Static Reservoir Modeling of Petrophysical properties; A case study one of the offshore oil field in the south of Iran

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ABSTRACT

Static reservoir modeling plays an essential role in evaluating reservoir reserves and estimation production capability of petroleum reservoirs. The static reservoir modeling is investigating to estimate reservoir properties of the Upper Sarvak Formation in one of the offshore oil fields of the Persian Gulf. The structural reservoir model includes fault modeling, geocellular networks and seismic horizons. The 3D geocellular network consists of pillars and 50 * 50-meter dimension cells in the X and Y directions and one-meter thickness in the reservoir zone. In this paper, we used the distribution of petrophysical properties of Sarvak Formation in one of the southern oilfields of Iran is investigated using geostatistical analysis. Finally, the permeability, porosity, shale volume and water saturation distribution models have been developed using statistical methods Sequential Gaussian Simulation (SGS). The results show that the generate SGS model presents with acceptable accuracy the permeability distribution of the studied reservoir.

Keywords: Static reservoir modelling, Geocellular, SGS, Kriging.

INTRODUCTION

In the oil and gas industry today, Static reservoir modeling has become an important process for characterization reservoir parameters. These three-dimensional models provide a digital representation of the dispersal properties of the reservoirs (permeability, porosity, water saturation, shale volume, etc.) that can be used to address many issues including hydrocarbon volume estimation. Reservoirs, design of new wells, alignment of forensic alignment between drilled wells, uncertainty analysis of results, cost estimation, reservoir dynamics simulation (Zakrevsky, 2011; Holden, 2003). Petrophysical reservoir data, such as porosity and permeability, are data that represent spatial correlation and correlation in the reservoir space, and in geostatistical terms, the spatial structure itself, and these are the same variables that the geostatistics act on in relation to the relationships between the variables (Joa Feipe Costa, 2000; Hassani pak,2010). Generally, 3D geological modeling is carried out in two deterministic and probabilistic ways. When the input data contains a wide range of data, the definitive method is used and this method has only one answer. When available field information is scattered and possible, modeling methods can be used. One of the definitive methods is the kriging method and the possible Gaussian simulation methods can also be referred to as the Gaussian sequential simulation (SGS) method (Oliver, 2010). In the present study, we have estimated the petrophysical parameter such as porosity and permeability using a sequential Gaussian simulation of one of the Persian Gulf oilfields.

Geological setting

The study area is one of the oil fields in the Persian Gulf basin. In this oil field, the three sequences, the upper part sequences are Sarvak formation with the age of Cenomanian and in the lower part is Surmeh formation, the lithology dominant of the Upper Cretaceous limestone (Arab zone) with the Kimmeridgian age, the major facies is dolomite-limestone, Daryan with the Aptian age and the dominant lithology of Daryan is limestone. The formations studied in this field are Sarvak

Formation. It seems that the limestone and shale of the deep part of this formation which between of anhydrite and dolomite layers, reduce the quality of the reservoir in this field. In the Khatiyah and Mishrif zones, this field is reported with a high-quality oil. The formation of structures in this field, like other salt dome structures in the Persian Gulf region, is related to salt tectonics and uplift of the Hormuz Formation locally. Based on seismic studies, it seems that the time of salt uplift has begun as a result of the formation of the structure in the late Jurassic, and this trend continues to the tartar. In tectonic terms, the oil field study structure is one of the slopes along the eastern part of the Qatar arc and has a dome structure that is influenced by normal faults. Sarvak Formations, with Middle Cretaceous age (Albian to Turonian), is widely deposited in southern to southeastern Iran (Fig, 1).

