G02

Integrated Reservoir Modelling of Astokh Area of Piltun-Astokhskoye Oil-Gas Condensate Field

A.V. Marchenko* (Sakhalin Energy Investment Company), A. Khabarov (Sakhalin Energy Investment Company), A. Popov (Sakhalin Energy Investment Company), A. Golushko (Sakhalin Energy Investment Company), S. Pesotsky (Sakhalin Energy Investment Company), A. Dubok (Sakhalin Energy Investment Company) & I. Taushev (Sakhalin Energy Investment Company)

SUMMARY

Astokh area of Piltun-Astokhskoye oil-gas condensate field (Astokh field) is one of the oil assets of Sakhalin Energy Investment Company Ltd. (Sakhalin Enegy). The field has seventeen years of production history and currently has being developing under water flood scheme. It still has significant reserves to recover and at the current stage of the field development main focus is put on further infill drilling and water injection optimization. Full-field integrated modeling with realistic range of subsurface scenarios is an essential tool for optimizing further field development strategy and maximizing the value of the asset.

In the presence of long production history, 4D seismic and surveillance data reservoir model construction work cannot be efficiently done without integrated approach where all relevant disciplines provide their input to the final product. This paper describes reservoir modelling work that has been recently done in Astokh field. Multi-disciplinary team of petrophysicist, geoscientists and reservoir engineers of Sakhalin Energy has made an effort to combine all available information for constructing a brand new Astokh integrated model with in-depth reviewing of petrophysical and geological aspects in close connection with reservoir engineering data and reservoir simulation modelling.

Introduction

Astokh area of Piltun-Astokhskoye oil-gas condensate field (Astokh field) is one of the oil assets of Sakhalin Energy Investment Company Ltd. (Sakhalin Enegy). The field has seventeen years of production history and currently has being developing under water flood scheme. It still has significant reserves to recover and at the current stage of the field development main focus is put on further infill drilling and water injection optimization. Full-field integrated modeling with realistic range of subsurface scenarios is an essential tool for optimizing further field development strategy and maximizing the value of the asset.

In the presence of long production history, 4D seismic and surveillance data reservoir model construction work cannot be efficiently done without integrated approach where all relevant disciplines provide their input to the final product. This paper describes reservoir modelling work that has been recently done in Astokh field. Multi-disciplinary team of petrophysicist, geoscientists and reservoir engineers of Sakhalin Energy has made an effort to combine all available information for constructing a brand new Astokh integrated model with in-depth reviewing of petrophysical and geological aspects in close connection with reservoir engineering data and reservoir simulation modelling.

The overall Integrated Reservoir Modelling project framework was done accordingly to Shell-based opportunity realisation process to ensure the appropriate technical & business integrity and fastest cycle-time of modelling effort. The process considers several model maturation phases with in-depth technical work quality assessment.

Methodology

The integrated modelling work has started with multi-discipline opportunity framing. This exercise allowed to understand general issues related to previous model and possible improvements, frame key uncertainties that needs to be captured in the updated model and sketch up general features of the final product. This helps the team to prioritize work streams and realise boundary conditions.

The following step was related to reference case and uncertainties range understanding within every discipline. Properly representing complex geological environment in a 3D static model was not a trivial task and required completely new modelling approach which was built as part of entire Piltun-Astokh Model update project. The model was built using sequence stratigraphy principles and resulted in:

