New Approaches to Geological Uncertainties in STOIIP Estimation for Greenfield in South Vietnam Shelf*

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Abstract

The Beluga oilfield was discovered in 2014 and is in the southern part of the offshore Vietnam–Cuulong Basin. Geological settings characterize a high oil column (1000m), complex faulting structure with amplitudes up to 500m, and high lateral and vertical heterogeneity in reservoir continuation. Initially it was obvious that the oilfield needed a non-standard approach. To the very important but still common task of data collection and study, which leads to accurate digital representation of reservoir geology, we added complex conceptual sedimentological modelling to ensure the capture of geological uncertainties and their influence on final reserves calculations. All data were thoroughly examined. Three exploration wells were drilled, from which logs, core and well tests, mud reports, geological well reports, check shots and 3D seismic cube over the area of interest were available. Well tests proved oil bearing reservoirs in Lower Miocene and Upper Oligocene, oil flows estimated at 7-260 m^3/d in the Lower Miocene and 191-961 m^3/d in the Upper Oligocene. As well tests cover only 50% of whole net pay intervals, we categorized tested zones into four types of pay – good flowing, flowing, weak flowing and no flow. First three are considered as reservoir in further modelling. Miocene and Oligocene reservoirs were deposited in continental lacustrine and alluvial plain environments. As there was not enough core data to describe all reservoirs, we used electrofacies based on log response shapes. We recognized channel, bar and alluvial plain facies. Due to the lack of RCAL data, it was not possible to get poroperm for each facies, however later this was handled by geometry variations. Facies modelling was performed as object-based modelling of electrofacies. Characteristics of geobody geometry were chosen based on conceptual models and present-day analogues. Three qualitied types of reservoir (good, poor, bad) based on Vsh analysis as well as from production logging data were modelled

inside geobodies. For non-tested reservoir NTG values from tested intervals were assigned. Structure, net volume, types of reservoir, water-oil contacts and NTG values were included in the uncertainty analysis. STOIIP were estimated at 12, 25 and 95 million tons for 1P, 2P and 3P categorizes respectively. This extremely wide range of reserves reflects high geological uncertainty.

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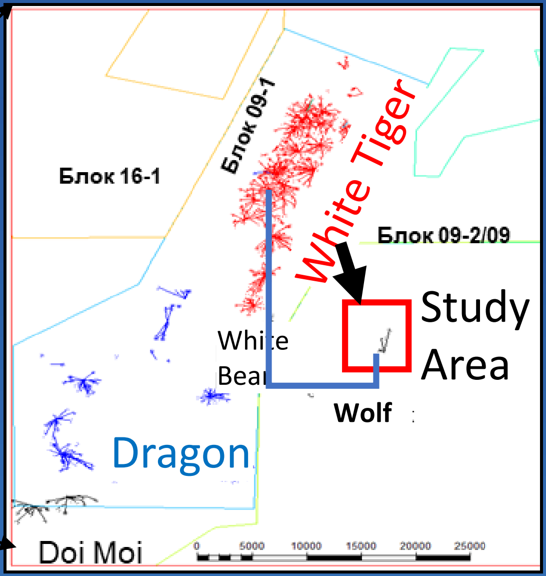
Content

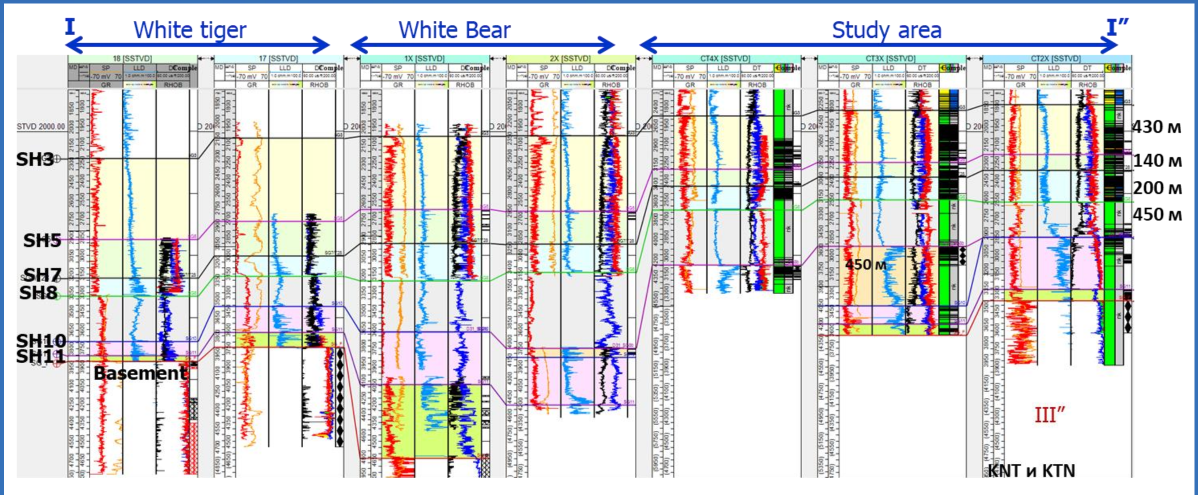
General information

- Study area located in South Vietnam shelf in Cuu Long basin
- Greenfield – 3 expl. wells
- Complex fluvial reservoirs of Miocene and Oligocene ages
- Thick oil column (1000m), depth 2km-3km
- «Tough» tectonic settings
- Known problems: Rapid production decline and water breakthrough in nearby fields

