

Degam Wedge Sediments- A New Petroleum Play An Outcome of Sequence Stratigraphic Analysis of Narmada- Broach Block, South Cambay Basin, Gujarat, India

Mr. K Dhandapani*, S S Sawkar, A K Das, D S Randhawa, P B Pandey

ONGC Baroda

Summary

The sequence stratigraphic approach for understanding the deposition of litho-stratigraphically designated Dadhar Formation sandwiched in between two maximum flooding surfaces, within the framework of system tracts has been firmed up based on distinct seismic characters. Two members Viz, Amod & Degam Members, have been identified within Dadhar Formation. Amod Member deposited over the Kanwa shale, in high stand system tract under the influence of normal to forced regressive phase. It is composed of alternations of sand & shales in shelf areas in the east. Whereas its equivalent section in the western slope and distal areas is represented by condensed section composed of shale. The Degam Member identified beyond the Dadhar shelf edge as "**DEGAM WEDGE SEDIMENTS**" composed of sand & shale alternations over the condensed section of Amod member, is deposited as low stand wedge ,lower part of Tarkeshwar shale. This low stand Degam wedge sediments has been identified as new play for the first time in south Cambay basin which extends from Akholjuni in the north to Navsari in the south.

Introduction

Cambay Basin is a NNW-SSE trending intracratonic rift basin situated in the western part of India. During the past five decades, the hydrocarbon exploration was restricted mainly to Cambay-Hazad play of Ankleshwar Formation of Middle Eocene age in Narmada-Broach tectonic block. The recent sequence stratigraphic approach has been applied for evaluating and understanding the depositional systems younger to Hazad in this part of Cambay Basin. The studies have led to identification of a new play namely "DEGAM WEDGE SEDIMENTS".

This paper deals with identification of problems relating to integration of geoscientific data within Dadhar Formation and application of sequence stratigraphic methods in developing the geological model based prospectivity of the play with reference to the accumulation of hydrocarbons.

Geological Setting

Narmada-Broach tectonic block of Cambay Basin has received around 7 km of Tertiary to Quaternary sediments resting over the acoustic basement represented by Deccan Trap Formation. In the basinal part the continental sediments corresponding to Olpad Formation are deposited over Trap. The area initiated by the marine incursion from the south during the early Eocene and

remained as a narrow elongated Basin till date i.e. Gulf of Khambhat. The alternating pulses of regression and transgression of sea in the Basin have deposited the Cambay, Kanwa and Tarkeshwar argillaceous units separated by Hazad, Dadhar and Babaguru arenaceous units. The area experienced regional transgression during close of Miocene represented by regional seal Kand Formation.

Seismic Data Calibration And Methodology

In order to understand the depositional systems of Ankleshwar Formation and younger of the area, seismic data of about 2000 GLK of 2D and 3D data of around 1500 Sq.km were analyzed along with data of 400 wells.

The geological markers were transferred on seismic data with the help of synthetic seismogram. The reflections corresponding to Hazad, Kanwa, Tarkeshwar, Babaguru and Kand were found to be well correlatable with the sequence boundaries represented by parallel to sub parallel reflectors. Whereas, the seismic events corresponding to Ardol and Telwa Members and Dadhar Formations are not consistent and cut across each other from east to west and no meaningful map could be prepared. This has prompted the authors to revisit the geological data again to confirm the same. On careful examination of the electrolog data, it is observed that the wells on the eastern part exhibit the undifferentiated Ardol Member of Ankleshwar and Dadhar Formations. In order to resolve

