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Uncertainty Analysis of Reservoir Static Modelling: A Case Study of KMJ Oil Field

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Abstract: This case study explains the uncertainty of Original Oil in Place (OOIP) calculations in reservoir static modeling of KMJ Oil Field. This field consists of 4 (four) wells in an area of ± 600 acres with high heterogeneity, so in building a 3D Model, it is necessary to analyze the sensitivity and uncertainty of geological concepts, calculations of petrophysical properties, and fluid contact. The OOIP calculation uses a probabilistic method and determines reserves related to field development. The uncertainty analysis study begins by identifying the parameters with the most significant influence (Sensitivity Analysis) in calculating OOIP in the static reservoir model. To determine the ranking of reservoir uncertainty parameters, several geological, geophysical, and petrophysical factors in building a static model must be tested according to the method used in each parameter. The OOIP calculation in the static model is calculated into three scenario categories, namely low estimate (P10), base estimate (P50), and high estimate (P90). The combination of determining facies (shale volume) porosity, fluid contact, and the cut-off is a variable/parameter that is very influential in volumetric multi-scenario calculations (probabilistic method) in the KMJ Oil Field. The results of the uncertainty analysis of the KMJ Oil Field have a low OOIP estimate (P10) of 10.86 MMSTB, a base estimate (P50) of 11.49 MMSTB, and a high estimate (P90) of 12.01 MMSTB. Furthermore, the static model used for reservoir simulation (dynamic model) in the KMJ Oil Field is the base estimate model (P50) of 11.49 MMSTB.

Keywords: Uncertainty Analysis, Sensitivity Analysis, Original Oil in Place, Low Estimate (P10), Base Estimate (P50), High Estimate (P90)

1. Introduction

Three-dimensional (3D) geological static models of oil reservoirs at present are very sophisticated, namely by using computer software processing so that it will get representative 3D model results close to actual conditions with accurate modeling results. In geological and geophysical modeling (geological concepts), the existing model conditions are often unknown, and 3D modeling uses geological interpretation/assumptions [1-5]. Each input data used to build a static 3D model has uncertainty, so the model building cannot be realized in a deterministic model [6-8].

The combination of the depositional environment facies uncertainty, porosity–water saturation, net-to-gross (NTG), and fluid contact determination contribute significantly to the estimation of volumetric hydrocarbon calculations [8-12]. In terms of the distribution of rock properties, using unrealistic variogram parameters (nuggets, sills, and correlation ranges) can result in calculations of Original Oil in Place (OOIP) that are too high or too low so that reserves cannot be calculated correctly [13-15].

This work describes the problems encountered in constructing geological 3D models and OOIP calculations with probabilistic methods to achieve mutually acceptable results toward the transition to dynamic models.

Production of the KMJ Oil Field started in 1992 until now and is still in production in the primary production phase. The total number of wells in the KMJ Oil Field until 2021 is 4 (four) wells. As of November 2021, the number of wells still actively producing is 1 well. Cumulative oil production in the KMJ Oil Field until November 2021 is 3.36 MMSTB, which comes from the sandstones of the Bekasap Formation. Geology 3D modeling in the KMJ Oil Field is done using the software. The reservoir layer in the KMJ Oil Field for which 3D modeling will be carried out consists of 9 (nine) sand reservoir units included in the Bekasap Formation, namely Sand Units A, B, C, D, E, F, G, and H. In the KMJ Oil Field, 8 (eight) units of sand are proven to produce hydrocarbons, based on the results of fluid contact analysis. The total results of STOIIP in KMJ Oil Field using deterministic volumetric calculation is 10.98 MMSTB [16], as shown in Table 1.

Table 1. *KMJ oil field deterministic OOIP calculations [10].*

Unit Sand	Net Volume (ft^3)	Pore Volume (RB)	HCPV Oil (RB)	STOIIP (STB) 10^6
A	184,070,111	6,070,476	2,973,752	2.66
B	42,076,385	1,513,045	853,163	0.76
C	100,628,365	3,568,525	1,880,230	1.68
D	254,622,814	9,438,053	5,825,670	5.20
E	10,082,492	357,659	160,652	0.14
F	16,786,555	666,425	330,094	0.29
G	4,137,217	154,034	73,990	0.07
H	8,820,745	394,894	197,904	0.18
Total	621,224,684	22,163,111	12,295,455	10.98

2. Research Methodology

This study consists of several steps, from creating a static model through calculating OOIP (Step 1 to Step 4) as shows in Figure 1. Determining the research methodology is made by modification of the previous studies conducted by Bueno et al. 2011 [9], and also based on guidance of SKK Migas, 2018 [17].

