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AVO Analysis of Rohtas Formation and Kaimur Sandstone along selected reprocessed lines in Son Valley, Vindhyan Basin, India

Sonu Kumar [1], Vivek Kumar Singh[2], Prabhat Ranjan[1], Nancy Jain[2], N.K. Verma[1], A.K. Arya[1], D.K.Srivastava[1] & D.N. Singh[1]

1. **Frontier Basin, ONGC, Dehradun- 248195 2. GEOPIC, ONGC, Dehradun**

e mail: sonugeo11kuk@yahoo.com

Abstract

Seismic information from a carbonate reservoir, even fluid effects can be modelled and extracted from basic AVO conditioned gathers using attribute analysis and elastic parameter inversion. Recent advances in these areas are reviewed along with new studies in carbonate rock properties, carbonate AVO characteristics due to fluid effects, and elastic rock properties. This petrophysical understanding forms the basis for AVO calibration and interpretation and is a key issue to be considered.

AVO analysis in Damoh-Jabera-Katni area of Son Valley, Vindhyan Basin has been attempted on few selected reprocessed seismic profiles. The primary objective of the study was to calibrate the known gas pools in drilled wells vis-a vis their AVO response and also to look for the impedance characteristic of limestone and sandstone reservoirs which may generate different classes of AVO anomalies.

Gradient Plot and Cross-plot of the selected lines indicate class-I AVO anomaly corresponding to likely gas bearing layer of wells N #A, B and C. Weak anomaly could be observed in the gathers corresponding to the gas bearing zones within the Rohtas Limestone. The characteristic class III anomaly, however, was not observed in any of the well in Kaimur or Rohtas Formation which can be attributed to absence of typical low impedance sandstone or porous dolomitic limestone reservoirs in the area.

Key words: Impedance, AVO response, Gas Anomaly, Fluids effects.

Introduction

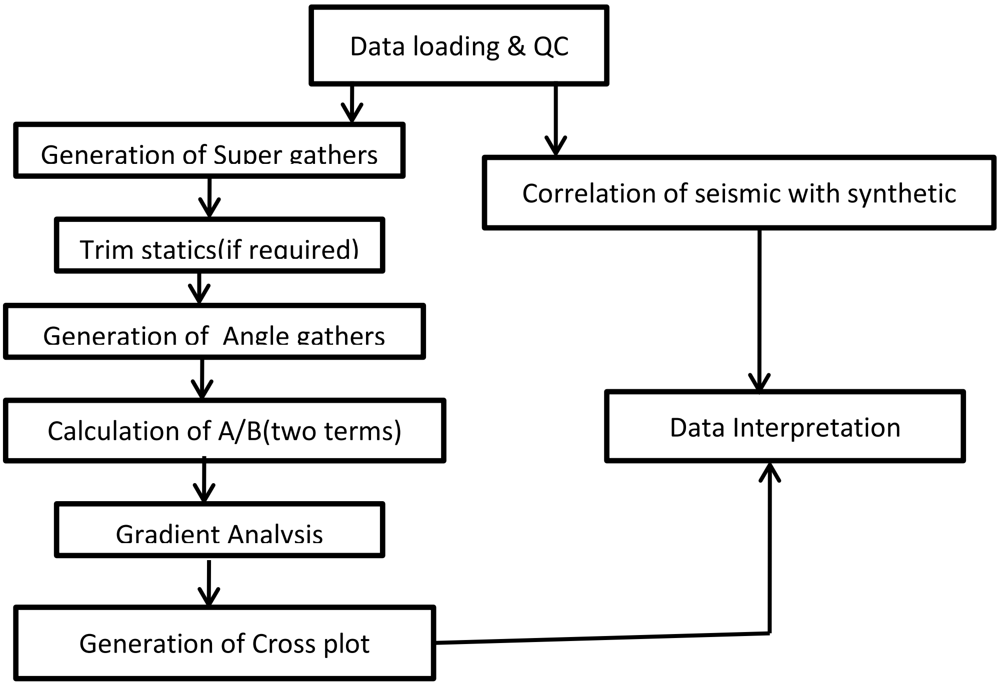
Presence of hydrocarbon gases has been established within different stratigraphic levels of Lower Vindhyan Rohtas Limestone and Upper Vindhyan Kaimur Sandstone in the Damoh- Jabera-Katni PEL block, Vindhyan Basin. AVO Studies on pre-stack gathers of selected profiles were planned in the study in this block with an object to calibrate the response of gas bearing zones in wells and to correlate them with AVO anomaly responses if any. Eight 2D seismic lines passing through the drilled wells/ released locations (Fig. 1) in the Damoh-Jabera- Katni PEL block were reprocessed up to PSTM stage.