Cuu Long Basin in the Southeast Continental Shell of Vietnam



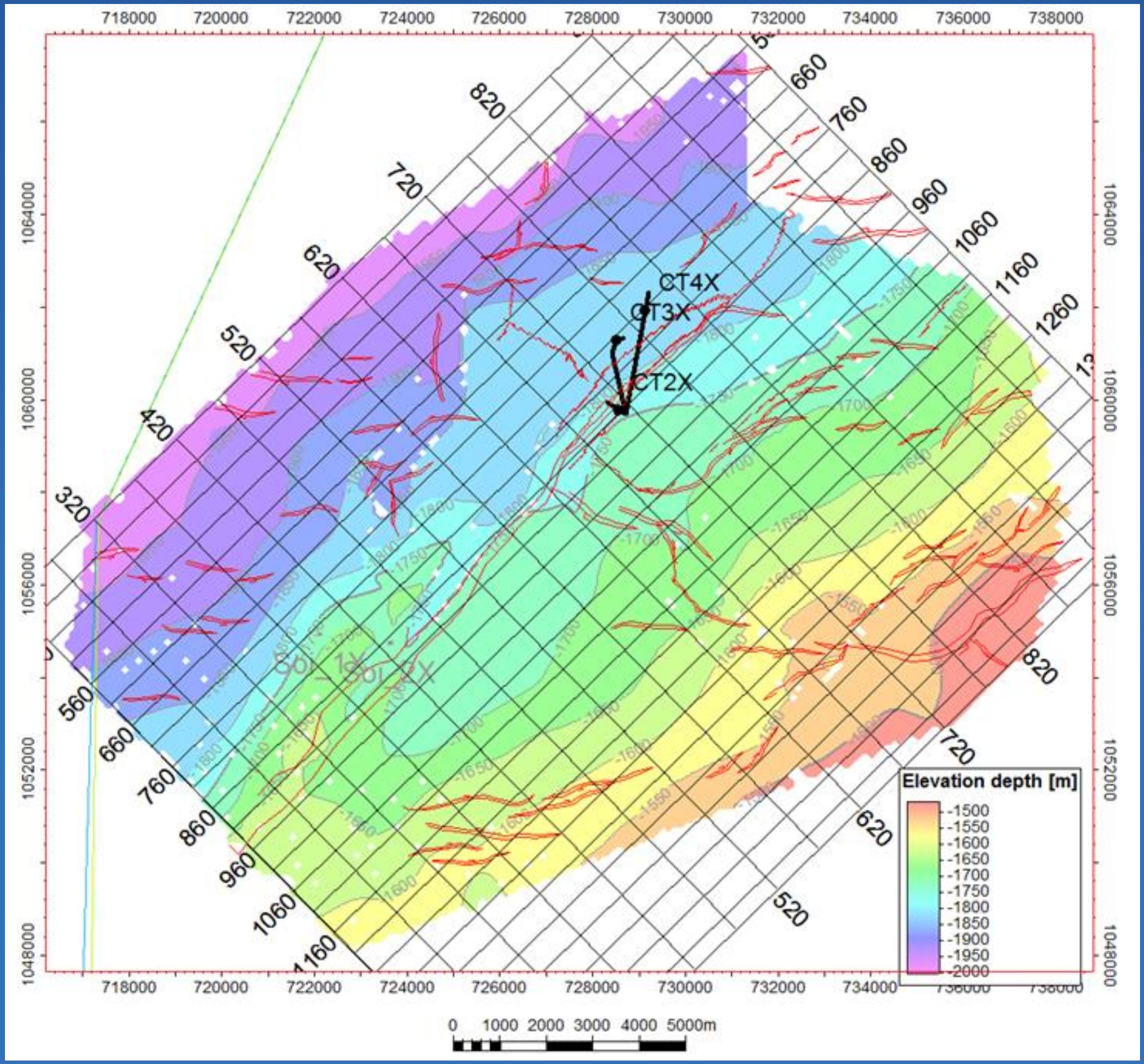
Nearby oilfields location



Well section with nearby oilfields

Data available

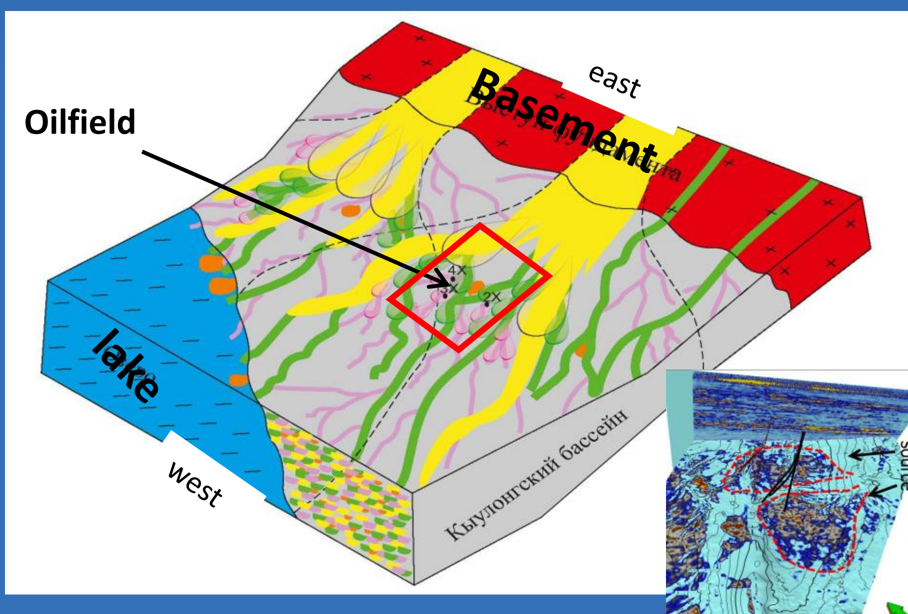
- 3 exploration wells
- Well log sets
- Well tests
- Production logs
- Core data (RCAL, SCAL)
- Mud reports
- 3D seismic 250km^2



