Schlumberger Digital Forum 2022

UBOC
Umid Babek Operating Company

CROSS DOMAIN APPROACH TO IDENTIFY AND EVALUATE MUD VOLCANO IMPACT ON RESERVOIR FOR PLANNING OF FURTHER UPSTREAM ACTIVITIES

Maarif Allahverdiyev

Head of Exploration and Production Department, UBOC

Agenda

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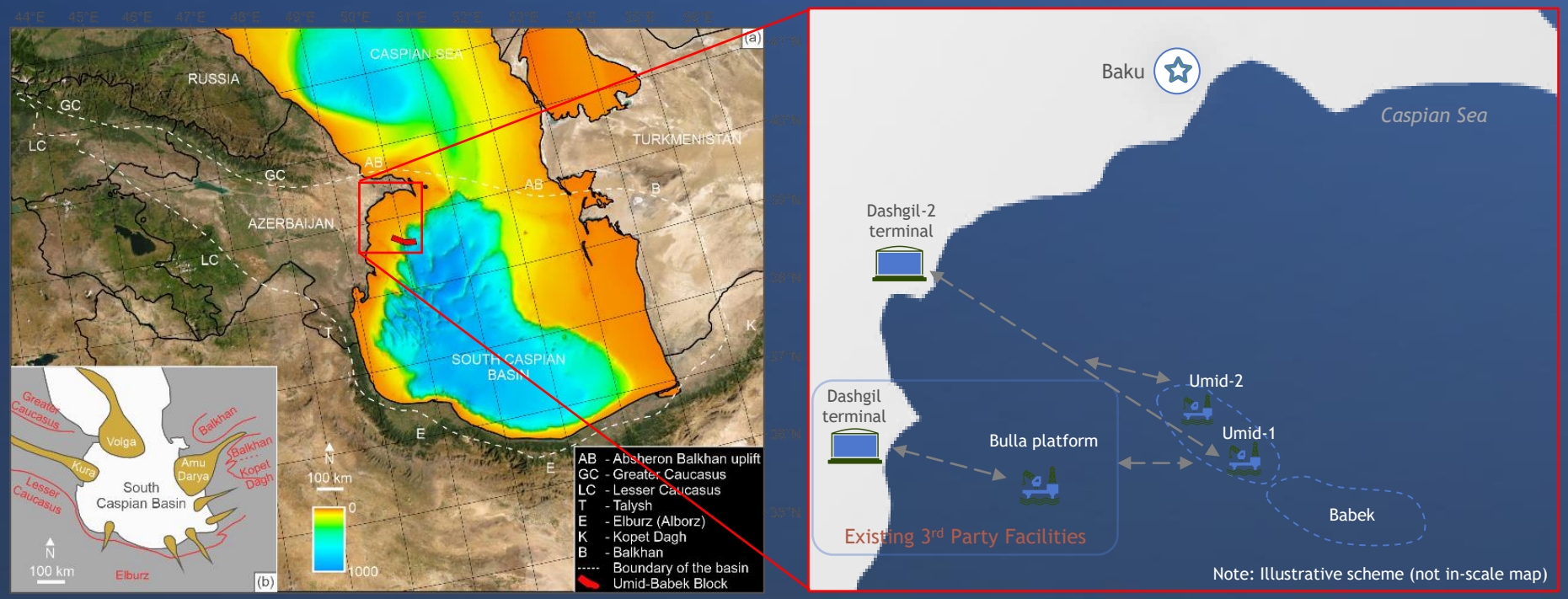
- Field Overview
- Problem Statement
- Key Challenges
- Regional Mud Volcano Occurrence
- Solution
  - Mud Volcano Delineation
  - Dynamic Model Building and History Matching
  - Risk Analysis and Mitigation Plan
  - Impact on Well planning
- Summary & Conclusions

Field Overview



Umid-Babek Gas & Condensate Field

Reservoir parameters	One structure separated by mud volcano with high probability of geological success: reservoir depth (6000-7000 m) high pressure (770-930 atm) normal temperature (100-110 ^{0}C)	
Water depth	Umid: 50-60 m Babek: 50-650 m	
Activities	2010	Discovery of Umid Gas-Condensate Field
	2012	Delivering first gas

Problem Statement

Cross-flow through mud volcano

- Potential barrier for gas communication between Umid and Babek fields

A drilling hazard

- Very high risk of well control issues, wellbore instability, kicks/losses ~XX$ for drilling a well

Surface infrastructure design

- Location of the mud volcano should be also considered for infrastructure design