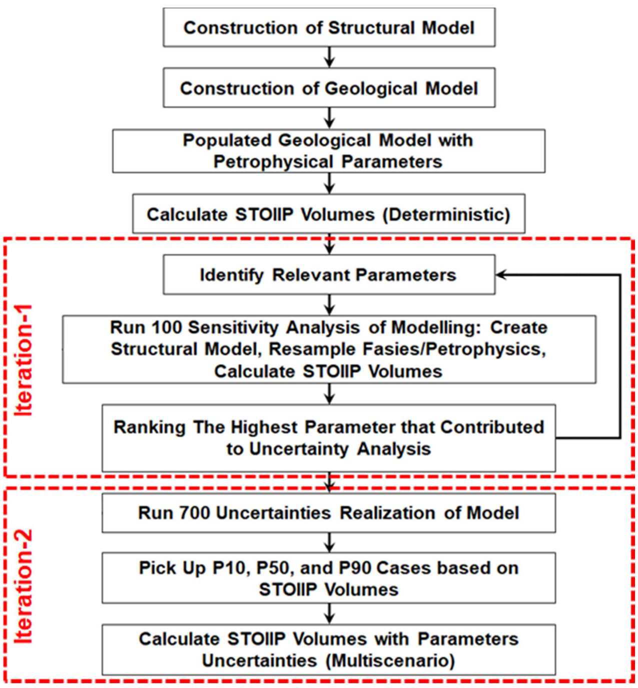

Figure 1. *KMJ oil field uncertainty analysis research methodology.*

2.1. Step 1: Construction of Structural Model

2.1.1. Mapping

Mapping aims to make a subsurface map from well markers that result from correlations between wells. Marker mapping is carried out on sand units (layers) A through H, in the form of top and bottom.

2.1.2. Fault Modeling

The fault pattern to be modeled is derived from seismic interpretation results, integrated with production and pressure data, and also supported by local geological concepts.

2.2. Step 2: Construction of Geological Model

2.2.1. Pillar Gridding

The gridding process carried out in the KMJ Field is in the form of depth units (x and y: meters and z: ft). The grid size used is (50x50) meters.

2.2.2. Segmentation

Segmentation is a division of the 3D Grid, which is bounded by faults that intersect, intersect, or faults that exceed the boundary model boundaries.

2.2.3. Make Horizon and Make Zone

The Make Horizon stage creates a 3-dimensional (3D) depth structure map controlled by well-marker data and fault modeling results.

Make Zones stage, this is done to create horizons that cannot be mapped based on seismic interpretation due to the limited resolution of seismic data.

2.2.4. Make Fluid Contact

Analysis of the determination of fluid contact in the KMJ Field begins with a review of the analysis results of previous studies. The review results are then carried out in an integrated analysis of the data from the petrophysical analysis and production tests.

2.2.5. Layering

Layering is done to create thinner and more complex layers in each reservoir zone. This layering will be the thickness of the cells in the well properties to be modelled. Layering validation makes scale-up well logs of petrophysical properties by comparing the histogram data with the layered histograms.

2.3. Step 3: Population of Geological Model

2.3.1. Scale up Well Logs

Scale Up is the process of averaging the log values from the well, which initially had a high vertical resolution, to one value for each cell penetrated by the well.

2.3.2. Data Analysis

Data analysis is the data analysis stage resulting from the scale-up of well logs before distribution throughout the 3D Grid model. The data analysis process uses variogram geostatistics by analyzing the trend toward the spatial distribution of data, both laterally and vertically.

2.3.3. Facies Modeling

Facies modeling begins with defining facies both vertically and laterally. Defining vertically is by using well data such as log data and core/petrographic data while defining laterally using seismic analysis results in the form of seismic attributes and validated with production data.

2.3.4. Petrophysical Modeling

Petrophysical modeling can generally be done in 2 (two) ways: geostatistical distributed (Vshale, PHIE, Sw) and calculated (NTG, permeability, Sw, and petrophysical cut-off). Petrophysical properties are geostatistically distributed: Vshale, PHIE, and Permeability, while Sw is calculated based on the capillary pressure curve. While, production data control Vshale, NTG, and PHIE cut-offs.

2.4. Step 4: Calculate STOIIP Volumes (Deterministic)

Volume calculations in the KMJ Oil Field were carried out using the volumetric method and based on the 2001 SPE regarding the classification of reserves [2, 6].

2.4.1. Iteration 1: Sensitivity Analysis

At this stage, the aim is to identify the variables that influence the size of the calculation results of the KMJ Oil Field OOIP. Sensitivity analysis was carried out for 100 samples using the Equal Spacing Sampler method as shown in Figure 2.

2.4.2. Iteration 2: Uncertainty Analysis

At this stage, the aim is to analyze the uncertainty of multi-scenario OOIP calculations (P10) low estimate, (P50) base estimate and (P90) high estimation with the 3D model input variables that have been obtained from sensitivity analysis. Uncertainty analysis was carried out for 700 samples using the Monte-Carlo Sampler method as shown in Figure 3.

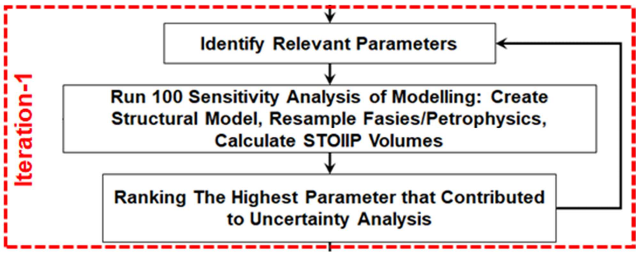

Figure 2. *Stage of iteration-1 sensitivity analysis.*

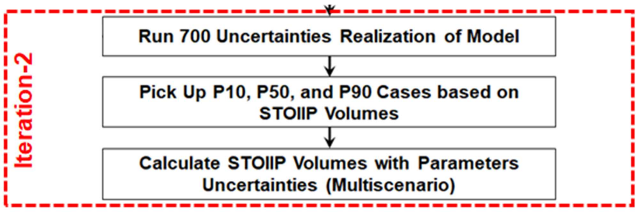

Figure 3. *Stage of iteration-2 uncertainty analysis.*

3. Results and Discussion

3.1. Sensitivity Analysis

A. Sensitivity Cut-off

The determination of the cut-off used in the sensitivity analysis is divided into 3 (three) value scenarios, namely the minimum, base, and maximum values. The size of this value is determined based on petrophysical analysis, namely plots between rock property data (Vshale and PHIE) vs. test data (oil rate), as show in Figure 4.