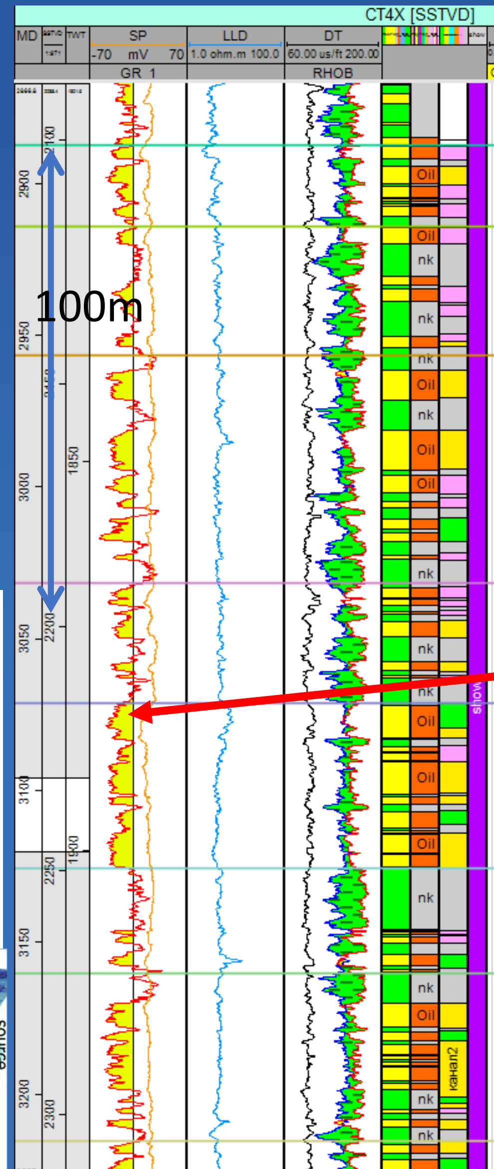
Well location on structure map (Lower Miocene)

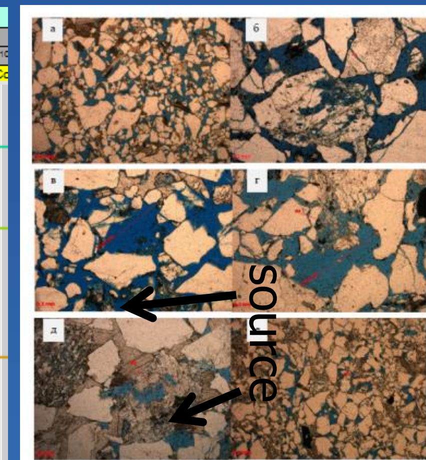
Conceptual modelling

- Regional settings – fluvial depositional environment
- Only 4% of Pay interval covered by core
- Facies from core correlate with log signature (GR)