Background

Detection of presence of hydrocarbon fluid using AVO analysis has been extensively used in the hydrocarbon industry. There are several publications (Castagna *et al*; 1997, Goodway *etal ;* 2011) citing the use of this technique for the identification of pore fluid particularly gas as well as lithological properties. The AVO (amplitude variation with offset) technique assesses variations in seismic reflection amplitude with changes in distance between shot points and receivers corresponding to a CDP. AVO analysis is widely used in hydrocarbon detection, lithology identification and fluid parameter analysis, due to the fact that seismic amplitudes at layer boundaries are affected by the variations of the physical properties just above and below the boundaries. AVO anomalies related to hydrocarbon may show increasing or decreasing amplitude variation with offset (Castagna *etal* 1997)

Methodology

Pre-stack gathers have been taken for the present study. SEG-Y, log data, check shot data and velocity data have been loaded in the Hampson Russell software. Well-seismic tie have been correlated to identify the gas bearing objects in the gathers to see their AVO effects before carrying out AVO procedure. The following work flow was adopted for the AVO analysis;



Limitations of the study

AVO study in the Proterozoic basin has been carried out for the first time where the physical properties are not very well known. In the area of study mainly class-I anomaly are observed in the known gas bearing layers present in the Rohtas Limestone Formation. As we know that a very small amount of gas may cause AVO effects but it cannot predict the commerciality of the gas presence in the layer. In carbonates the effects may also at times be attributed to lithological variations.

Discussion

A pilot 2D seismic line passing through wells N# A&B (gas bearing wells) has been taken for the calibration of the presence of gas and its AVO effect. Well to seismic calibration (Fig.2A) shows an event near 700ms found to be gas bearing on production testing. Angle gather have been generated applying RMS velocity on offset gather. Angle Gathers are reasonably flat near the gas bearing zone shown in red circle (Fig 2B).

Gradient product (Fig 3A) and cross plots (Fig. 3B) have been generated in well N#A for the events within the time interval 620-665ms. The cross plot indicate the clear separation from the background noise (Fig 3B). Gradient Plot (Fig.3c) shows decrease of amplitude with angle and thus indicating class-I AVO anomaly in 620-665 msec. This validates the presence of gas in well N # A which was tested in this zone barefoot and produced gas

Similarly, AVO analysis was also carried out for wells N#B, N# C (Fig, 4 A-E) and J# C (Fig.5 A-D) in time intervals corresponding to gas bearing zones. In such cases, the class-I AVO anomaly is observed which validates the presence of gas.

Conclusion

The AVO analysis has validated the gas bearing zones in some of the tested horizons within Rohtas Limestone. Class I anomalies observed against the gas bearing zones. The anomaly can be used as a supportive evidence for the exploration of gas within Rohtas Formation.

