

3-Dimensional Static Modeling: Property Modeling Of a Reservoir Using Petrel

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ABSTRACT- In the development of new fields as well as developed fields reservoir models are used by oil and gas company where reservoir characteristics and conditions are need to know to make investment decision. A 3D model can visualize the reservoir most clearly and the position of the new well drilling can be determined accurately which was not possible by 2D model. 3D models may help in development by identifying the number of wells required, the optimal completion of the wells, the present and future needs for artificial lift. In this purpose a 3D static model is done by using 3D seismic and well log data . The input interpreted horizon grids and fault polygons is generated by 3D seismic data and the wells which are cut through the horizon is used for petrophysical analysis. The Gaussian random function simulation, moving average method, Kriging method is used for different zone for distributing porosity, permeability in constructed 3D grid. Besides object modeling(stochastic), assign value, sequential indicator simulation is used for different zone for fluvial facies distribution and sequential indicator simulation is used for all zone for facies cut-off distribution in 3D grid. Volumetric calculation is run to find the STOIP and GIIP of different zone and classified these zones as poor to excellent.

Keywords – Well data, Seismic data, Check Shots data, Facies modeling, Fluvial Facies modeling, Petrophysical modeling.

I. INTRODUCTION

A hydrocarbon project involves hundreds of millions of dollars investment. So, the risk associated with the selected development plan must be assessed and minimized. That is why reservoir modeling and simulation is required to visualize, understand and to predict the reservoir performance under different operating condition. The aim of the reservoir study is to predict the future performance of the reservoir and find a way to enhance the

recovery of the reservoir. Before simulation study, first we need to build a proper reservoir model by combining seismic, well log, well head and well deviation data.[1]

II. LITERATURE REVIEW

A 3D static model is done by using 3D seismic and well log data in KN field of Niger Delta Province. The input interpreted horizon grids and fault polygons is generated by 3D seismic data and the six well which is cut through the horizon is used for petrophysical analysis. The sequential Gaussian simulation and Sequential indicator simulation algorithms is used for distributing porosity, permeability, water saturation and facies in constructed 3D grid. Volumetric calculation is run and the potential zone is found and classification of these reservoir is done as moderate to good reservoir.[2] A 3D-modeling of the Asmari reservoir in the Ramin oil field, South-West of Iran by geostatistical method. RMS (Reservoir Modeling System) software is used for constructing the Structural and petrophysical models. It is also predicted that which part is good candidate for drilling.[3] A 3D-static model of lower shuaiba in the West of Persian gulf is constructed by using geostatistical method. The STOIP for each zone is calculated by volumetric calculation and recovery is also calculated by assuming natural depletion.[4]

III. METHODOLOGY

Property modeling in petrel is split into three separate process:

- Geometrical modeling
- Facies modeling
- Petrophysical modeling

In additions there are other three steps which is used when modeling properties-

- Scale up well log
- Data analysis
- Fault analysis

IV. DATA COLLECTION AND ANALYSIS

The collection of primary data is very costly because it is carrying out by seismic survey

and running well log. So, secondary data is used for this research work. All soft data which is loaded in petrel are in such a format which is given below-

Data	Format
1- Well Data	
A- Well Headers	Well heads (*.*)
B- Well Deviations	Well Path deviation (ASCII) (*.*)
C- Well Logs	Well Log (LAS 3.0) (*.las)
2- 3D Seismic Data	Seg-Y seismic data (*.*)
3. Check shots Data	Checks hots format (ASCII) (*.*)

Table I: Data type and format

All data are collected from Norwegian oil company Statoil that has released the data set of the Gullfaks oil field for commercial use. Well data, seismic data and all check shots data is used for this research which is enough to build a static model. Other data like fault data, horizon data, well tops data, isochore data also need to build a static model which is made by interpreted seismic and well log data in petrel software. Due to unavailability data pressure, temperature, compressibility of rock, fluid, formation volume factor of gas, oil etc, data has been assumed. For the same reason history matching is not possible to make due to lack of real production and pressure data with time.

Well data has three types of data which is discussed below.

