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SALDANADI GAS FIELD: A STUDY ON WELL LOGGING AND FORMATION EVALUATION.

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Abstract- *The study has been done to compare different Petrophysical Properties i.e. Porosity, Permeability Facies for different zone of Saldanadi Gas Field, Bangladesh. Saldanadi Gas Field is a part of greater Rukhia Structure. Using Seismic and Wireline log data the structure of this field has been modeled by Petrel Software. Structural model, facies model, property model including porosity, permeability models have been generated using various algorithms present in Petrel. Wire-line log data was used to correlate Gas Sand Zones between wells Saldanadi-1 and Saldanadi-2. As no fault was identified in any of the seismic sections, Fault modeling was neglected. From facies model it has shown that it has domination of Sandstone. Porosity ranges are 18%-27% at Zone-1, 16%-29% at Zone-2 and 16%-35% at Zone-3. Permeability model gives the range of Permeability as 55-150mD at Zone-1, 40-180mD at Zone-2 and 30-410mD at Zone-3. So gas production rate of Zone 3 is greater.*

Keywords: Saldanadi Gas Field, Petrel, T-Z curve, Facies, Fault.

1. INTRODUCTION

Natural gas is considered as the cleanest fuel as it produces about 29% and 44% less co_2 than oil and coal respectively and potentially fewer pollutants than other hydrocarbon fuels. To meet the energy demand of a country Natural gas is one of the prominent element and it contributes about 75% of total energy demand of Bangladesh. At Saldanadi structure, 3 wells has been developed. The total gas in place of Saldanadi gas field which is 114.96 BCF. The measured gas rate and software calculated gas rate are almost similar and the result variations are less than 7%.

Saldanadi Gas Field is situated about 50 km south east of Brahmanbaria town. Saldanadi Gas Field on the Rukhia anticline is occupying the major part of the Tripura Basin. Tripura Basin covering an area about 90,000sq.km has mainly two parts known as Agartola Dome and Rukhia Anticline located in the northeastern part of India. At Saldanadi structure, 3 wells has been developed. Well # 1 on the Saldanadi Gas Field was drilled in 1996 and was terminated at a depth of 2511 m (MD). Two gas zones were discovered out of three zones while conducting DST which are upper zone and lower zone. From the Saldanadi Gas Field well #1 lower zone, 29.907 BCF and well #1 upper zone 5.841 BCF gas was produced from 29th march 1998 to October 2010 including two shut-in periods. Well #2 on the Saldanadi Gas Field is a deviated well and was drilled in 1999 and the total depth is 2458 m (MD). Three prospective zones were tested. Only middle zone (2300-2365 m) produced gas. From SD # 2 26.573 BCF gas has been produced from 4th May 2001 to October 2010 and presently the well is in production. Drilled depth of Saldanadi well # 3 is 2860m and started production from 31 January, 2012. [BAPEX, Well Completion Report on Saldanadi, 2004] [8].

Fig.1: Location of Saldanadi gas field structure in the Petroleum Exploration blocks of Bangladesh. (Source-Petrobangla) [11].

2. DATA INPUT METHOD

2D seismic data and well log data were used for this research work. All relevant data are collected from Bangladesh Petroleum Exploration (BAPEX) in computer supported form (softcopy). The workflow of the research work is given in figure 2. 3D Model has also been performed in this research work. A block diagram of the workflow chart has been given below:

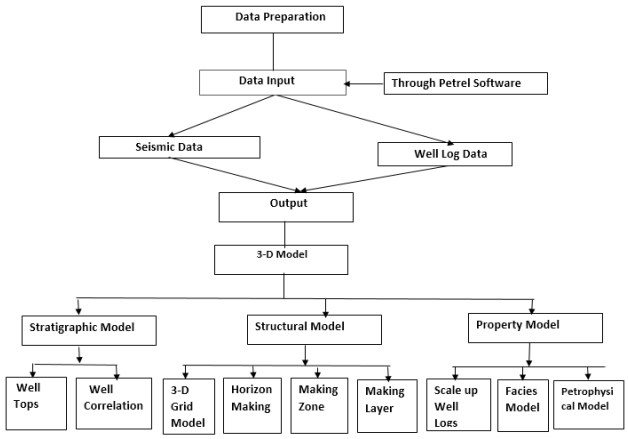

Fig.2: Workflow diagram.

3. TIME DEPTH CONVERSION

T-Z curve has been formulated for this thesis work. Through this formulation Time is converted to Depth in this research work. Following equation were used for this purpose:

$$Z_i = Z_i\text{-}1 + V*\{t_i\text{-}(t_i+1)\}/2$$

Where, V denotes Velocity, t_i denotes Time required and Z_i denotes Depth of a particular location.

