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Surveillance over a Blowout Region using NRMS repeatability : A case Study from Dikom Field in Upper Assam Basin.

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Summary

3D seismic data from 1995 and 2008 are used to investigate blow-out related seismic amplitude changes in the Eocene reservoirs of the Dikom field. Differences in reflection amplitudes and other attributes in these data vintages are used to interpret and constrain the spatial distribution of reservoir properties and probe into insight of the depletion process due to blow-out. 4D seismic data is considered as a relative measure of change in the reservoir and it has to be suitably calibrated and normalized. NRMS data is used to remove more anomalous measurements. NRMS amplitudes can be interpreted as a fractional change in amplitude relative to the original. Production profiles for several wells and seismic based attributes align towards the results predicted through NRMS amplitude differences. This study normalizes the two seismic surveys acquired in two vintages and interprets the amplitude differences, as well as correlating the seismic volumes thereby identifying the regions which may be affected by the blowout. On the process of updating the reservoir by calibrating 4D data of different vintages has given a better understanding of changes to the reservoir and also reduces risk in forecasting leading to better decisions about reservoir maintenance and infill well targeting.

Background of investigation

The area of interest lies in the southern bank of the river Brahmaputra. In September 13, 2005 there was a blowout in the well Dikom 15 which was producing oil @40 klpd through 12mm bean . Immediate actions were taken and blowout /fire was controlled with the help of M/s Boots and Coots, USA, ONGC, and Oil India personnel on 05.10.2005. Following circulating the well with Bentonite gel, a cement plug was placed in the range from 3498-3194m on 09.10.2005 and the well was shut in. Finally the well was abandoned during July`06. Basemap of the study area is represented in Figure 1.

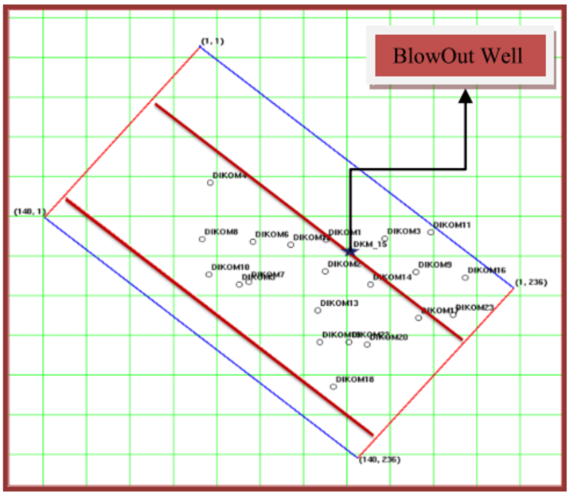

Figure 1 : Basemap of the Study Area.

Time lapse (4D) seismic monitoring is accomplished by recording surveys over the same field at different vintages. Seismic surveys were carried out in 1995 (referred as the BASE survey) and in 2008 (referred as the MONITORED survey). The technique assumes that the blow-out changes the acoustic/elastic properties of the reservoir. Since seismic signals related to reservoir geology are common to all surveys, they can be removed by subtraction. In addition, differences in the signal acquired in different vintages improve the ability of the seismic to detect subtle blow-out related changes in the reservoir. **Figure 2.1(a)** represents the difference in RMS reflection strengths over In Line 46 (near the Blowout well) and **Figure 2.1(b)** represents the difference in RMS reflection strength over Inline 123 (away from the blowout well), and clearly demarcates that the changes in amplitude has occurred on

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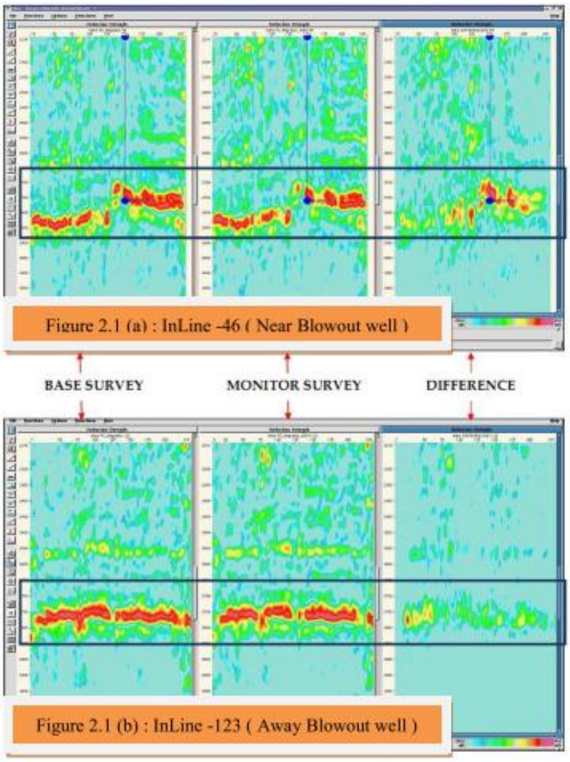
seismic traces near the blowout well. Significant changes between the traces are also observed over a window of 200ms (2650ms to 2850ms) which corresponds to producing formations of Lk+Th and Langpar sands , both of Eocene age in Dikom field.



