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Understanding the Sub Seismic Complexity Form Integrated Borehole Image Analysis and Reservoir Pressure variation: A case study from Tapti Daman Field

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Keywords

Petrophysics, Image logs, Fault Interpretation, Seismic Interpretation

Summery

In the present study integrated geological evaluation was performed to understand the sub-seismic complexities. In the present workflow detailed image interpretation and bore structural modeling was completed to understand the sub-seismic complexity.2D reservoir dip modeling was performed to understand the subsurface complexity and reservoir continuity. Detailed observation reveals that faulting extends away from borehole in the seismic section. may impact compartmentalization of the reservoir. Integration with petrophysical studies and well testing data indicates that the fault is sealing in nature and may impact compartmentalization of the reservoir.

Introduction

Understanding the near bore sub-surface geological detail is critical for understanding sand dispersion in the field. Coarse resolution seismic alone is not adequate to understand detailed aspects of structural complexity. Therefore, significant uncertainty exists with regard to field development. To address this issue a multi-disciplinary integrated approach is preferred.

Borehole image log data was used to understand the sub-seismic structural complexities present in the well. Manual dips were picked in the well to identify the structural discontinuity. The bed boundary dip analysis was used to construct a structural cross section which clearly indicates the presence of fault. Reservoir pressure data indicates a pressure difference at reservoir level. The results were further validated using reservoir pressure data and the seismic section which indicates presence of a discontinuity across the well on a cross-line section.

This workflow identifies the high-resolution, near-wellbore geological architecture based on the structural dip data derived from image logs. A conceptual model was established based on the findings from image log and seismic data; which can help for better understanding the subsurface geology thus reservoir development. Further study is required to understand the sealing properties and the extension of the fault which will help in improving the exploration strategy.

Background Geology

The Tapti-Daman block is a predominantly clastic sub-basin in the Bombay Offshore basin (Figure-1). The block is located at the junction of the Cambay and the Narmada rifts. The basin is moderately well explored up to the Oligocene level. The Panna formation (Paleocene to Lower Eocene) is underexplored especially in the deep basinal part. Most of the discoveries are predominantly gas. The basin forms a broad syncline rising towards the north against the ENE-WSW trending marginal faults and in the east towards the NNW-SSE trending basin margin, and in the south against the E-W trending Diu fault (Chakrabarti.K.M et al., 2005). The western limit of the Tapti-Daman block is represented by the Diu arch. The block is dominated by the three major lows namely the Navsari, Purna and Daman lows that make up the Surat depression. The Tapti –Daman block consists of Tertiary clastics from Paleocene to Recent. The depositional lows contain in excess of 5000m-6000m of sediments.

The generalized stratigraphic column is shown in Figure. 2. The Lower Oligocene is represented by the Mahuva Formation which can be subdivided into a lower shale unit and an upper unit with lenticular sands and thin limestone bands. This formation is a major target for exploration and a number of gas lays and occasionally oil bearing pays have been probed. The Upper Oligocene is represented by the Daman formation which has been deposited in a delta front environment.

In this study, an integrated workflow (Figure 3) was implemented to solve the reservoir uncertainty. Image log analysis and seismic interpretation was integrated to establish a conceptual model of the field.

Results

Borehole image analysis provides a high resolution image of the formation by capturing the detail of the borehole wall, a method known as virtual coring. Image texture along with dip information provides a basis for defining the sub-seismic structural detail needed to understand reservoir complexity impacting reservoir productivity. Well-X is a candidate for evaluating the structural complexity in the Tapti-Daman field. The pressure data of Well-X at reservoir level 237 ksc, however another nearby offset well indicates pressure data at reservoir level is 230ksc. The pressure difference reveals that there is discontinuity present in between the wells.

