A new approach to manage non-traditional structural model geometries applied to Lubina - Montanazo field, Spain: Powered by Volume Based Modeling algorithm in Petrel

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What's Next?
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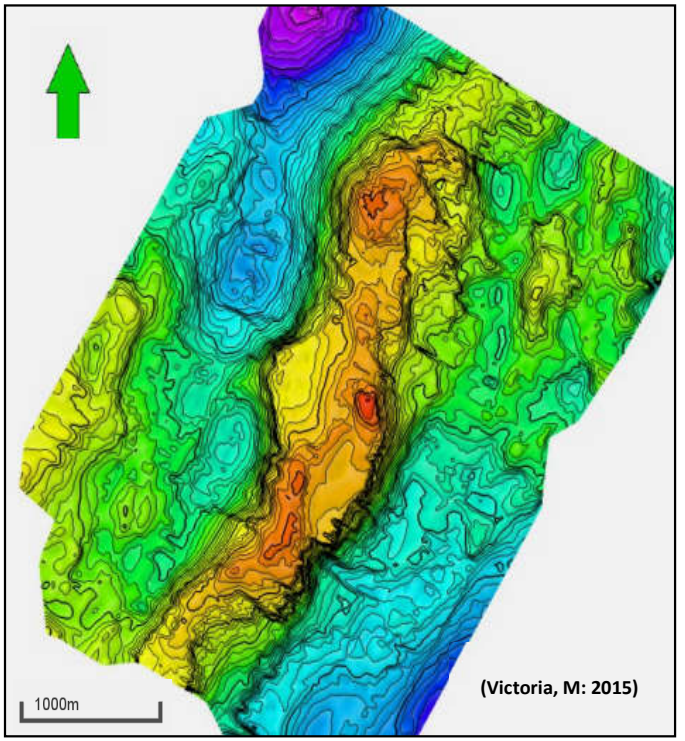
Agenda

- Introduction
  - ✓ Background
  - ✓ Challenges
  - ✓ Proposed solutions
- Reservoir characterization
  - ✓ Faults
  - ✓ Horizons
- Fault framework and Volume Based Modeling (VBM)
- Stair-Step Gridding
- Results & Conclusions

Background

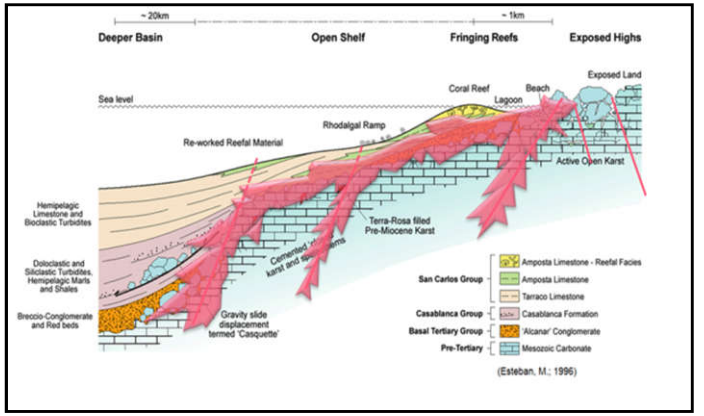
- Two oil wells producing from a fractured carbonate reservoir
- 5 km NE-SW elongated structure with rotated blocks limited by two lateral faults
- Two reservoir rocks over-imposed; sucrosic dolomites and karstified limestones
- Complex stratigraphic relationships with carbonates patches and onlaps/downlaps
- Complex fault geometries and truncations

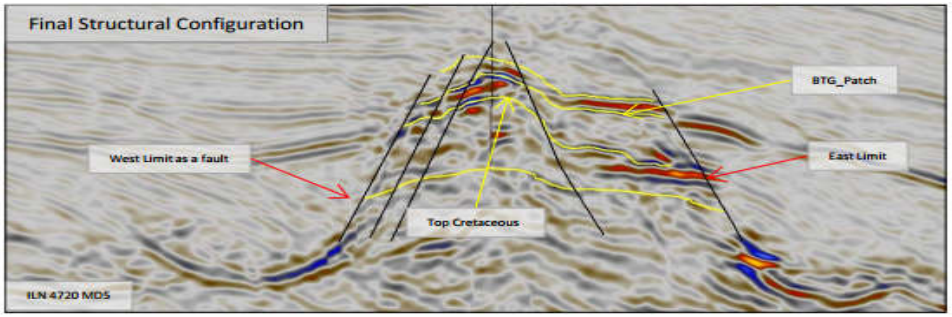


Challenges

- Represent the complex carbonate's geology in a 3D model capturing the reservoir behavior and connectivity.

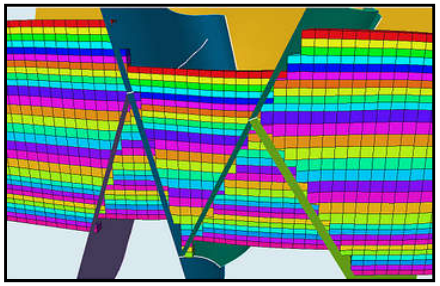
- Several issues faced using Traditional Pillar gridding :
  1) Too complex fault modeling process; not all the faults included in the 3D grid
  2) Structural and stratigraphic complexity was not honored
  3) Resulting 3D grid with a large number of distorted cells; slow simulation and convergence problems

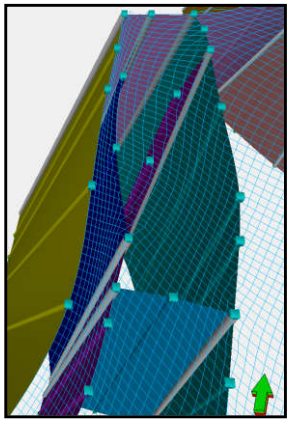




Proposed solutions

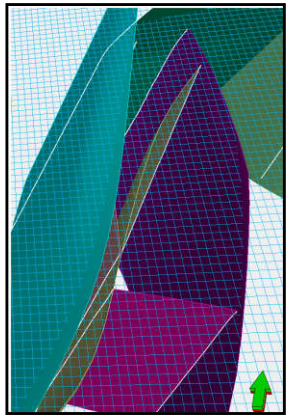
- Use the Structural Framework (SF), Volume Based Model (VBM) algorithm, and Stair-step gridding to :
  - ✓ Reduce the time spent on building the structural grids
  - ✓ Solve the stratigraphic and structural complexities
  - ✓ Assure to build the optimum grid to run dynamic simulations





