seismic traces through inversion.

Example-4:

This example shows the effectiveness of stratigraphic inversion in delineating thin pay sands, which are encased in shales at depth ranging from 2.5 to 3.5 km. These sand units have been divided in to 12 units from bottom to top and some of them are further divided into still smaller subunits as can be seen in the Figure(7). The thickness of these units generally vary between 2-18 m which lies well below the limit of seismic resolution and as a result composite seismic response is being observed in most of the cases. The systematic delineation and development of these thin sand reservoirs from conventional seismic is a challenging task due to their limited areal extent and greater depth of burial. The amplitude variations of seismic traces depend on impedance contrasts and thin layer interference. A zero phase vertical seismic section XX' extracted from 3D seismic data volume, along with interpreted horizons is shown in Figure (8a). The amplitude map of upper unit 12, extracted from seismic volume shown in Figure(8b), shows the spread of sediments in eastern part of the area with patches in western side also. As per well data, unit -12 is absent in the western part of the area. To resolve the situation, stratigraphic inversion was carried out. The interpreted horizons, well log data and extracted wavelet from seismic data were used to generate initial acoustic impedance model for carrying out post stack stratigraphic inversion. Model based inversion technique was used for inverting seismic data volume into acoustic impedance volume. The acoustic impedance vertical section along seismic line XX' shown in Figure(8c) displays the layer by layer acoustic impedance information of reservoir and nonreservoir facies between wells and away from the wells in terms of their thickness, lateral areal extent and quality of sand which were not possible in case of conventional 3D seismic data. An acoustic impedance map was generated taking a window of 14ms below the tracked horizon, which corresponds to unit-12 and is shown in Figure(8d). This map clearly shows that the sand distribution is only in eastern part of the study area and rest of the area is devoid of this producing sand unit and the reservoir distribution within the eastern lobe is modified which matches with well data. This precise mapping of reservoir sand geometry has been very helpful in delineation of the hydrocarbon pool limits.

Conclusions:

These examples show that post stack stratigraphic inversion integrates seismic and well log data along with other geologic informations. Acoustic impedance provides a superior basis for detailed reservoir characterisation compared to reflection amplitudes and amplitude based attributes. Higher vertical resolution and accurate layer-by-layer lateral extrapolations of acoustic impedance has proved to be an ideal "common currency" for communication between geophysicists, geologists, petrophysicists and reservoir engineers. Acoustic impedance volume can be used with concrete physical meaning to improve the stratigraphic interpretation, sedimentary architecture, lithology prediction and to refine the drilling and / or planning of development and new exploratory and development wells in onland and offshore areas. Thus, stratigraphic inversion has emerged as an invaluable tool for estimating the spatial distribution of thin reservoirs and also for quantifying various reservoir properties in an effective way.

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Structural Play and Hydrocarbon Distribution in OLPAD-DANDI Area, Cambay Basin, India

BVRRK Murty, A. K. Parakh, P.H. Rao, D. B. Jadhav, C. P. Sharma, S.P. Painuly

Oil and Natural Gas Corporation Limited, Vadodara- 39 0 009

Abstract :

A network of alternate horsts and grabens forms the structural style of Olpad Field. Incidentally, on the crestal part of Olpad structure, the wells drilled on cross trend highs produced gaseous hydrocarbons whereas the lows are devoid of hydrocarbons. This observation is interesting and the same could be applied logically to fit on the plunging part of the structure also, which opens up vast area for exploration around the flanks of the structure. A fence diagram based on Micro detailed correlation of log data is attempted to bring out the extension of sands in Olpad-Dandi area. The fence diagram, with its own limitations, however, could explain the conceptual sand model and its shale out limit. Seismic inversion a better method to understand the vertico-lateral extension of the lithological units, was attempted on 2D lines in the area and the cross trend high in the plunging part of the structure, where the presence of reservoir facies is confirmed by the inversion method, merit exploration on the analogy adopted by the logic of cross trend highs entrapping hydrocarbons vis a vis lows proving dry.

