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Khami Reservoir Evaluation using Structural and Petrophysical Models, Ahwaz Oil Field, Zagros, Iran

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Abstract

Three dimensional structural and petrophysical models of the Khami reservoir were constructed using Reservoir Management System computational software in Ahwaz oil field. These models are helpful in the exploratory reservoir evaluation and can be affected on production management and hydrocarbon well planning in the reservoir development. The reservoir understudy consisted of Fahlyan, Gadvan, and Daryan formations. The reservoir zones was reviewed and improved to a new classification. Based on the study, the reservoir divided into eleven zones. Input data to provide 3D model was getting from different sources such as geophysical interpretation, well description, and 2D maps of reservoir properties which were used after controlling in view of quality. Structural model consisted of stratigraphy and fault constructed by help of Daryan top surface as interpreted surface and the top surfaces of Gadvan, Khalij limestone member, and Fahlyan formations. Top zones and subzones were considered as calculated surfaces. The entrance depths of wells into the reservoir are also used. Subsurface iso-contour map of Daryan formed by seismic and geophysical data was corrected, digitized and considered as the base contour map. According to structural model, the dip is different in flanks. The fault model revealed three limited faults which caused to uplift the central part of the anticlinal. Petrophysical data detected that the Daryan is in oil potential and the Fahlyan is in gas prone. Zones of 1, 7, 9, 10, and subzone 1-1 are showing higher hydrocarbon potential, but subzone 1-2 is lower. Petrophysical modeling indicated that the reservoir characteristics such as porosity and water saturation are in best level in the middle and west culminations. The calculated in-situ oil and gas volumetric values are 10^8 bbl and $2 \times 10^8 m^3$.

Key words: RMS software, Khami Reservoir, Structural Model, Petrophysical Model

Introduction

Foreland basins are the best settings to reserve hydrocarbons in the world. Iran as one of largest production area in Middle East is a region that consisted of 16% of gas and 10% oil reserves (Sexton and Chairman, 2006; Bahmannia, 2006). Hydrocarbon reservoirs are mostly located at south-southwest of Iran in Zagros region (Alavi, 1999).

Reservoir modeling started at Hyde oil field in Kingdom province in south North Sea using geostatic methods (Sweet et al., 1996). Multi layer 3D modeling based on geostatistic and kriging methods was used in several regions (Deraisme et al., 2000; Telje et al., 2000; AL- Khalifeh and Makkawi, 2002; Hauge et al., 2003; Pyrcz et al., 2005; Mitra and Leslie, 2005; Soleimani et al., 2008). The present study is also an attempt to evaluate the deep explored reservoir using 3D reservoir modeling

Geological position

Ahvaz oil field is located at Dezful Embayment with 60Km length and 5-6Km width (Fig 1). In this oil field, there are three reservoirs: Asmari, Bangestan and Khami. The last one is in exploratory state. The Khami group divided into two parts. The lower one consisted of Surmeh and Haith (Jurassic) and upper part consisted of Fahlyan, Gadvan and Daryan (Cretaceous). The Khami Group with the thickness of 1500m was overlain by Kazhdumi Formation and separated from Bangestan Group. The reservoir divided into eleven zones (Fig.2).

Methodology

In the present study, all data of three available drilled exploratory wells was used to predict the hydrocarbon potential and evaluate the reservoir characteristics applying reservoir Management System (RMS) computational software. All steps to reconstruct the models were shown (Fig.3).
Stratigraphic model benefited of structural calculated maps, true stratigraphic thickness, isochore maps (Fig.4), Isodip maps (Fig. 5) and isothickness maps (Fig.6) (using TST, dip and azimuth of Daryan top zone) which is plotted by:

Isochore map= TST/ cos dip
Next surface = Above surface + Isochore

After generation of these maps, entrance depths of each surface/zone should be adjusted. UGC map also is necessary for all zones to construct structural model. To increase the accuracy of the map, interpolation method and local B- spline function was applied. Generally, interpolation is estimation of the value of points for a parameter in the map. Local B- spline function is determine the frequency of a quantity around known points based on bell shape functions that can define a function in X and Y axes and extend it for input data. Griding is also done by RMS software into ways: xy regular and corner point. In the present study the second one was used due to the applying of model for reservoir engineering during dynamic model performance (Li et al., 2003).