Well Header (Well Location On Map)

Initially, well header is created by text editor such as the Notepad, WordPad, or Word. It is prepared according to the format including Name, Y (northing), X (easting), Top Depth, Bottom Depth, Kelly Bushing (KB) and Well symbol of the wells.

Well Deviation Data (Well Path)

It is the second type of well data which has specific type of file format. The well's path is divided into a number of points to represent its deviation. For each point, MD, X, Y, Z, TVD, DX, DY, AZIM, INCL is given. The MD shows the positive value of the measured depth of each point and the X and Y values are the x and y-coordinates of each point and the Z refers to the negative value of the depth of each point and TVD is the true vertical depth of each point and DX is the difference between the X value of the point and the well's x-coordinate and Similarly DY is the difference between the Y value of the point and the well's y-coordinate. Deviation data have been prepared according to the well path deviation (ASCII) format.

Well Logs Data

The third type of well data is well logs data. Well logs are read into Petrel in a specific LAS format (both LAS 2.0/3.0 formats are currently supported) as shown figure I. Here gamma log and interpreted digital log quantities such as porosity, permeability, net gross, fluvial facies in las file format is used.

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A10 - Notepad
File Edit Format View Help
UWI. 02c62c82-552d-444d-bf6b-69cd07376368 : UNIQUE WELL ID
API. : API NUMBER
#-----
~Curve
DEPT .m : DEPTH
Perm .m :
Gamma .m :
Porosity .m :
Fluvialfacies .m :
NetGross .m :
~Parameter
#-----
~Ascii
1499.879000 -999.250000 -999.250000 -999.250000 -999.250000 0.000000
1500.129000 -999.250000 -999.250000 -999.250000 -999.250000 0.000000
1500.629000 -999.250000 -999.250000 -999.250000 -999.250000 0.000000
1501.129000 -999.250000 -999.250000 0.270646 0.000000 0.000000
1501.629000 124.579900 78.869453 0.267428 0.000000 0.000000
1502.129000 125.334580 78.008301 0.256076 0.000000 0.000000
1502.629000 117.121100 75.581558 0.242126 0.000000 0.000000
1503.129000 109.646790 73.238037 0.238589 0.000000 0.000000
1503.629000 106.011070 71.504173 0.238377 0.000000 0.000000
1504.129000 112.714790 71.459229 0.240893 0.000000 0.000000
1504.629000 131.833600 73.447800 0.244279 0.000000 0.000000
  
```

Figure I: LAS File Format

Seismic Data

Here 3D seismic data in SEG-Y format is used for seismic interpretation. Using this data horizon interpretation and fault interpretation is done in petrel software. Here in figureII 3D seismic data file is showed

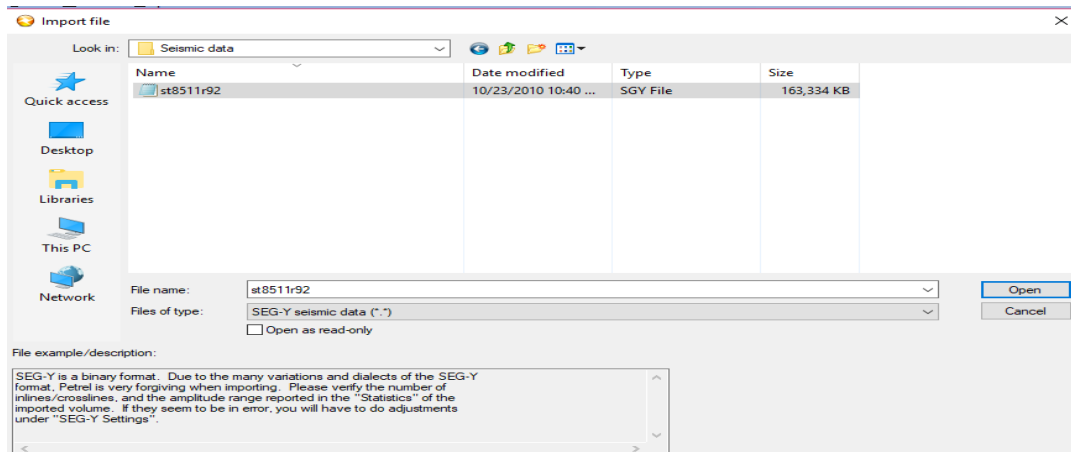
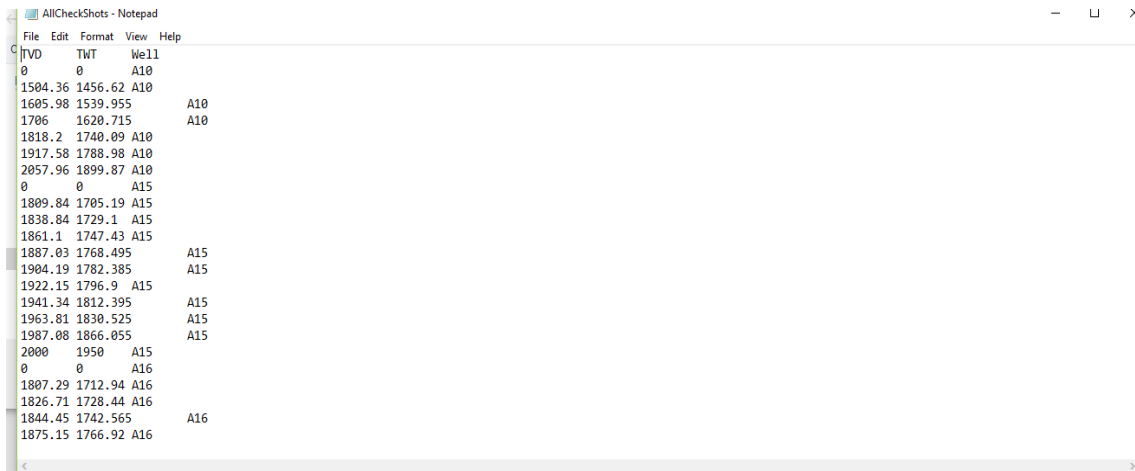


Figure II :Seismic Data File

Check Shots Data

This data includes Two way travel time (TWT) in milli second unit, True vertical depth (TVD) in meter unit and corresponding well name. This data is used to convert the well path from depth domain to time domain.



