahmedabad tectonic block of North Cambay Basin (Fig.1). The area is flanked by Nardipur low to the east, Nandasani field to the north-west, Kalol field to the south-west and Langhnaj field to the north. Nardipur Low is the principal hydrocarbon generation centre for the adjacent fields in this part of the basin.

The fields have commercial hydrocarbon accumulations in multiple clastic reservoirs of Kalol Formation of Middle Eocene age. The Kalol Formation represents the progradation of a fluvial delta system, which was fed from an igneous/metamorphic source in the north. During periods of low clastic input and relatively high base level, coals and carbonaceous shale were deposited in swampy plains. According to established sequence stratigraphic framework the Kalol Formation is part of 3rd order Middle-Late Eocene sequence which has unconformable lower and upper contacts. The sequence is subdivided into TST and HST separated by MFS. The MFS corresponds to the Kansari Shale Member of Kalol Formation, which separates the two arenaceous members- lower Sertha and upper Wavel Member (Bhadu et al, 2012). The subsurface geology

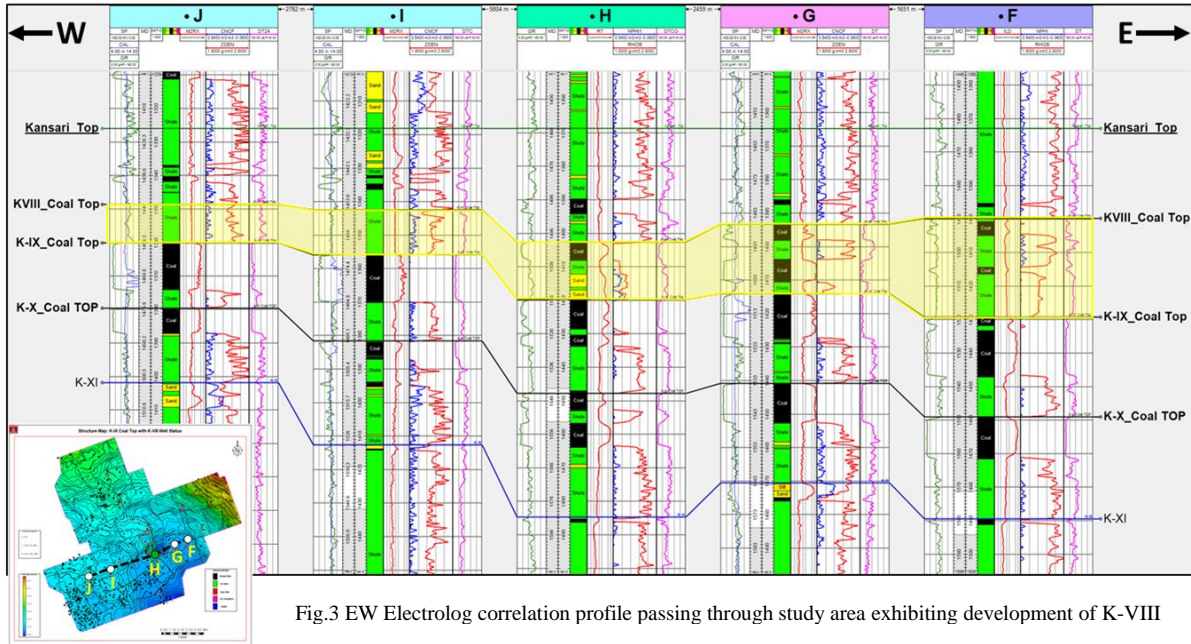
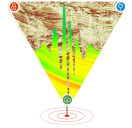


Fig.3 EW Electrolog correlation profile passing through study area exhibiting development of K-VIII

and north direction in the study area. The K-VIII reservoirs are mostly found confined within 20 m above K-IX coal. The effective reservoir thickness varies between 1-20 m. EW electrolog correlation profile depicts that development of reservoir facies in K-VIII unit is limited in extent. Well H in the profile is an oil producer from K-VIII sand (Fig.3)

The structural configuration of the area is brought out

with the help of 3D seismic and drilled well data (Fig. 4). The structure maps indicate NS to NNW-SSE trending multiple fault bounded corridors which got shifted by younger E-W trending cross faults. The deepest part lies towards SE i.e. Nardipur Low. The basin is getting shallower towards north and east. Sand / Silt isolith map of K-VIII was prepared considering the thickness of sand and silt encountered in the drilled wells and depositional setup in the study area (Fig.5)

