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Confounding effects in seismic imaging – a case study

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Summary

Sometimes sole reliance on seismic data to decipher the morphology of certain geo-bodies could be misleading, as seismic signals are contaminated by noise. Many a times noise is so aligned that it is difficult to distinguish real feature from a seismic artifact. Judicious integration of all available geoscientific data with a strong knowledge of regional geology of the area will help in modeling correct reservoir description. In present study an integrated approach incorporating well data, petrological & geochemical data and reservoir performance analysis was induced as integrated design to minimize the uncertainity of seismo-geological model. The resultant has been a robust and comprehensive picture. A case study is presented from a field in Cauvery Basin where seismic alone could not depict depositional geometry of Oligocene sands. All seismic features and attributes were suggestive of channel- levee complex. However in the newer version seismic data with better imaging progradational features were seen in the sections. After integrating all the available well data and information from laboratories it could be confirmed that new seismic is showing reasonable picture and sediments were found to be deposited in prograding shelf edge slopes. This invites cautious approach for deciphering features from seismic alone without assimilating relevant geological data, information, perception and imagination.

Introduction

In the pathway of exploration to exploitation, the natural approach is to take the seismic data as prime input, due to its spread and density. In early stage of interpretation due to availability of closely spaced sampled data points other geo-data is put at low priority. Sometimes this approach may lead to weak integration of G & G data which may result in unrealistic model. Furthermore, aligned noise in seismic may give an impression of real geological picture and erroneous results may be produced(J. Hesthammer et al, 2001).

An example of such case was encountered in an area which has been covered by various vintages of 2D and 3D seismic. The area falls in the Cauvery basin of India, and covers part of southwestern plunge of Karaikal high. The NE-SW trending Tranquebar Depression in the northwest and Nagapatnam Depression in the southeast are separated by the Karaikal High (Fig-1). The generalized stratigraphy of Cauvery basin is given in Fig-2. Oligocene and Eocene sands are oil producers in the area. Mainly Oligocene sands, subdivided into 11 producing sands are the major producers. The area is densely populated with wells but delineation and production behavior from these reservoir sands is an enigma.

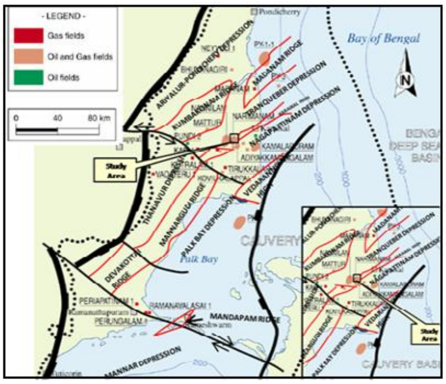

Fig 1 :Index map showing study area

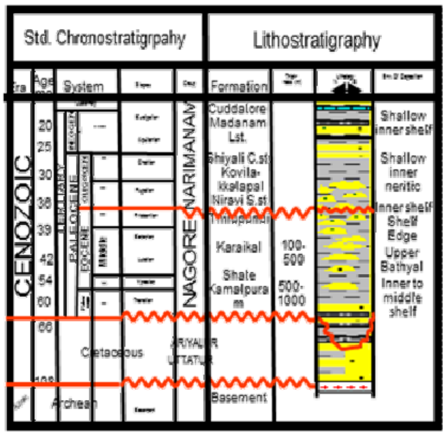

Fig 2 :Generalised stratigraphy of the area

Problem

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In the area under discussion, reservoir characterization of Oligocene pay sands was taken up. The area has been covered by repeated 3D surveys. Older volume of 3D seismic shows channel like features in the seismic (Fig-3) as well as attributes (Fig-4), whereas newly acquired seismic depicts progradational continental shelf edge in Oligocene sediments. Now problem lies in "which data to honour and true geological model be constructed" (Fig-5,6).

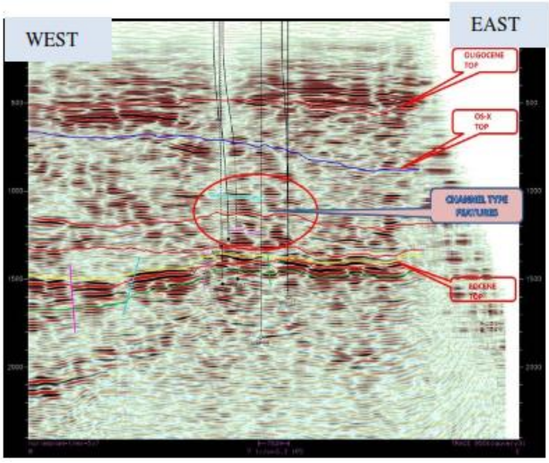


Fig 3 :Older vintage of seismic showing channel features.