impacts on dynamics of pressure and gas in place distribution

well counts and their locations

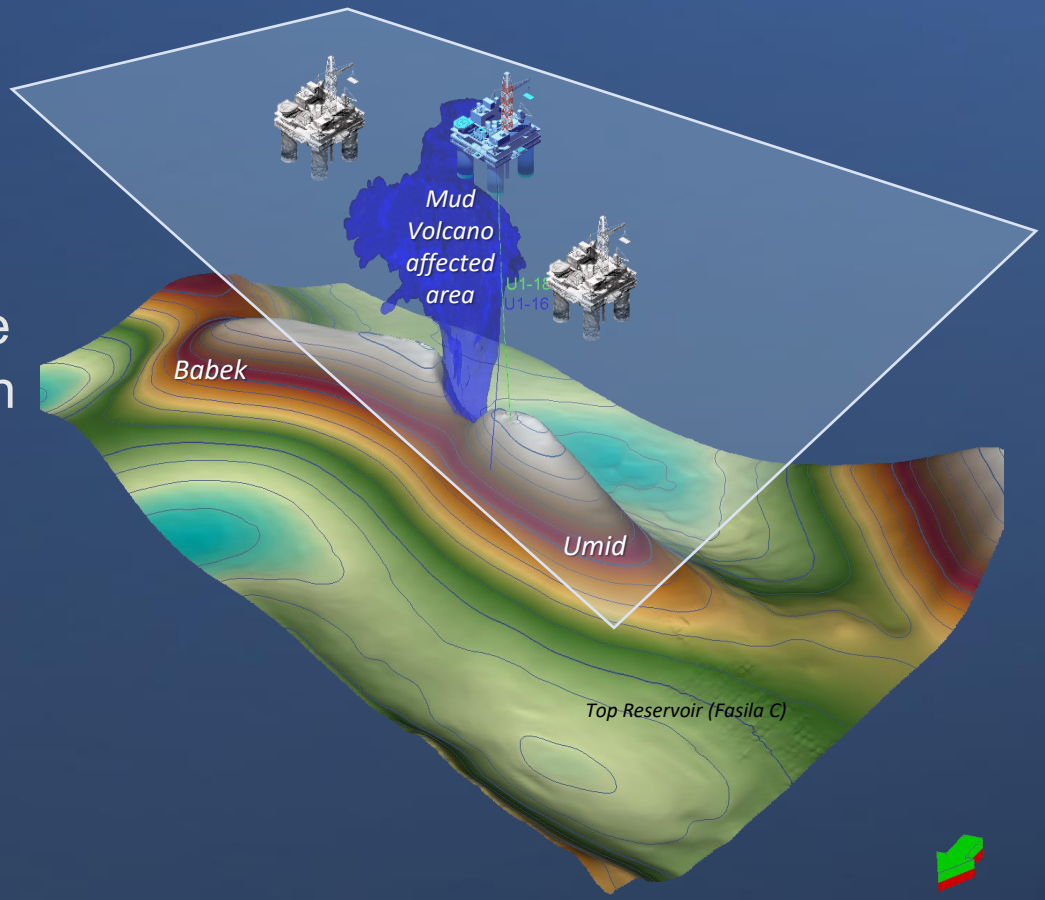
CAPEX expenditures and risks

Impact on FDP:

- potential barrier for gas communication
- a drilling hazard
- a hazard for surface infrastructure design

Key Challenges

- Delineate mud volcano from moderate quality data under high geological uncertainties
- Deal with difficulties in determination the degree of Umid & Babek communication through mud volcano affected area
- Develop the FDP under the presence of uncertainties caused by mud volcano & other geological inputs



Impact on FDP:

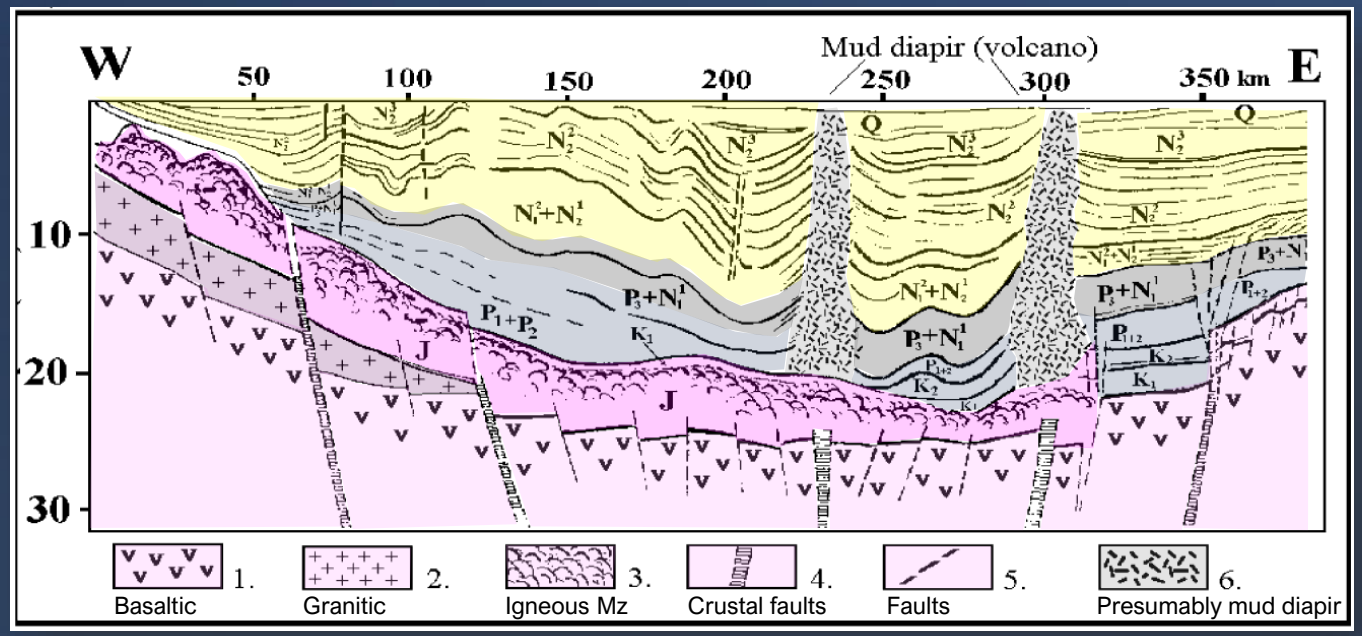
- potential barrier for gas communication
- a drilling hazard
- a hazard for surface infrastructure design