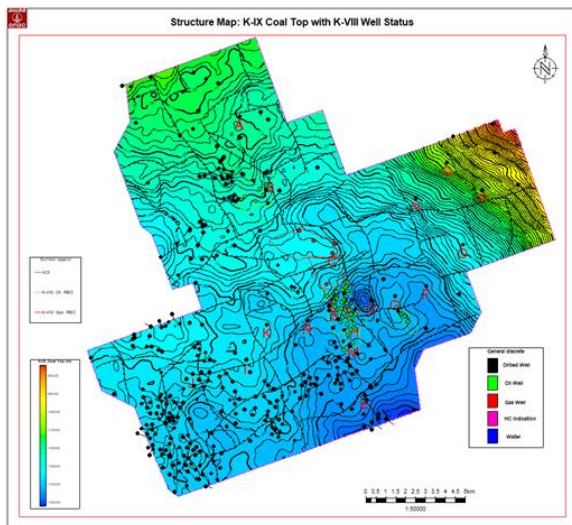


Fig. 4 Structure map: K-IX Coal top

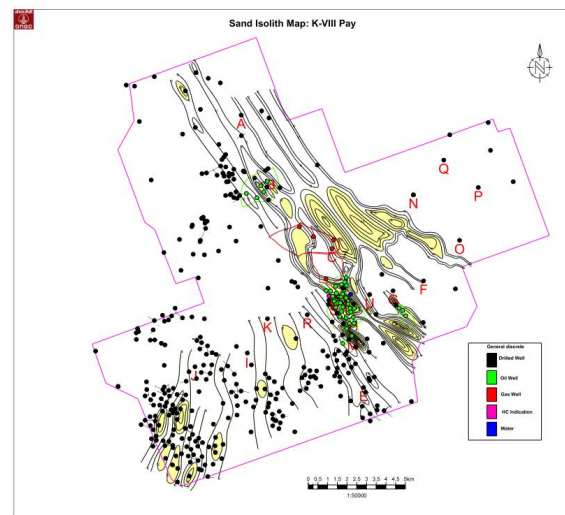


Fig. 5 Sand/Silt Isolith map of K-VIII

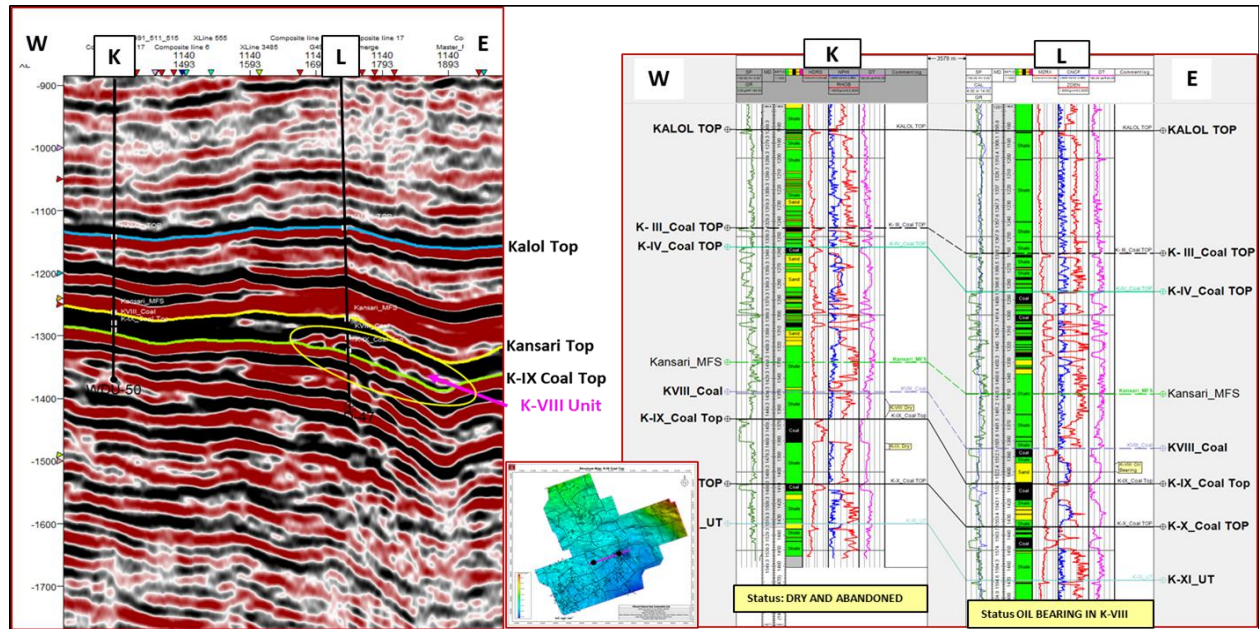
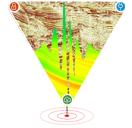