Figure 4 shows that the minimum limit for the Vshale cut-off is 0.4, the base value is 0.5, and the maximum value is 0.6; while the minimum limit for the porosity cut-off is 0.11, the base value is 0.13, and the maximum cut-off porosity value is 0.15. Tabulation of the use of minimum, base, and maximum values can be seen in Table 2.

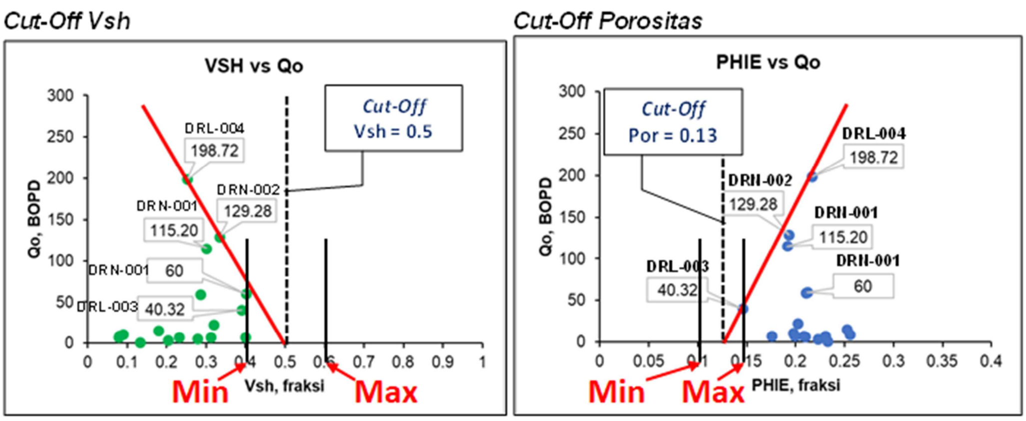

Figure 4. *Determination of minimum, base, and maximum values on sensitivity cut-off.*

Table 2. *Tabulation of minimum, base, maximum values of sensitivity cut-off.*

Parameter	Min	Base	Max
Cut-off VSH	0.4	0.5	0.6
Cut-off PHI	0.11	0.13	0.15

B. Fluid Contact Sensitivity

Determination of the depth of fluid contact in the KMJ Oil Field is divided into 3 (three), namely LTO (Lowest Tested Oil), OWC (Oil Water Contact), and LKO (Lowest Known Oil). LTO depth is determined based on the outermost well with oil test results at the lowest perforation interval (bottom perforation). OWC depth is determined by integrating test data and log data to determine the maximum contact depth in each sand unit. LKO value is obtained from the integration of test data and log data, and then the contact withdrawal is determined based on the cut-off resistivity for each sand unit.

There is still a possibility of decreasing the LKO depth if the unit sand below the LKO depth still has good rock properties (Vsh value below the Vsh cut-off and PHIE value above the PHIE cut-off). From these three types of fluid contact, we can determine the minimum - maximum values that will be used in the contact uncertainty analysis. Tabulation of minimum - maximum uncertainty of fluid contact is shown in Table 3.

Table 3. *Minimum - maximum values tablation on fluid contact sensitivity.*

Unit Sand	Well Reference	LTO (ft-TVDSS)	OWC (ft-TVDSS)	LKO (ft-TVDSS)	Remarks
A	KMJ-002	-3828	-3830	-3828	Single Swab Test 3800' Sand (1-Feb-1995, 17.28 BPH / 98% wtr)
B	KMJ-002	-3845	-3845		Single Swab Test 3840' Sand (1-Feb-1995, 24.96 BPH / 98% wtr)
C	KMJ-002	-3870	-3872		Single Swab Test 3860' Sand (24-Aug-1992, 16 BPH / 20% wtr)
D	KMJ-002	-3938	-3938		Single Swab Test 3900' Sand (24-Aug-1992, 42 BPH / 23% wtr)
E	KMJ-001	-3927	-3930		Single Swab Test (9-Oct-1992, 816 BPH / 15% wtr)
F	KMJ-001	-3947	-3952		Single Swab Test (17-Aug-1993, 239 BOPD / 0.2% wtr)
G	KMJ-004	-3991	-3993	-3991	Single Swab Test (5-Sep-2005, 9.76 BPH / 90% wtr)
H	KMJ-004	-4021	-4034	-4021	Commingle Swab Test 4020' Sand and 4140' Sand (5-Sep-2005, 29.28 BPH / 96% wtr)
		Min	Max		

C. Sensitivity Property Modeling (Seed)

The realization of the KMJ Oil Field model properties used in sensitivity analysis is Vsh and PHIE property models. The seed value in the property model is used randomly to get different OOIP values for each model. An example of using petrophysical modeling (seed) variables can be seen in Figure 5.