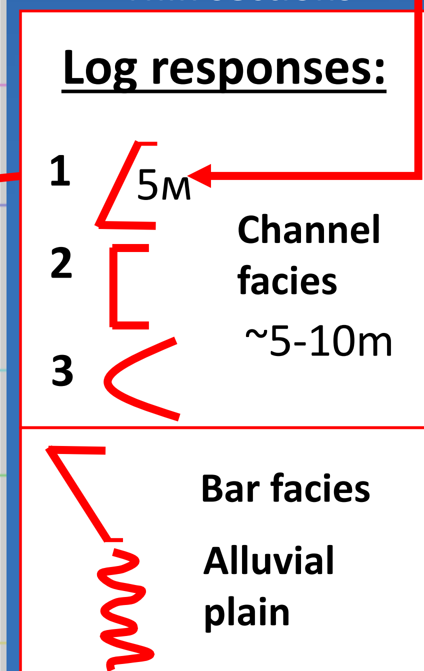


Conceptual model





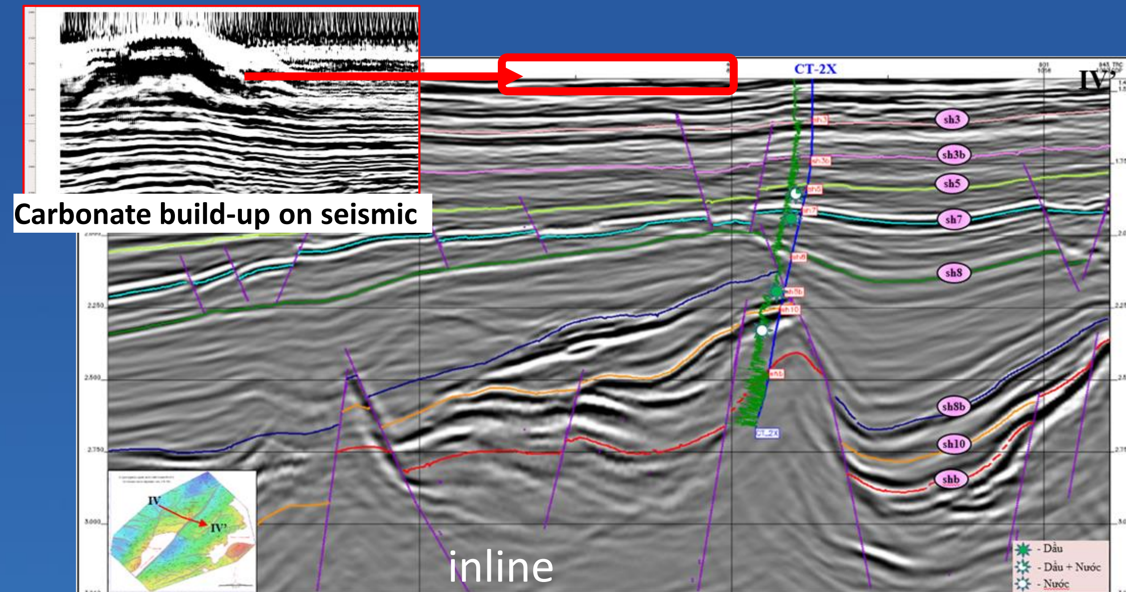
Thin sections

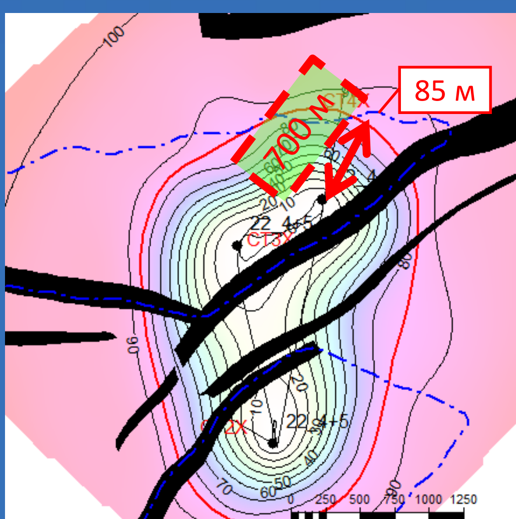


Example of Log Signatures

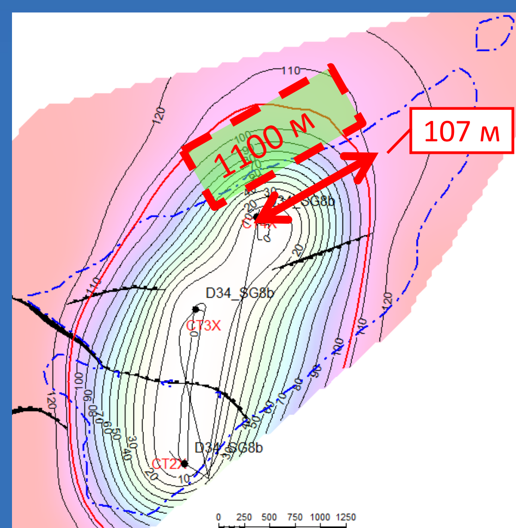
Structural uncertainities

- Structural discrepancy reach 120m
- Present day carbonate build-up as well as complex faulting influence seismic data quality
- Maps of Uncertainties used in geomodel

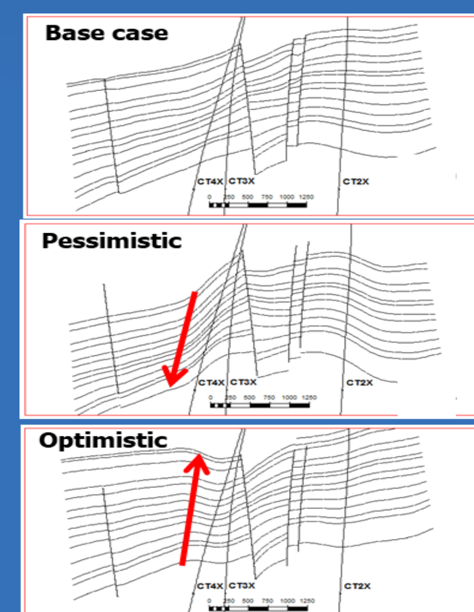




Structural error map
Lower Miocene



Structural error map
Upper Oligocene



Reservoir uncertainties

Production logs show that not all pay intervals "work"

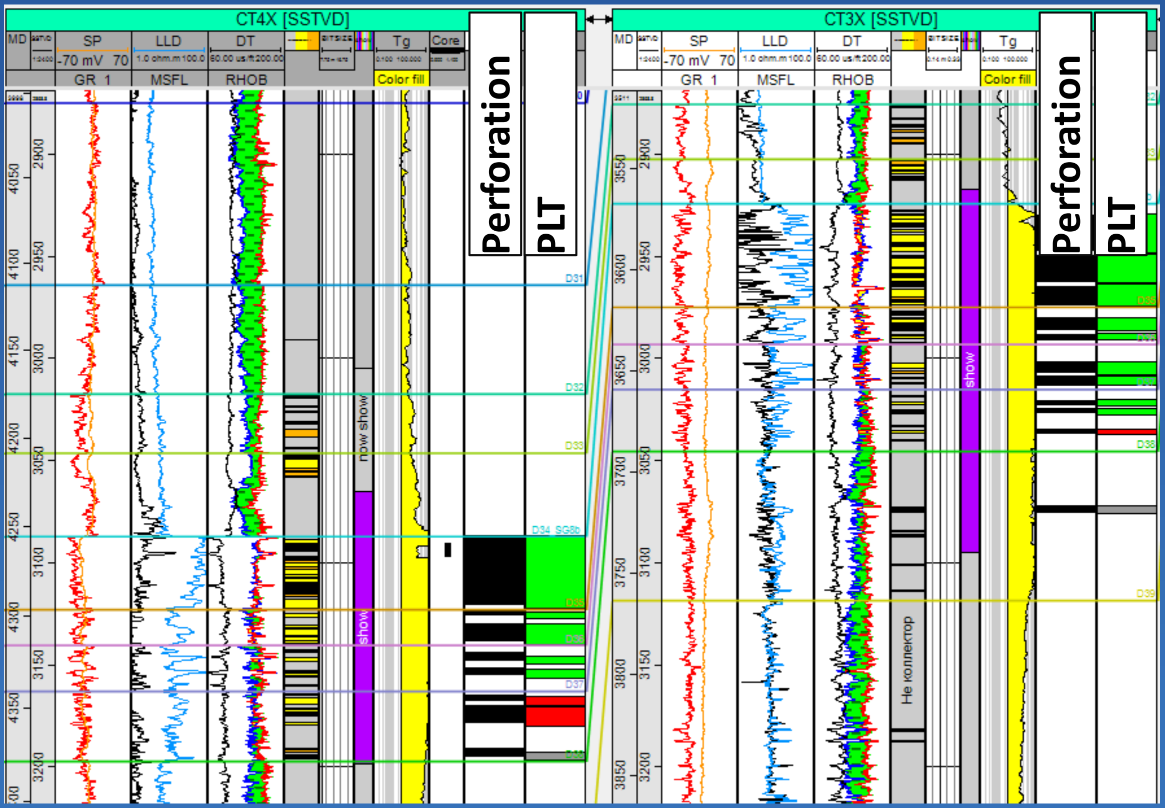
Not all pay zones tested (50%)

