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# Simultaneous analysis for Dry well and Future prospective location with the use of calibrated seismic attributes and newly generated rock property volumes – A Case Study

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***Summary***

*The analysis of complex trace attributes with the incorporation of petrophysical rock properties provide a meaningful explanation for the lithology prediction. Moreover, it may also help to identify hydrocarbon bearing sands in the clastic environment. The current paper presents a unique combination of the seismic attributes along with generation of the rock property volumes and their blending, which helps us to justify dry well, oil bearing wells and new exploratory locations for the oil bearing sands. The attributes discussed in this paper are the outcome of the work relating to the combined use of several attributes for lithology prediction and reservoir characterization.*

## Introduction

The calibrated seismic attributes with the known petro physical properties provides more precise information about the lithology and reservoir (Cynthiaetal1997). The current study is carried out in Panidihing area of Assam &Assam Arakan Basin, which falls in the north eastern part of the india (Fig.1a).The work is carried out for the PreBarail formations (Sylhet ,Tura, Barail ),which have the proven oil wells in the area, where tectonic plays an important for the oil entrapment. Coherence & sweetness seismic attributes, along with the P impedance & Porosity (using available Log data) volumes are generated from 3D seismic. Pertinent combination of different attributes and their blending provides a meaningful justification for the producing, dry and prospective (New) well locations.

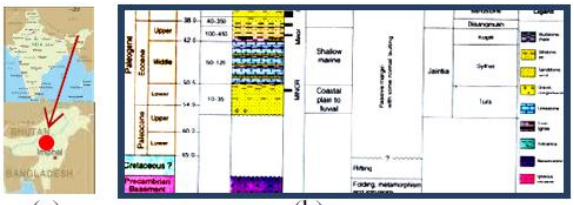


Fig.1 Location map of the area (a) and Geology of upper Assam for Pre Barail formations (b).

## Brief of Geology of the Area

The basin is primarily a south east dipping shelf over thrust by Naga hills on the south east and Himalayan mountain range to the north. The petroleum system in the Pre Barail are found in the rocks of Kopilli/Sylhet and Barails of Eocene – Oligocene of Age. Sylhet represents the platform carbonates and Tura represents the clastic rocks of shallow marine shales and sandstones (Fig.1b). The Reservoir rocks are carbonates of the sylhet formation, interbeded sand stones of kopilli formation and sanstones of Barail, Surma and Tipam Groups. The trapes are primarily anticlines and faulted anticlines along with few subtle stratigraphic traps. There is also a likelihood of

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anticlinal traps in the sub thrust. The area is well known for the oil bearing pockets both in Sylhet and in Tura. In general the Tura thickness is about 80 to 100 m and has two sand packs deposited in two different environments (Fig1 (b)). Moreover, only the upper part of Tura sand contains hydrocarbons. The accumulation is governed by structural play with superposition of different tectonic regime. It is found that curvilinear fault plays an important role in the oil entrapment. However, the younger formations in the area are devoid of hydrocarbons in spite of the good fault closures.

## Methodology

The synthetic seismogram generation and their correlation for few wells in PreBarails formations are carried out in the area. Accordingly, The Horizons correlations at Sylhet top, Tura Top and Basement top are tracked in the PSTM 3D Seismic volume (Fig.2). All the PreBarails formations i.e Zone of interest are falling in Time window of 3100 to 3400 msec of the seismic volume .

**Table 1: STATUS OF DIFFERENT WELLS**

| Sl.No. | Name of the well | Status |
|---|---|---|
| 01. | PD-A | Dry Well |
| 02. | PD-B | Oil well |
| 03. | PD-C | Dry Well |
| 04. | PD-D | Oil Well |
| 05. | PD-E | Dry Well |
| 06. | PD-F | Oil Well |
| 07. | RPD-A | Prospective Well Location |
| 08. | RPD-B | Prospective Well Location |

The seismic attributes volumes for Coherency and Sweetness are generated from the seismic volume in the time window of 3100 to 3400msec.(Fig.3, 4&5).Model based seismic data inversion is carried out in the same window for the generation of P Impedance volume and there after generation of the Porosity volume using Probable Neural Network (PNN) algorithms.(Fig 6 &7).Using all the generated volumes, the reservoir analysis has been carried out mainly at the pay sands and its extension both in Tura and Sylhet formations. The results are calibrated with the known findings in the Tura and Sylhet formations. Analysis in different combinations of attributes has been carried out.