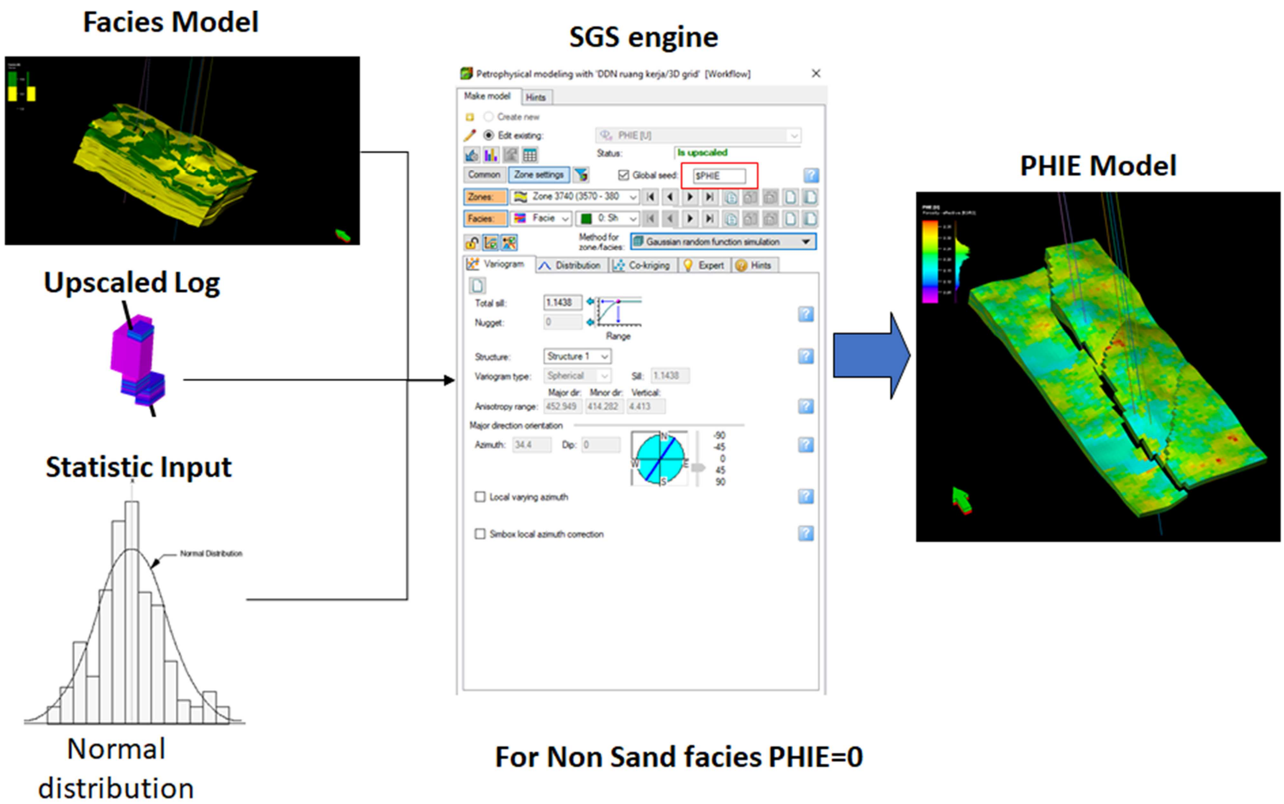

Figure 5. *Usage of seed values on uncertainty analysis.*

D. Sensitivity Property Modeling (Variogram)

Variogram variables include major direction, minor direction, vertical, and azimuth. These four directions will be used in the uncertainty analysis at the KMJ Oil Field. In the KMJ Oil Field, 3 (three) scenario models are used, namely Low Case, Base Case, and High Case, hence each model has different variogram direction values.

Determination of the minimum - maximum value based on the largest difference in each sand unit and each direction. After sorting from the smallest value to the largest value, this value is used as a subtracting or adding factor to produce a minimum - maximum value in each direction, as shows in Table 4. While, examples variogram of sensitivity analysis in the KMJ Oil Field is shows in Figure 6.

Table 4. *Minimum values tabulation - maximum variogram direction property Vsh.*

Unit	Major			Minor			Vertical			Azimuth		
Sand	Min	Base	Max	Min	Base	Max	Min	Base	Max	Min	Base	Max
A	131.20	273.86	416.52	187.71	258.69	329.68	1.81	2.49	3.16	14.70	21.90	29.10
B	173.86	416.52	559.17	186.91	257.90	328.88	0.36	1.04	1.71	15.40	22.60	29.80
C	291.32	433.97	576.63	267.62	338.60	409.58	2.70	3.38	4.06	14.70	21.90	29.10
D	122.58	265.23	407.89	194.25	265.23	336.22	5.58	6.26	6.94	15.70	22.90	30.10
E	350.01	492.67	635.32	209.02	280.00	350.98	3.60	4.28	4.95	28.10	35.30	42.50
F	423.37	566.03	708.69	451.03	522.01	592.99	5.78	6.46	7.13	17.10	24.30	31.50
G	107.90	250.56	393.22	164.90	235.89	306.87	0.16	0.84	1.52	24.40	31.60	38.80
H	328.00	470.65	613.31	355.65	426.63	497.62	6.83	7.51	8.18	17.20	24.40	31.60