Introduction :

The area under study (fig-1) falls in the west of Sayan low in south Cambay Basin, India. A number of wells drilled in the area on the Olpad structure produced gaseous hydrocarbons from Oligo-Miocene sands. Though Tarakesvar and Babaguru sands of Oligo-Miocene age are wide spread in the area there have been surprises in exploration, which necessitated the prediction of sand extensions and porosities in the area. The interval subdivision of Tarakesvar sands into five units has been made on the basis of electro log data, the lower most having been designated as TS1 and the top unit as TS5 in the increasing chronological order.

Fig.1: Map of Cambay Basin showing study area.

Most of the wells drilled in Olpad field fall on the crestal part of the structure. A close look into the distribution of hydrocarbons in the field reveals that all the producing wells are falling on cross trend highs and the dry wells on low. The plunging part of the structure also exhibits a similar pattern of structural style and offers a vast area for exploration as the same logic of high producing gases could be extended to the entire spread of the structure. So far most of the cross trend highs on the plunging part have been tested for hydrocarbons. Therefore, a critical study to find out the extension of reservoir facies on to these highs has been made, first by preparing a fence diagram based on micro-detailed electrolog correlation and then by carrying out seismic inversion on some selected lines passing through the drilled wells. Seismic traces converted into acoustic impedance logs have better served the purpose of identification of vertico-lateral variations of a stratum. Though, the techniques of seismic inversion is more useful in a 3D volume of sesimic data, in the present study, it has been applied on 2D seismic lines passing through drilled wells, as 3D data is not available in the area, Fence diagram depicting micro-detailed correlations of sand reservoirs within Tarakesvar Formation has been prepared (fig. 2).

Geology of the Area :

The referred area under study is a part of Narmada tectonic block of Cambay Basin. The tectonic, geologic and sedimentary evolution of Cambay Basin resulted from the early Cretaceous to Paleocene rifting and subsequent extension and widening, which was subjected to severe tectonic activity during Miocene period.

Structural inversion, as a consequence of intense compressional forces, is the main tectonic exhibit in the area. Olpad-Hazira reverse fault trending NE-SW with an element of strike slip movement resulted from the severe tectonic activity and fold propagated structures Olpad, Hazira and Laxmi were formed along the fault. All these structures are hydrocarbon producers in Oligo-Miocene sands.

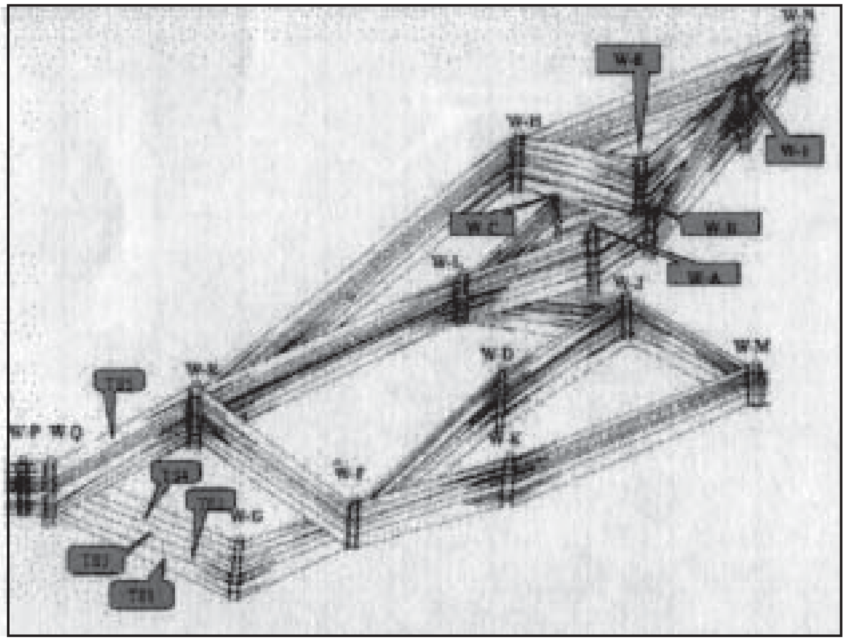

Fig.2 : Fence diagram depicting the micro-detailed correlation of sands within Tarakesvar Formation.