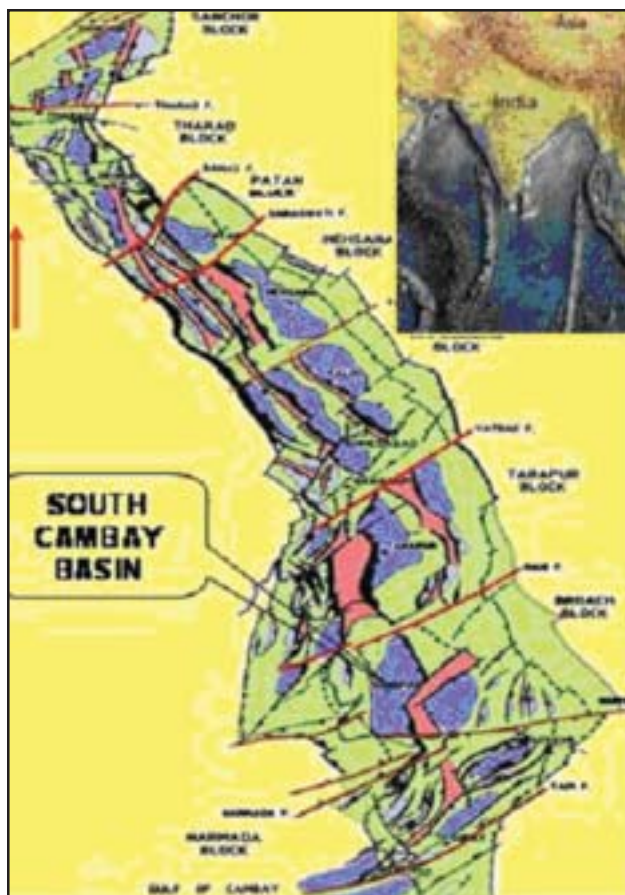


Fig 1 Location map of Cambay Basin

the problem, the authors have followed the sequence stratigraphic approach in the framework of system tracts for firming up of depositional processes associated with Ardol, Telwa and Dadhar Formations

Sequence Stratigraphic Approach

The study of seismic data was carried out within the framework of deposition in system tracts. Over the Cambay shale, the prolific hydrocarbon producing Hazad sequence was deposited by the first major fluvial system in the area and over this the Kanwa shale was deposited in transgressive system tract.

Lithostratigraphically designated Dadhar formation composed of sand and Shale alternations is sandwiched in between maximum flooding surfaces corresponding to Kanwa and Tarkeshwar Shales. Two genetically differing depositional units have been identified within the Dadhar formation and named as Amod and Degam Members based on their reflection configurations. In the east, the older Amod Member, is identified on the seismic sections by low to high angle clinoforms (Fig 2 & 3) indicating progradations from east to west in the shelf areas. In the basinal areas, the equivalent of this Member is represented by thin section of parallel reflections corresponding to condensed section. The Amod member comprises of earlier lithostratigraphically designated Ardol, Telwa and eastern Dadhar Formations. The top of Amod



Fig 2 Seismic section in Broach Block showing high to low angle clinoforms defining the Parasequences within Dadhar Formation