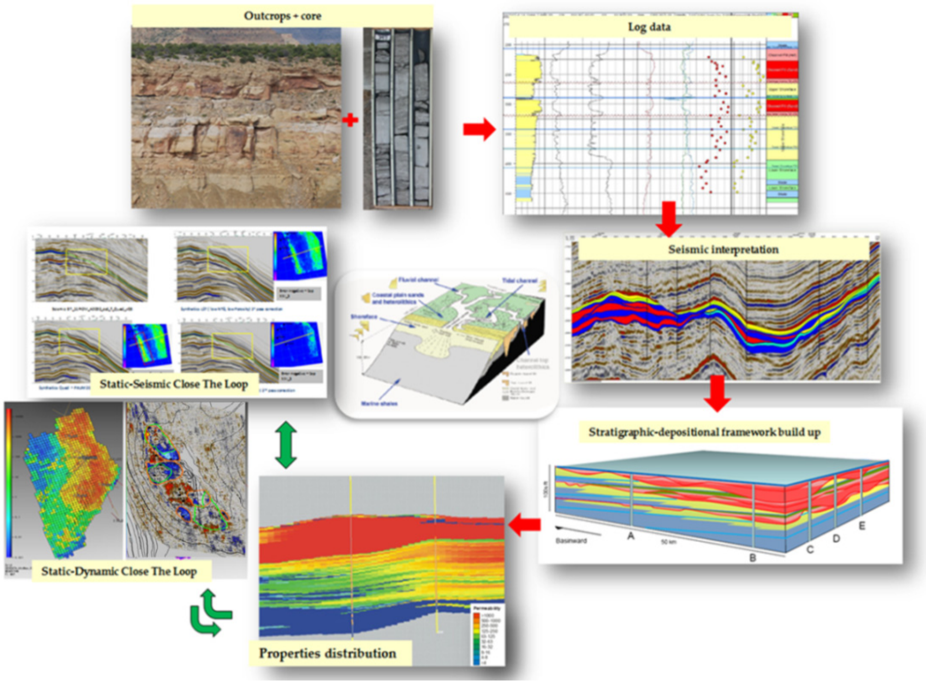
- Improved understanding of depositional environments and reservoir modelling strategy;
- Adequate capturing of lateral property variation from West to East and North to South;
- Reflecting of vertical property variations and connectivity between layers.

Historically, significant contribution to field material balance was caused by very heterogeneous formations which are consisting of thin bedded intercalation of sands, silts and shales. Standard logs have an insufficient vertical resolution for a proper characterization of such thinly-bedded reservoirs. To mitigate this problem a special log deconvolution & squaring technique was applied. Firstly, a short spacing density data (small sonde readings) were used for the resolution improvement of regular density curve. Then, a special reversed filter was used for the further “sharpening” of density log response. Finally, a special squaring algorithm was applied in order to mitigate distorting influence of adjacent non-reservoirs, so called – “shoulder bed effect”. Deconvolution strength was adjusted to get the best agreement between log evaluation results, core data, RFT mobilities & actual well rates. As a result, a significant increase of average porosity, net thickness & hydrocarbon saturation was achieved, as well as an increase of average permeability.

The overall model skeleton workflow was constructed to stream the data from petrophysical input, through geoscience static model, to the dynamic model assessment on alignment with available production, 4D seismic and surveillance data. This step was required to build data flow from one discipline to another which preserves required reservoir complexity at the dynamic level.

The most intensive part of the modelling in terms of cross discipline interaction was related to integration of available data and reservoir understanding into unique picture. The initial model was showing systematic mismatch with field observations which resulted in revisiting of geological connectivity, properties distribution assumptions and petrophysical basis of the static model. After several iteration loops the reservoir model has been significantly improved and properly represented all field observations data including 4D seismic.

The final stage of the integrated reservoir modelling work was focused on capturing uncertainties range for subsurface data, assessment of reference case model within this rage and construction of reliable low and high reservoir model realisations for future evaluation of development decisions upside and downside. This work required comprehensive petrophysical – geological – dynamic probabilistic analysis of entire solution space with respect to available field observations. A range of petrophysical, geological, structural and dynamic uncertainties was incorporated into a single framework to achieve reliable results. The integrated approach allowed to narrow initial volumetric uncertainty range and to define key subsurface parameters that impacts development decisions



IRM workflow.

Conclusions

The described integrated reservoir modeling approach in general is following Shell best practice reservoir modeling workflow. The existing reservoir complexity, range of uncertainties and the field performance data was pushing cross discipline team to find non trivial solutions and approach to construct a solid and integrated story of Astokh reservoir. The models were further used during field development optimization work and helped to properly capture existing uncertainty range.