Structural Setup :

Structural maps (fig-3) prepared close to the tops of Babaguru and Tarakesvar Formations reveal the structural setup of the area. Olpad structure was the resultant of the fault-propagated fold along the Olpad-Hazira reverse fault that was reactivated during the late Eocene to early Oligocene period along the pre-existing normal fault. Besides Olpad-Harzira reverse fault trending NE-SW, many similar trends parallel to it are mapped. Cross trends aligned in E-W direction are also mapped which merge with the main reverse fault displacing the NE-SW trends. The network of NE-SW and E-W trending faults generate a horst-graben configuration.

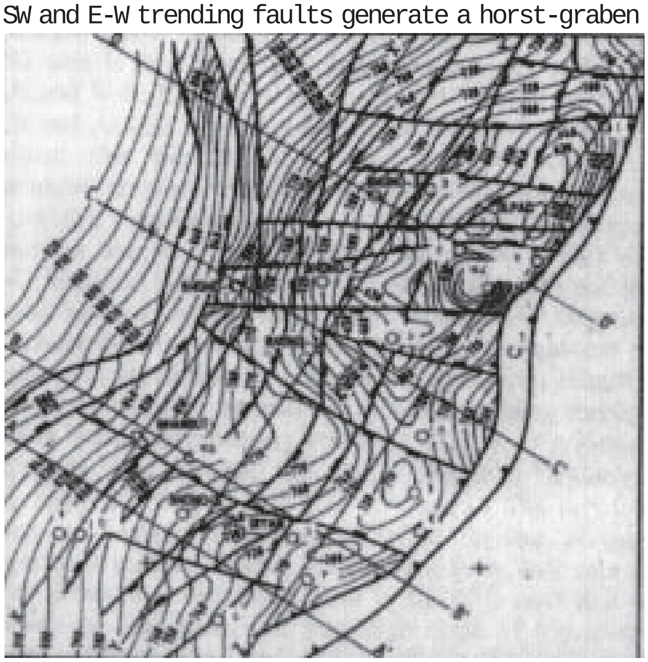

Fig.3: Structural map on top of Babaguru Formation.

Seismic Inversion :

In the study area sonic and density logs are available for wells W-Q and W-R, By using these logs inversion was carried out on a few lines passing through the drilled wells and the prospective areas. Based on seismic inversion results, geological model was built which was helpful for micro-analysis of lithological units in a given frame work of depositional environment. The amplitude spectrum and the calibration of well log, seismic fig-5 respect

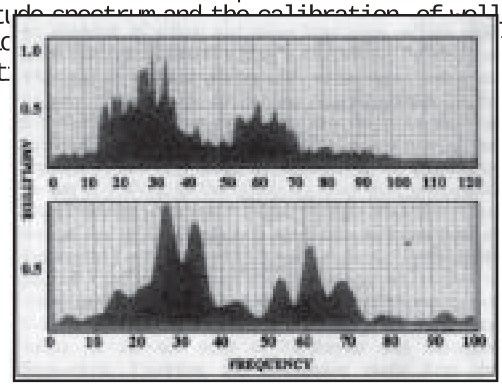

Fig.4: Amplitude spectrum at the zone of interest.

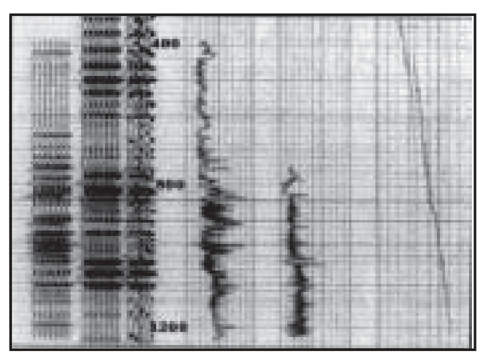

Fig.5: The correlation window indicating correlation between synthetic and actual data.