Stratigraphic model constructed by the surfaces of different formation top zones, of zones and subzones is one of important part of modeling. Daryan top zone is the first interpreted surface that is formed the base of model. Isochore map (Fig. 4) was digitized based on drilled wells data and loaded as DXF format and formed an interpreted surface in RMS modeling software. In stratigraphic model it is provided other maps such as isothickness and isodip for all formations.
Petrophysical parameters modeling was made by data resulted from structural model. The aim of petrophysical modeling is to produce block well with the help of petrophysic data, statistic step of 3D of variogram and petrophysical properties of porosity and water saturation and Net/ Gross.

Because of presence of oil and gas in different parts of the Khami Group, two cut off values were used. In Daryan reservoir with heavy oil, the value was 4.5% for porosity and <50% for water saturation but in Fahlyan containing gas these values were changed in to 2.5% and 70%, respectively. Cut off values are made in volumetric calculation since data and variance in estimation are used when they are indicating normal distribution and trend less. If there is no difference between average and space variance means data are trend less (Bohling, 2005). To do this objective, normalization should be done then extend normal distribution to cover whole reservoir. This step was performed during data analysis which is in fact mostly contribution in petrophysical model. To overcome petrophysical trend, scatter plot was made for porosity and water saturation in all zones in four directions: X, Y, Z, and true vertical depth. All scattered data was removed. Data variogram was done after remove the trend (Li and White, 2003). Variogram is a variable dependence to space and showing dissimilarity of data and increasing their distance (Journal and Stanford, 1990). This property is a function of the reservoir heterogeneity. These models are useful in estimating of in situ oil volume.

Discussion

The reservoir fractured by three faults. These are identified by 2D seismic maps and drilled wells data. F1 and F2 characterized by 35º and F3 by 30º dip. These faults (Fig. 7) caused the reservoir axis plane to deviate (Fig. 8). The movements terminated to break up and uplifted the reservoir (Fig. 8 and Fig.9) and produced some disturbation in deepest zones. In the structural model, Ahvaz oil field presented three culminations in the Khami reservoir. However, it consisted of only two in the upper parts above the Asmari reservoir. This matter most probably related to the fault movements.

Calculation of in-situ hydrocarbon volume is a basic stage in the reservoir evaluation and future production strategy. This process can be made by different methods such as volumetric calculation, balance matter calculation and production line variation analysis. In these methods, the basis of calculation is determination of mass rock and mean of petrophysic parameters since it will be indicating of active and dead hydrocarbon. In the present work, volumetric calculation was made using parameters such as water-oil/gas contact (WOC, WGC), volumetric oil (BO) and gas (BG) coefficients, and Net to grass thickness (N/G) are formed input data of structural and petrophysical models (Fig. 10). Net thickness is in fact the formation thickness with acceptable petrophysical characteristics and reservoir conditions. These conditions determined by porosity and water saturation cut off for all reservoir zones which may be different from one reservoir to another. In the present research work based on reservoir data, cut off value of 4.5% for porosity and 50% for water saturation in petroleum Daryan reservoir but these values changed for gaseous Fahlyan reservoir to 2.5 and 70% respectively. Water oil contact for Daryan is -4676.9m and water gas contact for Fahlyan is -5134.6m. Estimated in-situ oil and gas volumes are 10^8 bbl and $2 \times 10^8 m^3$, respectively in reserve tank conditions.

Concluding remarks

Khami reservoir modeling includes of structural (fault and stratigraphic), griding and petrophysical models using of reservoir management system computational software. Based on seismic and drilled holes data and modeling of the reservoir indicated that fault system increased complexity of lower zones. This is also caused to increase the dip in northern flank. Structural model and dip data revealed that the fold is symmetry in the nose and central parts and asymmetry in eastern part. The reservoir limited by two faults (F1 and F2) that uplifted the structure.

Interpreted surface based on UGC map of Daryan top zone formed, digitized and loaded input data for software to generate lower surfaces of formations, layers, zones and subzones. Reservoir petrophysical model was made by help of geostatistics and simulation methods used in the software. Distribution style of the reservoir parameters such as porosity and water saturation predicted and modeled.