Fig.6 Identification of seismic response corresponding to reservoir of K-VIII unit

The reservoir facies of K-VIII unit has very restricted development in the north and western part of the study area. In the western and northern parts of study area, the drilled wells indicate poor development of reservoir facies within this unit. Sand geometry map shows the preferred direction of sand Input from NW to NNW.

A number of seismic driven amplitude attributes like RMS, Sweetness and Spectral Decomposition etc. were attempted for deciphering possible sand dispersal pattern and depositional geometries. Close examination of log data with seismic response revealed very interesting correlation between the two with respect to K-VIII pay. A log correlation profile through wells K & L shown in Fig. 6 indicates the development of K-VIII sand unit in well L which shales out towards west in well K. The seismic section through these wells indicates the development of an additional layer just above the K-IX unit in well L which is absent in well K. This additional unit may correspond to the K-VIII unit (Sand and overlying Coal layer) which is developed in Paliyad & Wadasma fields, however, absent in eastern part of Wadu field.

Proportional slices have were generated between

surfaces corresponding to Kansari Top & K-IX Coal Top and the offset slice 5 from the Kansari Top horizon may correspond to K-VIII Unit Top. Sum of Negative amplitudes have been extracted within the window of Kansari offset slice 5 to K-IX Coal Top. The attribute slice has very well brought out the extent of development of K-VIII unit corroborating with the sand dispersal pattern and validating with the data of most of the drilled wells (Figs. 7).

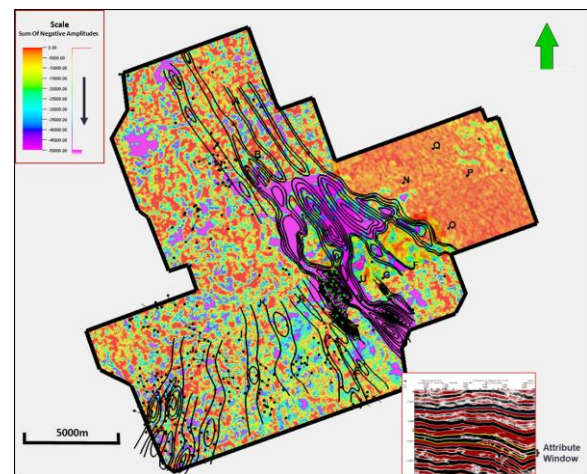
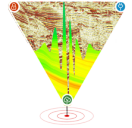


Fig. 7 Sum of negative attribute overlain with Sand/Silt Isolith map



Discussion

The attribute slice corroborates with most of the drilled well data in the area. The E-W electrolog correlation profile through key wells is shown in Fig. 8. The wells K & R in the west and U & O in the east have not encountered K-VIII sands as evident from the electrolog signatures. The wells S & T are oil producers and lie within the established hydrocarbon pool of K-VIII pay.

The wells S & T have produced 13708m³ & 53740m³ of oil from K-VIII pay respectively. The well U drilled just outside the limits of main sand lobe has proven to be dry and abandoned. Eastern most well O is also falling outside the eastern shaleout limit of K-VIII sand. The corresponding seismic section corroborates with all the observations made on electrologs and extent of seismic signature corresponding to K-VIII reservoir facies (Fig. 9).