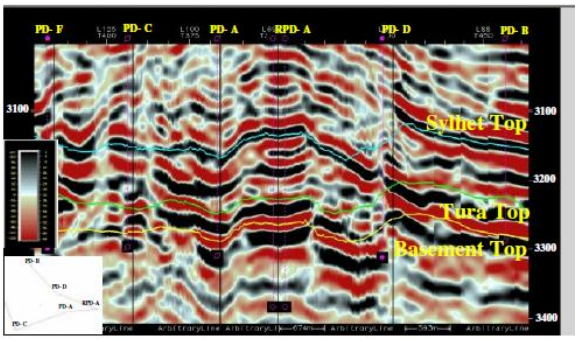



Fig.2 An arbitrary seismic line passing through different wells and new probable locations.

## Discussion

Complex Seismic Trace Attributes have gained considerable popularity, first as a convenient display form, and later, as they are incorporated with other seismic and well log derived measurements, they became a valid analytical tool for lithology prediction and reservoir characterization (M. T.Taner2001etal.).

The coherence cube offers a high resolution unbiased image of the variations within the volume, wherein geologic features and faults are enhanced (Fig.4).It helps to identify the zones for

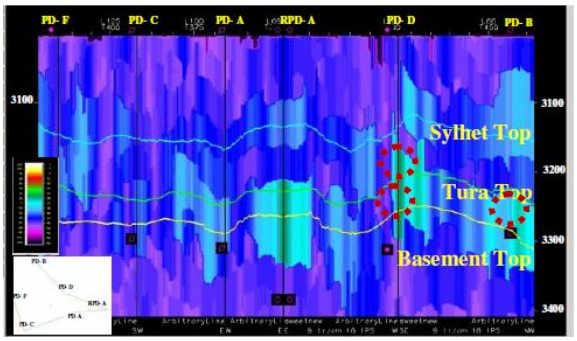



Fig.3 An arbitrary line from sweetness attribute volume passing through different wells and new probable locations. Dotted circles shows the oil producing zones for PD-D&B. Relatively, higher the value shows the distribution of the sand body. Producing wells fall in it, except PD-C, where structure does not support, so found to be dry.

