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81ST CONFERENCE + EXHIBITION

LONDON | UNITED KINGDOM

Lossless progressive compression of meshes for upscaling and upgridding in reservoir simulation with HexaShrink

Lauriane Bouard[1,2]

supervised by: Laurent Duval[1], Christophe Preux[1], Frédéric Payan[2], Marc Antonini[2]

[1] IFP Energies nouvelles, France

[2] Université Côte d'Azur, CNRS, I3S, France

3 - 6 JUNE 2019

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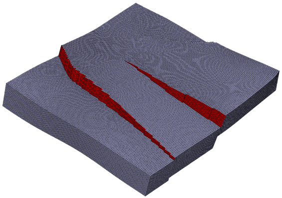
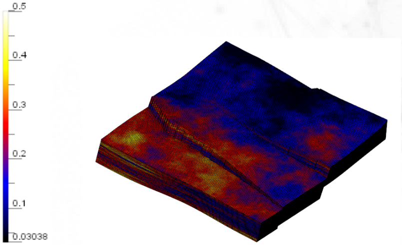
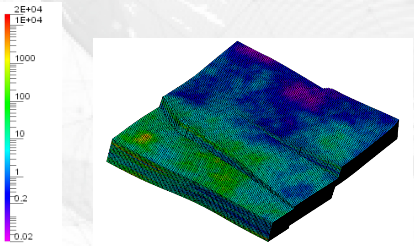
Context



Mesh structure



Porosity

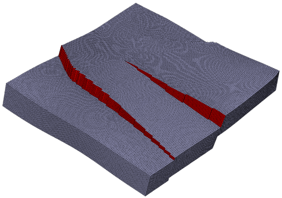


Permeability (mD)

Composite reservoir meshes (millions of cells):

- Faulted structure
- Petrophysical properties

Context



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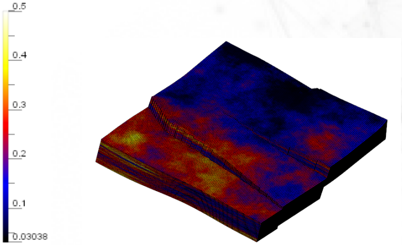

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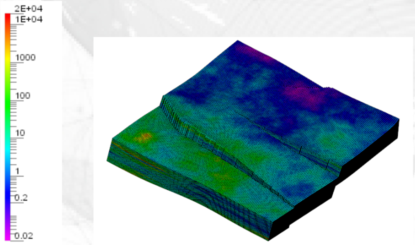

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Composite reservoir meshes (millions of cells):
- Faulted structure
- Petrophysical properties

Challenges:
- **Visualization**
- **Storage**
- **Simulation**

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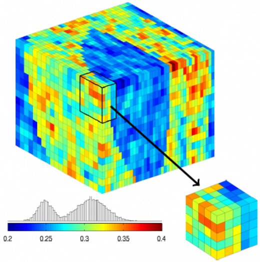
Existing solution in geosciences for managing huge meshes

Upscaling methods:

- Durlofsky and Chen (2012)
- Li and Beckner (2000)
- Qi and Zhang (2009)

Initial mesh



[Computational Geosciences - SINTEF]

Existing solution in geosciences for managing huge meshes

Upscaling methods:

- Durlofsky and Chen (2012)
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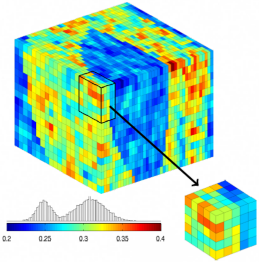
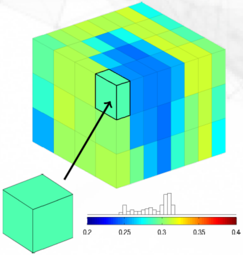
Suitable solution for simulation
but not for storage
(additional and redundant information)

Initial mesh



+

Additional mesh *from upscaling*



[Computational Geosciences - SINTEF]

An alternative from multimedia Wavelet

Data represented in a mutiscale fashion, by an embedded structure

Di i Decomposition step
of wavelet decomposition

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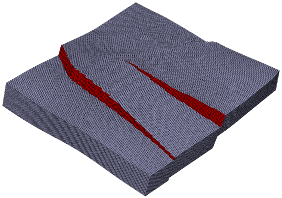
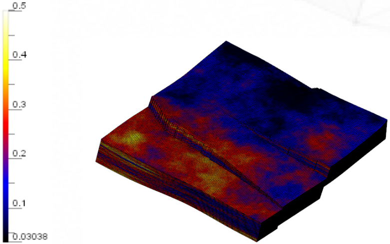
2.0 Meshes from Geosciences