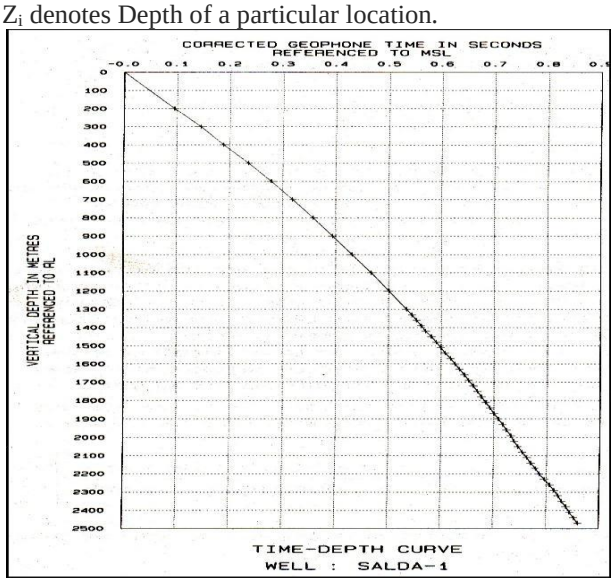

Fig.3: T-Z curve (Saldanadi #1)

Time depth (T-Z) curve has shown that the conversion of time to depth is almost straight line in Saldanadi# 1.Here as time increases a few amount of fluctuation have been found which is almost negligible.

4. WELL CORRELATION

Petrel includes a tool for making rapid on-screen correlation, with the possibility to bring up multiple wells in a well section, make marker-picks (well tops), re-datum and then bring up new wells to compare with already correlated wells.

The location of Saldanadi#1 is in the axial part of the formation. Deviated wells Saldanadi#2 and Saldanadi#2 also located in the axial location. Well correlation has been done mainly by using different available log in the formation. Gamma ray log is mainly used for the identification of the lithology. Resistivity log, Sonic log, Neutron porosity log also been used to validate and strengthen the correlation.

Well correlation work are performed in more than one wells i.e. between 2 wells or between 3 wells. Log value of those wells are compared and its production optimization decision has been made.

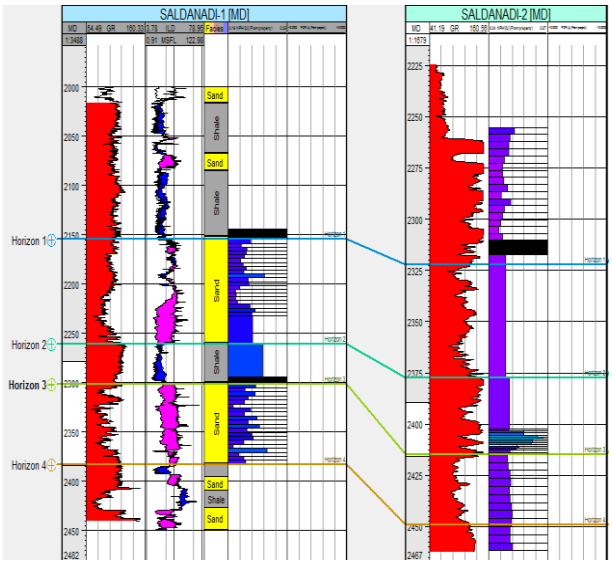

Fig.4: Well correlation between Saldanadi#1 and Saldanadi#2 [Petrel]

The well correlation between Saldanadi#1 and Saldanadi#2 reveals that the Middle Zones of Saldanadi#2 is highly potential than gas producible Lower and Upper Zones of Saldanadi#1. The zone with lower Gamma ray value has greater hydrocarbon possibility (Figure 4). Gamma ray log, Resistivity log, Neutron Porosity log has been used in this correlation.

5. SCALE UP WELL LOGS

To average the log value in a well is known as scale up well logs. When scaling up the well logs Petrel will first find the 3D grid cells that the wells penetrate. For each grid cell all log values that fall within the cell will be averaged according to the selected algorithm to produce one log value for that cell. The resulting 3D grid will only hold values for the 3D grid cells that the wells have penetrated This has been performed by averaging discrete (facies) and continuous (porosity, Permeability etc.) in each grid cell.