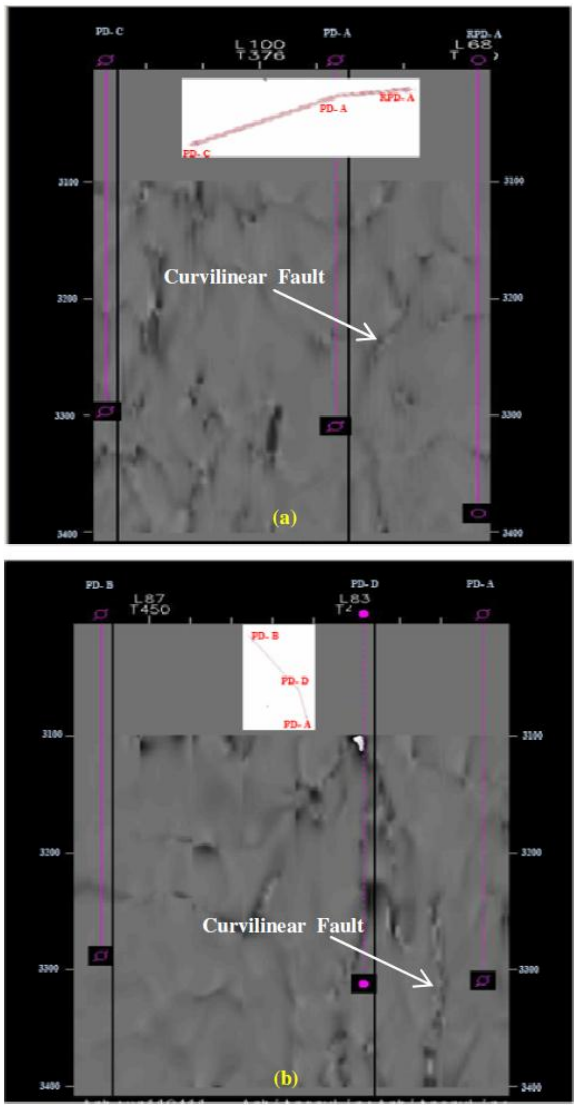



Fig.4 Arbitrary lines from Coherency attribute volume passing through RPD-A,PDA& C(a) and PD-B,D &A(b). It explains the pattern of faults e,g curvilinear etc. existing in the zone of interest.

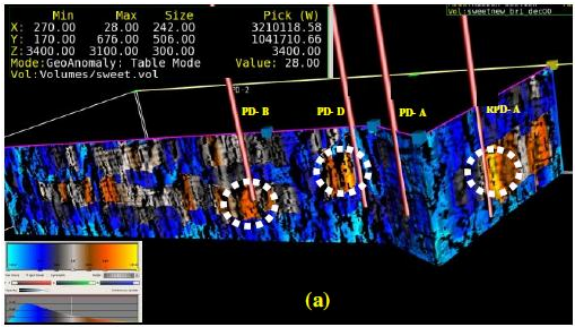
The hydrocarbon entrapment. Sweetness is instantaneous amplitude divided by the square root of instantaneous frequency (Bruce S. Hart1,Qubec,Canada). It is usually a sand shale indicator for siliciclastic environments. Presence of hydrocarbon increases the amplitude strength and decreases frequency content. Hence, sweetness attribute helps to identify the sand body This attribute often helps to locate not only successful exploratory wells but also gives an idea about the extent of the pool(Fig.3),as marked in the dotted circles. An arbitrary line from sweetness with coherence volume shows(Fig.5a) , that wells PDB & D are producing oil from marked (dotted cirle) yellow colour attributes, while the well PDA is dry, does not fall in the same colour ,however the RPD-A ,falls in the colour of the producing zones for PD B & D, so it could be prospective location for the hydrocarbon point of view, since the structural and stratigraphic features are favourable. Similarly well PD-A (Fig.5b) does not fall in the colour attributes(dotted circle) of the producing wells as in PD-B &D(Fig.5a).So, Well PD A is found to be dry. It justifies and calibrates the attributes. Moreover, again well RPD-A is found to be favourable for new location. Another arbitrary line (Fig.5c) shows that the well PD-B &D falls in the colour(dotted circle) of the producing wells, while PD-A does not fall in the colour of the producing well i,e a dry well. The other arbitrary line (Fig.5d) passing through wells namely PD-E & C are dry and not supported by the attributes(dotted circle) and The other location i,e RPD–B ,which is identified on the basis of the structural location does not support the attribute of the producing well. So, the location RPD-B may be ignored on the basis of the attributes analysis.

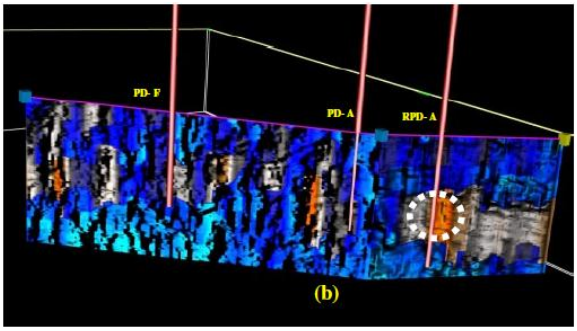
The inverted seismic volume exhibits an improved image of the P-impedance variations, which can be used for lithologic and stratigraphic interpretations. (Brian P. West etal.2002) The RMS time slice(Fig.6a) of the P impedance volume for Tura top with 10ms above and 10 ms below, i,e the producing zone window from the Tura formation shows that the producing wells PD –D(falls in fault plane thus shows high porosity and high P-Impedance) & B falls in same colours of impedance values than those of the dry wells ,i,e PD-A & C. However, the new prospective location namely RPD-A & B do falls in the impedance values of the producing wells. The same P impedance volume has been taken as input for the calculation of Porosity volume in the same zone of interest. The RMS time slice of the porosity volume in the same windows(Fig.6b),justifies the producing wells PD-D & B and one new location RPD-A, at the same time also justify the dry well locations namely PD –A &C on the basis of the values of(Low) porosity distribution in the volume. The arbitrary line passing through different wells in porosity and impedance volumes (Fig.7),shows that producing wells are having more porosity values (Fig.7a) and less