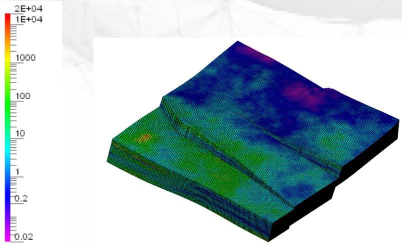
- Structure
  - Corner Point Grid format (CPG)
  - Fault network
- Cell activity
- Petrophysical properties: continuous ($\mathbb{R}$) (with high dynamic)



<mesh structure



Porosity



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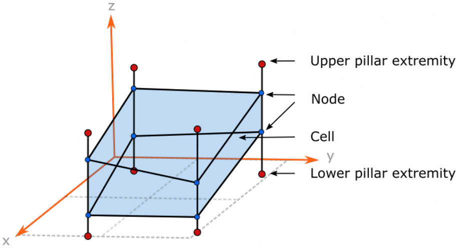

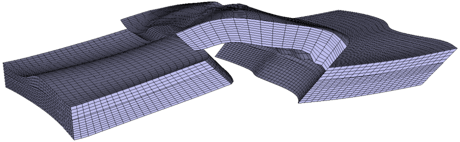

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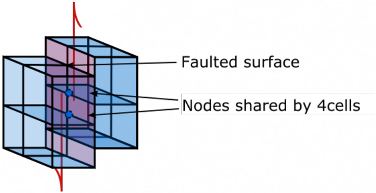

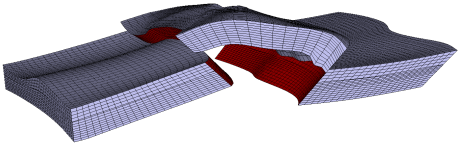

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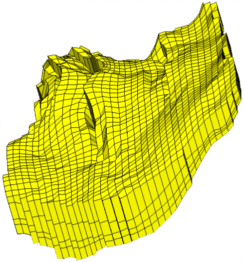

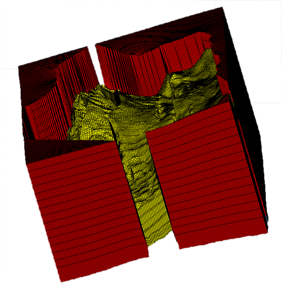

Activated

Desactivated

- Structure
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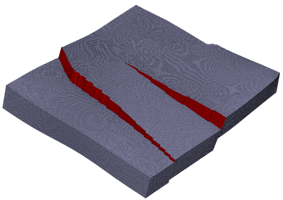

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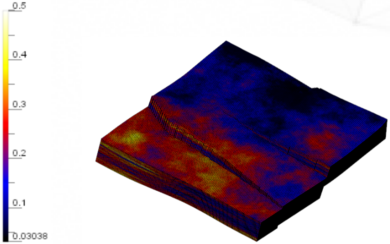
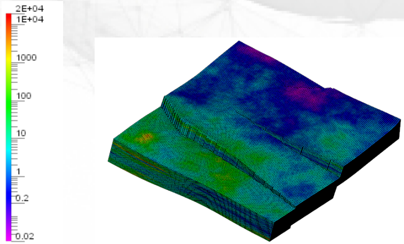


Porosity



Permeability (mD)

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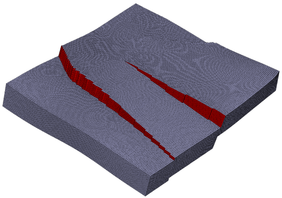
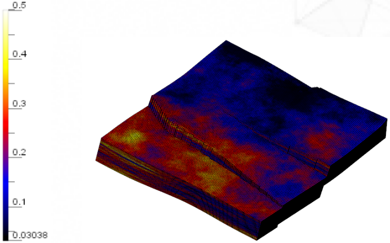
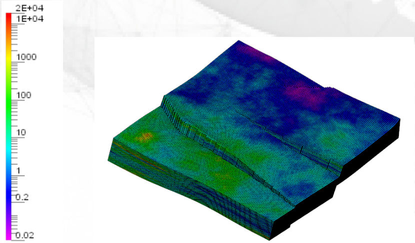
3.0 Mesh decomposition: HexaShrink Peyrot et al. (2019)

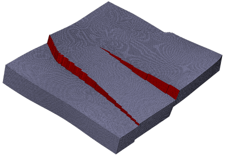
Mesh components → Constraints → Developed tools