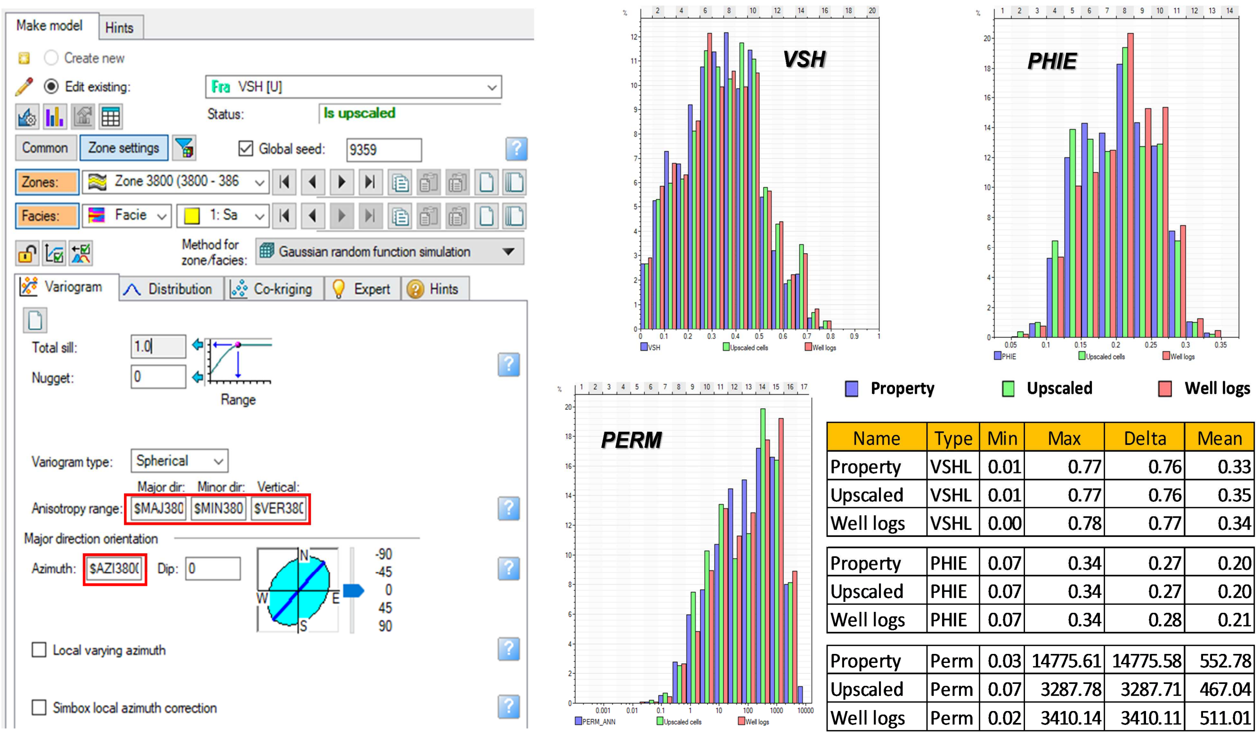

Figure 6. *Examples of using variogram on uncertainty analysis.*

Table 5. *KMJ oil field uncertainty category.*

No	Category of Uncertainty	Number of Variable
1	Fluid Contact	15
2	Cut-off VSH	1
3	Cut-off PHI	1
4	Seed PHI Model	1
5	Seed VSH Model	1
6	Variogram PHI	40
7	Variogram VSH	40
Total		99

3.2. Uncertainty Analysis

The KMJ Oil Field uncertainty analysis consists of 7 (seven) categories, namely fluid contact, Vsh cut-off, PHIE cut-off, seed PHIE model, seed Vsh model, PHIE variogram, and Vsh variogram. In these 7 (seven) categories, there are a total of 99 variables used in the analysis as shown in Table 5.

As an example, it can be seen in Figure 7, which shows that variable No. 1 through No. 15 is a fluid contact uncertainty category. The sensitivity results for each category of uncertainty which has the greatest to the least influence on the results of OOIP KMJ Oil Field calculations. The uncertainty category that has the most significant effect on the OOIP calculation is the Vsh cut-off, as shows in Figure 8.

KMJ Oil Field Uncertainty Analysis using the Monte-Carlo Sampler method with 700x running samples. The uncertainty analysis results of KMJ Oil Field have a low OOIP estimate (P10) of 10.86 MMSTB, a base estimate (P50) of 11.49 MMSTB, and a high estimate (P90) of 12.01 MMSTB as shown in Figure 9. In comparison, the detailed results for each sand unit can be seen in Table 6 through Table 8. Furthermore, the static model uncertainty results used for reservoir simulation modeling (dynamic model) of the KMJ Oil Field is the base estimate model (P50) of 11.49 MMSTB.