Four types of reservoir according to PLT are distinguished

1. **good flow**
2. **flow**
3. **weak flow**
4. **no flow**

Vsh cut-offs 0.3 and 0.4 as an uncertainty of net thickness

There is big risk that weak flow and no flow intervals won't work at all!



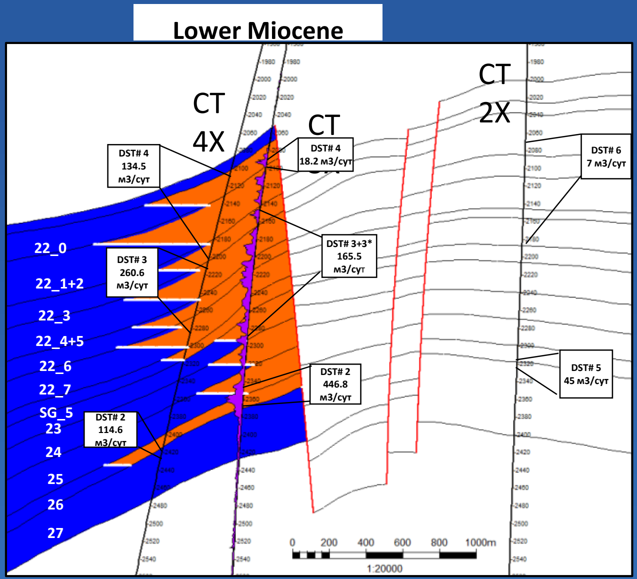
Production log results

PLT interpretation:

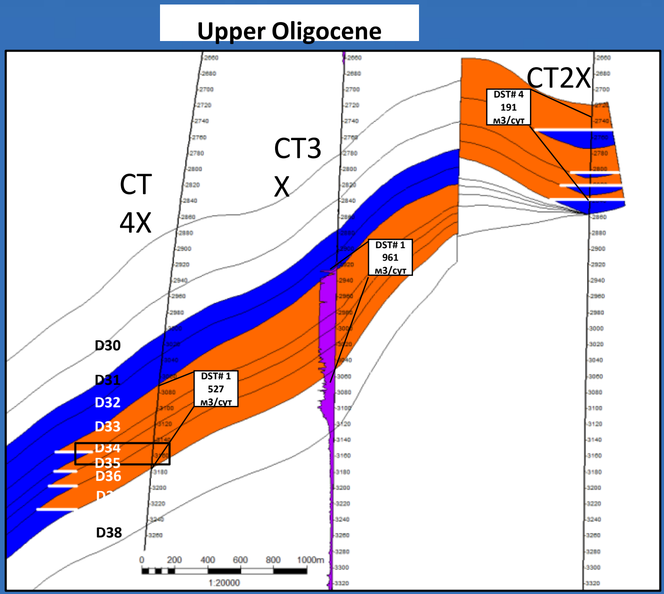
- good flow and flow
- weak flow
- no flow

Fluid contact uncertainties

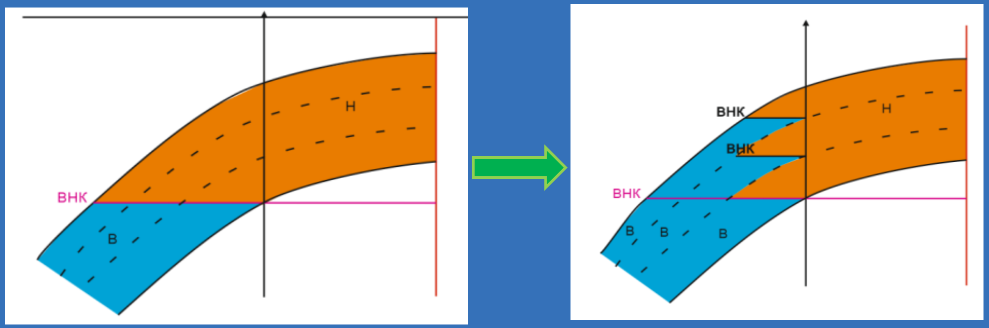
- Well tests proved oil bearing reservoir intervals in Lower Miocene and Upper Oligocene
- Oil flows estimated at 7-260m3/d in Low Miocene and 191-961m3/d in Upper Oligocene.
- Fluid contacts are not observed directly
- Rules P1, 2P, 3P - ODT, “half” and structure closure respectively applied.