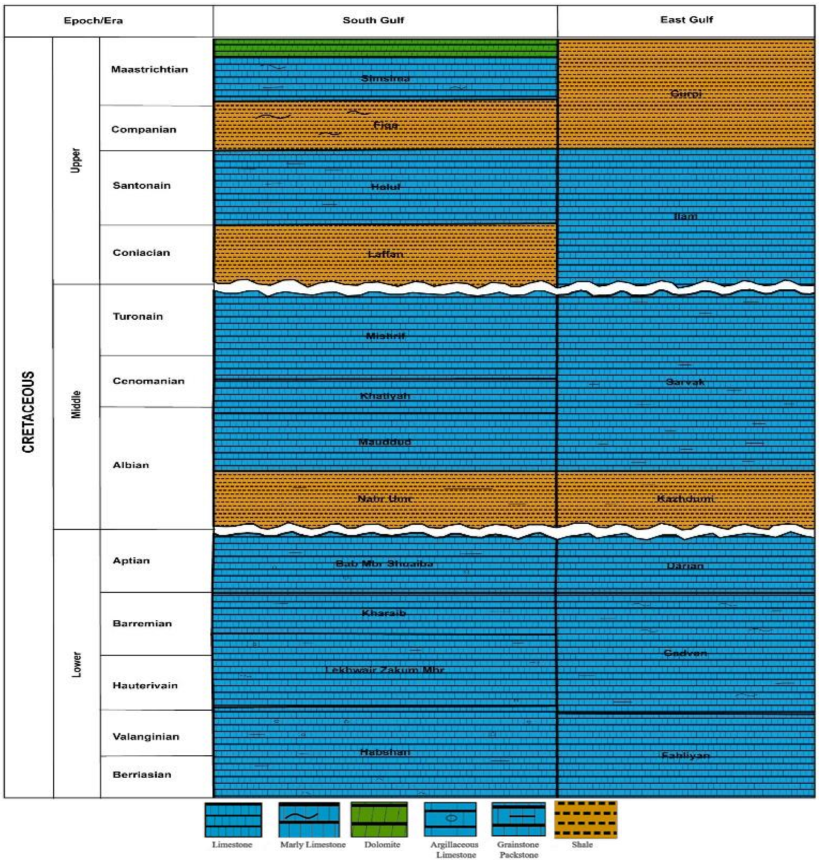


Fig. 1. Cretaceous stratigraphy chart in the south and east of the Persian Gulf (modified Al-Husseini, 2007).

METHODOLOGY

The essential step in reservoir studying is to build a static model. Using three-dimensional geocellular grid to represent reservoir geology, structure and stratigraphy, reservoir substrate and fault modeling that results in the construction of reservoir models and properties. A geocell model generally has hundreds to thousands. There are millions of cells. For each cell, rock and petrophysical properties such as porosity and permeability are defined. The construction model of a reservoir is a common model for geological horizons and faults that form the geometrical framework of the three-dimensional grid and form the boundary of the facies and petrophysical models that represent rock properties.

In addition, it forms the basis of volume measurement calculations, well design, and fluid reservoir simulation networks. The reservoir parameters are plotted as well log data along the drilling path. In this step, the input parameters in the geocell designed in the reservoir network model are evaluated by the averaging method. This will assign a number to different parameters in each cell. The trend in the data makes the variogram not reach a fixed ceiling. After making the necessary corrections, the geophysical data (porosity, permeability, shale volume and water

saturation) are ready to enter the model environment (fig, 2). In this study, in the X and Y directions, the dimensions of the 50 * 50 m geocell with a thickness of one meter are defined. At this point, the petrophysical data is entered into the model to select the interpolation method.
The interpolation methods used to find the properties of petrophysical variables in the space between wells are considered to be deterministic modeling approaches. In this method, based on the petrophysical diagram at the location of the well, an algorithm called interpolation function allocates a reservoir variable to the space between the wells. The method was applied based on the type of application in this study and considering the computer hardware features.
The aim is to upscaling the value of each petrophysical parameter in the geocell designed in its geometrical location. The two primary conditions for upscaling, that the data has a normal distribution, and the input values have no specific orientation. In Sequence Gaussian Simulation method, the data normalization should be done to simulate data. Then the production of the random number, points are estimated in the network, and this stage continues until the final model is produced. Static modeling of the reservoir shows the distribution of effective porosity values and the permeation values in Fig. 3 for reservoir properties. In general, the accumulation of samples with porosity and permeability is close to zero. The probability of the presence of silty deposits in the reservoir layer or when the porosity and permeability diagrams are increasing, it is likely to have a channel or fracture.