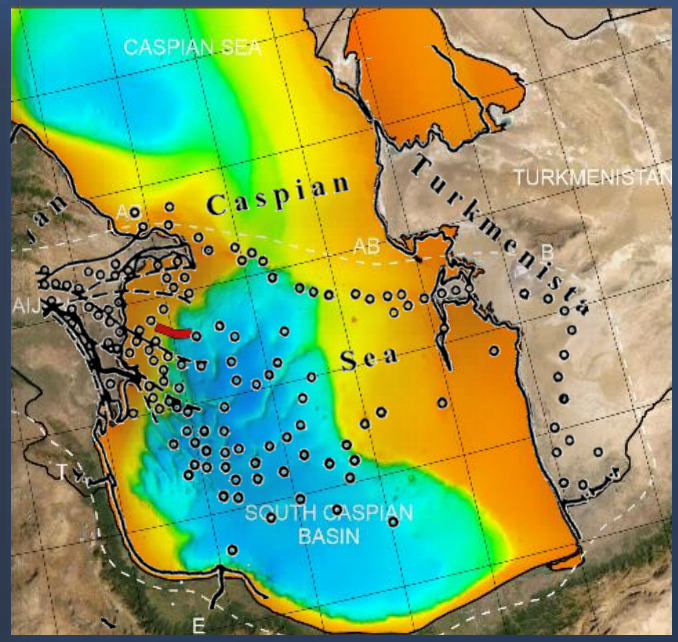
Regional Mud Volcano Occurrence

- Mud volcanoes accompany oil and gas fields in South-Caspian basin (SCB) and are **a drilling hazard**, **a threat to engineering infrastructure** and could be a **barrier for reservoir fluids flow**.
- Maycopian formation is regarded as major source rock for mud volcanoes
- Tectonic movement along the Apsheron-Pribalkhan Ridge has created shale diapirs by forcing overpressured shales into zones of weakness (*Abdullayev, 1999; Delvin et al, 1999*)

Mud volcanoes in South-Caspian Basin

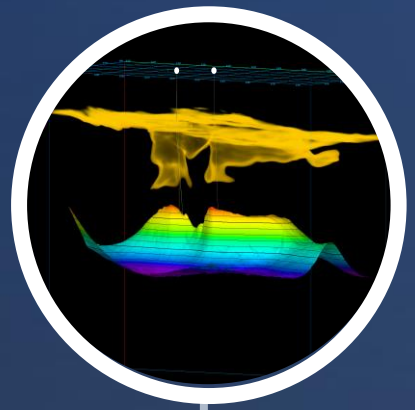
- 900 onshore
- 160 offshore





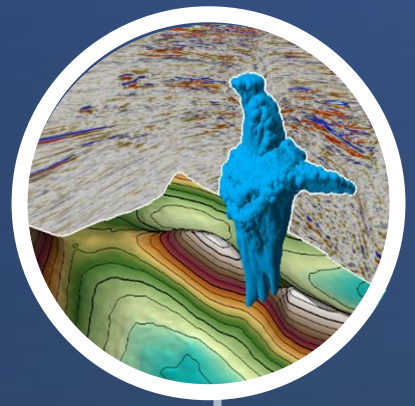
Modified from Huseynov and Guliyev, 2004

Solution



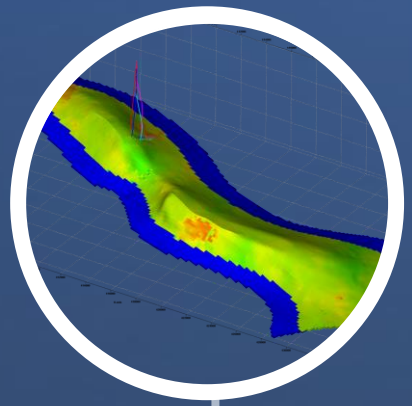
Seismic Reprocessing

High end seismic reprocessing workflow by Geo Solutions in OMEGA software which improved seismic image



Delineation

Detailed seismic interpretation with application of advanced structural attributes for delineation of mud volcano in Petrel



Modeling & Simulation

Equally history matched simulation model realizations should be considered to assess probabilistic forecasting

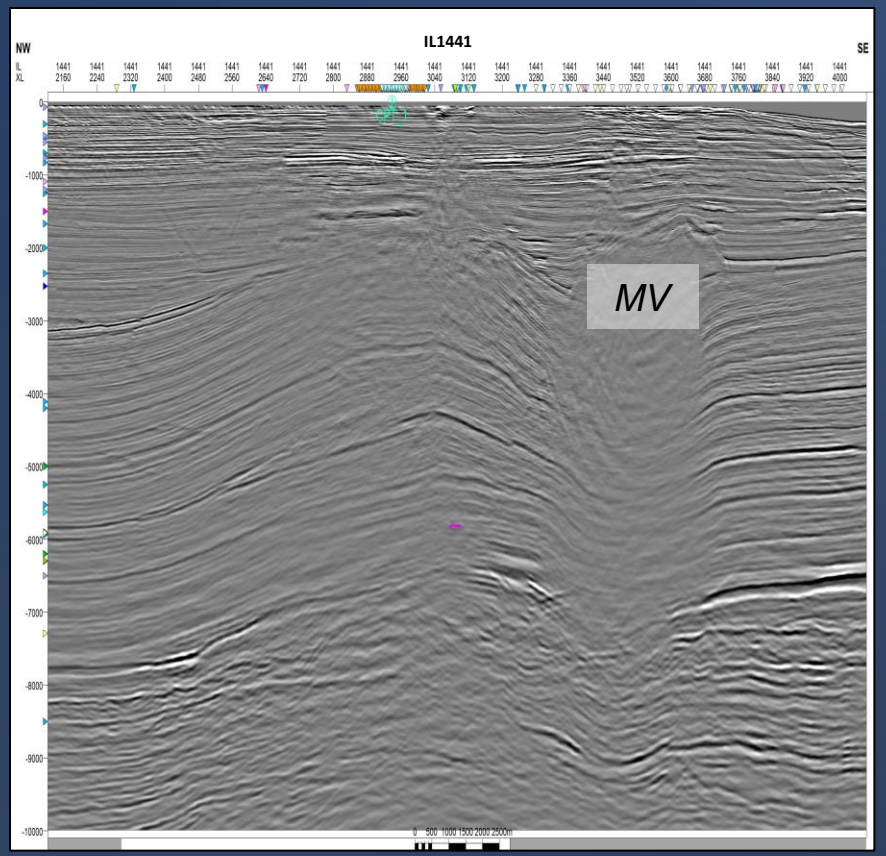
Key challenges:

- Seismic data quality
- Limited well studies
- Geological uncertainties

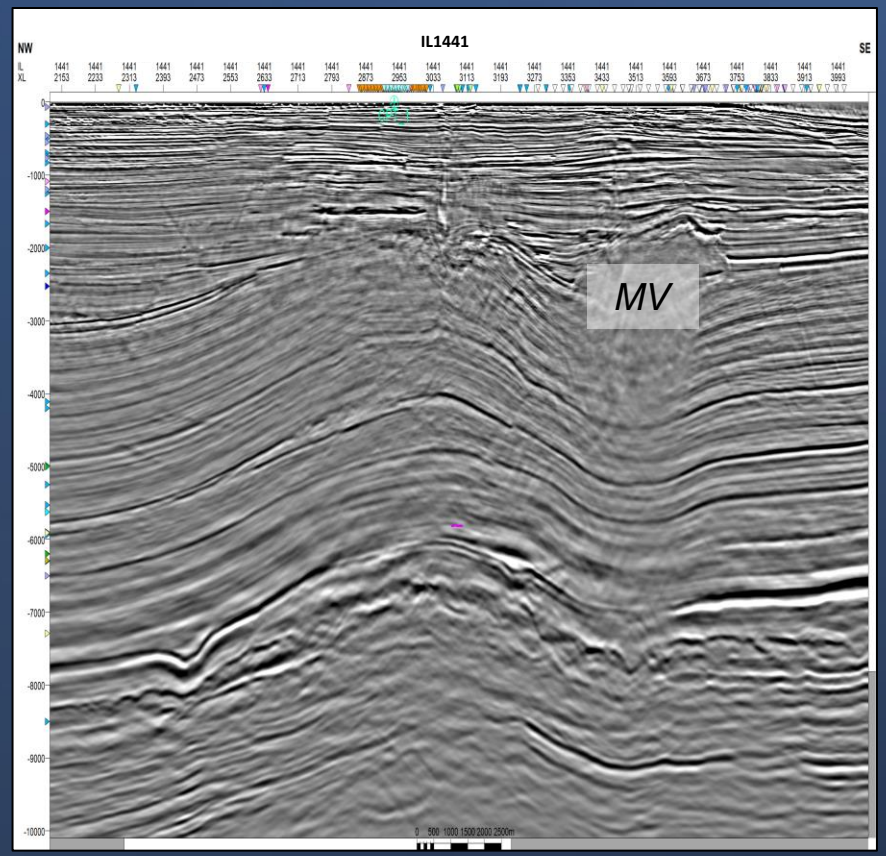
Seismic Reprocessing

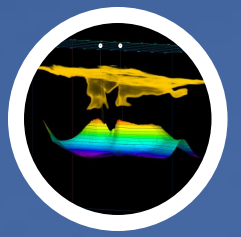
- In 2020 PSDM Reprocessing was performed
- FWI & anisotropic TTI velocity model building and Depth Migration improved imaging

2019 PSTM



2020 PSDM





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Solution

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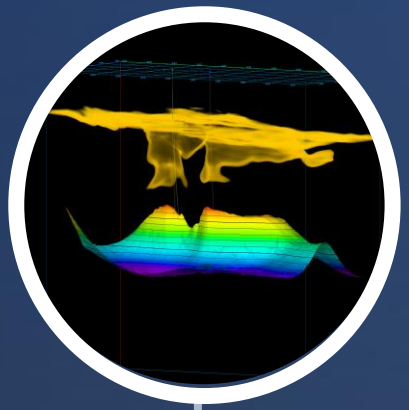

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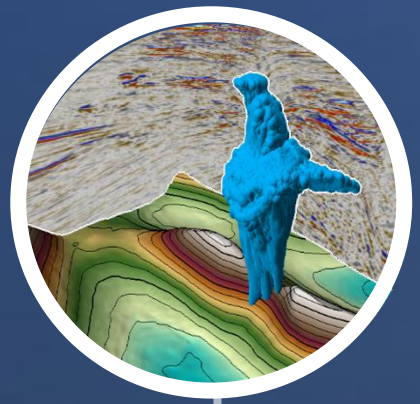

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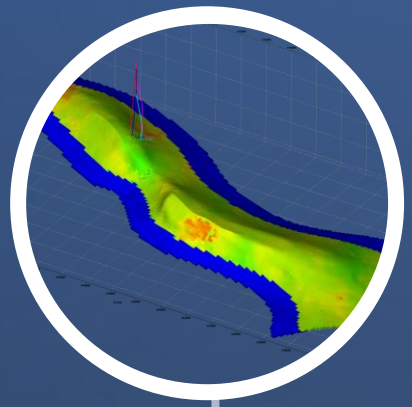

Modeling & Simulation

Equally history matched simulation model realizations should be considered to assess probabilistic forecasting

Key challenges:

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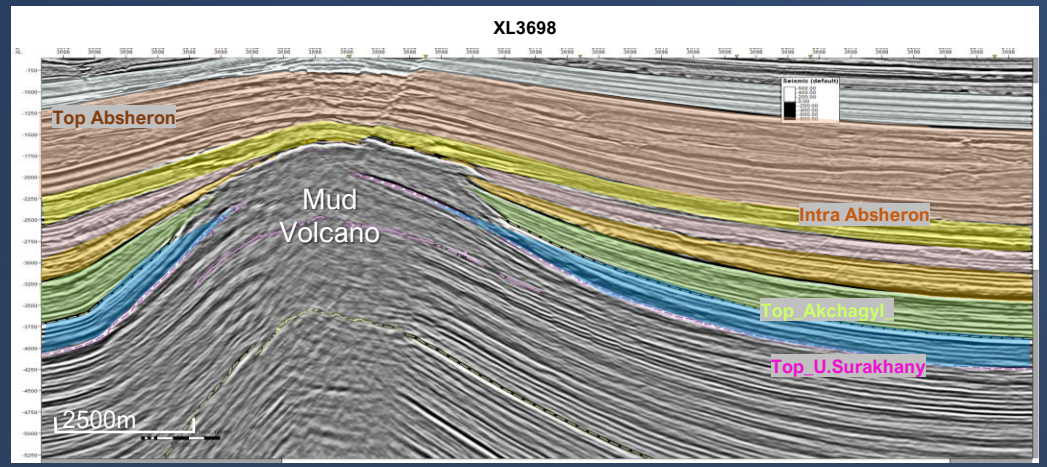
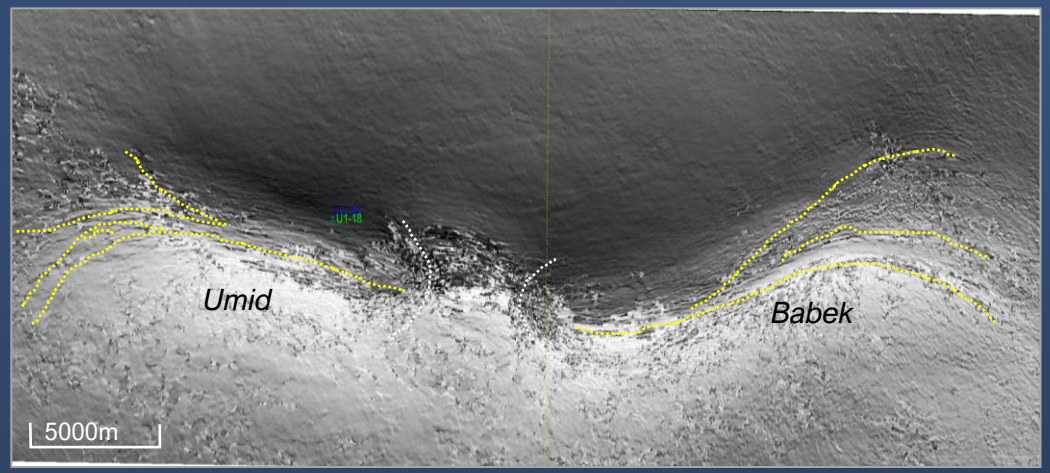
Mud Volcano Delineation

- Structural and stratigraphic interpretation, understanding the tectonic history and stages of structural growth of the fold
- Structural Interpretation. Delineation of faults
- Detailed interpretation and geomorphological analysis



Thickness analysis



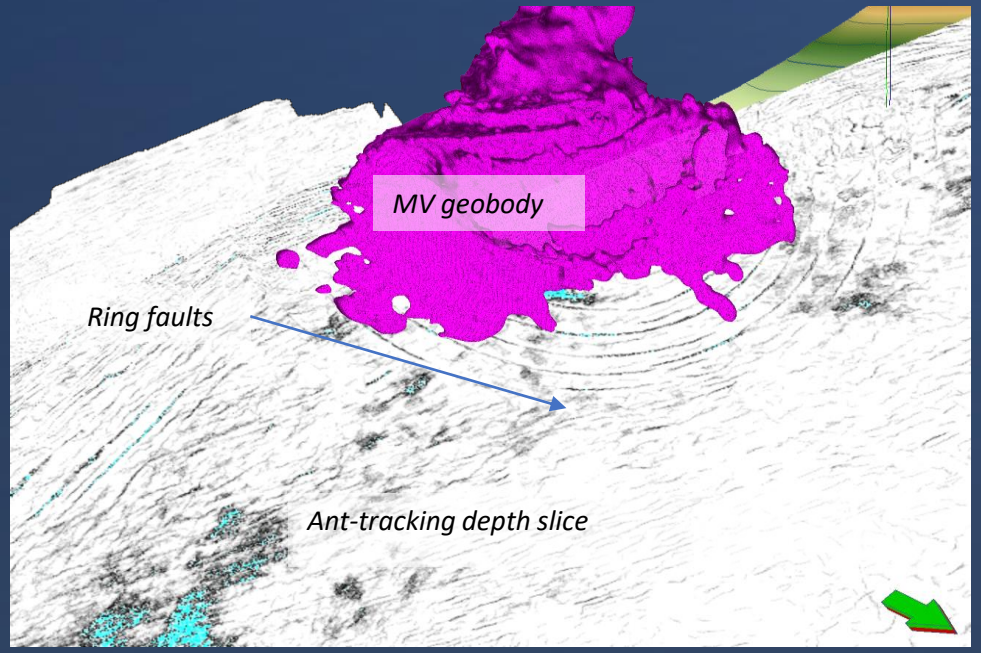
Directional blending along top Fasila C. 50deg

Key challenges:

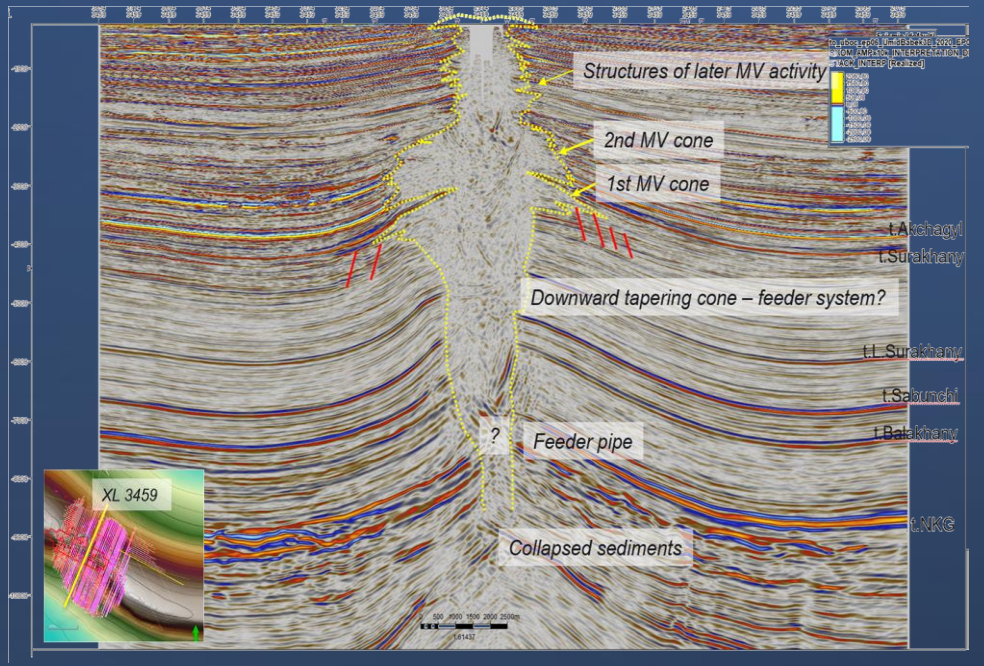
- Seismic data quality
- Limited well studies
- Geological uncertainties