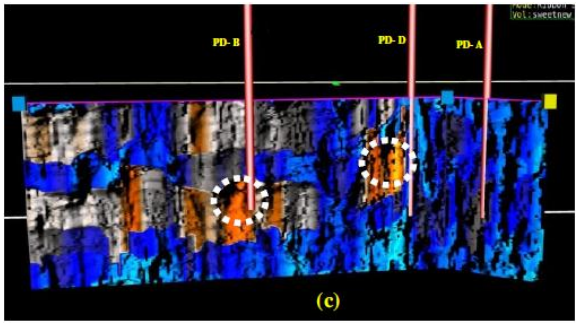
impedance values,for Tura formation,(Fig.7b).The well log correlation (Fig.8) interpret the oil bearing lithology for Tura formation.It provides a clue for producing and non producing lithology, as marked. The blending of the Sweetness and porosity volume with the known producing zones (in range) values (i,e well locations, PD-B,D and F) are attempted (Fig.9).The blended output attributes in map view shows that the calibrated values at the wells PD-B,D &F, spreads justify the dry wells (does not fall on attributes cloud) and also justify one exploratory location RPD-A, while discarding the other RPD-B. in the known producing zone of interest,i,e 3100 to 3400ms .

## Results

The integration of the coherence and sweetness attribute volumes depicts the changes that can be



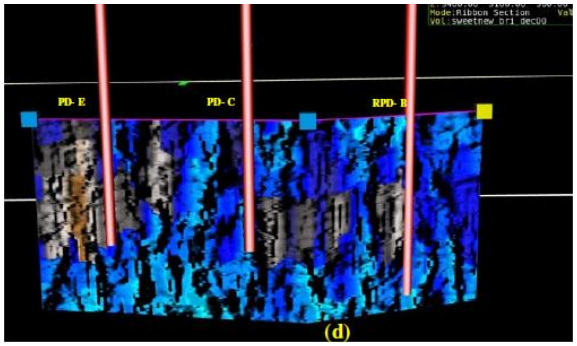




Fig. 5 Arbitrary lines from Sweetness attribute overlaid with coherency volume passing through PD-B,D&A,RPD-A(a),PD-F &A,RPD-A(b), PD- B,D&A(c),PD-E &C,RPD-B(d). The marks area shows the producing zones.

readily identified within sedimentary systems for Pre Barail formations of the Panidihing Area, resulting in unparalleled detail of subtle sedimentary depositional features. Moreover, Seismic inversion for acoustic impedance provides an easy and accurate interpretation for the lithologic and stratigraphic identification. The generation of the porosity volume using Probable Neural network (PNN) alogorithim with P impedance volume further enhance the quantitative interpretation confidence. As discussed above, the convergence of all these studies provides a more confident Geological interpretation of the area. Which may be simultaneously used for Dry Well analysis and prospective exploratory locations with justification.

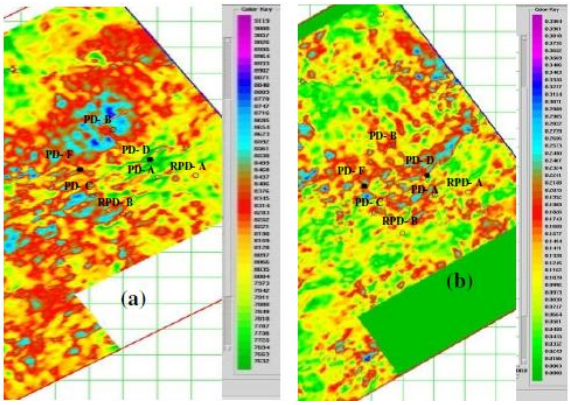



Fig. 6 RMS Time slice extracted from P- Impedance volume (a) and from porosity volume (b).