TVD	TWT	Well
0	0	A10
1504.36	1456.62	A10
1605.98	1539.955	A10
1706	1620.715	A10
1818.2	1740.09	A10
1917.58	1788.98	A10
2057.96	1899.87	A10
0	0	A15
1809.84	1705.19	A15
1838.84	1729.1	A15
1861.1	1747.43	A15
1887.03	1768.495	A15
1904.19	1782.385	A15
1922.15	1796.9	A15
1941.34	1812.395	A15
1963.81	1830.525	A15
1987.08	1866.055	A15
2000	1950	A15
0	0	A16
1807.29	1712.94	A16
1826.71	1728.44	A16
1844.45	1742.565	A16
1875.15	1766.92	A16

Figure III: Check Shots Data

V. RESULT

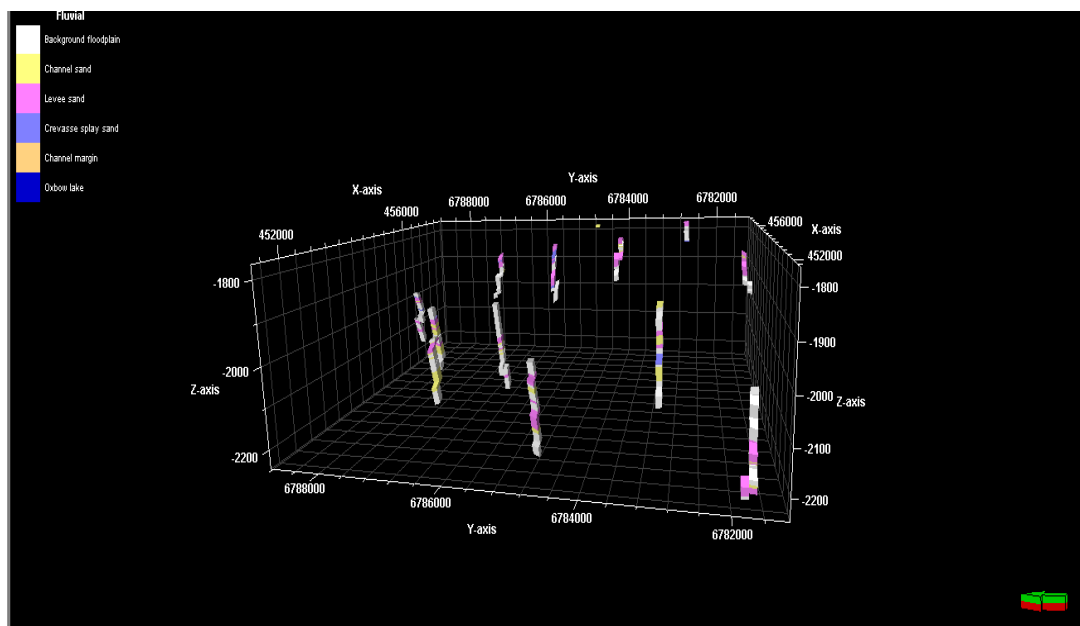
Property Modeling:
 Scale Up Well Logs

It is the process of assigns log value to the cells in the 3D grids that are penetrated by the wells.

The steps to scale up well logs are as follow-

- Double click on the scale up well log from process pane
- Select create new property
- Select the well which will be used for upscaling of the well log

- Select the log type
- Set the scale up setting like average log, treat log and method
- Here average log- most of, treat log- as line, method- neighbor cell has been set for fluvial facies
- Click apply
- And repeat that process for porosity log and permeability log to scale it up.



FigureIV: Scale up Fluvial facies log

Data Analysis

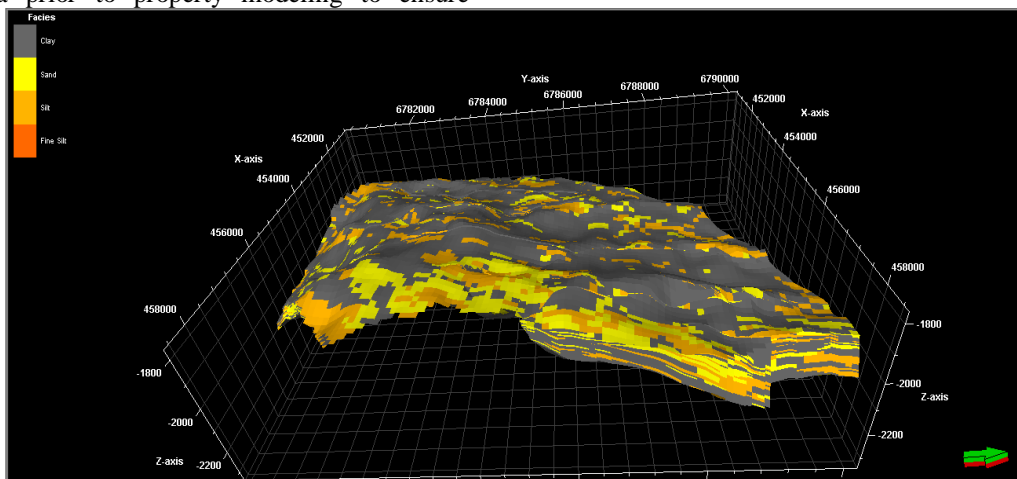
It is a process of quality controlling, exploring and preparing the data for the Facies and petrophysical modeling. There are two types of data analysis- discrete and continuous.