Fluid contacts of Lower Miocene



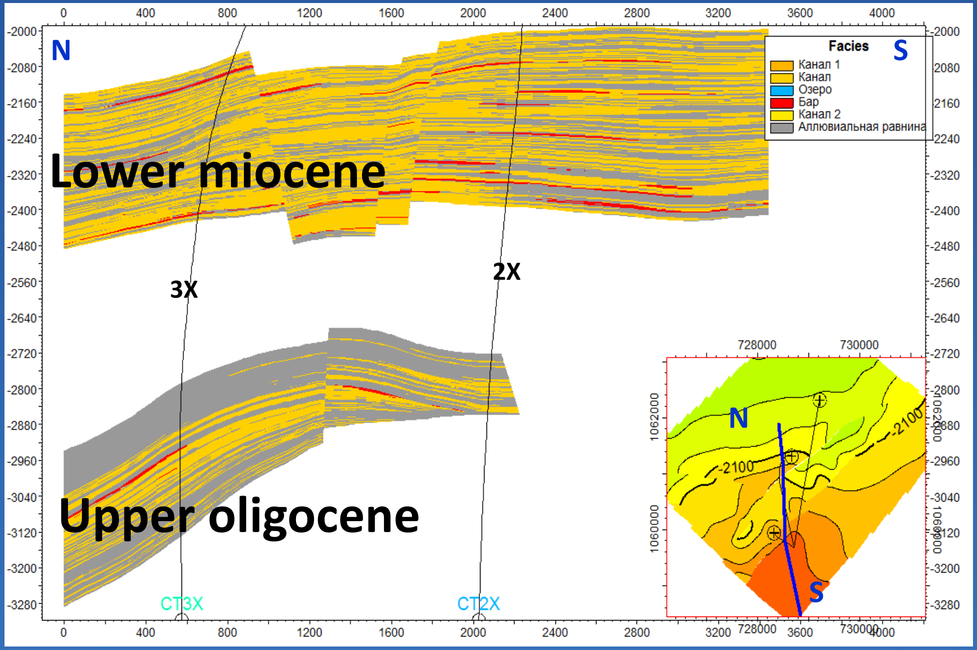
Fluid contacts of Upper Oligocene



Correlation effects on volumes

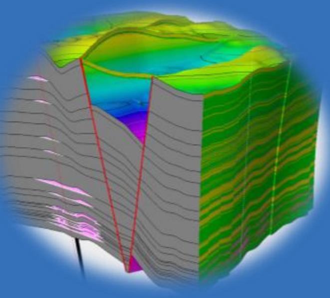
Building static model

- Object based facies modelling used
- Reservoirs of different qualities inside facies
- Properties inside each reservoir propagated
- Water saturation calculated by J-function and adapted to Well Log interpretation

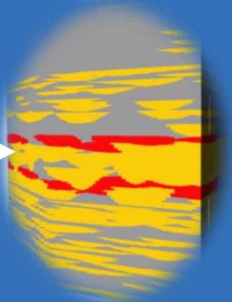


Cross-section of Facies model

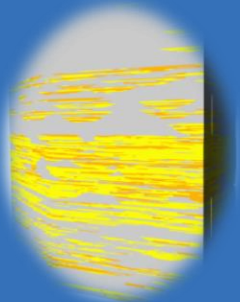
Structural and fault modelling



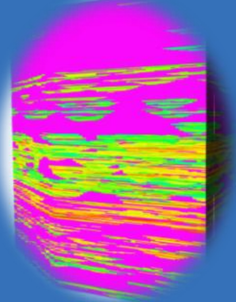
Facies modelling



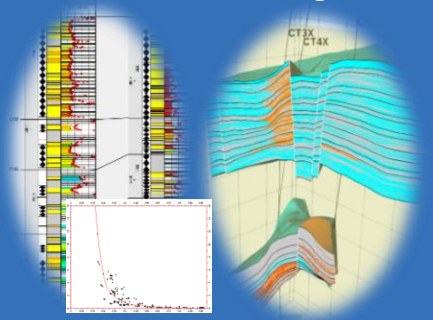
Reservoir modelling



Porosity modelling



Water saturation modelling



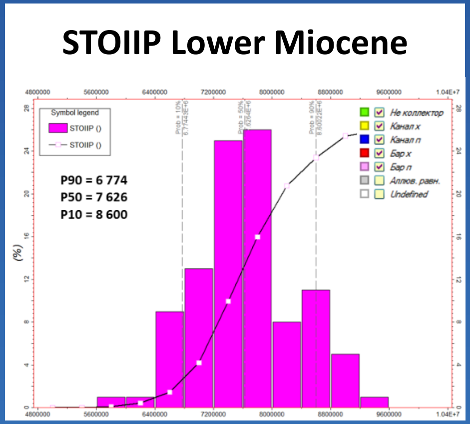
Geological modelling and uncertainty ranking in STOIIP stochastic calculations