Mesh components	→	Constraints	→	Developed tools
Geometry				
- Pillar	→	Fault preservation	→	2D morphological wavelet
- Zcorn	→	Global shape preservation	→	non-linear 1D wavelet



Mesh components → **Constraints** → **Developed tools**

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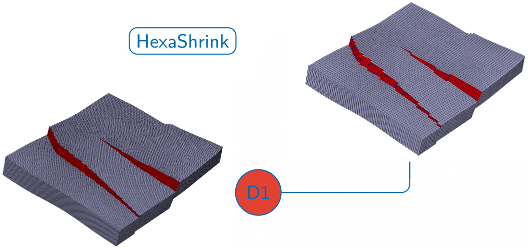

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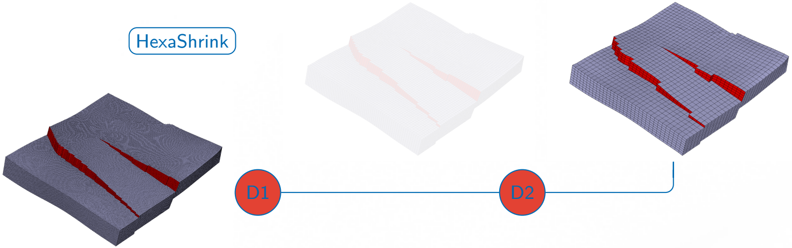

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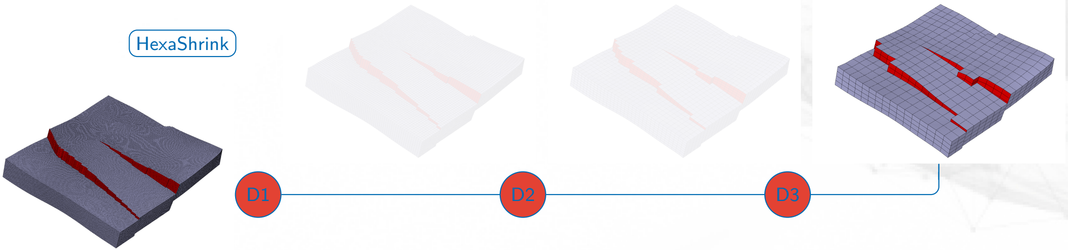

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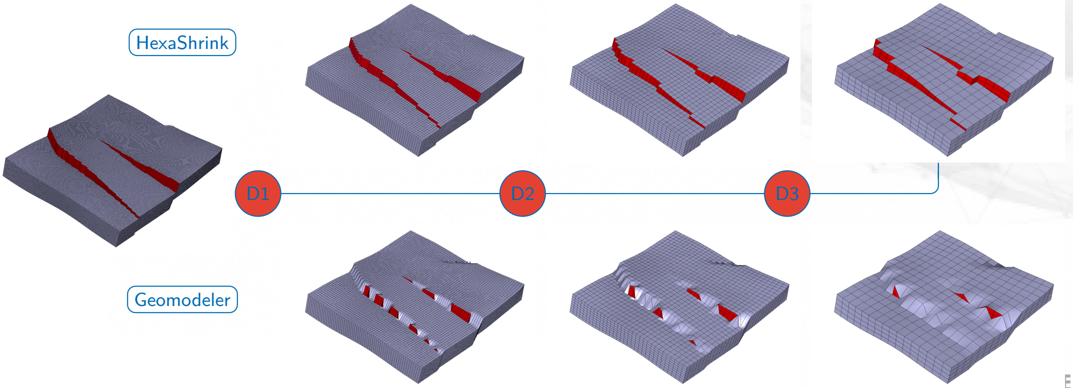

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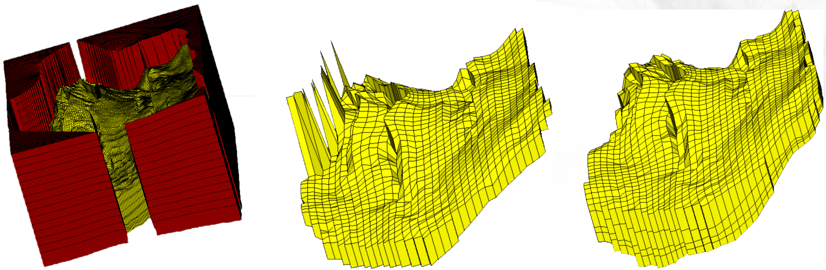