Acknowledgement

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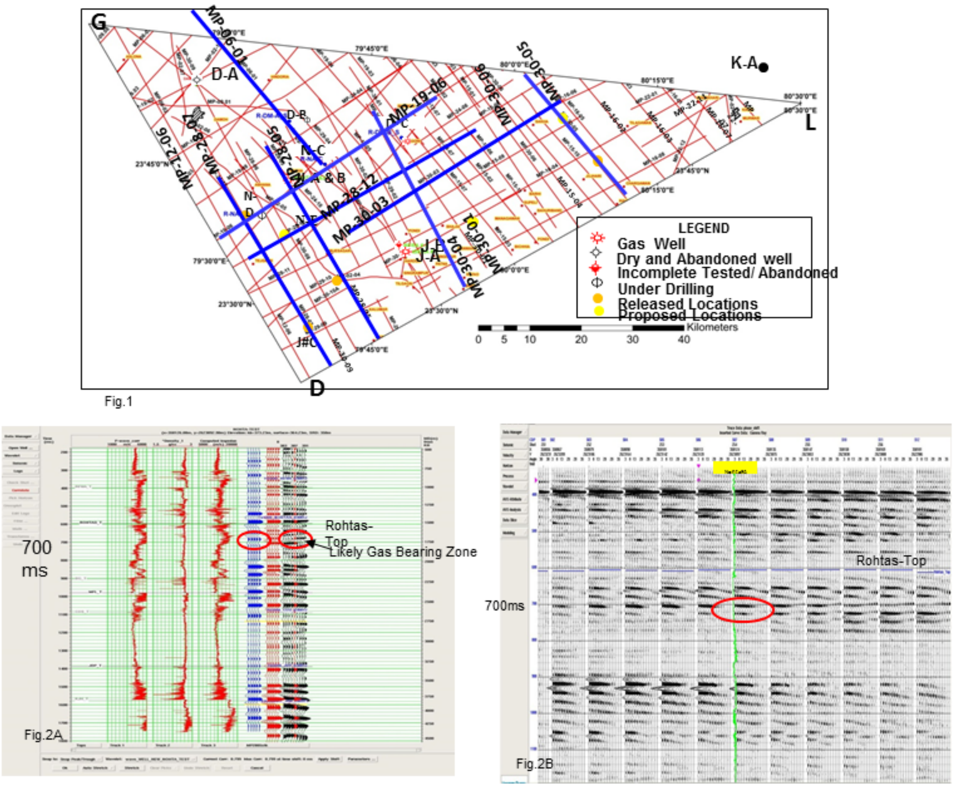
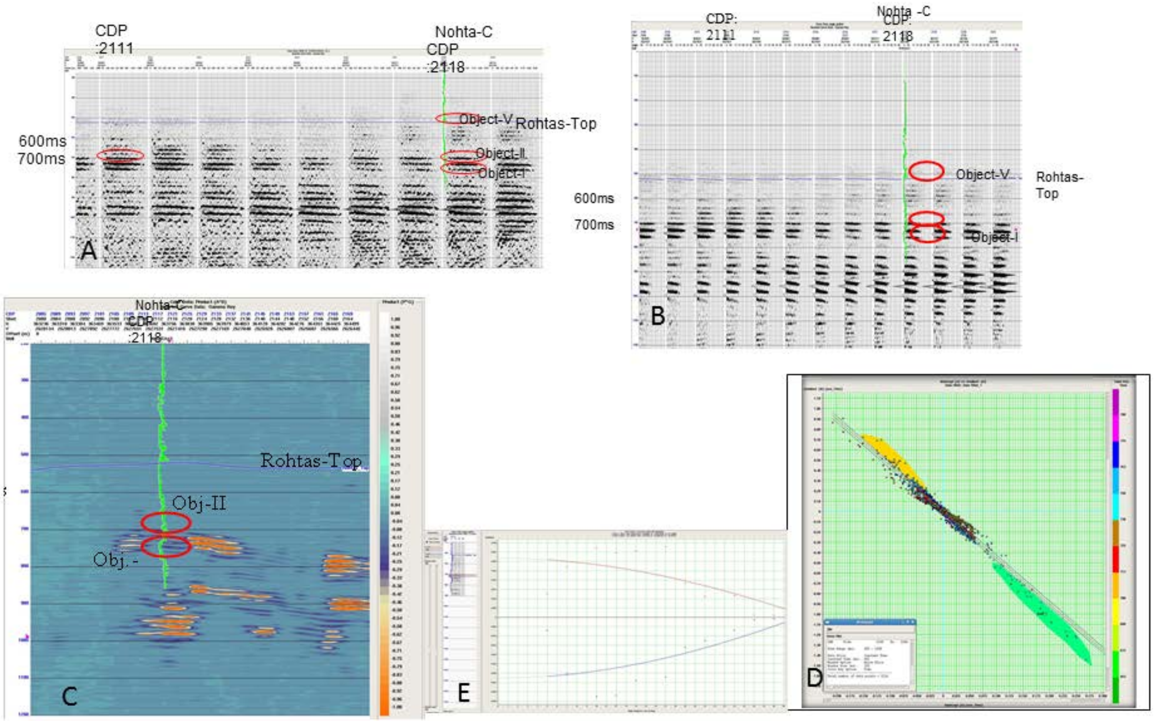


Fig.1.Location Map of the Damoh-Jabera-Katni PEL block with selected seismic lines for the studies . Fig. 2A. Synthetic seismogram of well N#A. Fig. 2B Angle gathers of N#A.



CDP: 2100-2140, Time: 650-800ms

CDP: 2118, Top event: 704ms, Bottom event: 718ms

Fig.4: A. PSTM gathers B. Angle gathers C. Gradient product D. Cross plot and E. Gradient Plot. The gradient plot (decrease in amplitude with angle) indicate class-I AVO anomaly in 650-850msec validating the presence of gas in object II and object I in well Nohta# C.