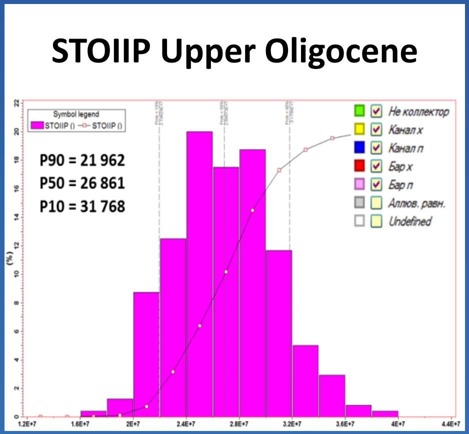
Scenarios	Pessimistic	Base	Optimistic
Structure	High angle	Basic	Low angle
Reservoir			
- good (Vsh<0.3)	+	+	+
- poor (0.3< Vsh <0.4)	-	-	+
PLT			
- good flowing	+	+	+
- flowing	+	+	+
- weak flowing	-	+	+
- no flow	-	-	+
Contacts	P1	2P	3P
STOIIP			
Seed, ranges, reservoir fraction and porosity	**P90**	**P90**	**P90**
	P50	**P50**	**P50**
	P10	**P10**	**P10**

The ranking of uncertainties is based on the structure, OWC and reservoir quality

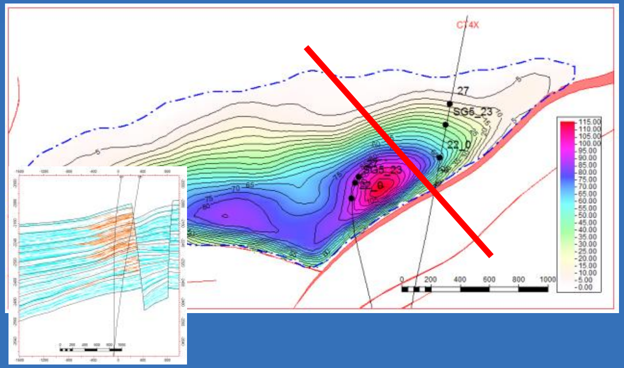
To determine p10 p50 p90, parameters were varied: seed, reservoir fraction, and porosity