- Discrete Data analysis- The facies proportion, facies thickness, calibration between continuous properties and facies within each zone have been analyzed and a variogram has been created.
- Continuous Data analysis- For defining data transformations and to generate variograms. Data transformation enables the user to make the data stationary and standard normally distributed, which are requirements of many of the standard geostatistical algorithms. Spatial trends in the data will be extracted from the data prior to property modeling to ensure

stationarity, and these trends will be reapplied to the modeled property, ensuring their preservation. Undiscovered trends in the data can invalidate data interpolation during property modeling.

Facies Modeling

It is a means of distributing the discrete facies throughout the model grid. For this a facies log has been created comprising clay, sand, silt and fine silt based on effective porosity and later facie log has been upscaled in scale up well log section. Variogram have been used as input for facies modeling and the major and minor range of variogram has been set as 5000 and 700 respectively with azimuth 25 for all zone.

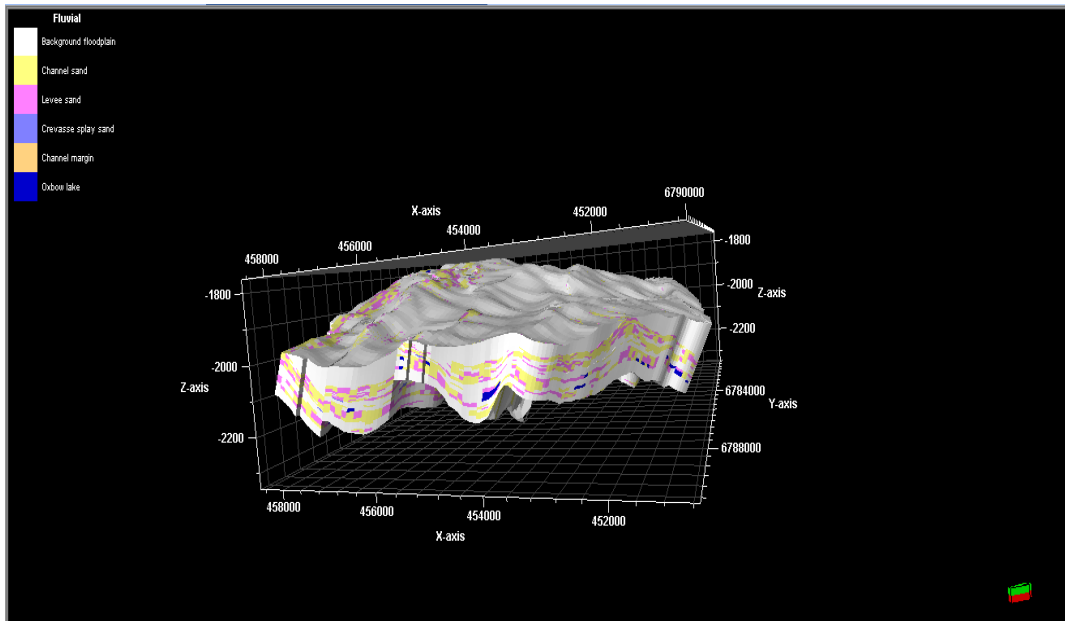


FigureV: Facies Modeling

Fluvial Facies Modeling

Before building a Fluvial facies model fluvial facies log has to be upscaled . After that

process click on the facies modeling on the process pane and then select the different zone, method and then set variogram and then click on apply.