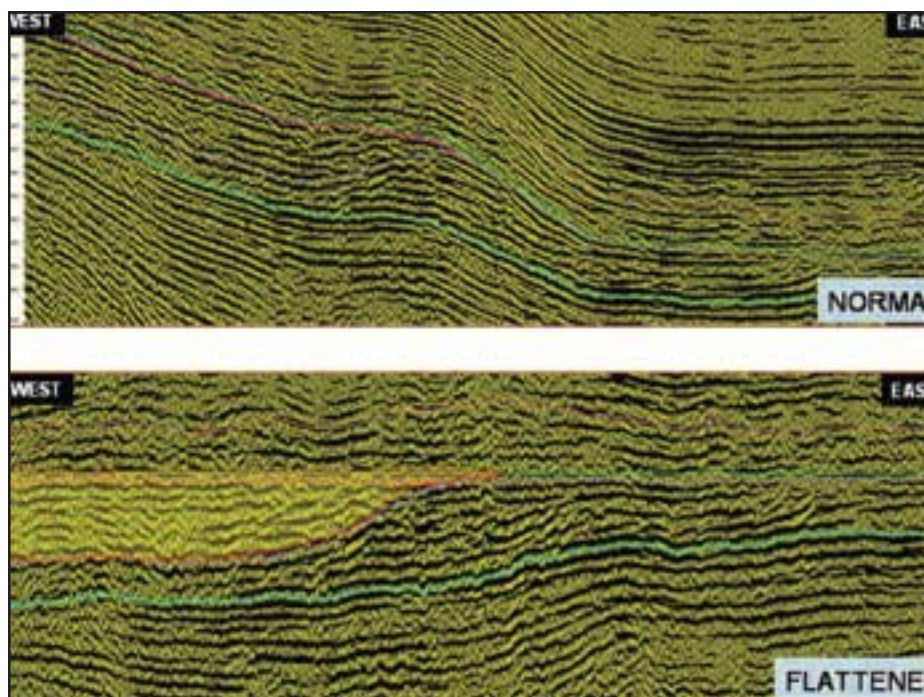


Fig 3 Flattened seismic section in Broach Block showing Dadhar wedge sediments

Member is an unconformity represented by maximum regressive surface (MRS). The MRS exhibits partial removal of the sediments seen as top lap and truncating seismic events in the shelf areas in the Broach sub block whereas in the Narmada block MRS is represented by the sub parallel reflectors attributed to minor erosion.

The younger Degam Member, deposited as lower part of Tarkeshwar shale, on seismic section is identified by a series of parallel reflectors Onlapping over the slope, shelf edge and maximum regressive surface of Amod Member and wedges out towards the east and thins down towards west. The Degam Member consists of alternations of sand and shale showing the impressions of coarsening upward log motif. The wide spread parallel reflectors corresponding to upper part of Tarkeshwar shale was deposited (Fig 4) in transgressive system tract conformably

Overlying the Degam Member and unconformably overlying the Amod Member in the east. Based on this study, log correlations and seismic interpretation have been redefined. (Fig 5 & 6)

Deposition Model Of Dadhar Formation

The present study under the sequence stratigraphic framework has identified lithostratigraphically designated

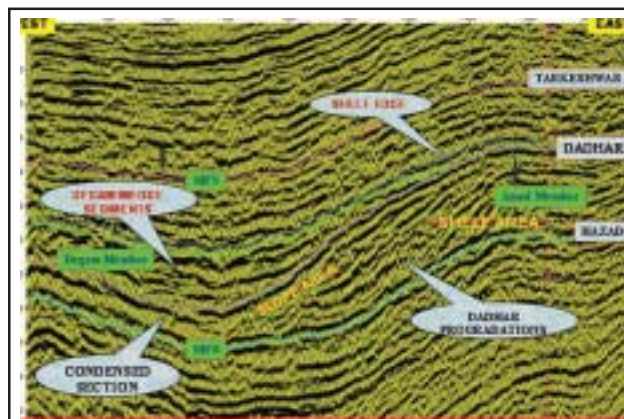


Fig 4 Seismic section showing Amod and Degam Members within Dadhar Formation

Dadhar Formation as consisting of two genetically different depositional units. Based on this the deposition model is evolved. The two units have been designated as older Amod Member and younger Degam Member deposited in two different depositional regimes. The Amod member in the Broach sub block was deposited over the Kanwa shale as a major single episode comprising of undifferentiated alternations of sand and shale during high stand system tract in regressive phase in the shelf areas in the east. The low angle prograding events at the basal part of the Amod Member suggest low to moderate influx of sediments by

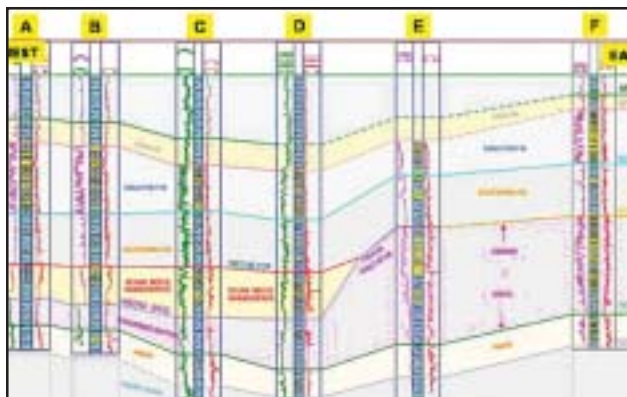


Fig 5 Redefined electrolog correlation representing Broach Sub block showing Amod & Degam members