Net/gross thickness, porosity and water saturation means in Daryan Formation are 0.153, 0.714, and 0.275%, respetively. In Daryan Formation these values are 0.83, 0.765, 0.372%.Gadvan Formation presents very low N/G ratio and very high water saturation. Khalij member in spite of its reservoir potential is water wet with mean of 70% water saturation. Hydrocarbon volumetric values were calculated with different percentage of porosity and water saturation for Daryan (4.5 and less than 50%) and Fahlyan (2.5 and less than 70%) reservoirs. The study approved that subzone 1-1 is oil prone and gas pron zones are 7, 9, and 10.

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References

Alavi, M, 1999, Tectonics of the Zagros orogenic belt of Iran new data & interpretations, tectonophysics, V.141, no 2-4,P.287-323.

AL-Khalifeh, M., and Makkawi, M., 2002, The import of data integration on geostatical porosity modeling: A case study from the Berri field, Saudi Arabia,J. Petroleum Geology V.25(4) PP.485-498.

Bohling, G., 2005, Introduction to Geostatistics and variogram Analysis, C and PE 940.

Bahmannia, G., 2006, Developing Gas Markets in Persian Golf Case Study: IRAN, 23rd Gas Conference, Amsterdam.

Deraisme, J., Allen, O., and Renard, D., 2000, Multi-layer reservoir modeling, www. Geovariances. Com/technical references-oil-gas ar0018.htm

Hauge, R., Syversveen, A.R., and MacDonald, 2003, Modeling facies bodies and petrophysical trends in turbidite reservoirs, SPE 84053, 7P.

Journel, A.G. and Stanford, U., 1990, Geostatistics for reservoir characterization, Society of Petroleum Engineers Inc., 20750, P.353-358p.

Li, H. and White, C.D., 2003, Geostatistical models for shales in distributary channel port bars (Ferron Sandstone, Utah): From ground – penetrating radar data to three-dimensional flow modeling, AAPG Bulletin V.87, NO.12,P 1851-1868.

Mitra, S., and Leslie, W., 2003, Three dimensional structural model of the rhourde el Baguel field. Algeria AAPG., vol, 87,No.2,P231-250.

Pyrcs, M.J., Catneanu, O., and Deutsch, C.V., 2005, Stochastic surface-based modeling of turbidity lobes, AAPG Bull., V.89, pp.177-191.

Roxar Softwar Solution, 2003.RMS User guid release 7.0

Saxton, J., and Chairman, 2006. Iran,s oil and Gas wealth, united states Congress, Joint Economic committee, Research Report # 109-310.

B. Soleimani, B., Nazari, F., Bakhtiar, H.A., Haghparast, G., and Zandkarimi, G., 2008, Three dimensional geostatistical modeling of oil reservoir: A case study from the Ramin oil field in Iran, J. Applied Science, 8(24),

Sweet, M. l, Blewden, C.J, Carter, A. M, and Mills, C.A., 1996, Modelling Heterogeneity In low-Permeability Gas Reservoir using Geostatistical techniques, Hyde field, southern north sea1, AAPG Bulletin V.80. No.11(November) p.1719-1735

Telje, G., Kihelblberg, A., and Wold, R., 2000, Reservoir modeling using 3D visualization. www. cseg.ca/conferences/2000abstracts/1244/pdf

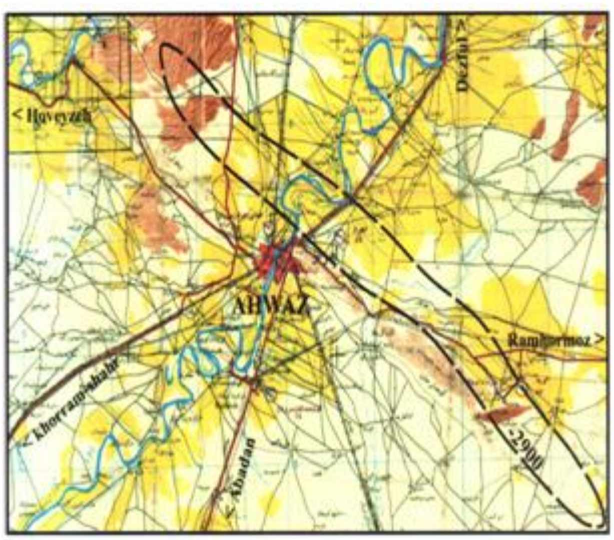


Fig.1-Oil field position (dashed line)