FigureVI : Fluvial Facies Distribution

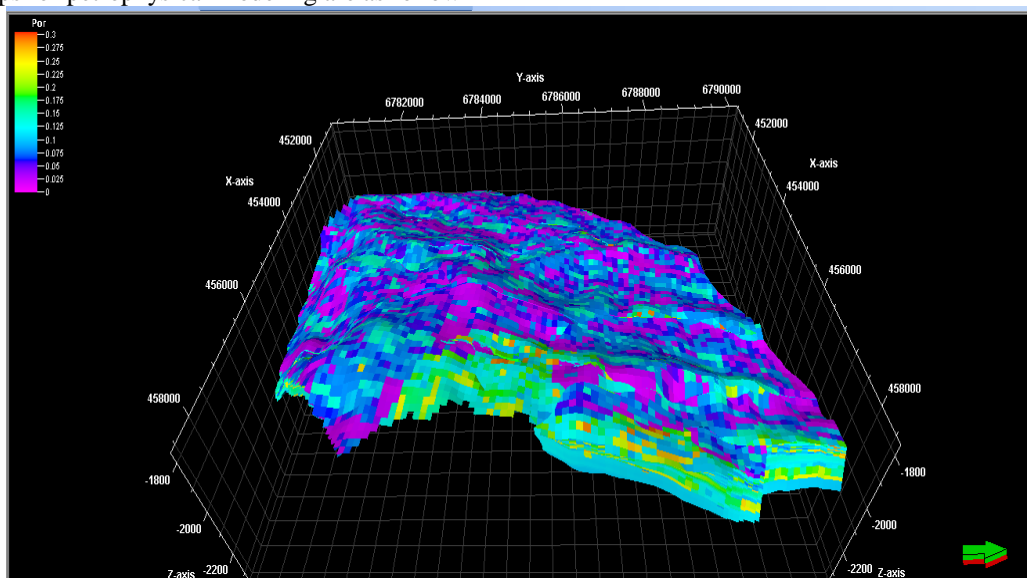
Petrophysical Modeling

For modeling the distribution of petrophysical properties, petrel offers several algorithms. After upscaling well logs, the scaled up log has been placed under the selected 3D properties folder in mode pane.

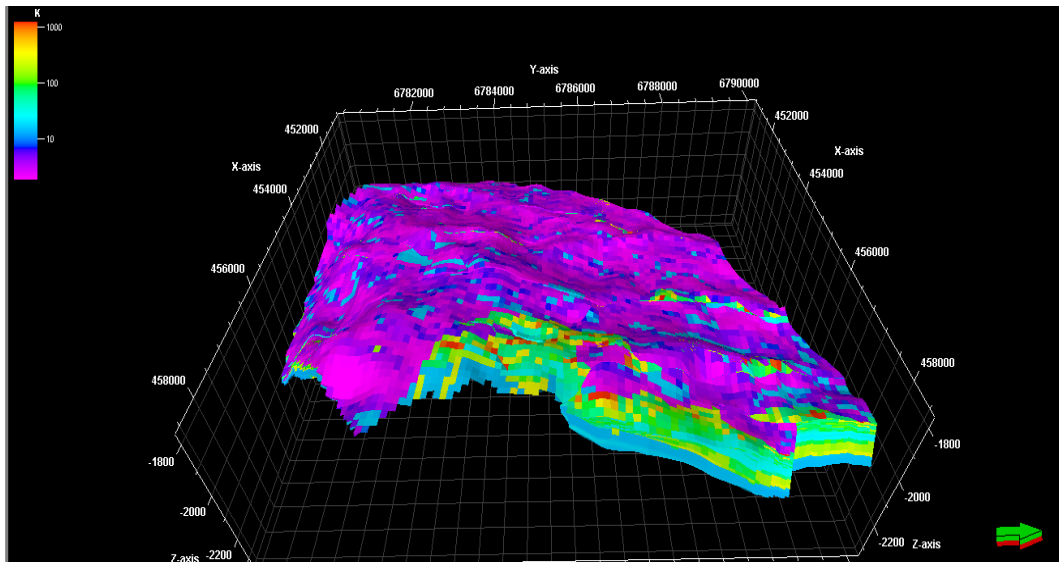
When performing petrophysical modeling, each cell for that property has been given a value. The calculation of the property value at each cell defined by the 3d grid was based on the input well data, facies, variogram, correlated secondary variable and trend.

The steps for petrophysical modeling are as follow-

- Double click on the Petrophysical modeling on the process pane
- Overwrite and upscaled property (Porosity/Permeability) have been selected
- Select the zone
- Select the method to use
- Set the variogram
- For each zone appropriate setting have been checked and by clicking ok the property model (porositymodel, permeability model) has been created.



FigureVII: Porosity Distribution



FigureVIII: Permeability Distribution

VI. CONCLUSION

For better understanding of reservoir quality and development of the field, reservoir modeling is being widely popular all over the world. From reservoir modeling, reservoir potential zone, its characteristics can easily be identified and it gets more easier to take decision where to drill for better production.

REFERENCES

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