Pillar grid faults

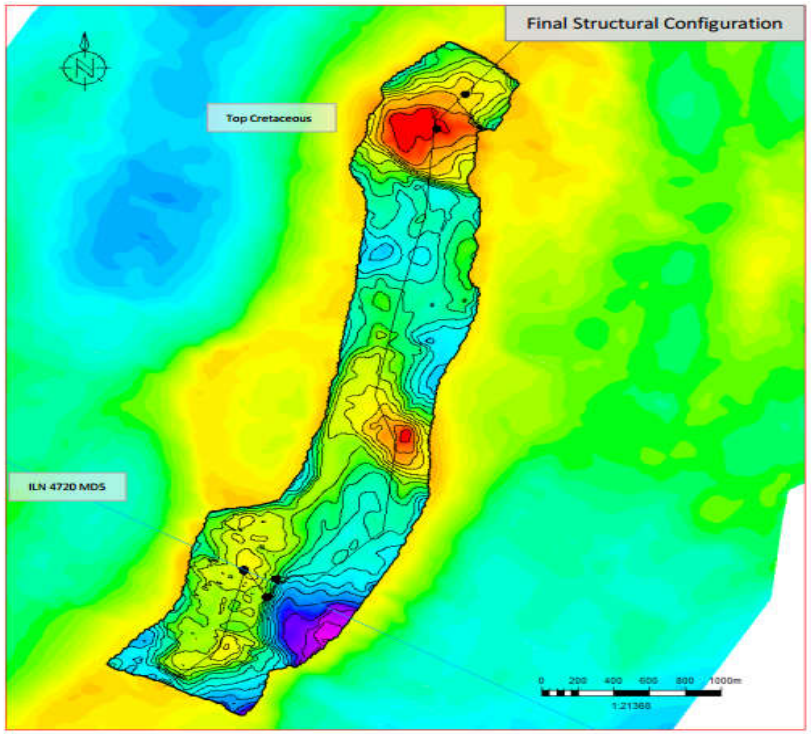
Vs.