The seismic section reveals presence of a discontinuity crossing the wellbore at the indicated depth (Figure 4).However; it is evident that the seismic discontinuity lacks clarity. Image log analysis clearly identifies the presence of fault in this depth interval. Hence, it is confirmed that the seismic discontinuity is a fault. Image texture reveals that resistive hallows are present around the fault which indicates the fault is resistive in nature. Further, analysis is required (using static and dynamic datasets) to understand the fault seal and impact on reservoir drainage.

Structural modeling was performed using the bed boundary dips, to visualize the structural complexity in the vicinity of the well. In the structural cross section shown in Figure 5 the bedding dip analysis clearly reveals the presence of a reverse fault in the wellbore. This confirms the depth and nature of the fault observed in the seismic section; this information can be used to calibrate the seismic interpretation and reservoir model.

The well has well flowed Gas @ 0.246MMSCMD from the same pay during initial testing; which indicates the immense potential of the reservoir and the necessity of proper reservoir model incorporating the high resolution findings.

Conceptual Model

The conceptual model shown in Figure 6 is based upon our observations and interpretation of the data. The model suggests the presence of compressive structural tectonic regime in the area which includes the presence of major and minor reverse faults in the system. Well-X was most probably drilled through a minor reverse fault.

Conclusions

The integration of borehole image analysis and seismic interpretations improves the understanding of geological complexity in the Tapti-Daman field.

The borehole image log clearly indicates the presence of faults in the well and confirms the discontinuity in the seismic section is a reverse fault.

Structural cross section modeling based upon the bed boundary dip analysis further confirms the location and nature of the fault observed in the seismic section. Hence borehole image interpretation was further used to calibrate the seismic interpretation and reservoir model.

The fault plane appears resistive on the image log which provides an indication of the sealing nature of the fault.

The reservoir shows immense potential; initial testing shows the well has flowed Gas @ 0.246MMSCMD from the pay sand. Further analysis is required to evaluate the fault continuity and seal potential within the reservoir to better understand the impact reservoir drainage and productivity.

A conceptual model was constructed based upon the observations and interpretations to visualize the subsurface structural architecture.

Acknowledgement

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Figures :

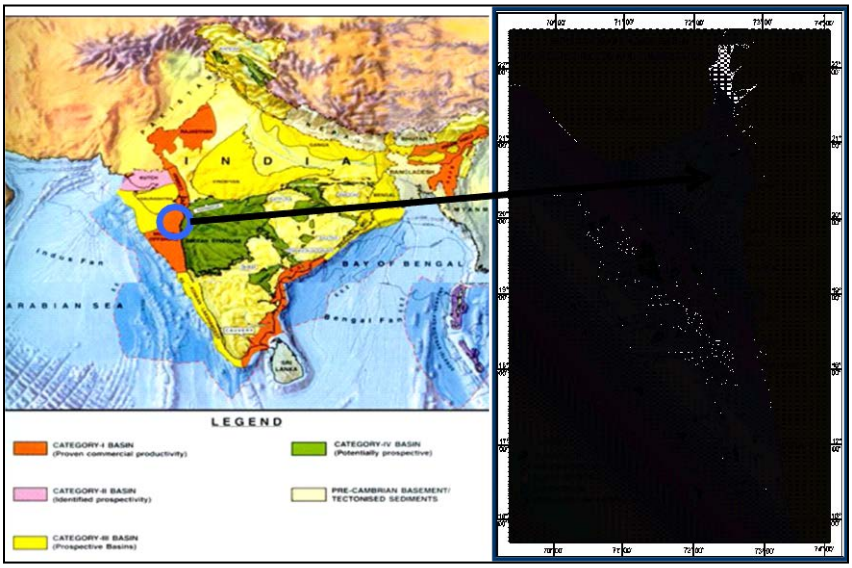

Figure 1: Location of Tapti Daman field (modified after Kalyani et al., 2009)