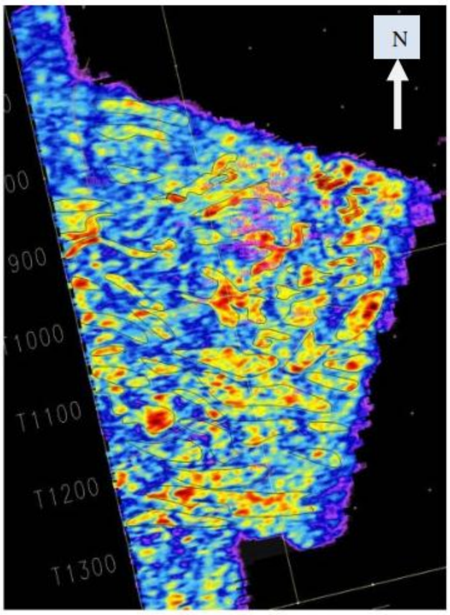


Fig 4 :Channel like alignments in older vintage seismic

Methodology

To encounter the problem an integrated approach was undertaken. All the results of studies from various laboratories, well data (including core data) and works done by the earlier scientists were gathered and analyzed. Old seismic depicted channels and the new, a progradational shelf; it was tried to understand through electro-logs but sands showed blocky nature and the result was inconclusive. Sedimentological studies suggested that Oligocene sediments indicate varying sedimentary environments from basin plain-slope-shelf in marginal marine conditions. Analysis of well data indicates lobate pattern of sand bodies spreading over a large area suggestive of shifting deltaic lobe sands and barrier beach sands over prodelta silts and muds. The pyritiferous sands and presence of H_2S in the sediments denote highly reducing environment (a situation not possible in channels). Detailed study of cores from the pay sands show presence of fine to coarse grained, also pebbly sandstone exhibiting upgraded to normal graded sequence. The facies in the sandstones are dominated by sandy debris flow and bottom current reworking with minor slumping (again refuting channel environment). With the support of these data it was confirmed that the pay sands of Oligocene age are definitely not channel sands as mis-interpreted in older version of seismic. The new 3D seismic is providing the continental shelf edge where sands have been deposited on the slopes (Fig-7).

Discussion

Most of the seismic interpretations are based on integrated use of seismic inlines, crosslines, random lines, time slices and horizon attributes (e.g. Buchanan, Marke, & Ruijtenberg 1988, Dalley et al 1989, Tucker, Franklin, Sampath & Ozimic 1985). Seismic data contains a mixture of signal and noise (sheriff, 1978), and the noise may sometimes be very much aligned giving an impression of geologic feature. At times the noise and signal interfere so intensely that the confounding effect makes interpretations erroneous. In present times when seismic has gone up to reservoir level this phenomenon can result in wrong investment decisions. The challenge is to separate a seismic artifact from real geological feature. In the present study area well data was abundant as the area is in development stage and hence the model could be refined, but in the cases of exploration well data is very sparse and it becomes very important to critically examine the data inside as well as outside the study area. The information available from nearby areas and areas having similar setups can play a vital role in seismic interpretation.

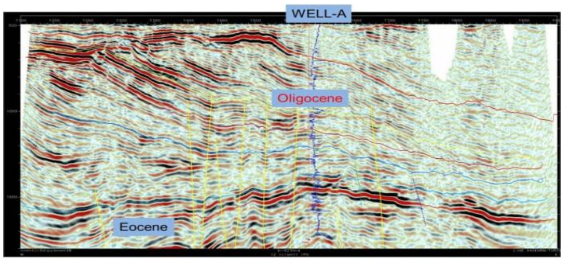
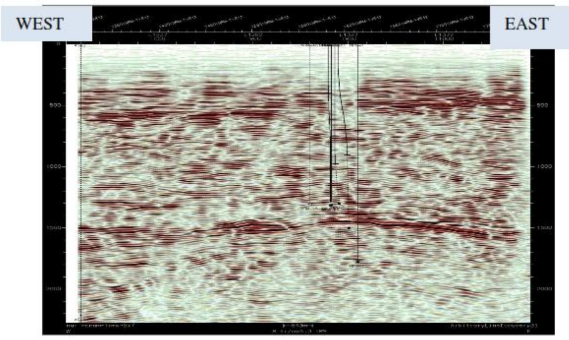
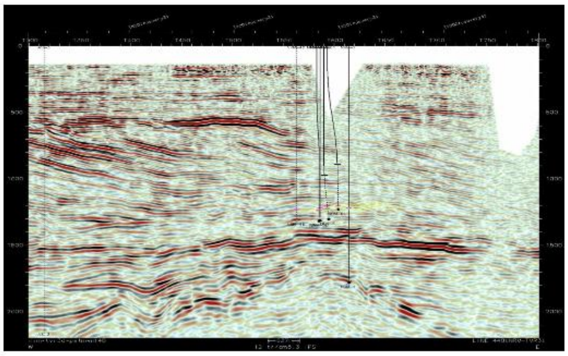


Fig 5 :Inline through well-A from new seismic vintage showing progradational features in Oligocene



Seismic line from old data



Seismic line from new data

Fig-6: Comparison of old and new seismic data set.

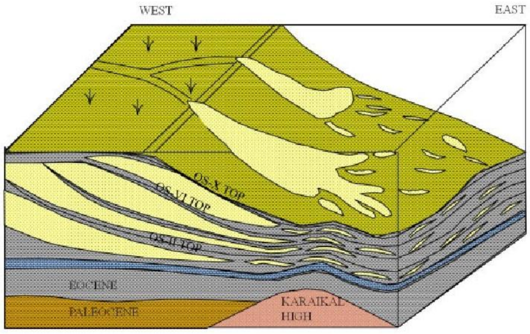


Fig 7 :Depositional model of Oligocene pay sands.

Conclusion

Seismic data provides the most important tool for interpretation but at times it can be deceptive because of noise alignments and other pitfalls. To separate real geological feature from a seismic artifact all the available data and information in and around the study area should be integrated before drawing any conclusion.

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