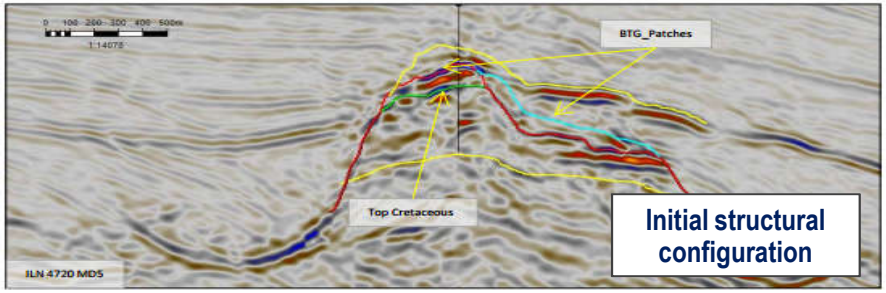


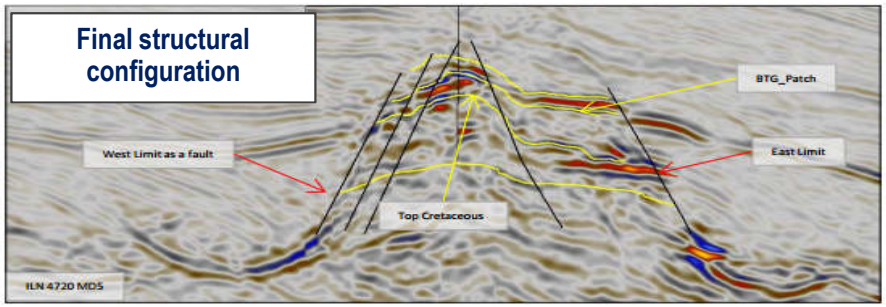
Structural Framework faults

Reservoir Characterization

Stratigraphic & Structural Model

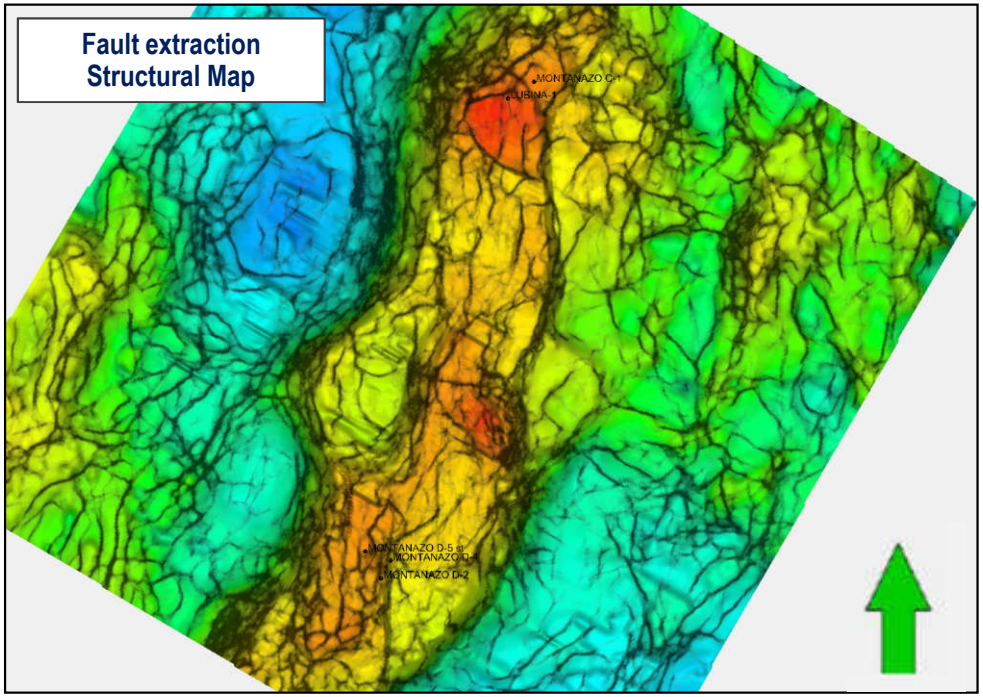


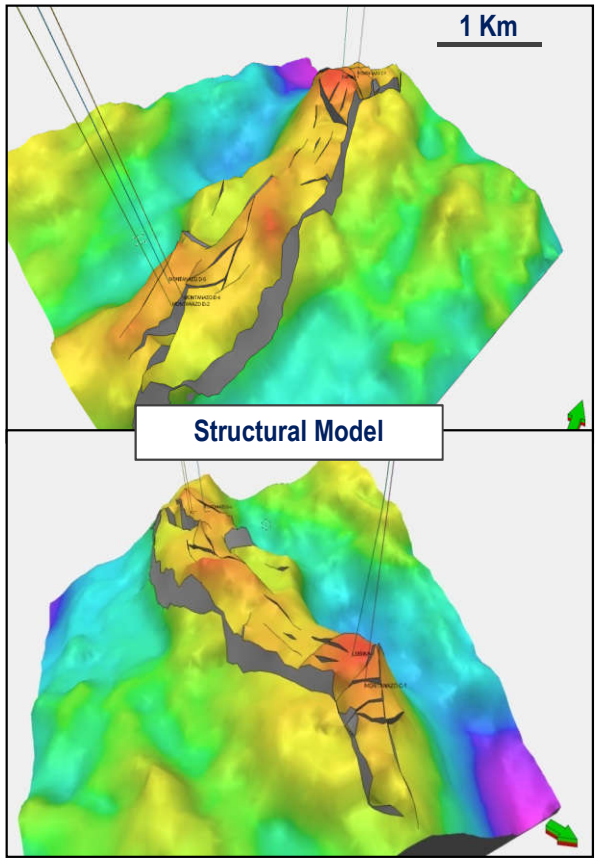




Reservoir Characterization

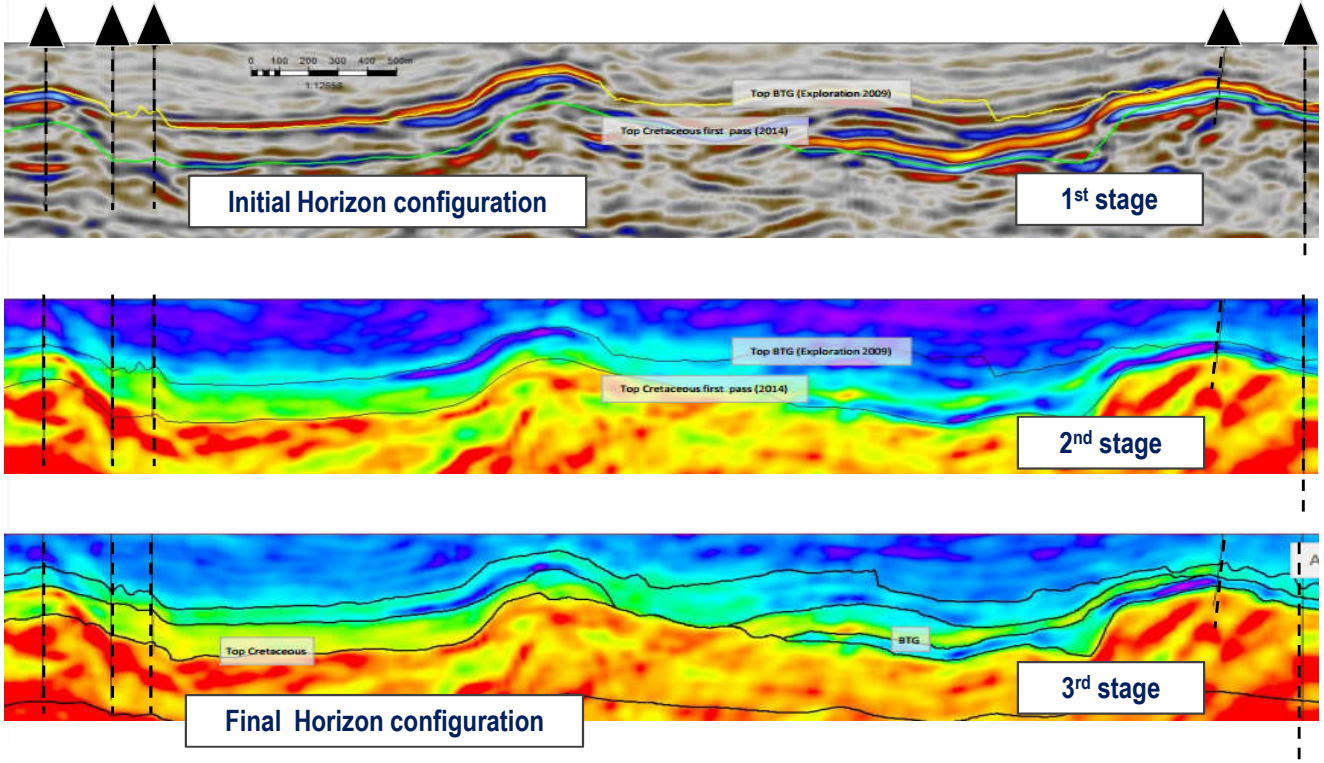
Faults Interpretation

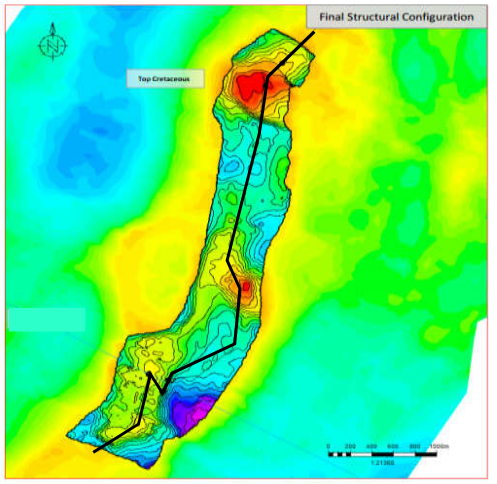




Reservoir Characterization