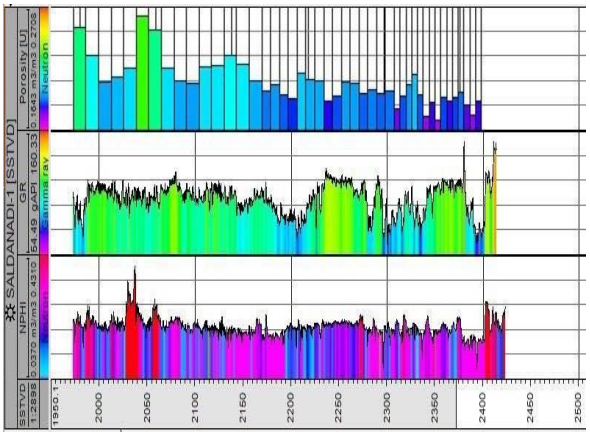

Fig.5: Scale up Well Logs of Saldanadi#1 well. [Petrel]

Scale up well logs with combination of Facies, Permeability, Porosity etc. with their averaging gives the idea that as time increases the productivity of Saldanadi#1 decreases. Gamma Ray with higher value contain lower hydrocarbon. Porosity decreases significantly in Saldanadi# 1 (Figure 5).

6. FACIES MODEL

A facies model has been created which is consist of Shale, fine Sand, Silt, Coarse Sand, Sandstone etc. based on effective porosity.

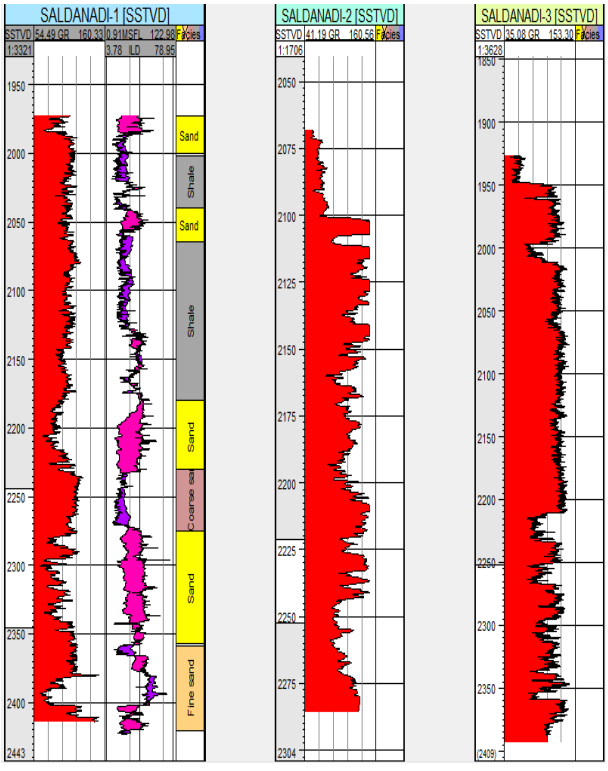

Fig.6: Log preview with Facies. [Petrel]

From the Facies Model it is found that it has the domination of Sandstone (figure 6).
A table has been given below which gives effective porosity with respect to each Facies.

Table 1: Facies vs. Effective Porosity

Facies	Effective Porosity
Shale	<10.5%
Siltstone	11-15.5%
Sandstone	≥ 15.5%

7. POROSITY MODEL

Porosity Modeling has been done by using upscale neutron log. In the data analysis process the distribution curve for each facies has been set and used as input in petrophysical distribution. From Porosity Modeling it is found that Porosity ranges are18%-27% at Zone-1, 16%-29% at Zone-2 and 16%-35% at Zone-3. Porosity Model of Zone 1, Zone 2, and Zone 3 has been shown below:

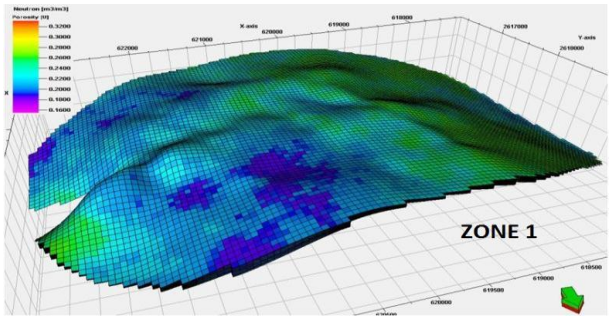

Fig.7: Porosity Modeling of Zone-1 [Petrel]

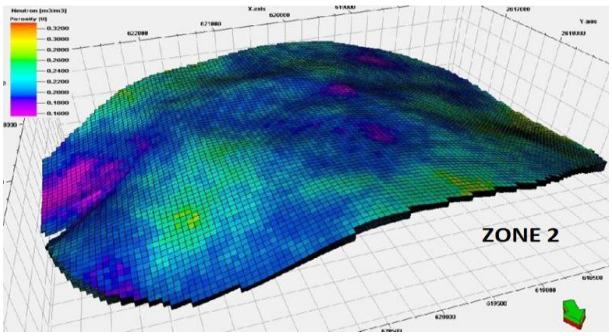

Fig.8: Porosity Modeling of Zone-2 [Petrel]