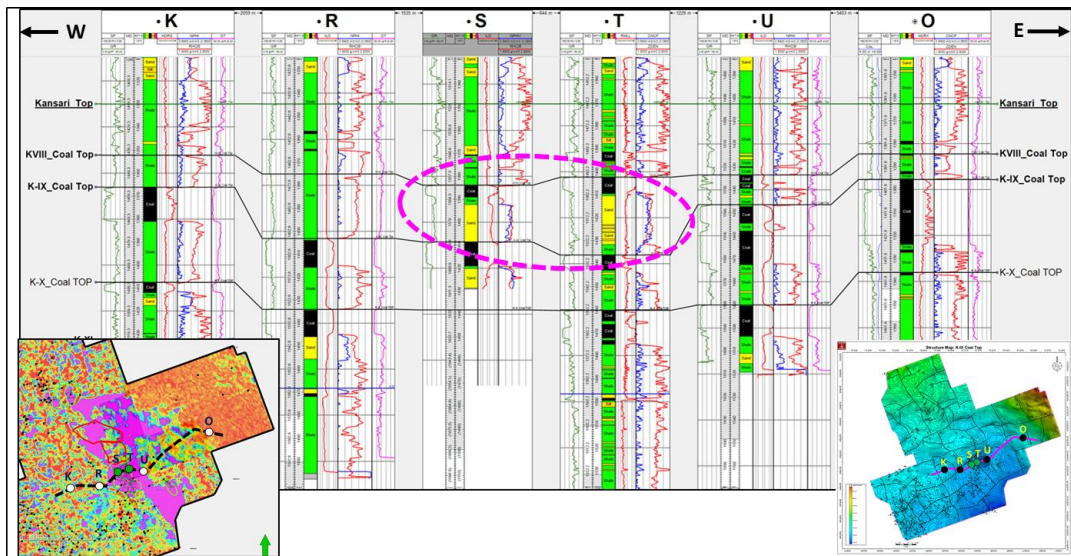


Fig.8 E-W Electrolog correlation profile the passing through key wells in the study area

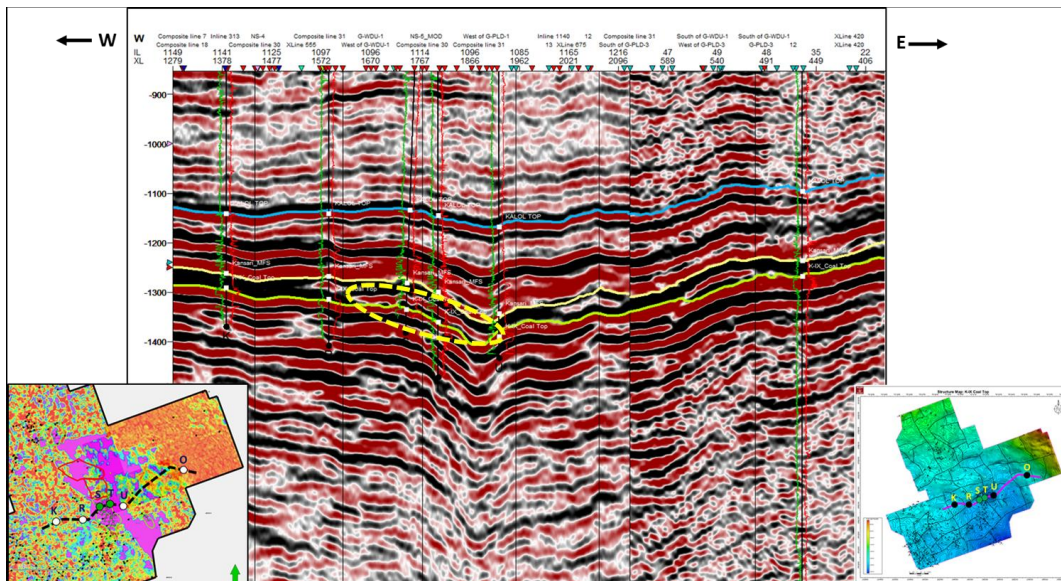
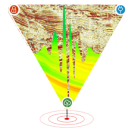


Fig.9 Seismic RC line corresponding to E-W profile in Fig. 8



The log correlation profile and seismic section validates the extracted attribute slice representing extent of the K-VIII reservoir facies. The main tidal channel in the south eastern part with good sand and overlying coal thickness is being captured. In the south western and northern part of study area the sand thickness is very less compared to main lobe in eastern side. Moreover, the quality of the reservoir deteriorates towards west and northern part of the study area. So the attribute is not capturing the deposition of sand/silt in this part. The attribute slice satisfies most of the drilled wells in the study area barring a few exceptions. One of the outlier is well M which has encountered around 16m of sand in K-VIII but falling outside the seismic body and the amplitude response.

Conclusion

The study across multiple fields has aided in improved understanding of Sertha play. The study brought out the presence of K-VIII sand further east and in the north-eastern rising flank of Nardipur low which was hitherto not established. Integration of G&G data has led to identification of drillable prospects targeting K-VIII pays of Sertha play in Kalol formation, which may give further impetus to the exploration in the study area.

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