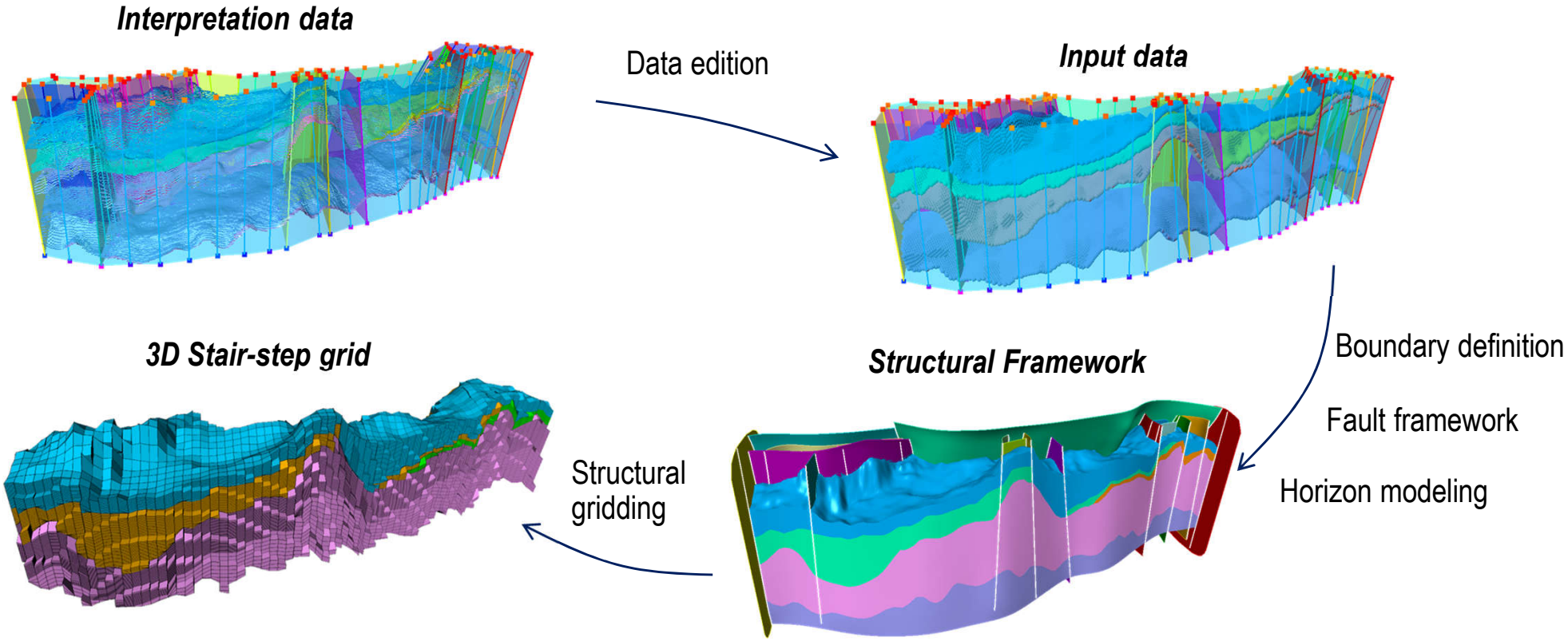
Horizon Interpretation





Structural Modeling Workflow

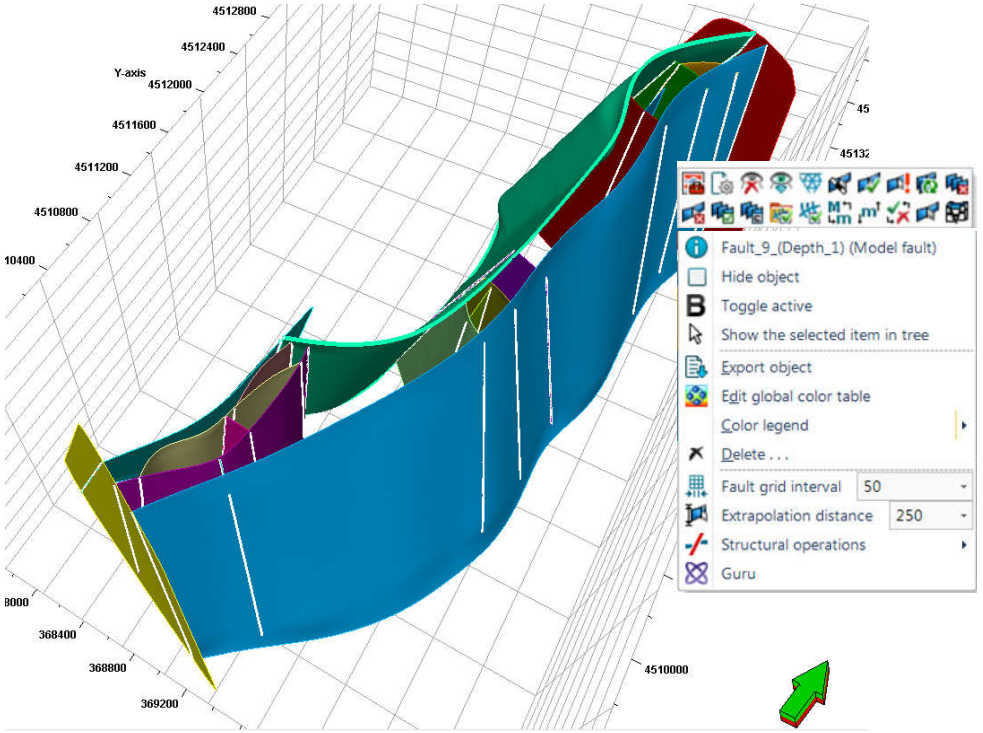
Structural Modeling – Summary Workflow



Fault framework and VBM

Structural Modeling – Fault Framework

- Fault framework process simplifies the fault modeling
- All fault geometries and truncations easily handled
- Drastic reduction of time spent in fault modeling and editing