Mud Volcano Delineation

- Interpretation of the mud volcano related ring fault system
- Multi-z meshing and geobody extraction
- Fault system, horizons and main Mud Volcano body interpretation results



Interpretation of the mud volcano related ring fault system



Detailed interpretation and geomorphological analysis

Key challenges:

- Seismic data quality
- Limited well studies
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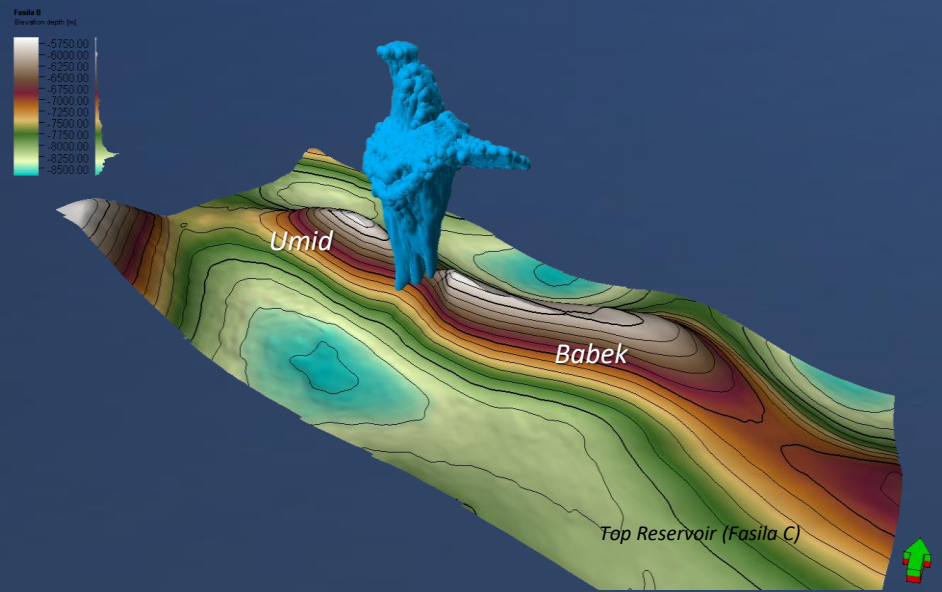
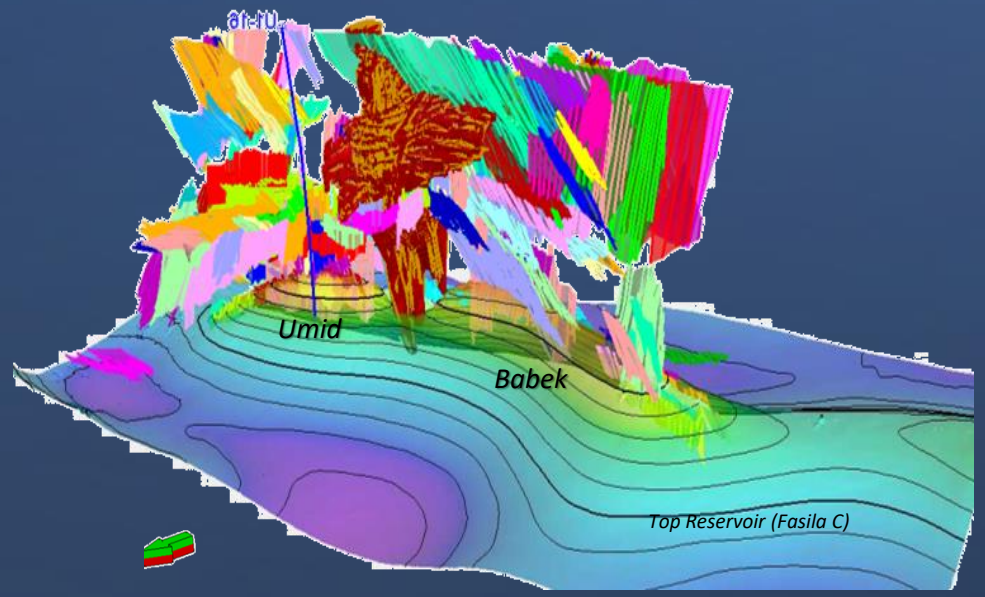
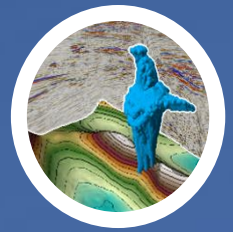


Multi-z meshing and geobody extraction



Fault system, horizons and main Mud Volcano body interpretation results



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Solution

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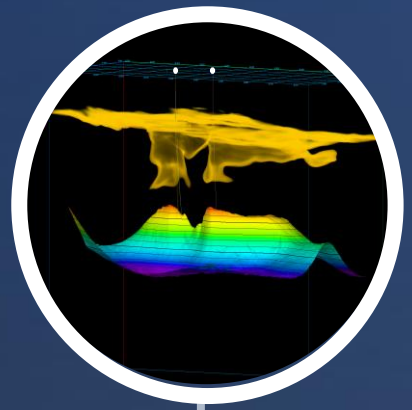