Theory & Methodology

The objective of the study is to compare the 3D seismic data acquired in 1995 (before the blow-out) and 2008 (after the blow-out) and find out the various geophysical attribute differences and identify the areas affected due to blow out. The process for this study contains a series of steps that has enabled to remove the spurious differences while assessing the level of change in the signals due to blow out & production effects.

A cross-correlation-based time shift is applied to the monitor data **(Figure-3).** Subsequently, phase / time shift has been applied to a time window between 2650ms and 2850ms which includes the reservoir zone. Phase shifting parameters are applied consistently to all traces which ensure that trace -to -trace variations are preserved. This is followed by a designing of a shaping filter is applied to the output of the above monitor data that tries to match the wavelet of the Base & Monitor data sets **(Figure-4a and Figure-4b)**. The shaping filter attempts to match the frequency, phase and amplitude spectra of the wavelet from one seismic volume to the other, where the cross-correlation of the two datasets is matched to the autocorrelation of the reference dataset. The shaping filter in the process attempts to make the wavelet of each data set similar.

Finally Cross- normalization of the monitor data is done to the modified monitor data after the effect of shaping filter and this is to ensure that the root mean square (RMS) amplitude of common traces is similar. In order to prevent production affected traces from influencing the aligned traces of higher cross correlation values, a threshold value greater than 70% is set for the P-wave data in almost all the area over the entire record length.

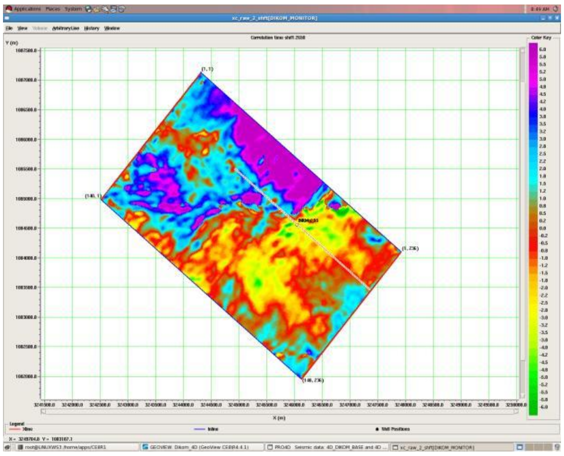


Figure -3 : X Correlation time shift between Base and Monitor Survey. Average time shift with raw X-correlation ranges 0.5 ms - 3ms south of blowout region.

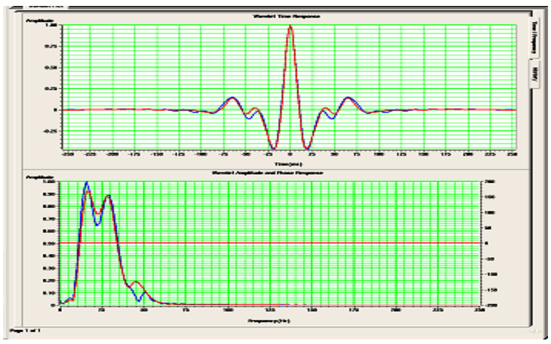


Figure 4a : Effect of shaping filter on traces having Higher cross correlation

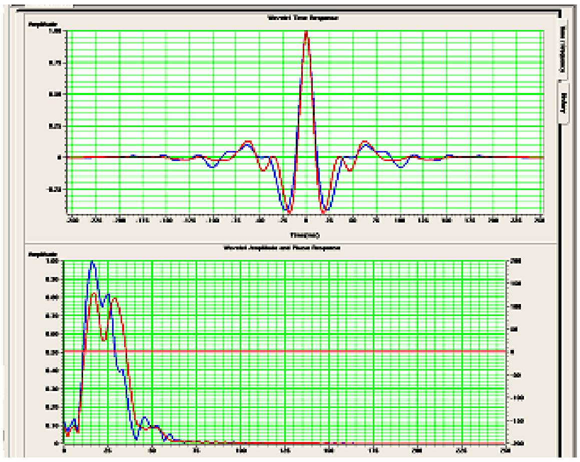


Figure 4b : Effect of shaping filter on traces having Lower cross correlation.