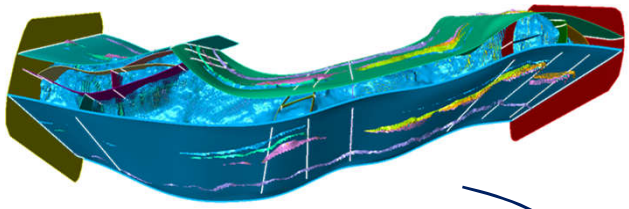


Fault Framework and VBM

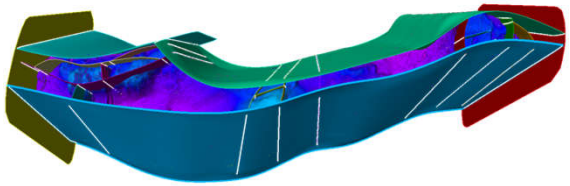
Structural Modeling – Input Data Preparation

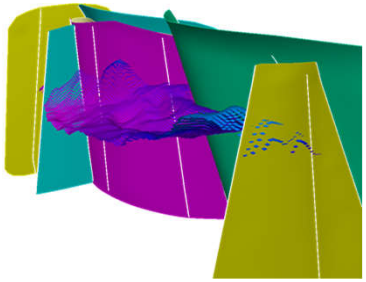
Horizon Clean-up:

Clean wrong sided data to avoid incorrect modeling of horizons

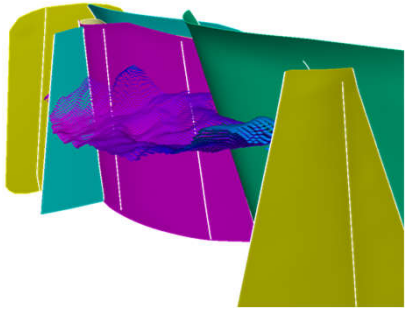


Cleaning of wrong sided data outside model boundaries





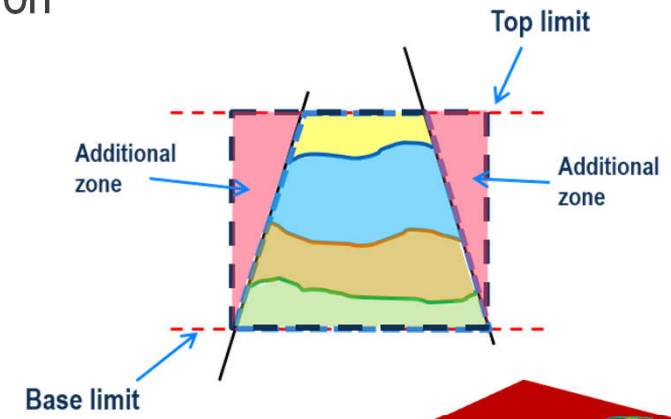
Cleaning of wrong sided data within model segments

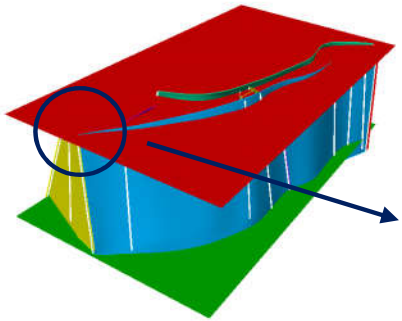


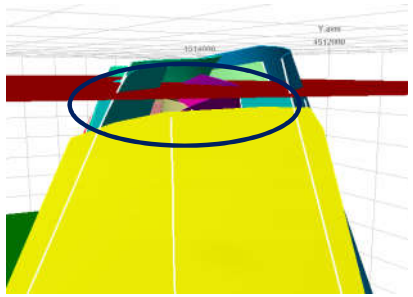
Fault Framework and VBM

Structural Modeling – Boundary Definition

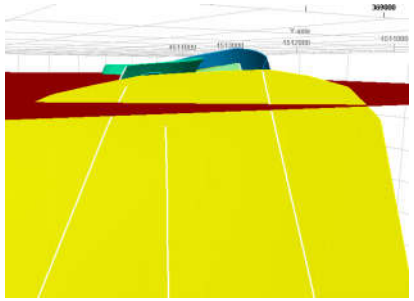
"Watertight model": the creation of a model with closed boundaries was key to avoid the extrapolation of the horizons out of the faults limits.