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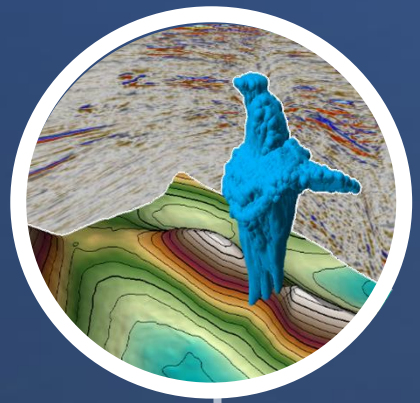

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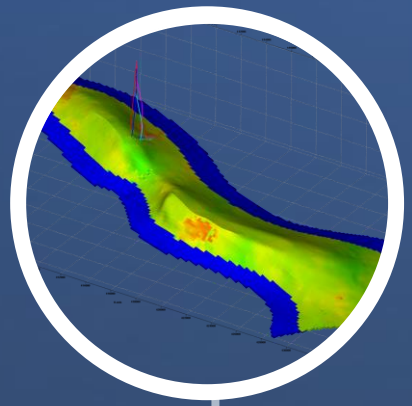

Modeling & Simulation

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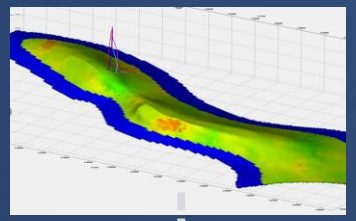
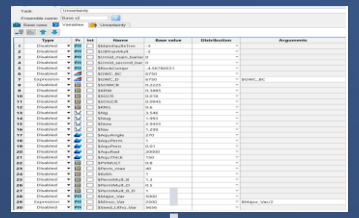
Dynamic Model Building and History Matching

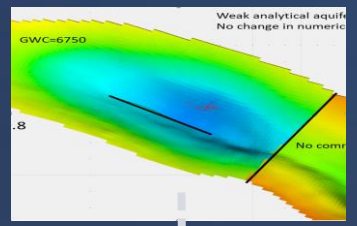
Base case construction



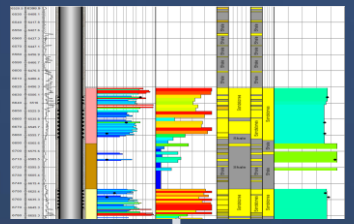
Sensitivity study



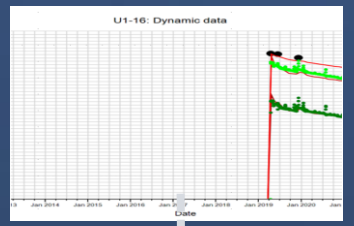
BHP matching
Global parameters adjustment
Permeability mult: Fasila B/C
Permeability ratio Fasila B/C



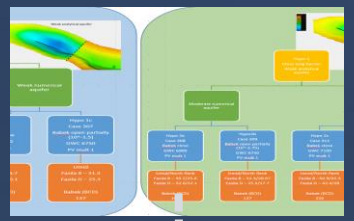
Hypothesis definition
Use major uncertainty parameters to define hypothesis



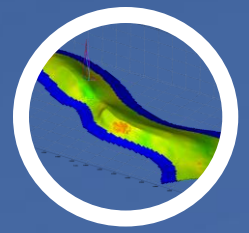
XPT matching
Vertical connectivity adjustment