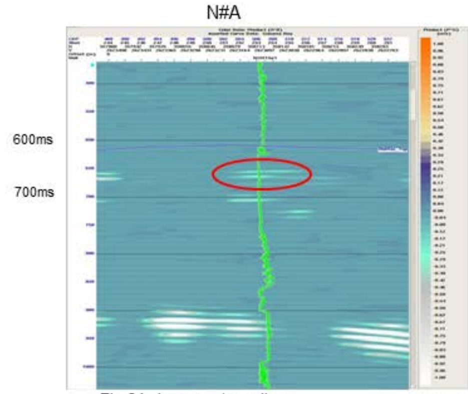


Fig.3A. Intercept* gradient product

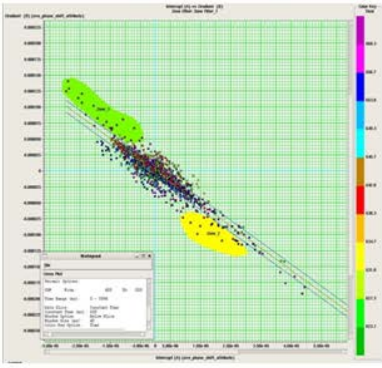


Fig. 3B. Cross plot of intercept & gradient well N# A(CDP: 450-550, Time: 620-665ms)

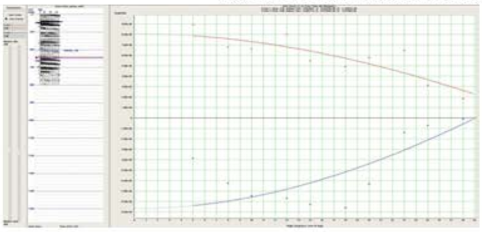


Fig. 3C. Gradient Plot: well N#A at CDP: 506, showing class I anomaly, corresponding gas bearing zone (event top: 642ms, event bottom: 648ms)

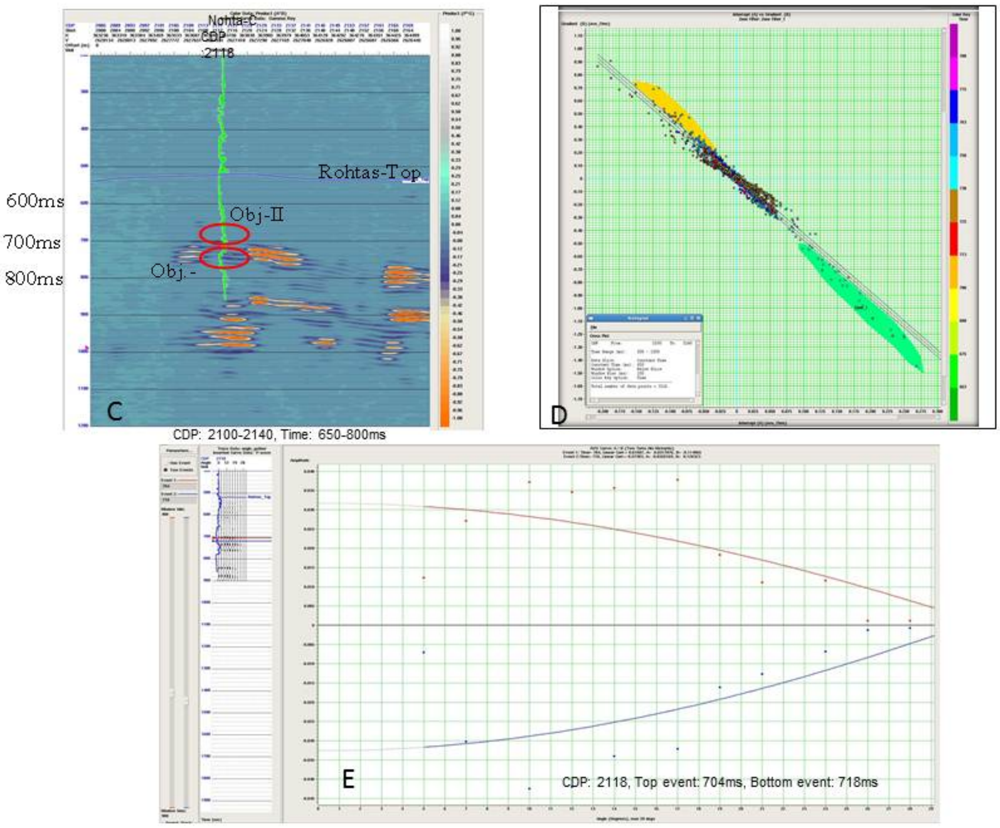


Fig.4: A. PSTM gathers b. Angle gathers, C. Gradient product D. Cross plot and E. Gradient Plot. The gradient plot (decrease in amplitude with angle) indicate class-I AVO anomaly in 650-850msec validating the presence of gas in object II and object I in well N# C.