Subsequently, repeatability of both base & calibrated monitor is analyzed using the normalized RMS amplitude. NRMS amplitudes can be interpreted as a fractional change in amplitude relative to the original. The relatively higher Normalized Difference RMS amplitude represents Blow out effect or production induced changes or both, while the relatively lower Normalized Difference RMS amplitude represents the areas may not be affected due to Blow out as well as production changes. **(Figure-5)**

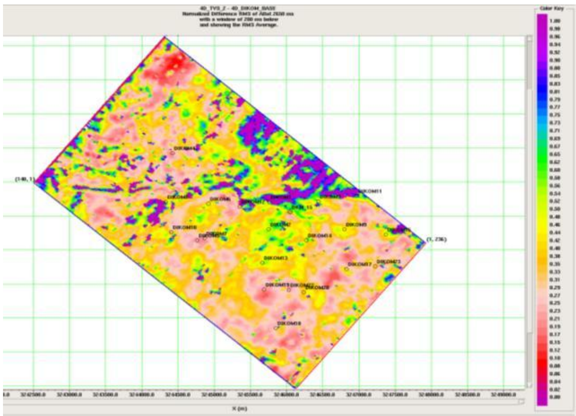


Figure-5 : NRMS Difference Amplitude map over study area. Areas color coded green resembles high NRMS difference value and affected by blowout.

Seismic attributes has also provide with some qualitative information of the geometry and the physical parameters of the subsurface. The rate of change of any of these attributes with respective to time and space helps to provide the stratigraphic and lithological parameters of the prospect. Figure-6 shows the Seismic Amplitudes map close to Lk+Th formation with volume window 20ms, and this deciphers a relative decrease of Amplitudes in the monitored survey in accordance with NRMS difference map.

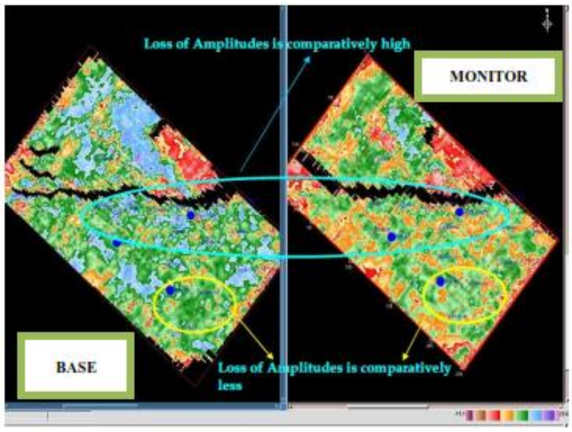


Figure-6 : Volume based seismic amplitude attribute with a volume window of 20ms in the Eocene level.

Remarks

From the above study specific regions are identified which seem to have been affected by Blowout. This is represented by relative higher differences in NRMS amplitudes. Seismic attributes derived over surface and different volume windows also demarcates and explains to some extent of the loss in the amplitudes over specified wells in the Monitored survey. Less differences in NRMS values are indicative of minor changes in the reservoir production, whereas larger differences on NRMS amplitude values infer about major changes in production. Production profiles for several wells in relation with the blowout period have shown a trend which is supportive of the analysis of NRMS amplitude differences. **(Figure-7 and Figure-8)**

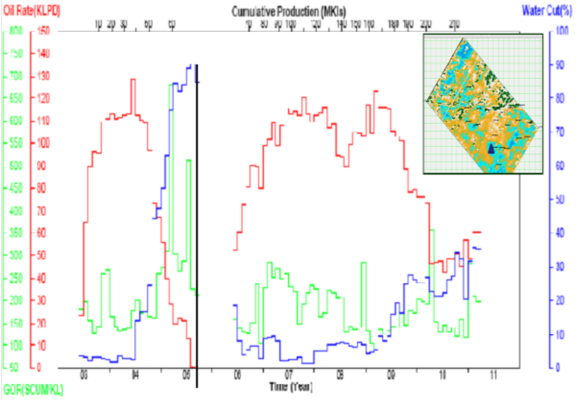


Figure-7: Production Profile at a well having low NRMS difference value.

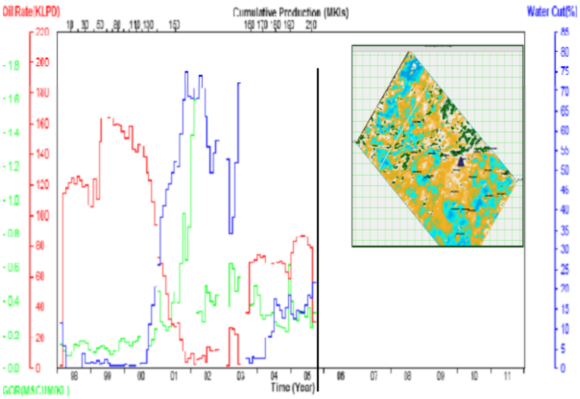


Figure-8: Production Profile at a well having high NRMS difference value.

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