Base case | Variables

	Type	Pr	Int	Base value	Distribution	Arguments					
1	Uncertain			-3884.5	Triangular	Min	-3885	Mode	-3884.5	Max	-3884
2	Uncertain			-3905.5	Triangular	Min	-3906	Mode	-3905.5	Max	-3905
3	Uncertain			-3930	Triangular	Min	-3930.5	Mode	-3930	Max	-3829
4	Uncertain			-3991	Triangular	Min	-3991.5	Mode	-3991	Max	-3969.5
5	Uncertain			-3996	Triangular	Min	-3996.5	Mode	-3996	Max	-3994.2
6	Uncertain			-4093	Triangular	Min	-4093.5	Mode	-4093	Max	-4090.5
7	Uncertain			-4266	Triangular	Min	-4266.5	Mode	-4266	Max	-4255.5
8	Uncertain			-3828	Triangular	Min	-3830	Mode	-3828	Max	-3827.5
9	Uncertain			-3845	Triangular	Min	-3846	Mode	-3845	Max	-3844.5
10	Uncertain			-3872	Triangular	Min	-3872.5	Mode	-3872	Max	-3870
11	Uncertain			-3938	Triangular	Min	-3938.5	Mode	-3938	Max	-3932
12	Uncertain			-3930	Triangular	Min	-3930.5	Mode	-3930	Max	-3927
13	Uncertain			-3952	Triangular	Min	-3952.5	Mode	-3952	Max	-3947
14	Uncertain			-3991	Triangular	Min	-3993	Mode	-3991	Max	-3990.5
15	Uncertain			-4021	Triangular	Min	-4034	Mode	-4021	Max	-4020.5
16	SEED variable			6441							
17	SEED variable			19629							
18	SEED variable			3088							
19	SEED variable			7822							
20	Uncertain			0.5	Triangular	Min	0.4	Mode	0.5	Max	0.6
21	Uncertain			0.13	Triangular	Min	0.11	Mode	0.13	Max	0.15

Variable Uncertainty 22-90

	Type	Pr	Int	Base value	Distribution	Arguments					
91	Uncertain			2.666	Triangular	Min	1.689	Mode	2.666	Max	3.643
92	Uncertain			1.514	Triangular	Min	0.537	Mode	1.514	Max	2.491
93	Uncertain			7.317	Triangular	Min	6.34	Mode	7.317	Max	8.294
94	Uncertain			5.97	Triangular	Min	4.993	Mode	5.97	Max	6.947
95	Uncertain			7.018	Triangular	Min	6.041	Mode	7.018	Max	7.995
96	Uncertain			6.845	Triangular	Min	5.868	Mode	6.845	Max	7.822
97	Uncertain			2.491	Triangular	Min	1.514	Mode	2.491	Max	3.468
98	Uncertain			7.266	Triangular	Min	6.289	Mode	7.266	Max	8.243
99	Uncertain			7.199	Triangular	Min	6.222	Mode	7.199	Max	8.176

Figure 7. *Examples of variogram on uncertainty analysis, where variable no. 1 through no. 15 is uncertainty category of fluid contact.*