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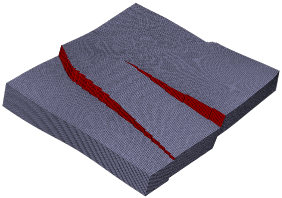
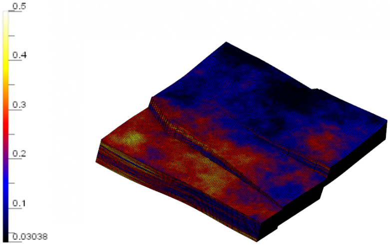
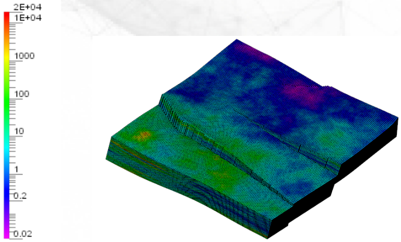
Cell activity	→	Borders preservation	→	boolean 3D wavelet
Petrophysical properties				
- Porosity & Permeability	→	Properties preservation	→	3D wavelet





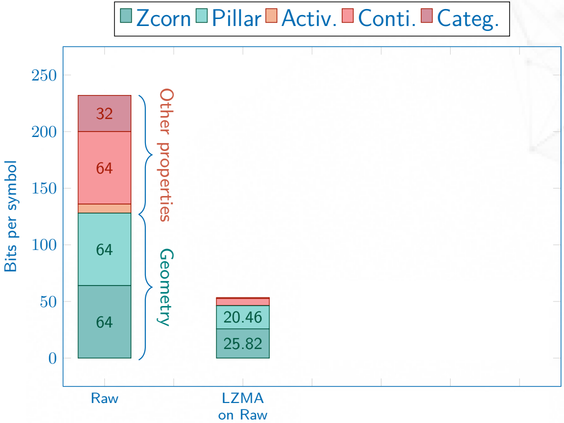
Porosity



Permeability

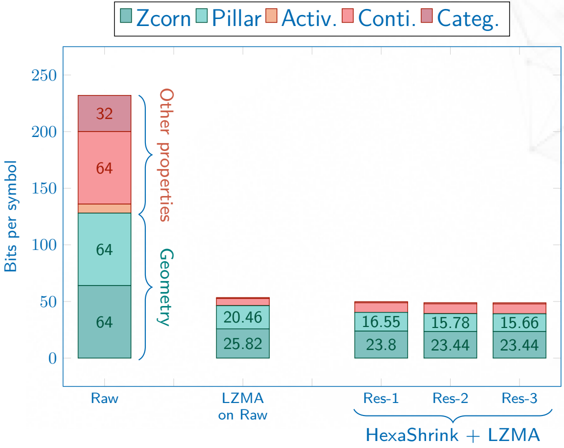
 Bouard et al. (2018)

Compression performance



- Generic encoder efficiency
- Hexashrink improves such performance

Compression performance



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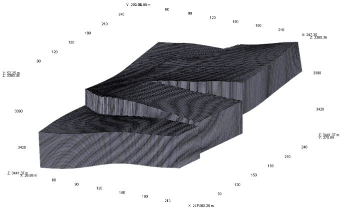
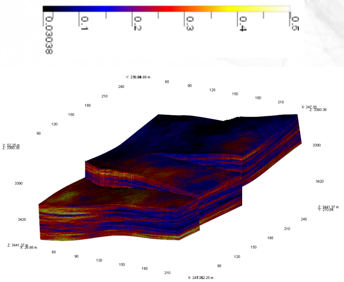
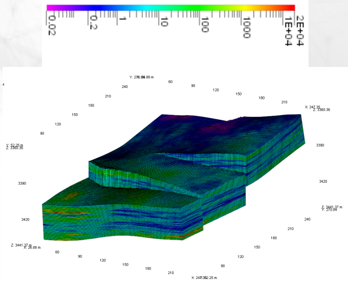
Simulation results



Porosity

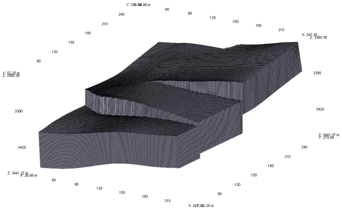


Permeability (mD)