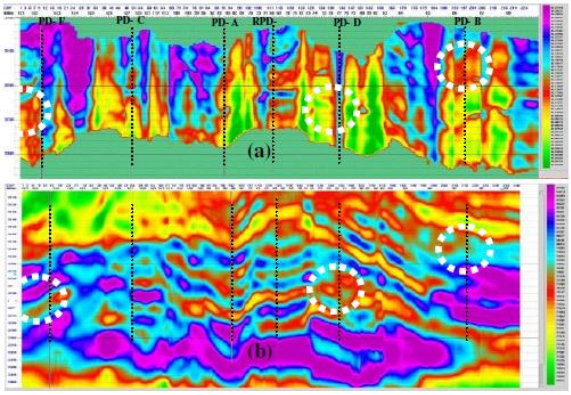



Fig.7 Arbitrary lines from porosity attribute volume(a) and (b) P Impedance volume passing through different wells in the zone of interest. Dotted circles shows the producing zones.

The study can further be used for the calculation of reservoir properties like fluid fill and net pay.

## Conclusion

The power of the combined use of multiple attributes has been recognized and a newtechnique has been introduced that produces reliable, quantitative results. The conventional seismic attributes such as coherence, sweetness, along with derived rock properties like P impedance and porosity provides enhanced ability to quantify and predict reservoir properties between sparse well data of Panidihing area. Blended plots of derived attributes were used to define precise reservoir and non-reservoir facies boundaries and reservoir compartments. This guides in making a logical analysis for new exploratory location along with the reason for the dry wells in the zone of interest. It may also help in understanding of the sub-surface and may be instrumental in reducing risk and uncertainty.

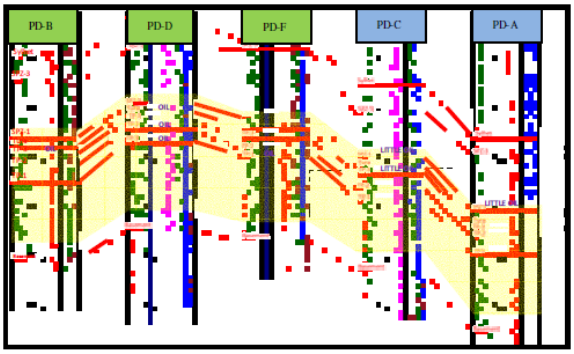



Fig. 8 Well Log correlation for the Tura formation for the well PD-B,D,F,C & A.

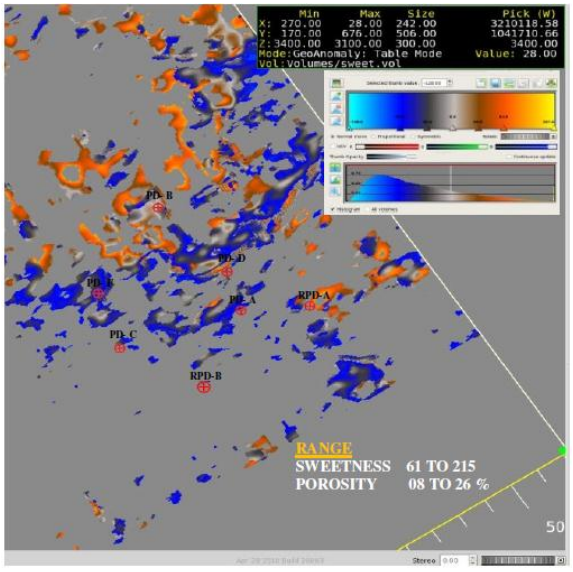



Fig. 9 Blending of attributes namely Sweetness and porosity volume in the zone of interest i,e 3100 to 3400 ms with known range of producing zones for the well PD-B,D &F. It justify dry wells PD-A & C and prospective location RPD-A.

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