Identification of Porosity Pods in Paleozoic Sediments in Ganga Basin

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Summary

Seismic derived velocities are very useful for understanding regional geological setups in terms of facies changes, compactness trends, overpressure zones, localized build-ups, etc. Model based PSTM / PSDM process enhances the confidence on the velocity estimates, thus contributing to confirm anomalies. Further, post-stack seismic amplitude inversion helps in identifying low velocity/acoustic impedance zones. These zones can be potential targets for hydrocarbon exploration. In such instances, seismic velocities tend to show a decrease in trend. Present study on velocities pertains to Ganga Basin in India, which has a long and complex evolution history with a valid petroleum system based on the drilled well data. Thick Paleozoic sediments deposited in passive margin setting are among potential targets with very high interval velocities vary from 3500-5000m/s. Lab studies show that the porosity of reservoir rock has been diagenetically altered due to infilling by calcite cement near the highly tectonized thrust zone. Lack of commercial hydrocarbons in this area is mainly attributed to poor development of porosity of the reservoir rock. Therefore an attempt is made to identify any velocity inversions within this zone through special processing of CDP data. Interestingly, post stack inversion studies show areas of low velocity zones may be due to higher porosity developed probably due to low magnitude faulting and fracturing and could be the potential targets for hydrocarbon exploration point of view. This paper demonstrates overall methodology used to bring out low velocity zones through special studies carried out on the seismic data.

Introduction

Velocities derived from conventional velocity analysis have been used for identifying any velocity inversions within the zone of interest. Ganga basin has a long and complex evolutionary history. Major tectonic grains shown in the figure 1. The Basin initiated as an Intra-cratic rift during Meso-Proterozoic in extensional settings and subsequently changed over to passive margin setup. Paleozoic sediments were deposited in the passive margin setting. This sequence during Paleozoic time represents a phase of continuous platform deposits. Sediments deposition was limited by pre-existent ridges and few basement controlled faults. Mesozoic and the early Palaeogene is the time of erosion and regional peneplanation during which sediments were mostly removed from highs and preserved within few linear lows across the basin.

Figure 1. Geology and Tectonic map of the Ganga Basin.
high in the proximal part (towards north) and thins out towards the distal part away from the orogenic belt. Geology and tectonic map of the Ganga basin is shown in the figure 1. Ganga basin is completely covered with alluvium at the surface.

Figure 2. Base map with seismic line AA’.

Seismic line AA’ (Figure 3) shows sedimentary thickness increase towards north. Wells drilled over structural highs in the south show that the Paleozoic section which is considered to contain possible reservoir facies is tight and indicated only HC shows. Careful analysis of seismic data in the basinal part of the area showed the presence of imbricate faults some of them appear to be sub-seismic. An attempt is made to examine CDP data to assess for any velocity inversion in the Paleozoic section.

Stacking Velocities

Close grid velocity analysis for the entire line was carried out at an interval 250m. Though sufficient offsets are not available for imaging deeper section, the offsets are just sufficient for meaningful analysis at the target horizons.

Consistent lowering of the stacking velocities is observed within this zone in the north compare to that in south (figure 4).

Figure 3. PSTM derived Stack section along the profile AA’

Figure 4. RMS velocity model.

Figure 5.A. Velocity analysis at CDP 600.
Interval velocities (figure 5A, 5B and 5C) at CDPs 925 and 975 decreases from 5000m/s to 3600m/s in the Paleozoic section while at CDP 600 velocity remained higher. Interval velocity profile derived using Dix equation indicate lowering of velocities within the Paleozoic sediments in the encircled zone.

Post-stack inversion

Normal incidence section from PSTM data is subjected for inversion studies. Smoothened interval velocity (figure 7) has been used for back ground trend for the inversion through recursive approach. The impedance section (figure 8) clearly indicates lowering of impedance from CDP 900 to 1333 between 2500 to 3100ms. Close examination of seismic section in this interval shows presence of number of low magnitude faults probably resulted in velocity inversion.

Coloured acoustic impedance overlay on PSTM stack highlight the area of interest with much more clarity.

The identified low velocity/acoustic impedance zone could be due to the higher porosity developed through low magnitude faulting and fracturing within the Paleozoic sediment as observed on the stack section (fig. 3) This zone could be a potential target for the hydrocarbon exploration.
Conclusions

Paleozoic sediments in Ganga basin are so far considered as poor reservoir facies but present analysis of data show that there are zones of interest for exploration. Conventional as well as PSTM velocities confirm lowering of interval velocities (drop in interval velocities of the order from 5000m/s to 3600m/s) in the basinal part. These porosity pods exist close to the kitchen and enhances the prospectivity. Additionally, the low acoustic impedance zones identified impedance section is probably due to the higher porosity. These zones are likely to contain primary and secondary porosity as a result of low magnitude faulting and fracturing. These faulted and fractured zones are not diagenetically altered because most of them are confined to Paleozoic sediments and below and hence forming a potential target. Thus a simple and most effective methodology has helped in identifying likely porous pods in Paleozoic section of Ganga basin.

Reference:


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