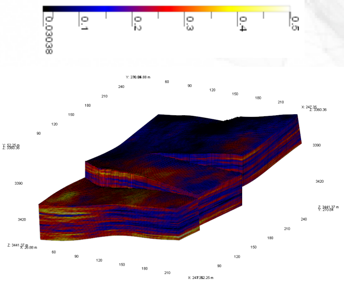


Simulation results

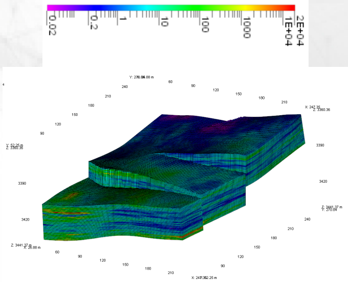
HexaShrink decomposition Res. -0



Porosity

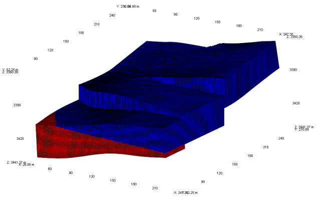


Permeability

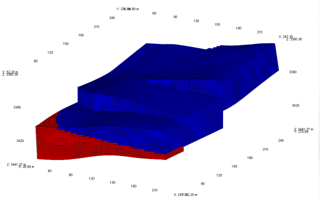


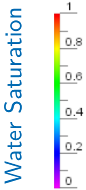
Water saturation: 0^{th} day

Raw $\approx$ 72 hours

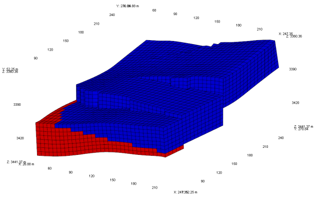


Res. -1 $\approx$ 4 hours

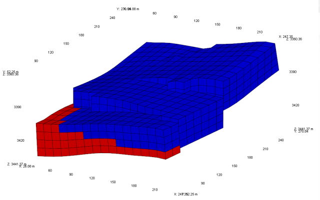




Res. -3 $\approx$ 20 minutes



Res. -4 $\approx$ instantly



Water saturation: 0^{th} day

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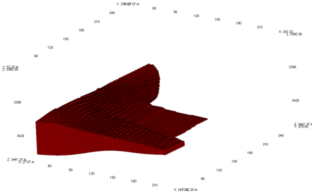
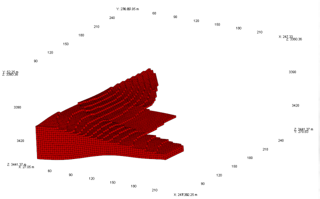
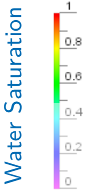
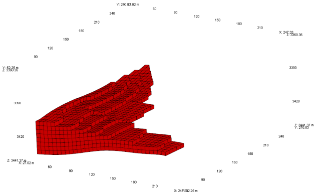


Res. -1 $\approx$ 4 hours

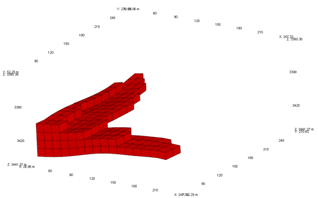




Res. -2 $\approx$ 20 minutes

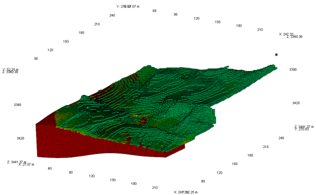


Res. -3 $\approx$ instantly

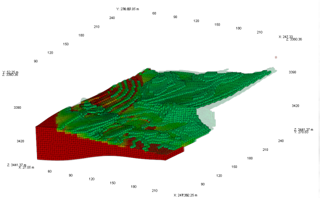


Water saturation: 90^{th} day

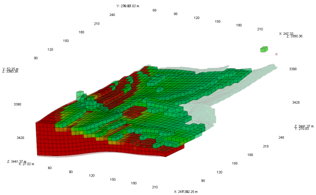
Raw ≈ 72 hours



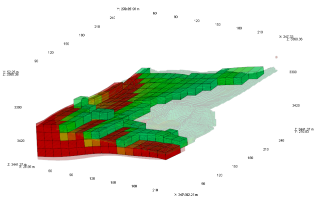
Res. -1 ≈ 4 hours



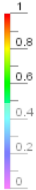
Res. -2 ≈ 20 minutes



Res. -3 ≈ instantly



Water Saturation



The management of reservoir meshes (huge and complex) is still challenging, but our solution based on a multiscale and embedded structure tackles several problems.

- **Visualization**
- **Storage**
- **Simulation**

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- ✓ **Visualization** Structure & Properties are preserved
- ☐ **Storage**
- ☐ **Simulation**

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- ✓ **Simulation** Promising results in simulation

Future works:

- Investigate lossy compression for increasing the coding performances
- Investigate further the potential gain of our solution in the simulation context

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References

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