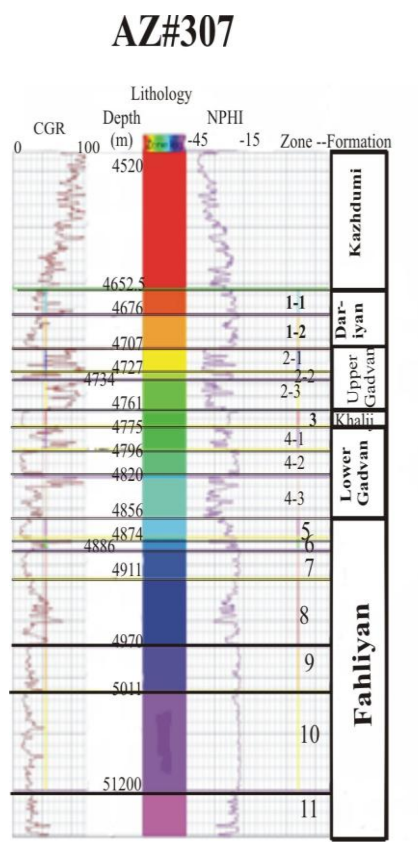
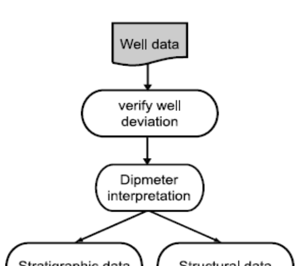
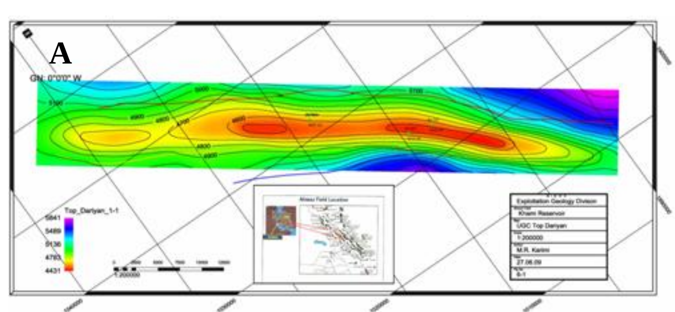


Fig.2- Stratigraphic column in selected drilled well (#307)





