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Efficacy of Real-Time-Data-Streaming for accurate and precise landing of the wells under drilling. - A case study in Mumbai High Field.

A K Nauriyal*, J Karthikeyan, Udai Singh, Jogeshwar Kumbhar, S K Anand, *(ONGC)*

Summary

As the days of easy oil are over, geoscientists have to rope in innovative technologies for exploitation of the left over oil. Further, as drilling and platform costs are sky rocketing, it is immensely important that the wells drilled should perform as per planning. Carbonate reservoirs are complex, as no fix methods are there to characterize them. Objective of this paper is to demonstrate an advanced method, in online correlation of different litho logical sections for accurate and landing of the wells at target layers.

The problem of precise landing at a particular depth/target layer can be approached in two different ways. First approach is the conventional method of predicting the target depth based on geological model superimposed on a curtain of seismic section. This may be accomplished but it has some uncertainties as encountered in geological model building and time to depth conversion. The second approach is a step ahead, as it uses the old traditional approach and ensures accuracy by the use of real-time-data-streaming technology.

The authors have depicted the efficient use of second approach as mentioned above. In this, a well correlation template is designed, which contains old drilled nearby wells and the well under drilling in between, with seismic curtain in the backdrop. As the drilling proceeds and the real time data streams in, the log motif of the well under drilling gets updated in the correlation template. The litho-logical markers are marked for the well under drilling and subsequently data is hanged at that marker level so that strati-graphically, the layers are correlated. This method predicts the anticipated depth of the next marker, enabling precise and accurate landing.

Introduction

Carbonates are strange rocks to most explorationists, although these rocks hold more than 60% of the world's petroleum reserves. Carbonate reservoirs are notoriously more difficult to characterize than siliciclastic reservoirs. These rocks offer unique challenges with respect to reservoir characterization. It includes (1) tight rock fabric resulting in problematic and not widely accepted rock physics model; (2) greater heterogeneity due to rapid vertical and lateral facies variation; (3) lower seismic resolution due to higher velocities; and (4) physical and chemical alterations causing fracturing and diagenesis.

In carbonate reservoirs, the ratio of estimated ultimate recoverable (EUR) and the original oil in place (OOIP) is significantly lower than in siliciclastic reservoirs. Therefore the incremental producibility enhancement through advanced technology application can result in significant reserve addition and economic benefits. Facies differentiation in carbonates is controlled by the geometry of the basin, water energy levels, and sedimentary type. Even in flat areas, lateral variation in facies exists. Mumbai High field (Fig.1) in India is also such type of multilayered complex reservoir.

ONGC, Mumbai, India,
Email ID: nauriyal_ak@ongc.co.in

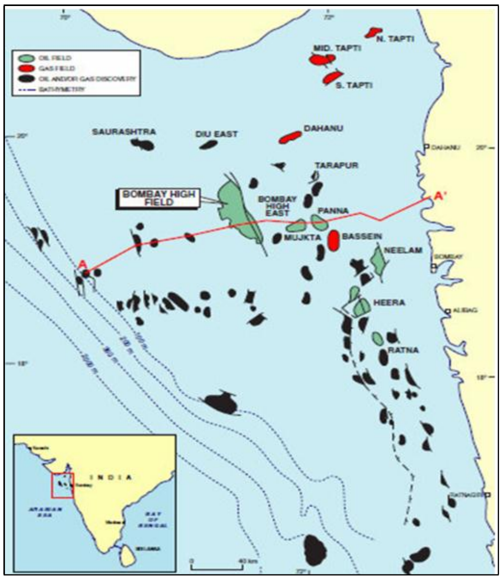

Fig 1: Location of Mumbay High (Sahay 1978)

Conceptualization of the methodology

Conventional 2D and 3D seismic mapping is not ideal for accurate mapping of carbonate reservoirs mainly because of the complexity and heterogeneity of carbonate systems. In the unique depositional systems of carbonate environment, a routine interpretation is inadequate and more sophisticated techniques are needed (Jose luis masaferro)1 . The carbonate reservoir of Mumbai High field is complex and highly heterogeneous in nature. The geological model of Mumbai High prepared on the basis of a close grid 3-D seismic data has been the input for drilling activities since the discovery of the field. It is good example of a drilling campaign driven by conventional 3-D interpretation. The geological model is continuously updated and refined with the availability of more and more well data as the campaign continues. Well no A & C (Fig 2) were already drilled and were completed conventionally. Well 'B' was recently planned and was to be drilled conventionally.