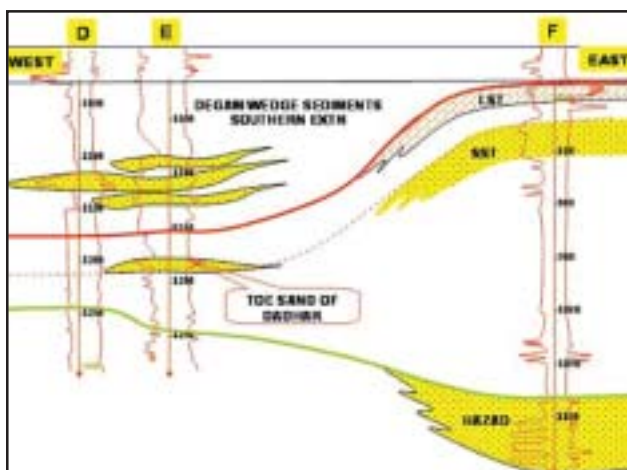


Fig 6 Redefined electrolog correlation representing Narmada Sub block showing Amod & Degam members

fluvial systems in the initial stage coupled with sufficient accommodation with minor regression of sea. Whereas series of high angle clinoforms seen at the top part of Amod Member in Broach sub block indicate the probable higher influx of sediments resulted in normal to forced regression along with rapid fall in the sea level with shifting.

In entire Narmada sub block, top most part of Amod member is represented by Limestone/Marl facies, indicating starvation of clastic input with calm and quite shallow marine environment. This has been exhibited on seismic sections as continuous high amplitude parallel reflectors in shelf, shelf edge, slope and basinal areas.(Fig 7 & 8)

Amod Member in the western basinal parts beyond the shelf edge condensed in to thin section composed of shale was deposited over the entire Broach-Narmada block demarcating the North-South running shelf edge.

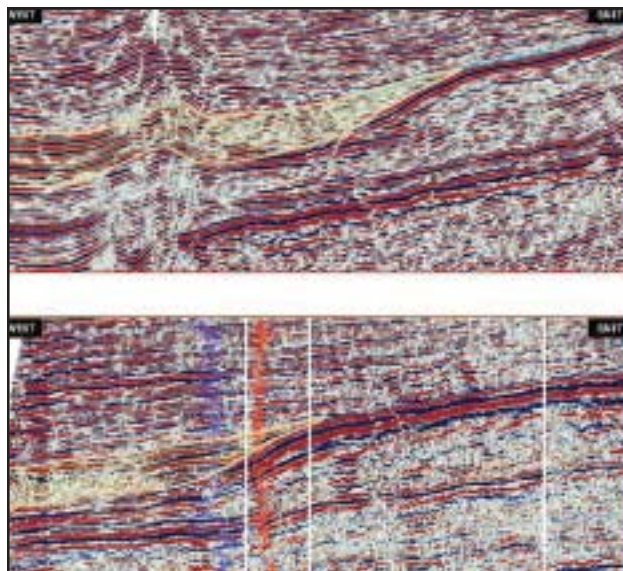


Fig 7 Seismic section in Narmada Block showing high amplitude reflections defining limestone at the top of Dadhar Formation

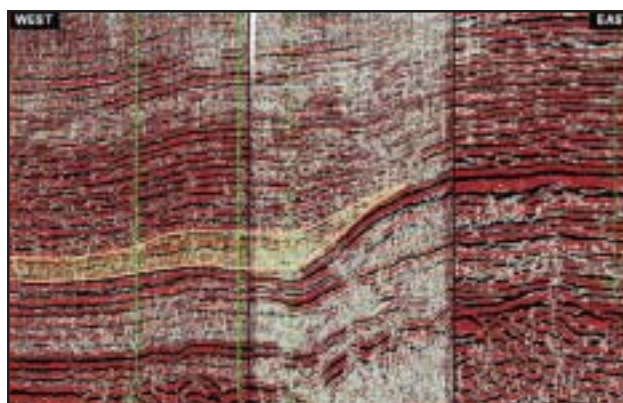


Fig 8 Multi panel section in Narmada Block showing Degam Member of Dadhar Formation of shelf edge towards west

At the end of Amod member, maximum sea level fall was observed resulting in exposure of entire shelf area. The new drainage system advanced over the shelf areas had eroded the top most part of Amod member and deposited the same, beyond the shelf edge coupled with fresh inputs, as wedge sediments in low stand system tracts. This process continued with minor fluctuation of sea level.