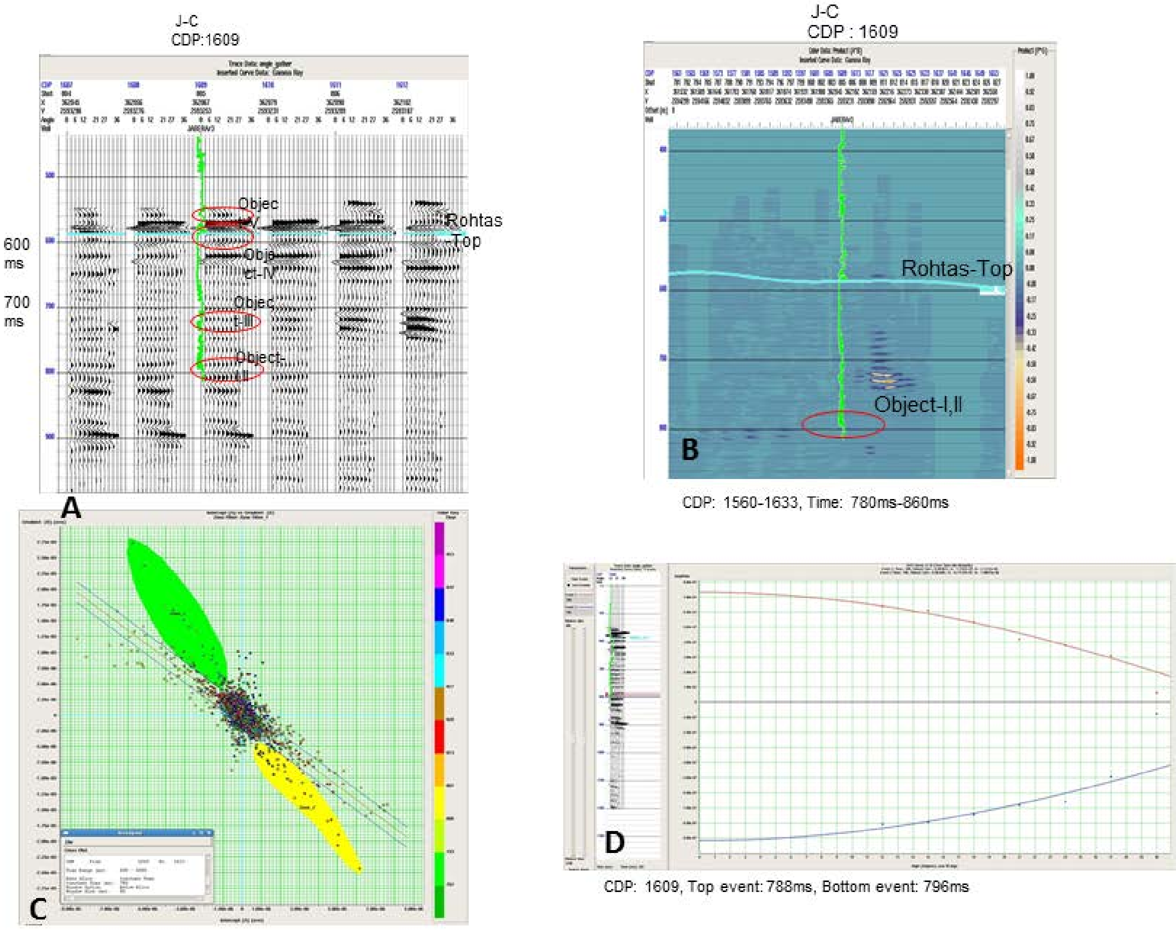


Fig.5 A. Flat angle gathers. B. Intercept gradient Plot .C. Cross plot of intercept and gradient indicating class I anomaly. D. Gradient plot shows decrease in amplitude with angle and indicates class-I AVO anomaly in well J-C.