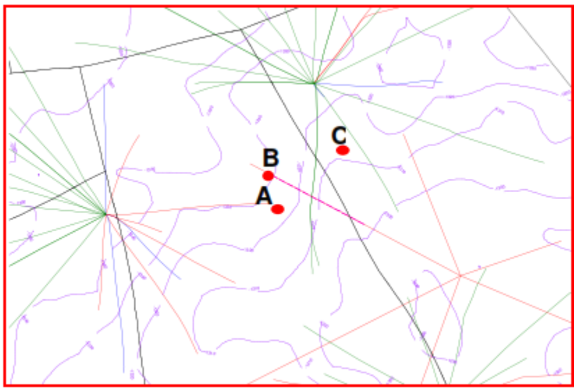

Fig 2: Location map of wells A B & C

Methodology adopted

As in the above figure, well B was to be drilled and its landing just above the 6th marker Fig.5(c) was to be ascertained.

The most important part is designing of BHA, in which the distances of different sensors from the bit are recorded. Once BHA is designed, real time data is allowed to stream in the model. The flow chart adopted is as in (Fig 3) .The logs of the adjoining wells were plotted on a well section template and the log of well under drilling is allowed to get plotted in between. As the real time data streams in, the log of the well under drilling moves further so that its markers can be validated.

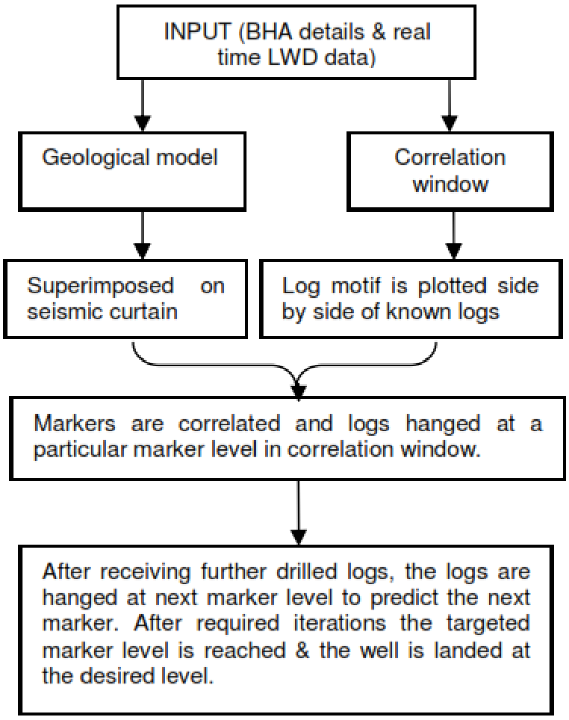

Fig 3: Flow chart adopted to target landing at the targeted layer.

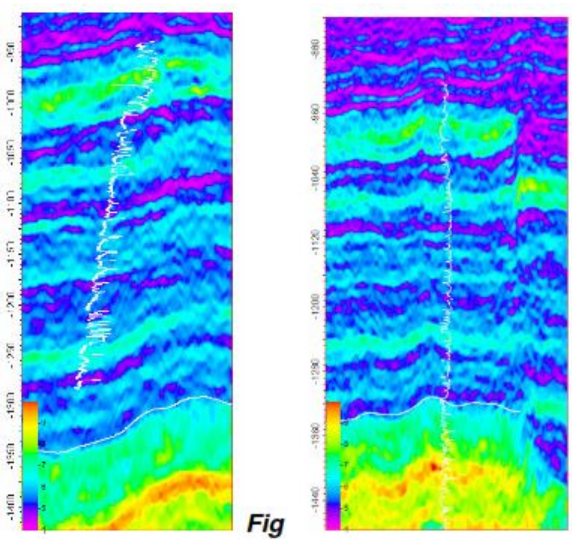

Fig 4: Gamma Log superimposed on inversion volume. In well B real time data streaming

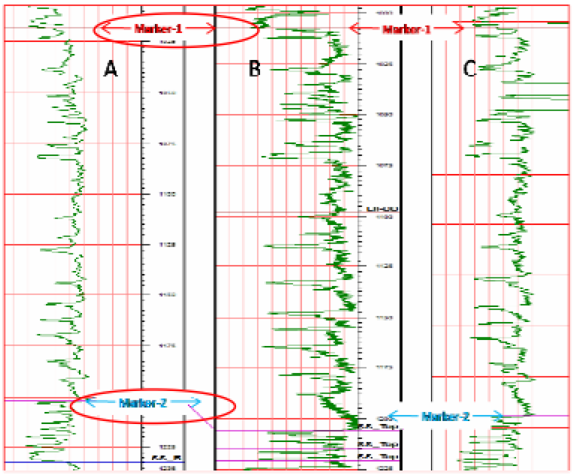

Fig 5(a):Logs hanged at marker1.