These sediments were subjected to reworking by North-South operating tidal currents in Gulf environment (Fig 9). The sand content of Degam wedge in the Broach sub block is more than that of southern Narmada sub block because of their composition of shelf and their intensity of fluvial activity and erosion (Fig.10). This low stand Degam

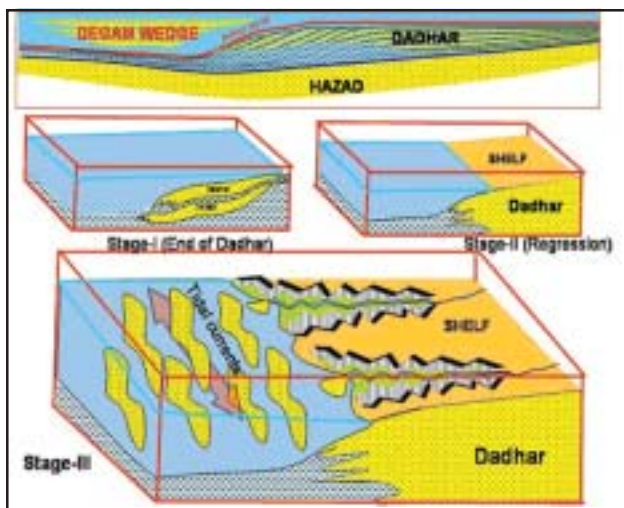


Fig 9 Multi panel section in Broach sub Block showing Degam Member of Dadhar Formation

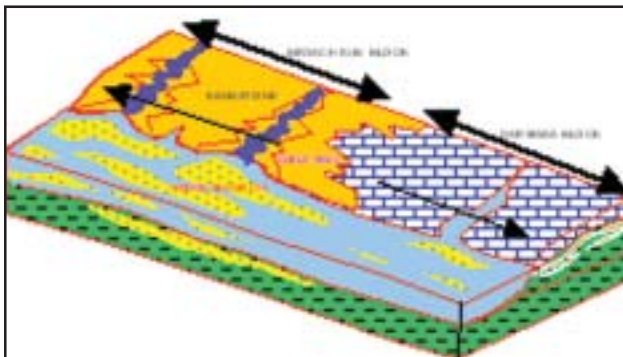


Fig 10. Geological Model showing the disposition of Amod member and deposition of Degam wedge in Narmada and Bharuch sub block.

wedge sediments composed of sand and shale alternations are designated as Degam member.

Identification Of New Play

The Degam wedge sediment has been identified as a new hydrocarbon play in south Cambay basin. This new play has all the required favorable geological settings to have hydrocarbon accumulations viz; alternations of shale and sandstone reservoirs, juxtaposed/underlain by proven Cambay/Tarapur shale source rock facies, overlain by regional wide spread transgressive Tarkeshwar shale cap rock facies along with Stratisturctural entrapment conditions provide the new play status.

Distribution And Prospectivity of Play

The Degam wedge play is well distributed over the entire western parts of the South Cambay Basin. This

play has a width of 25 Km and length of 150 km extending from Akholjuni in the north to Navasari in the south (Fig 11). It is also opening up in to open marine areas of Arabian Sea.

The maximum thickness of sediments is 350 mt aligned parallel to shelf edge of Amod Member. The reservoirs of Degam wedge play forms the first available reservoirs in absence of underlying Hazad arenaceous Member (Fig 12). The northern and western rising flanks of wedge play are the most ideal locales carved out as prospective areas. The arenaceous section of Degam wedge play is further divided into Subunits. These subunits have a north-south orientation. Each has its own exploration potential. Hence the up dip and lateral pinch outs of each subunits aided with structure associated with four way closures and fault closures are envisaged as prospective areas. Hydrocarbon accumulation has already been proved in top most part of this play.