BHP matching
Local modification



Hypothesis HM
Adjust GIIP and horizontal connectivity

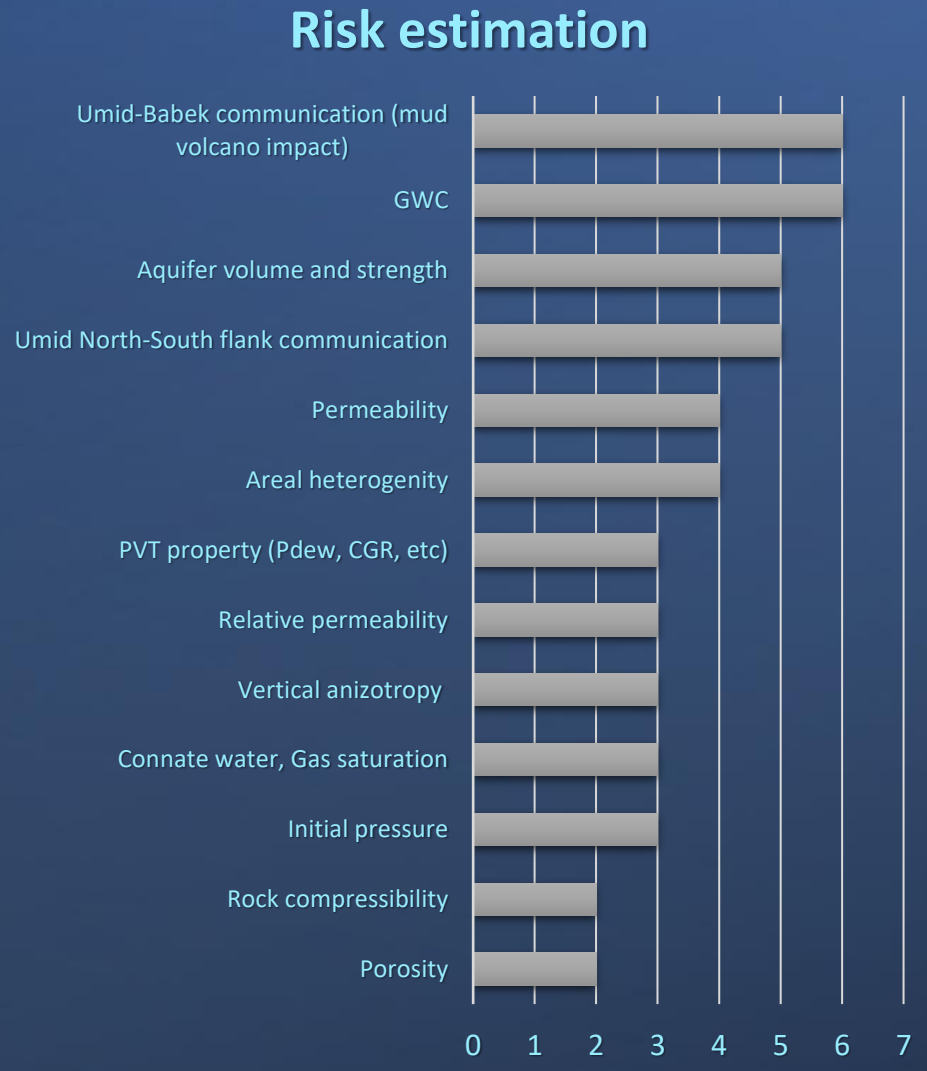


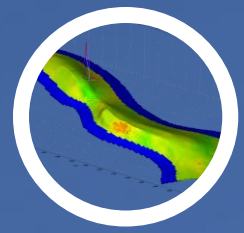
Key challenges:

- Seismic data quality
- Limited well studies
- Geological uncertainties

Risk Analysis and Mitigation Plan

- Risk analysis has been performed to identify key uncertain parameters that will impact FDP decision
- Major factors were split to several groups:
  - Initial gas in place volume
  - Factors limiting drainage volume, areal and vertical communication includes mud volcano impact
  - Factor responsible for additional pressure support and reservoir energy
  - Factors responsible for reservoir fluid mobility and well's deliverability
- Mitigation steps offered to reduce top scored risk factors
- Risk mitigation activities are associated with high CAPEX and economic calculation will be required to make business decision





Key challenges:

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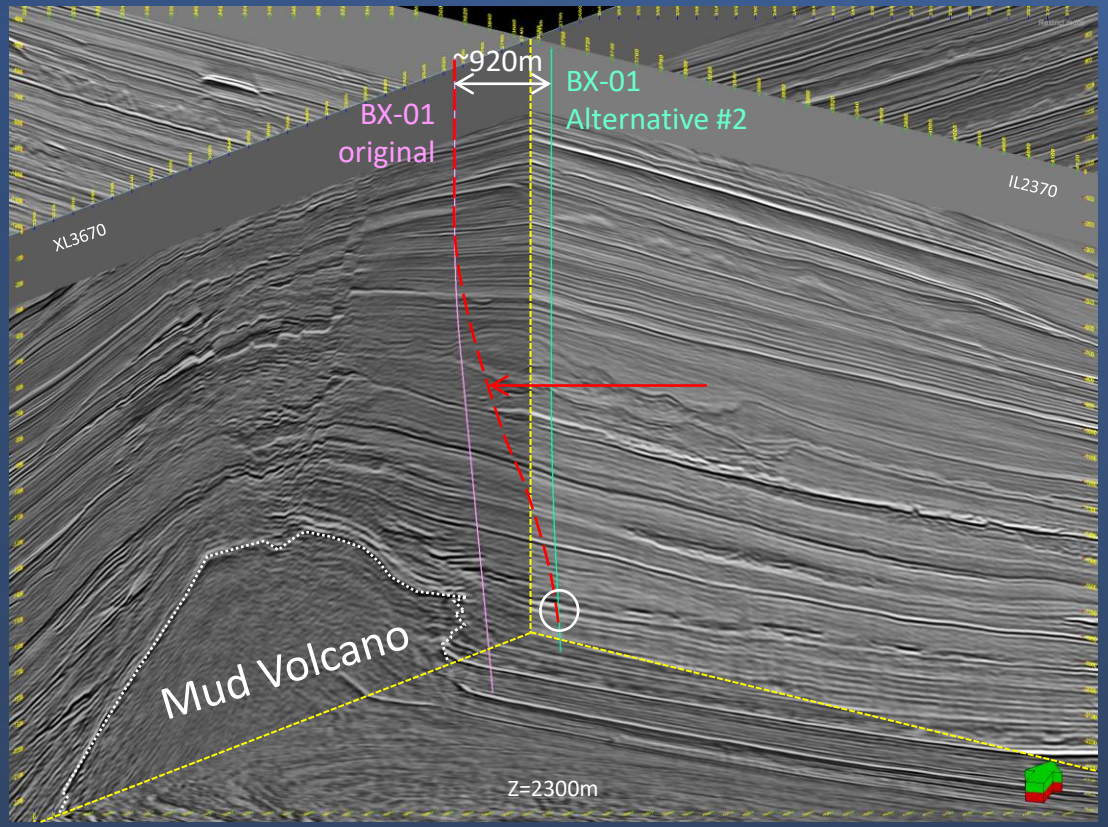
- Limited well studies
- Geological uncertainties

Impact on Well planning

- Initial trajectory of exploration well on Babek side in shallow and overburden sections experiences Mud Volcano influence and poses drilling risk
- The top-hole location of the well planned on Babek was optimized based on MV location
- A pilot well investigating shallow hazards was justified to be drilled



Other shallow hazards:

- *Sea bed topography*
- *Gas packages*
- *Faults*

Summary & Conclusions

- 2020 PSDM processing improved imaging: more precise structural shape; restored image and event continuity at crest and steeply dipping flank; improved vertical resolution; healthier amplitudes and their distribution; massively reduced depth uncertainty are obtained
- Interpretation of main mud volcano body allowed to consider it in planning trajectory of new exploration well and minimize the drilling risk, include in the static and dynamic model
- Uncertainty in mud volcano area transmissibility is estimated by 8 equally probable history matched models with different combinations of mud volcano transmissibilities
- Field Development Plan including optimized well counts is presented taking into account uncertainties associated with mud volcano and other geological parameters
- Mitigation plan is provided to reduce risks related to the most uncertain parameters

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- ✓ Delineate mud volcano from moderate quality data under high geological uncertainties
- ✓ Deal with difficulties in determination the degree of Umid & Babek communication through mud volcano affected area
- ✓ Develop the FDP under the presence of uncertainties caused by mud volcano & other geological inputs

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THANK YOU FOR ATTENTION