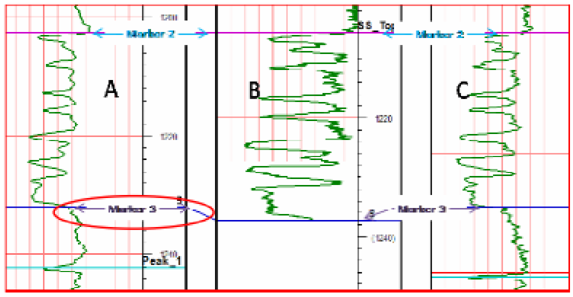

Fig 5(b):Logs hanged at marker2.

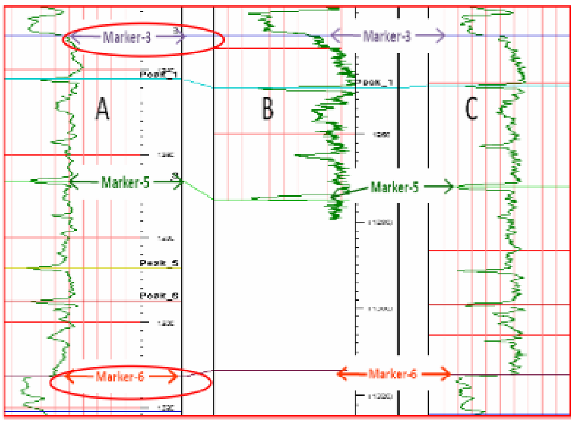

Fig 5(c):Logs hanged at marker3.

Once a prominent marker level is achieved say marker 1, the structure model is re-run and the logs are hanged at particular marker level, as in Fig 5(a),(b) & (c), so that the expected layers are correlated stratigraphically. The process is repeated iteratively till the target layer is encountered.

Discussion and Conclusion

In addition to further strengthen the confidence of layers being encountered by the logs, these are plotted against curtain of inversion volume (Fig 4).In the inversion volume, the sharp variation in values of gamma logs is clearly visible in areas where P- Impedance variations are there. This also proves the accuracy of depth match with the logs. Side by side, the logs are plotted on seismic curtain Fig(6), it also shows the variation in gamma log values. Further, the real time correlation of each marker level is done for each layer and after the structure model is updated, the logs are hanged at that marker level so that the layers are correlated stratigraphically. The process is iteratively repeated for the subsequent layers till the target layer is reached. Finally the well is landed just at the top of the target layer and thus real time data streaming is used innovatively for precise landing of the well at the top of target layers.

The development of a field depends upon how successfully, wells are placed at right depth. The uncertainty in the well placement at the top of a particular layer can be minimized by adopting a simple methodology as illustrated above.

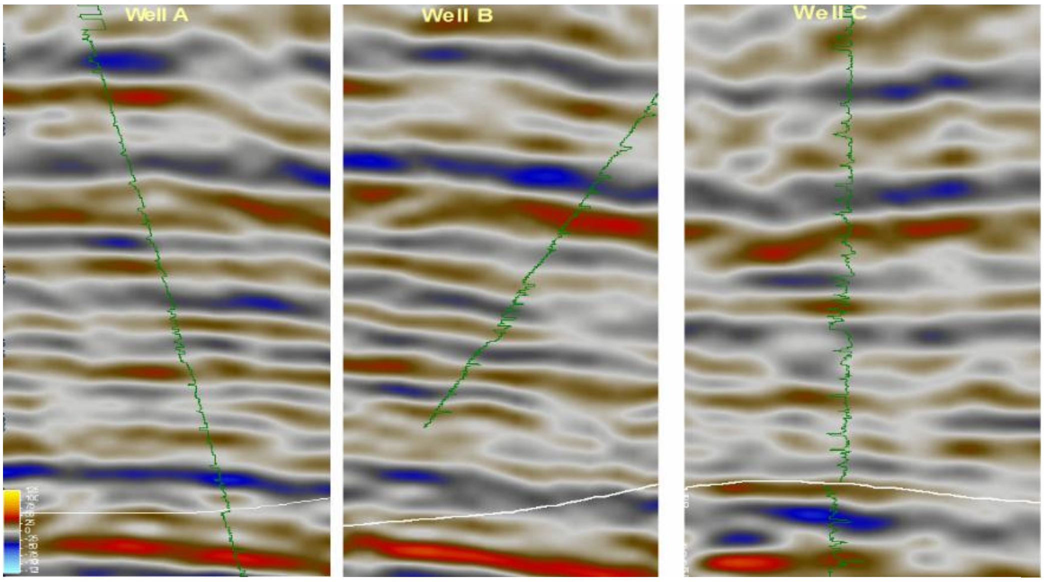

Fig 7: Gamma Log superimposed on PSDM volume. In well B real time data is being streamed.

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Further reading

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