Identification Of Prospects

Based on these studies, in the northern part of the Broach sub block, a NE-SW trending nosal feature with a



Fig 11 Distribution of Degam wedge play area over the western parts of Narmada-Broach block

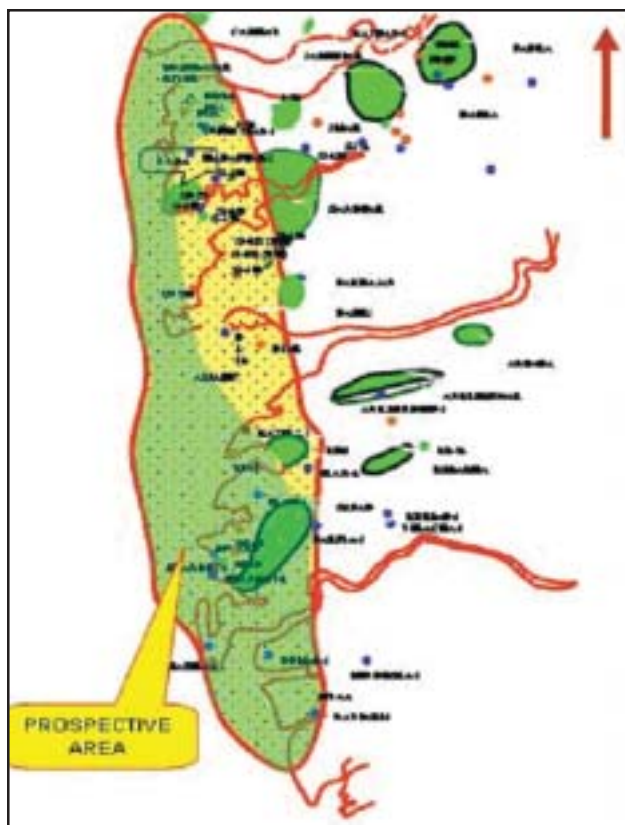


Fig 12 Prospective area of Degam Wedge play as first available reservoir in absence of Hazad Member.

culmination in the southern part of nose correspond to top of Degam Member has been recommended for testing the hydrocarbon potential of the top most subunit of the Degam wedge play. Likewise all the subunit within the wedge needs to be mapped for their hydrocarbon potential.

Conclusions & Recommendations

- The sequence stratigraphic studies have led to identification of Dadhar Formation as deposited between Kanwa shale and upper part of Tarkeshwar shales.
- Identified two genetically different depositional units and designated as Amod and Degam Members within Dadhar formation deposited in HST and LST respectively.
- Amod member was deposited as a single geological episode instead of earlier classified Ardol, Telwa Members and Dadhar Formation.
- It is recommended to redesignate the lithostratigraphic units viz. Ardol, Telwa and Dadhar as Amod member.
- Amod Member, comprising of the undifferentiated section of Ardol, Telwa and Dadhar Formation of the earlier lithostratigraphy, was identified as a single

depositional unit deposited in HST in regressive phase.

- The studies have identified the shelf, shelf edge, slope and basinal areas of Amod formation.
- Degam wedge sediments comprising of sand and shale alternations deposited over the condensed section of Amod member as a low stand wedge of lower part of Tarkeshwar shale and designated as Degam member.
- It is recommended that the Dadhar formation be, lithostratigraphically, reclassified into the lower Amod member in the east and the overlying Degam member in the west.
- This low stand wedge has been identified as a new petroleum play “**Degam Wedge Sediments**”.
- This play has extension (150 km length & 25 km. width) from Akholjuni in the north to Navasari in the south.
- 3D seismic data carpeting is required for mapping and evaluating the potential of each subunit within the play.
- A separate exploration strategy needs to be formulated to explore this play

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(The opinions expressed in this paper are only of authors)

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