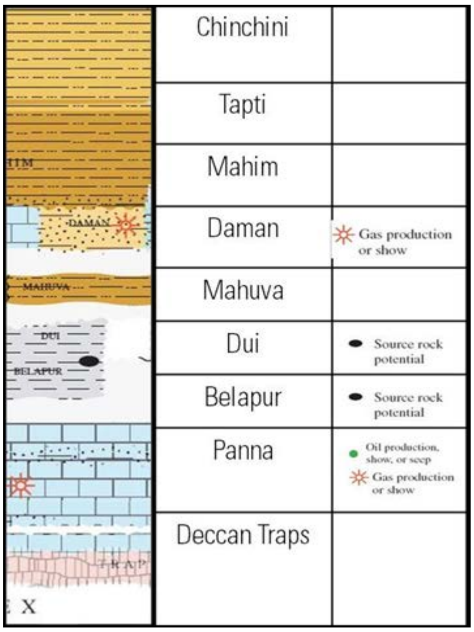

Figure 2: Generalized stratigraphy of Tapti Daman field (modified after Wandrey,2004)

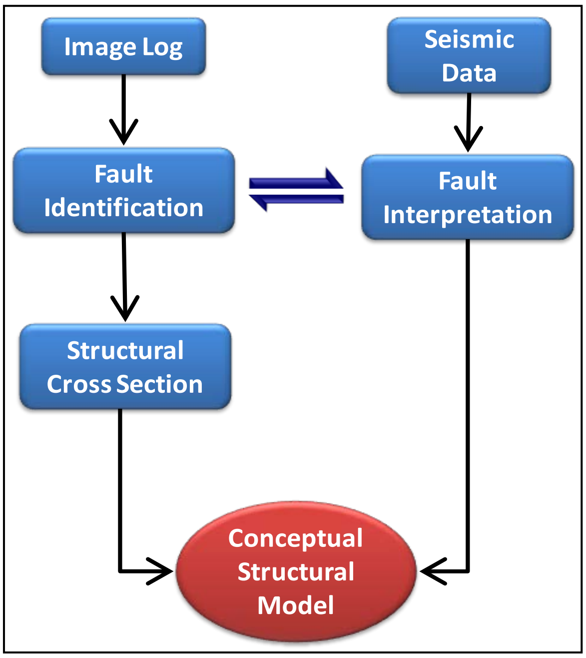

Figure 3 : Generalized Workflow

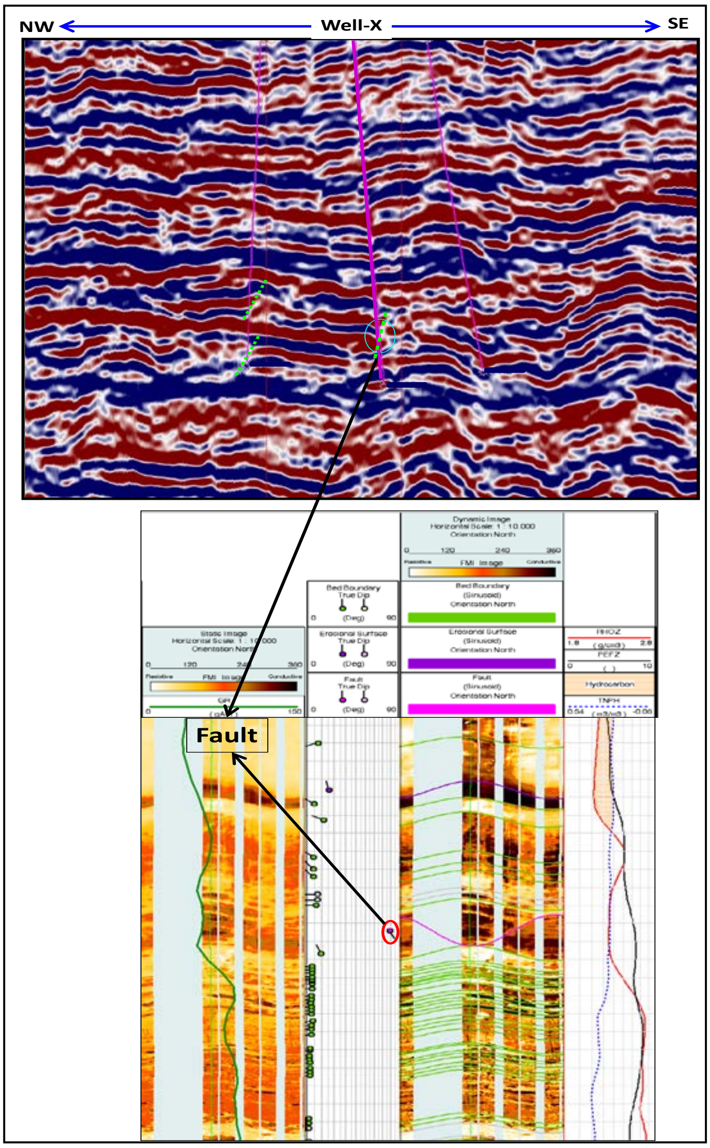