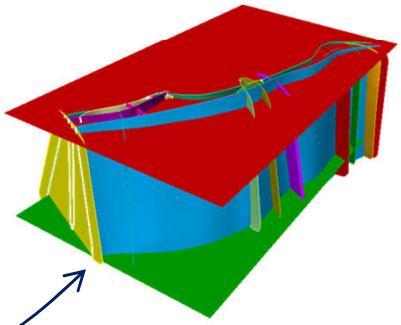






Increase extrapolation of faults

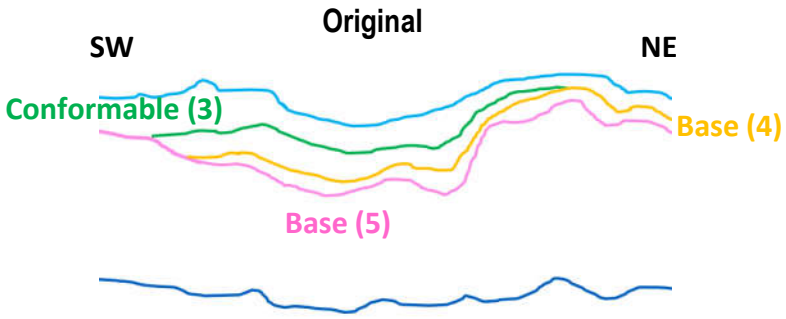


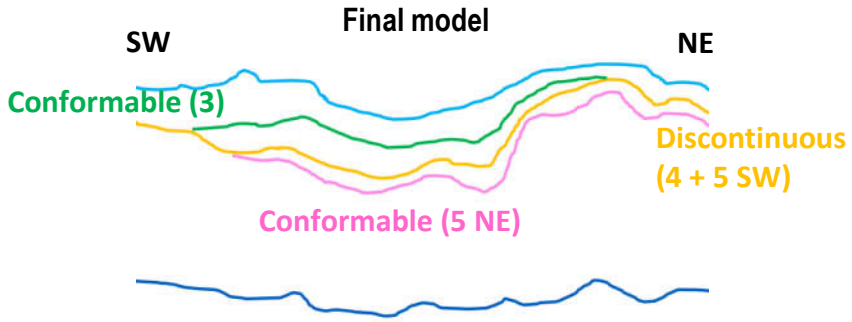


Fault Framework and VBM

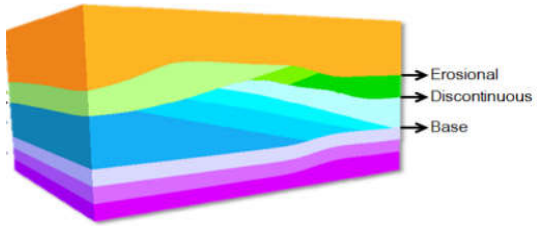
Structural Modeling – Horizon Modeling

Need of combining different horizons and changing stratigraphic relationships to capture complexity



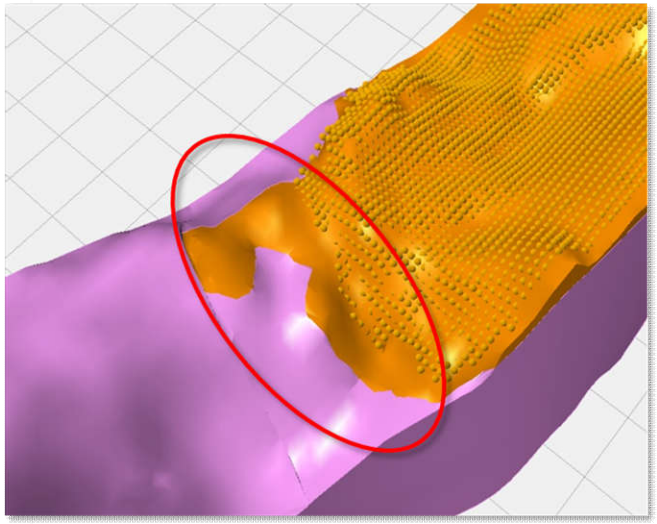


Stratigraphic relationships

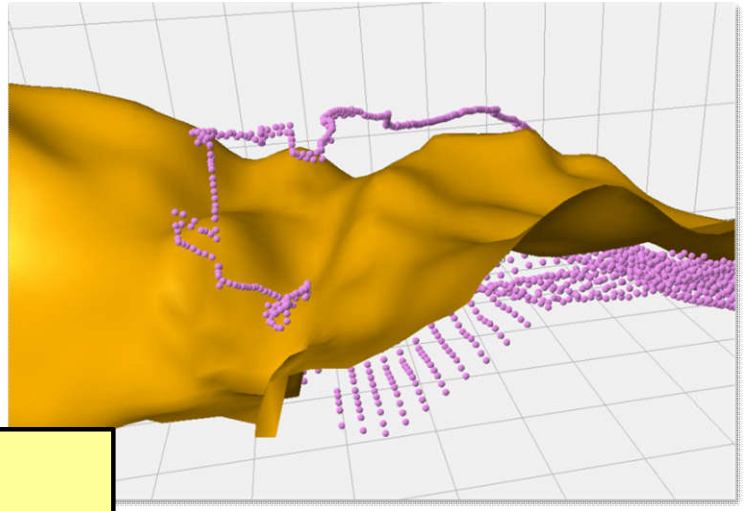


Petrel 2016 – Base-Base horizon relationship available. No need of combining horizons anymore

Stair-Step Gridding



Solution: **Control points to constrain the horizon modeling**



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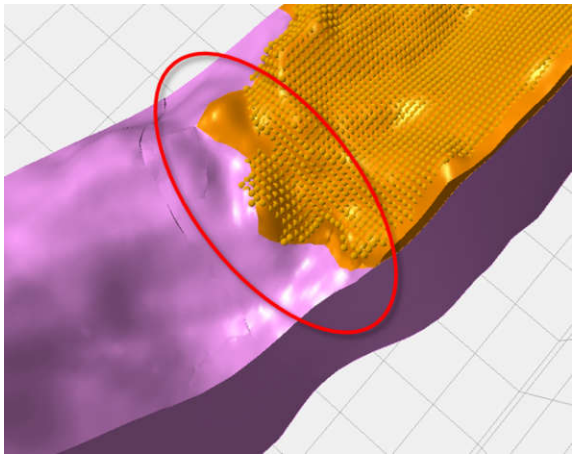
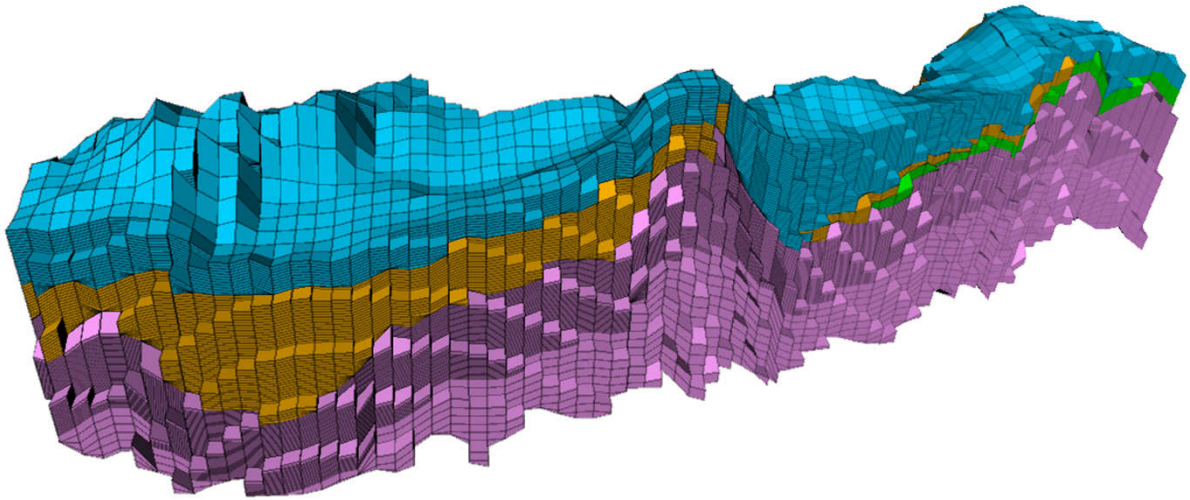