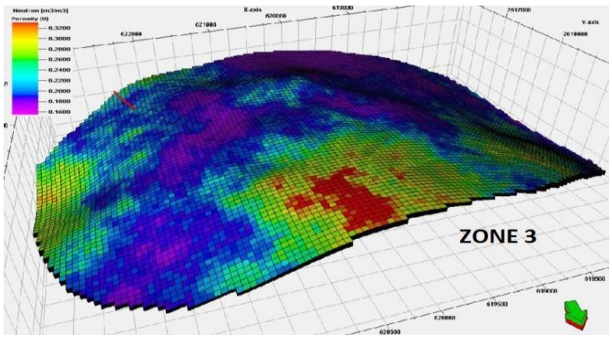

Fig.9: Porosity Modeling of Zone-3 [Petrel]

8. PERMEABILITY MODEL

By using Upscaled Permeability Log (K-log) data permeability modeling has been performed. Distribution curve has been used and data analysis is done for each

zone. From analysis of permeability modeling it is found that Permeability ranges are 55-150mD at Zone-1, 40-180mD at Zone-2 and 30-410mD at Zone-3. Permeability Model of Zone 1, Zone 2, and Zone 3 has been shown below:

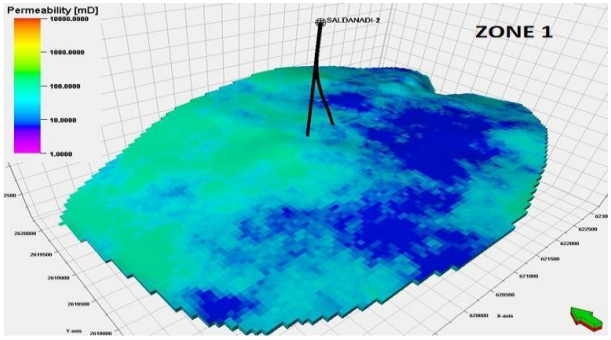

Fig. 10: Permeability Modeling of Zone-1 [Petrel]

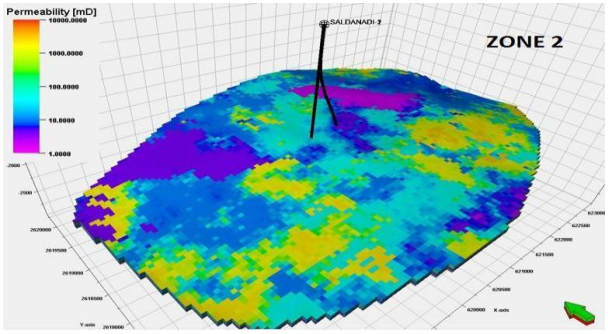

Fig.11: Permeability Modeling of Zone-2 [Petrel]

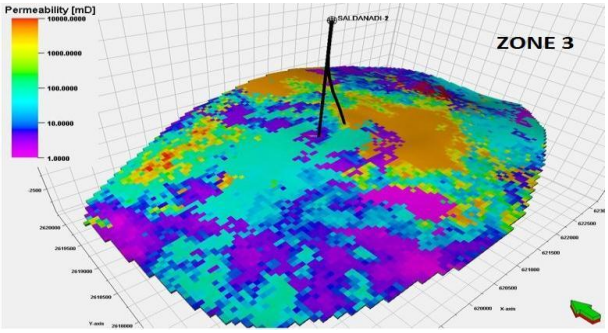

Fig.12: Permeability Modeling of Zone-3 [Petrel]

9. CONCLUSION

Saldanadi is an elongated anticline. Saldanadi anticline is smooth and uniform throughout the area which is found from the interpretation of seismic data. Saldanadi#1 stopped its production, Saldanadi#2 is still producing gas and Saldanadi#3 is under development. No fault has been found in this field. Recently the area faced uplift and erosion.

Mainly three logs named Gamma ray log, Induction Log, Microspherically Focused Log are performed in this research work. Facies Modeling has been performed by using upscaled gamma ray log. From the facies modeling it is clear that it has the greatest amount of Sandstone and a less amount of Siltstone and Shale. Fault Model not generated as no fault is found in the structure.

10. RECOMMENDATION

For any further Drilling campaign and Development of Saldanadi Gas field 3-D seismic survey should be preferred. 3-D seismic survey would give better information on Well Logging and Formation Evaluation and other required information.

11. ACKOWLEDGEMENT

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