Figure 4: Fault identification on image log and validation with seismic cross-section

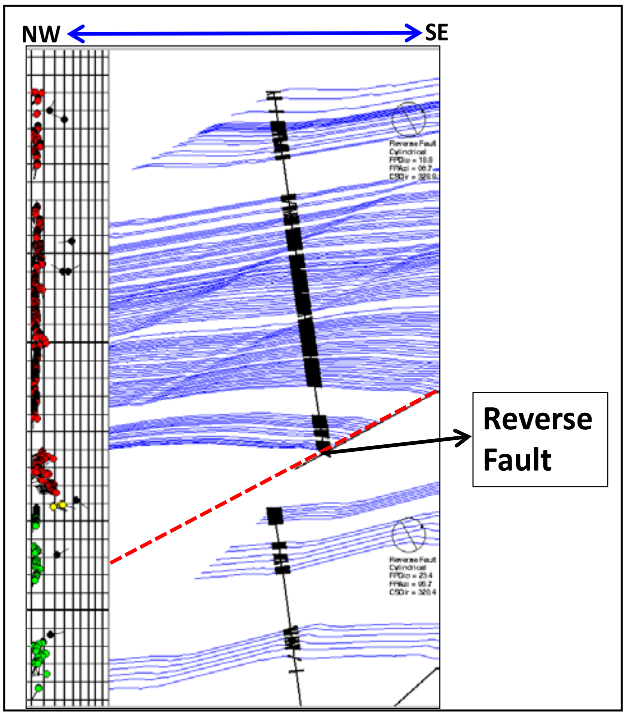

Figure 5: Structural cross-section using the bed boundary dips

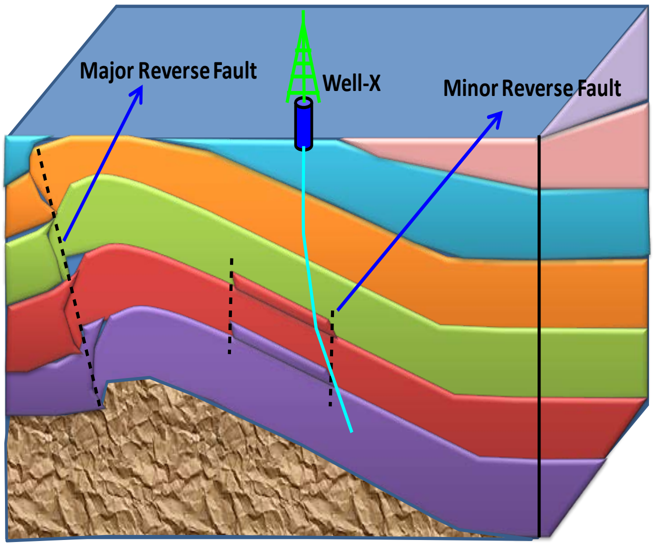

Figure 6: Conceptual model for the sub-surface complexity