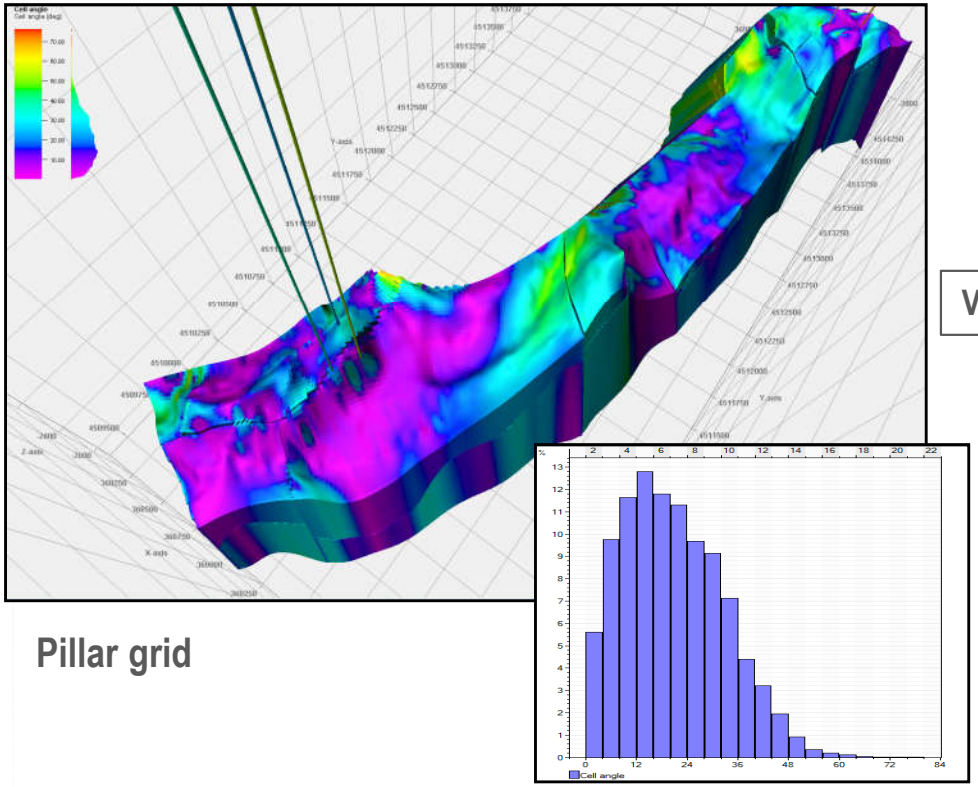
Structural gridding

- **Structural gridding** process generates **Stair-step grids** which avoid the shortcomings and limitations of the Pillar grids related to complex structural relationships and cells distortion.
- Stair-step grids are more suitable for simulation than traditional Pillar grids. Usually, less time is needed for review and QC



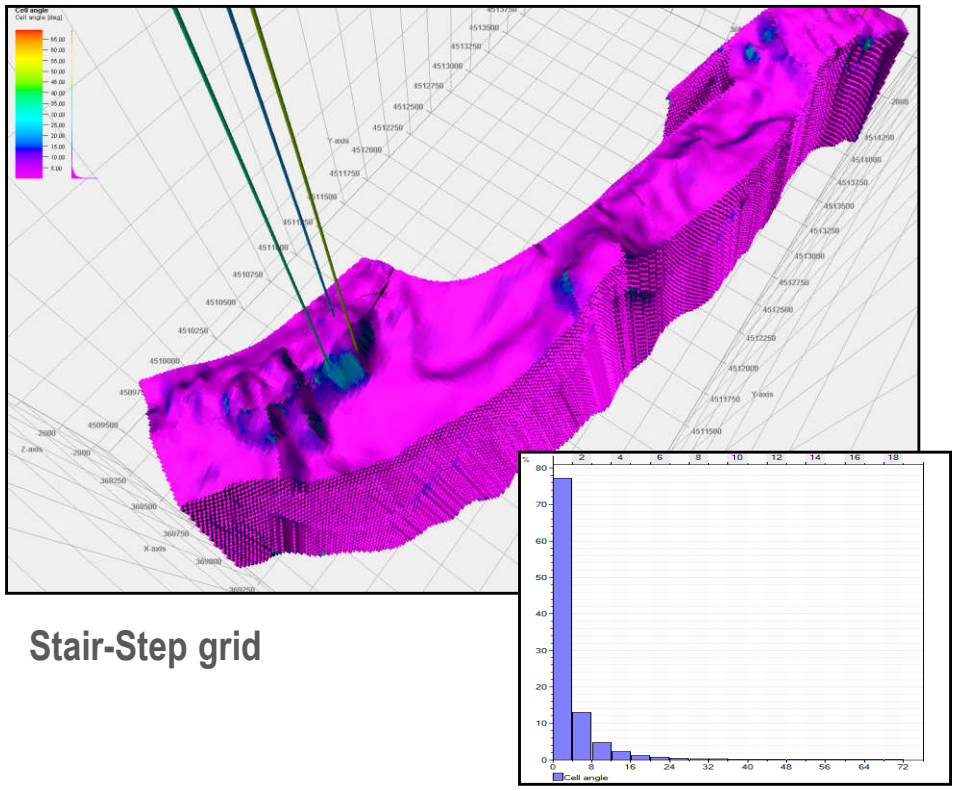
Structural Gridding

Cell Angle property



Pillar grid

Vs.