Base case results

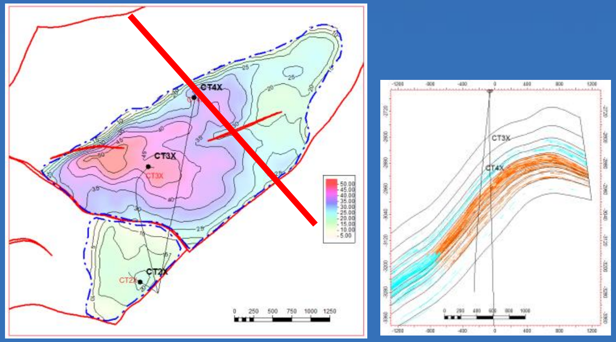




Net Pay map Lower Miocene

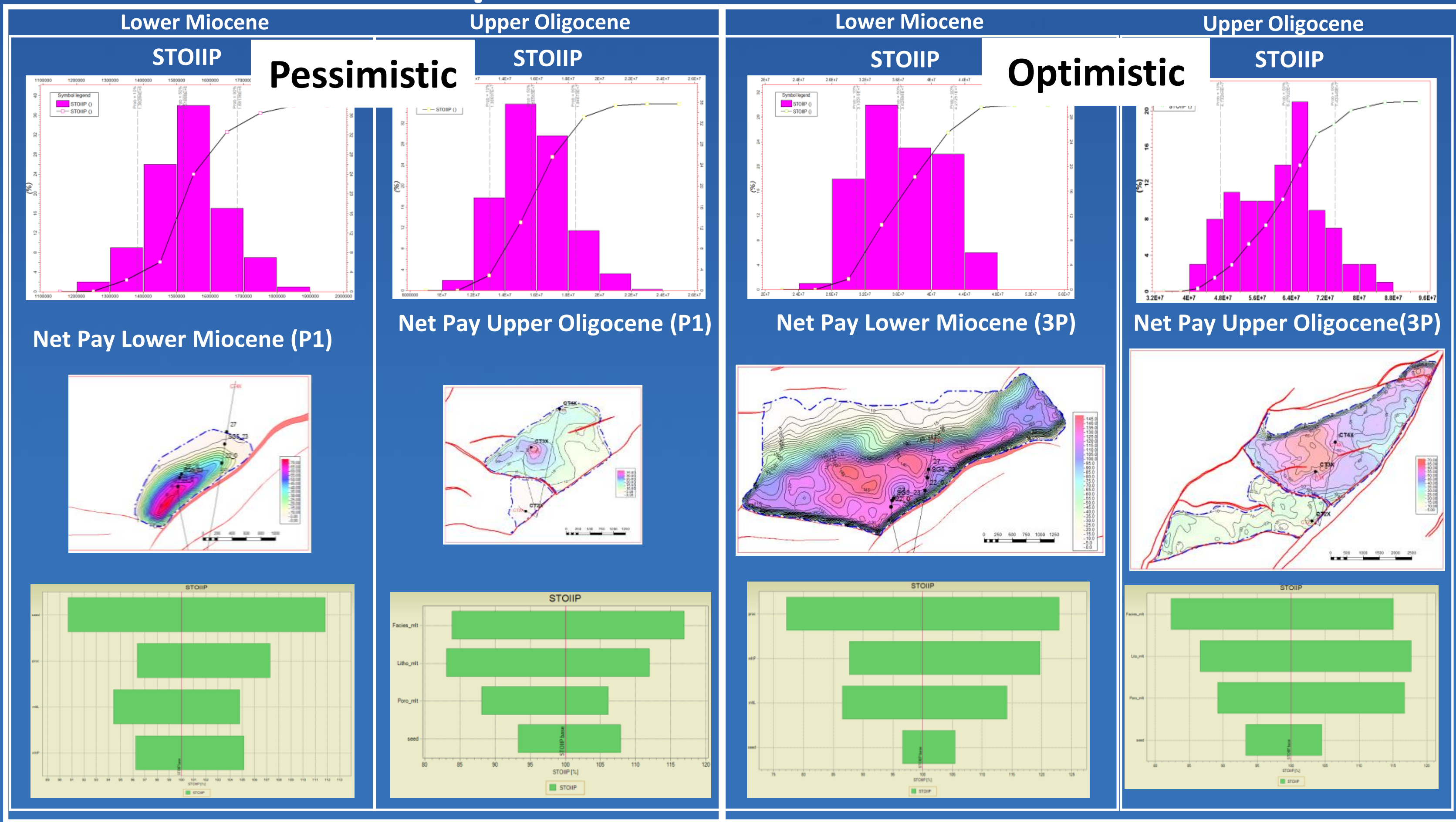


Net Pay map Upper Oligocene



In the base case, the base structure is used, the rule of “half” for the OWC and the poor reservoir and intervals that do not flow at all are not taken into account.

Pessimistic and Optimistic cases results



Optimistic case takes into account all possible positive aspects, such as the structure and OWC as well as the quality of the reservoir

In Pessimistic case all risks take into account: if structure fails and OWC will corresponds to ODT, and only the best reservoir will work

STOIIP results

Scenarios	Pessimistic	Base	Optimistic
Structure	High angle	Basic	Low angle
Reservoir			
- good (Vsh<0.3)	+	+	+
- poor (0.3< Vsh <0.4)	-	-	+
PLT			
- good flowing	+	+	+
- flowing	+	+	+
- weak flowing	-	+	+
- no flow	-	-	+
Contacts	P1	2P	3P
STOIIP			
P90	**10.2**	**20.3**	**77.5**
P50	**12.3**	**24.8**	**94.8**
P10	**14.7**	**28.5**	**116.1**

- Reserves estimated at low case (pessimistic) – twice less than base case and high case (optimistic) – almost four times more than base case.
- This extremely wide range of reserves reflects high geological uncertainty.

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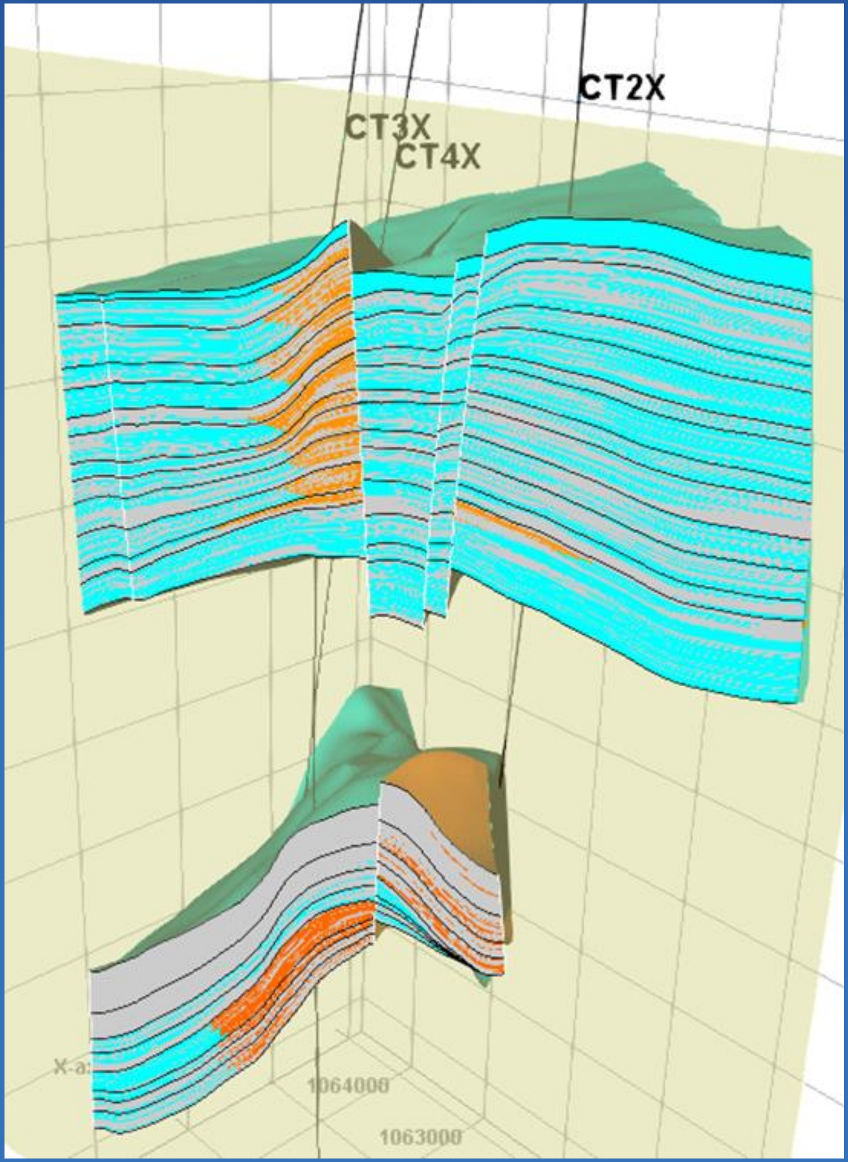
Conclusions

- **Main uncertainties described**
- **For greenfield it is very important**
- **Structure discrepancy estimated**
- **Conceptual model allowed to estimate sand bodies size ranges**
- **Reservoirs of different qualities identified**
- **New approach to handle uncertainties proposed**
- **High range of reserves reflects complex architecture of reservoir**
- **Proper Optimistic, Base and Pessimistic Cases help to make effective development strategy**



3D view of Static Model