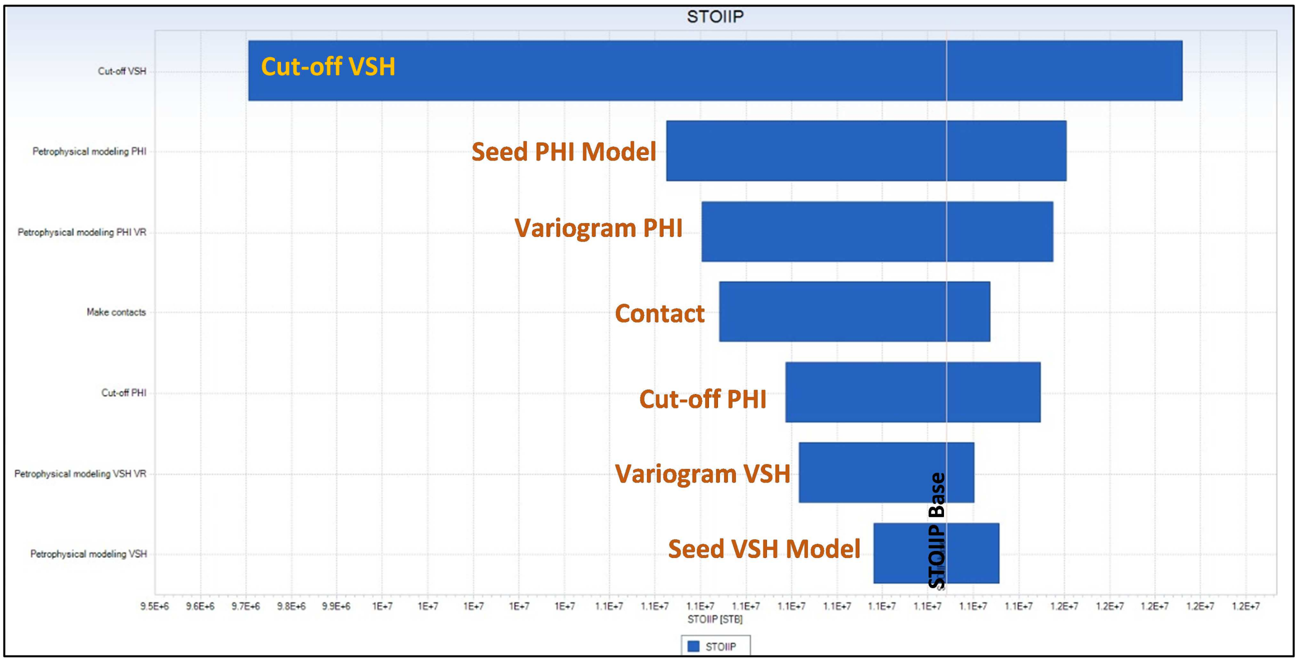

Figure 8. *KMJ oil field sensitivity analysis result.*

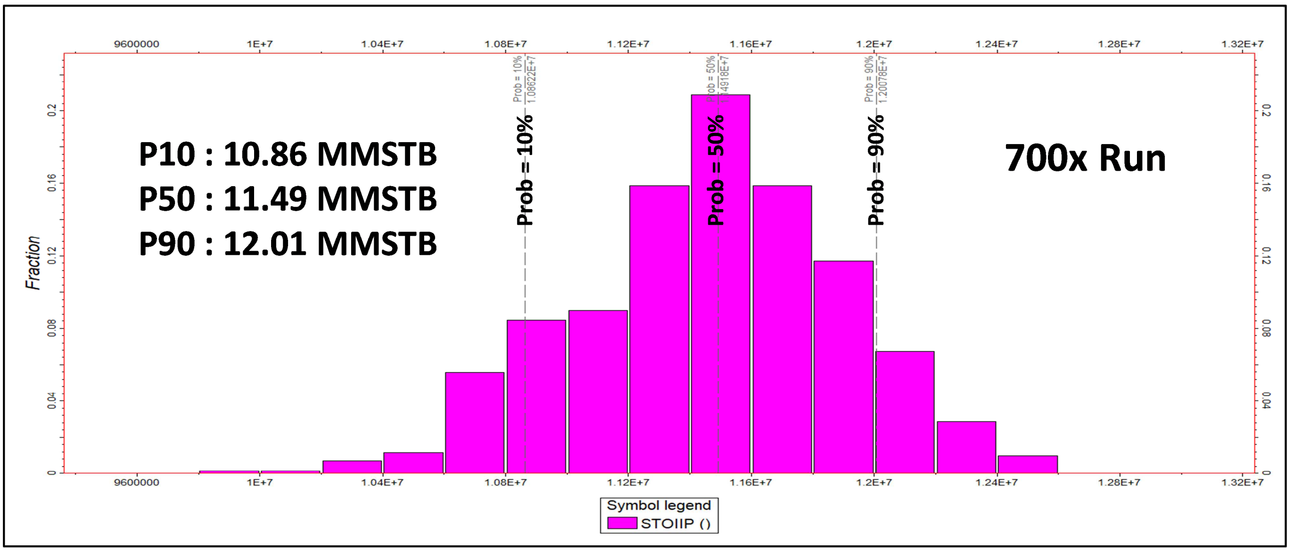

Figure 9. *KMJ oil field uncertainty analysis result.*

Table 6. *Calculation of OOIP KMJ oil field low estimate (P10).*

Unit Sand	Bulk Volume (ft^3)	Net Volume (ft^3)	Pore Volume (RB)	HCPV Oil (RB)	STOIIP (STB)	NP (STB)	RF (%)
A	289,916,206	169,209,406	5,857,574	2,702,144	2,413,047	1,173,356	48.63
B	52,216,381	46,503,815	1,605,940	819,457	731,785	209,931	28.69
C	128,637,726	95,214,946	3,302,756	1,727,424	1,542,611	565,287	36.64
D	316,472,518	264,533,801	10,941,836	6,213,575	5,548,798	1,305,868	23.53
E	6,723,425	6,346,009	237,163	127,949	114,260	66,245	57.98
F	17,413,388	15,081,525	626,908	313,341	279,817	23,052	8.24
G	5,682,899	3,298,884	118,417	58,089	51,874	8,209	15.83
H	10,716,632	10,385,921	466,205	201,193	179,668	3,984	2.22
Total	827,779,175	610,574,307	23,156,799	12,163,172	10,861,860	3,355,932	30.90

Table 7. *Calculation of OOIP KMJ oil field base estimate (P50).*

Unit Sand	Bulk Volume (ft^3)	Net Volume (ft^3)	Pore Volume (RB)	HCPV Oil (RB)	STOIIP (STB)	NP (STB)	RF (%)
A	297,670,931	206,519,694	7,067,802	3,217,866	2,873,593	1,173,356	40.83
B	47,909,249	42,923,840	1,530,562	850,000	759,060	209,931	27.66
C	118,269,484	94,184,351	3,457,801	1,888,927	1,686,834	565,287	33.51
D	289,519,785	254,436,611	9,987,964	6,144,582	5,487,186	1,305,868	23.80
E	11,973,089	11,973,089	407,608	156,514	139,769	66,245	47.40
F	17,825,632	17,322,029	693,840	335,970	300,025	23,052	7.68
G	5,122,110	3,452,335	138,737	67,966	60,694	8,209	13.53
H	8,701,661	8,652,047	401,036	204,989	183,058	3,984	2.18
Total	796,991,941	639,463,996	23,685,350	12,866,814	11,490,219	3,355,932	29.21

Table 8. *Calculation of OOIP KMJ oil field high estimate (P90).*

Unit Sand	Bulk Volume (ft^3)	Net Volume (ft^3)	Pore Volume (RB)	HCPV Oil (RB)	STOIIP (STB)	NP (STB)	RF (%)
A	274,882,423	200,999,421	6,769,000	3,321,890	2,966,488	1,173,356	39.55
B	47,082,322	43,010,796	1,489,148	837,132	747,569	209,931	28.08
C	130,788,931	108,077,123	3,726,128	1,917,139	1,712,028	565,287	33.02
D	293,257,562	273,372,222	10,913,066	6,619,566	5,911,352	1,305,868	22.09
E	10,884,979	10,884,979	381,334	160,074	142,948	66,245	46.34
F	17,369,296	16,936,428	674,725	330,950	295,543	23,052	7.80
G	6,972,047	4,655,917	165,230	72,774	64,988	8,209	12.63
H	6,961,528	6,942,355	328,590	186,625	166,659	3,984	2.39
Total	788,199,088	664,879,241	24,447,221	13,446,150	12,007,575	3,355,932	27.95

4. Conclusion

Based on the results of the analysis and discussion, can be concluded as follows:

The combination of determining facies (shale volume) porosity, fluid contact, and the cut-off is a variable/parameter that is very influential in volumetric multi-scenario calculations in the KMJ Oil Field, with the most significant parameter being the cut-off volume of shale.