Stair-Step grid

Results

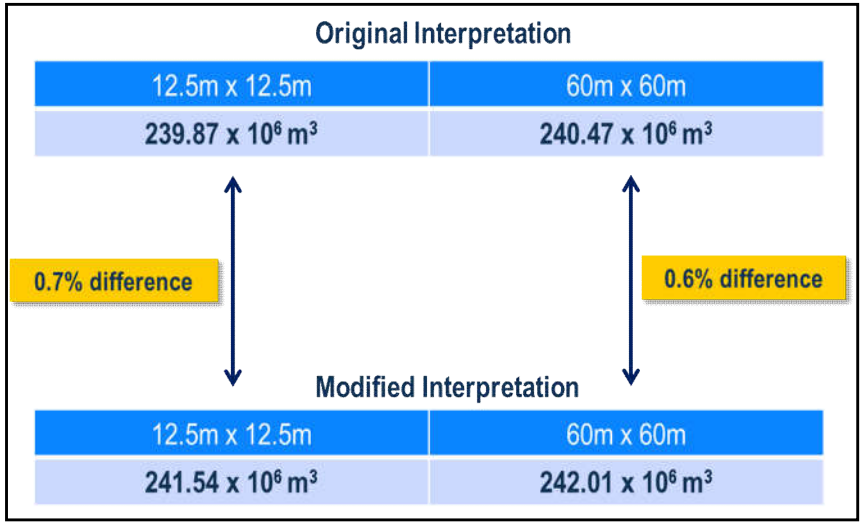
I. All the faults were included in the final Structural grid. It was not possible in the Pillar grid

II. Maximum **cells angle** drastically reduced

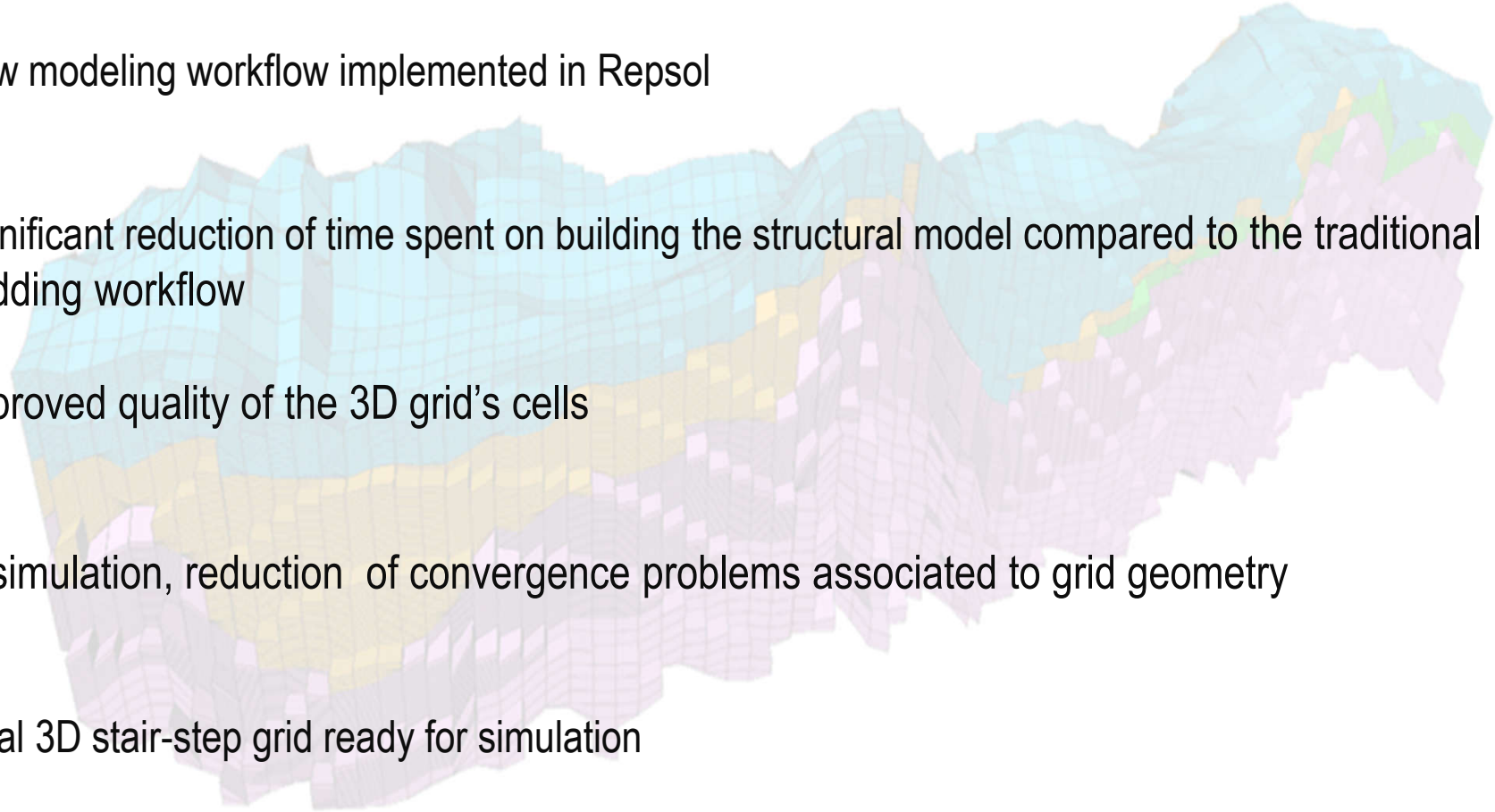
III. **No** cells **inside out** and **no** cells with **negative volume**

IV. **Volumetrics** showing similar values than the Pillar grid model, with a difference of less than 1%

Cell angle	% of cells (Stair-Step grid)	% of cells (Corner point grid)
<15°	95	37
<25°	99	66
Max. Angle	44º	77º



Conclusions



- ✓ New modeling workflow implemented in Repsol
- ✓ Significant reduction of time spent on building the structural model compared to the traditional Pillar gridding workflow
- ✓ Improved quality of the 3D grid's cells
- ✓ In simulation, reduction of convergence problems associated to grid geometry
- ✓ Final 3D stair-step grid ready for simulation