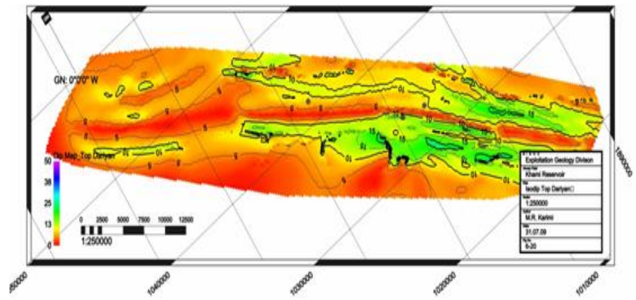


Fig.5- Selected isodip map of Daryan Top zone

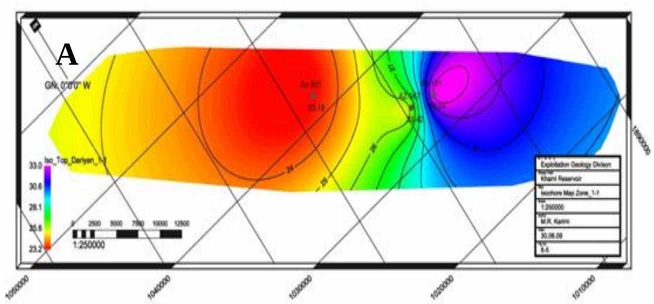


Fig.6- Selected isothickness map of Daryan Top zone

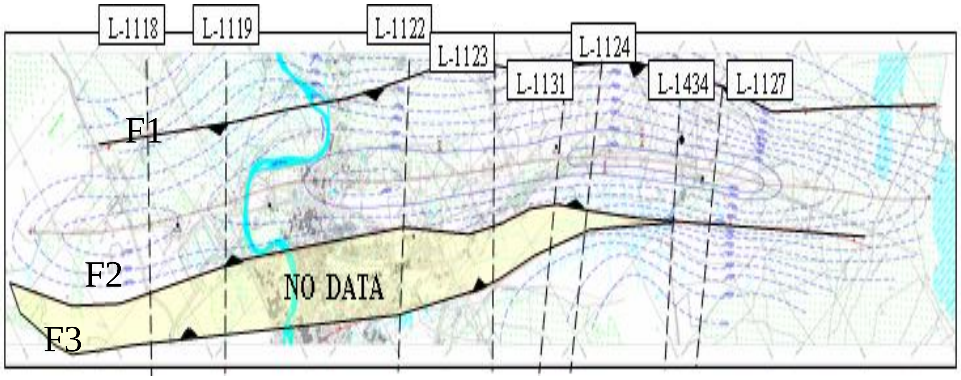
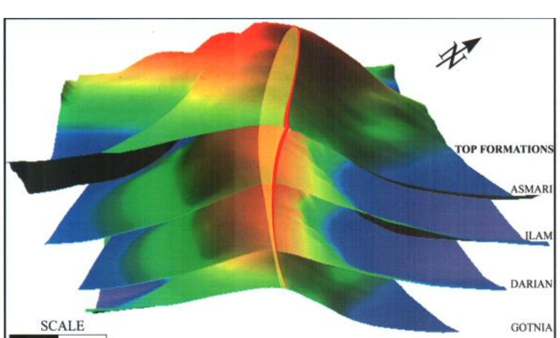
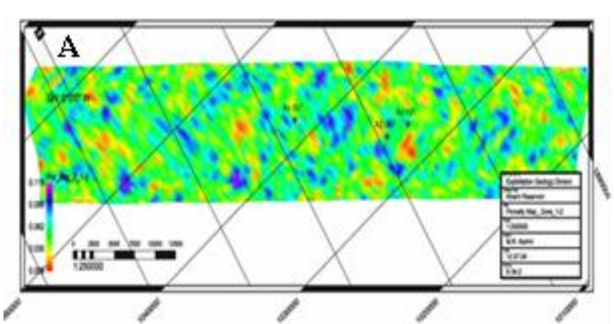


Fig. 7- Seismic lines position of the field





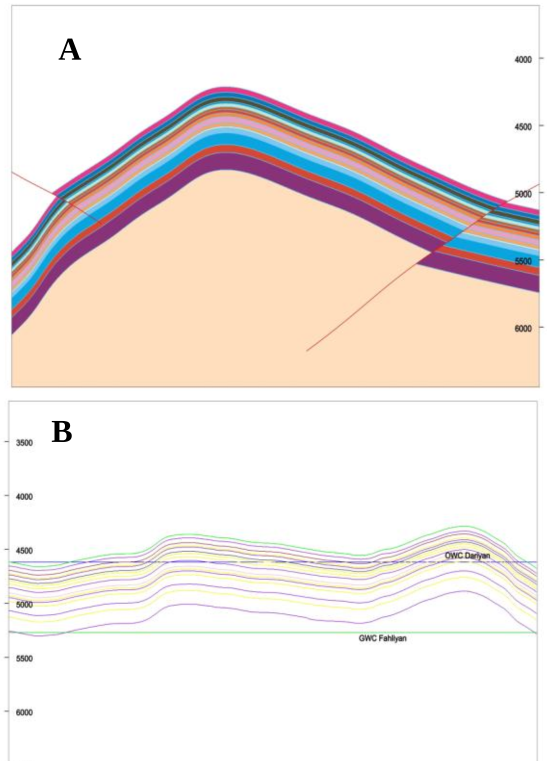


Fig.9-Longitudinal (A) and latitudinal (B) cross sections of the reservoir