The results of OOIP multi-scenario calculations for the KMJ Oil Field are based on a low estimate (P10) category of

10.86 MMSTB, a base estimate (P50) of 11.49 MMSTB and a high estimate (P90) of 12.01 MMSTB.

The static model used for reservoir simulation modeling (dynamic model) of the KMJ Oil Field is the base estimate model (P50) of 11.49 MMSTB.

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References

[1] Lelliott, M. R., Cave, M. R., and Wealthall, G. P., A structured approach to the measurement of uncertainty in 3D geological models. Quarterly Journal of Engineering Geology and Hydrogeology, UK, 2008. 42: 95-105.

[2] Fanha, A. B., Filho, J. S. A. C, Reyes-Perez, Y. A., Uncertainty Analysis of an Integrating Two Structural 3D Sthochastic Geological Models of a Siliciclastic Reservoir; Potiguar Basin, Northeast of Brazil, SPE EUROPEC/EAGE Annual Conference and Exhibition held in Barcelona, Spain, 2010.

[3] Perrin, M., Zhu, B., Rainaud, J., and Schneider, S., Knowledge-driven Applications for Geological Modelling, Journal of Petroleum Science and Engineering, 2005.

[4] Lazar, R., The Concept of Right Modelling, Toward a More Effective Usage of the Static Modelling Tool, SPE Paper Presentation at the Abu Dhabi International Exhibition & Conference held in Abu Dhabi, UAE, 2018.

[5] Gomes, J., Parra, H., and Ghosh, D., Quality Control of 3D GeoCellular Models: Examples from UAE Carbonate Reservoirs, SPE Paper Presentation at Abu Dhabi International Exhibition & Conference held in Abu Dhabi, UAE, 2018.

[6] Ellison, S. L. R. Rosslein, M., and Williams., A Quantifying Uncertainty in Analytical Measurement, Eurachem, CITAC Guide, UK, 2000.

[7] Kamanli, S. T., An Integrated 3D Geological Modeling Study of Heavy Oil Field in Southeast Turkey, SPE Paper Presentation at the SPE Annual Caspian Technical Conference held in Baku, Azerbaijan, 2019.

[8] Chongrueanglap, P., Siriwattanakajorn, W., Kamal, M., Poret, K. L. G., Soontornnateepat, T., Mahamat, S., Wongpaet, K., and Cheong, Y. P., Challenges on Building Representative 3D under Subsurface Uncertainties for a Giant Carbonat Field in Central Luconia, Offshore Sarawak, Paper Presentation at the Offshore Technology Conference Asia held in Kuala Lumpur, Malaysia, 2022.

[9] Bueno, Juliana F., et. al. Constraining Uncertainty in Static Reservoir Modeling: A Case Study from Namorado Field, Brazil, AAPG Annual Convention and Exhibition, Houston, Texas, USA, 2011.

[10] Al-Otaibi, A. M., Integration of 3D Seismic Data in reservoir Modeling and Assessing Uncertainty in Lithology Distributions in The Nuayyim Field of Central Saudi Arabia, SPE Paper Presentation at the 1997 Middle East Oil Show, Bahrain, 1997.

[11] Aguilar, E. G., Gonzalez, L. M., & Ruiz, V. G., Initial Characterization of an Extra Heavy Oil Carbonate Exploratory Field, SPE Paper Persentation at the SPE Latin American and Caribbean Petroleum Engineering Conference held in Mexico City, Mexico, 2012.

[12] Torres, K. M., Al-Hashmi, N. F., Al-Hosani, I. A., and Al-Rawahi, A. S., Reducing the Uncertainty of Static Reservoir Model in a Carbonate Platform, Through the Implementation of an Integrated Workflow: Case A-Field, Abu Dhabi, UAE, SPE Paper Presentation at the Abu Dhabi International Exhibition & Conference held in Abu Dhabi, UAE, 2016.

[13] Orellana, Ney, Cavero, J, et. al. Influence of Variograms in 3D Reservoir-Modeling Outcomes: An Example, The Society of Exploration Geophysicists, 2014.

[14] Bangsal, R. S., Vargas-Guzman, J. A., Uncertainty Quantification of Top Structures in 3D Geocellular Models, SPE Reservoir Characterisation and Simulation and Exhibition, Abu Dhabi, UAE, 2015.

[15] Rukmana, D., Kristanto, D., and Cahyoko Aji, D., Reservoir Engineering: Theory and Application, Revision Edition, Pohon Cahaya Publishing Co., Yogyakarta, 2018, Chapter 11, pp. 367-462.

[16] KMJ Field., Geology, Geophysics, Reservoir and Production Studies of KMJ Field, Field Reports, 2021.

[17] SKK Migas., Guidance to Study Geophysics, Geology and Reservoir (GGR) in Oil Fields, SKK Migas, Jakarta, 2018. pp. 385-412.