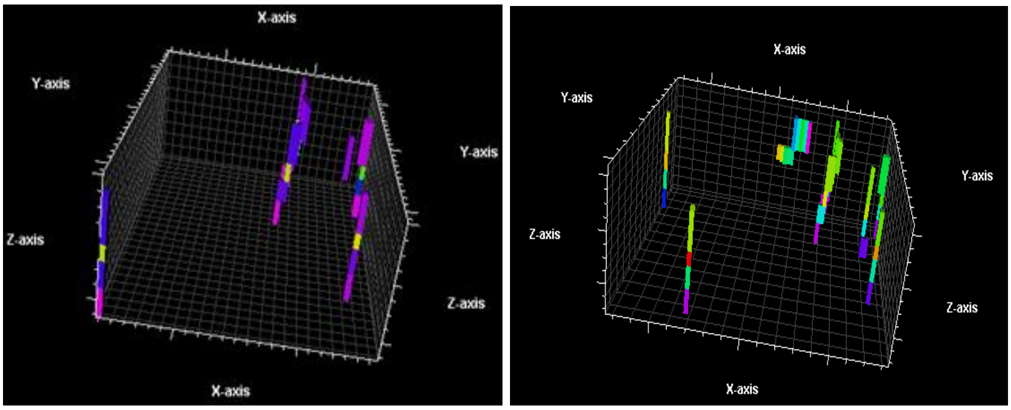


Fig .2 upscaled petrophysical well logs, a) Permeability b) porosity

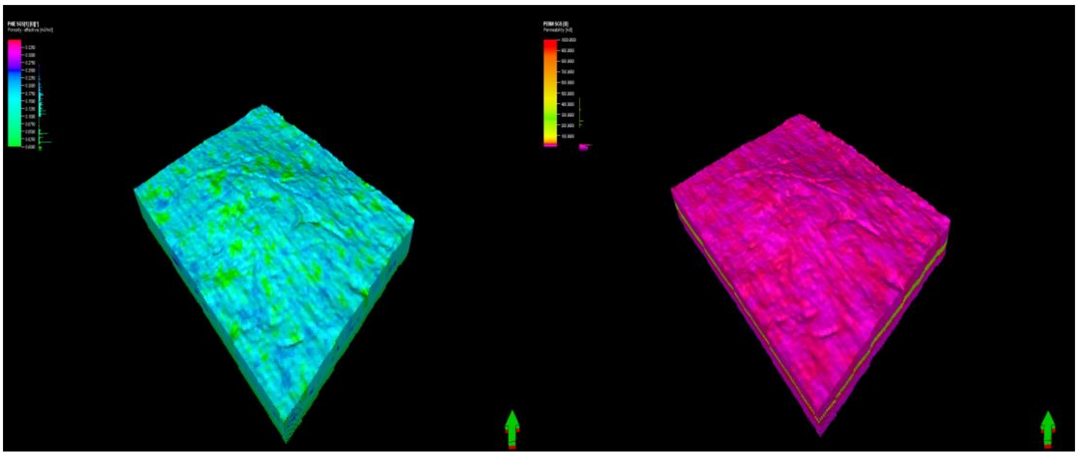
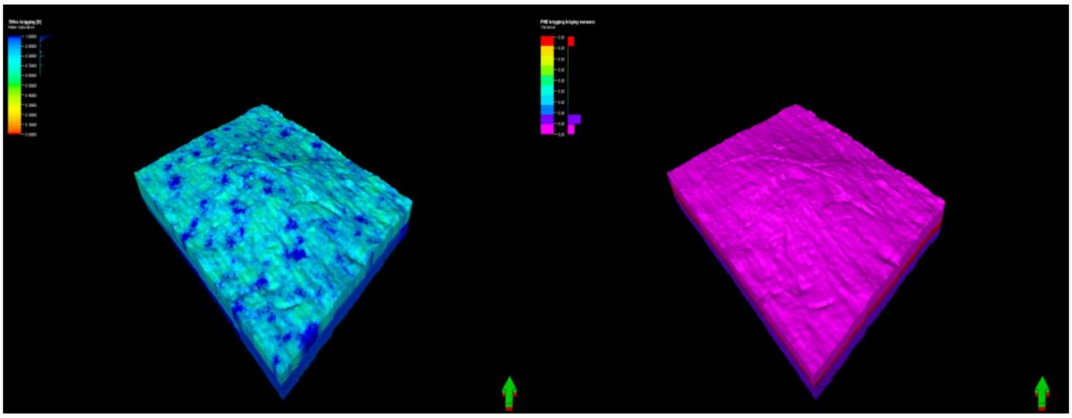


Fig 3. Static reservoir model. a) Porosity, b) Permeability.



c) Water saturation, d) Shale volume.

CONCLUSION

Static reservoir modeling using geostatistical methods provides acceptable results for evaluating reservoir properties that have complex geological conditions. The results are acceptable due to the high accuracy and no impact of changes in model estimates to obtain the final results in the calculations. In this study, static modeling is evaluated using seismic data and well log reservoir properties of the field under study. The results of the evaluation of petrophysical parameters using sequential Gaussian simulation show that in the reservoir layer the highest porosity is equal to 28% and the average permeability of 100 mD were estimated in the reservoir layer. The accumulation of the samples with near-zero permeability and water saturation amounts interpreted as the probability of mudstone and claystone existence; On the other hand, increasing trends of permeability diagrams in the wells emphasize the possibility of the presence of channel or fractures in the reservoir.

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