SmartAnALOG All Automated digital Outcrop

Enhancing reservoir characterization & modeling with outcrop reservoir analogues

Outline

1. SmartAnALOG Project
2. Acquisition of 3D outcrop model
   - State of the art
   - Benefits of our choice
   - Multiscale & multi focal acquisitions
3. Virtual Outcrop Analysis Software : VIRTUOSO
   - The Ainsa Channel – an example of a complete workflow

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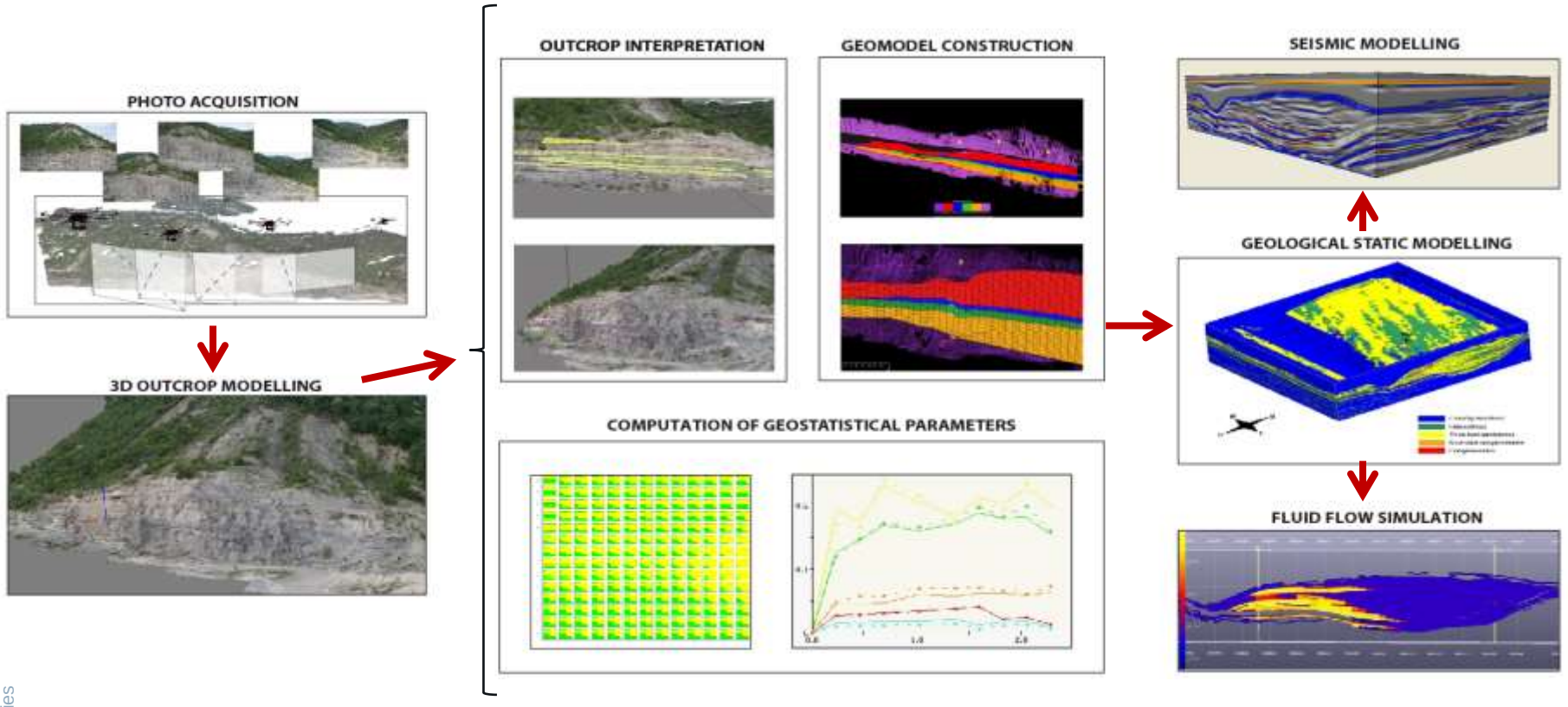
SmartAnALOG ?

- Objectives of the SmartAnALOG project
  - 3D outcrop modelling
  - Import 3D geological outcrop studies into a geomodelisation software
  - Light and fast acquisition
  - Moderate processing time
  - Easy integration of field data
  - Link with geomodelers (Petrel, Gocad)

To enhance reservoir characterization & modelling

SmartAnalog Workflow



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Acquisition : State of the Arts

LIDAR (Light Detection And Ranging)



Photogrammetry




The choice was obvious ...

Benefits of photogrammetry acquisition & modelisation

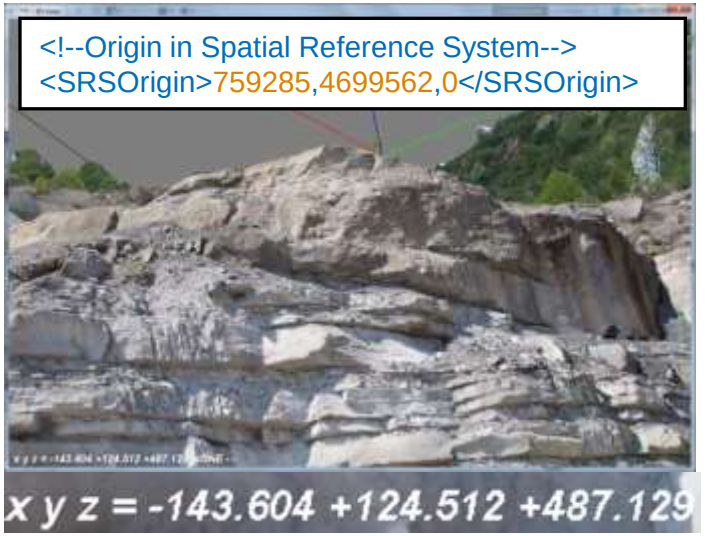
- Easy & fast acquisition
  - Easy : just know how to take a good picture
  - ex: Ainsa 30 minutes for ground acquisition
    1 hour for aerial acquisition (but greater coverage)
- Automatic method
- MultiScale & MultiFocal acquisition
- High Precision
  - 1 to 50 cm in relative
  - 2 to 3 m in absolute
- Low cost acquisition
  - A camera with a prime lens
  - A handeld GPS

Relative precision :
Geometry and Scale of the 3D model

Jacob Staff
measured on the model

Absolute precision :
Positionning accuracy of the 3D model in a cartographic reference system

RTK GPS positionning :
Y = 4699686.995
X = 759139.036
Z = 488.760



X= -143.604 + 759285 = ***759141.396***
Y= 124.512 + 4699562 = ***4699686.512***
Z = 487.129 + 0 = ***487.129***

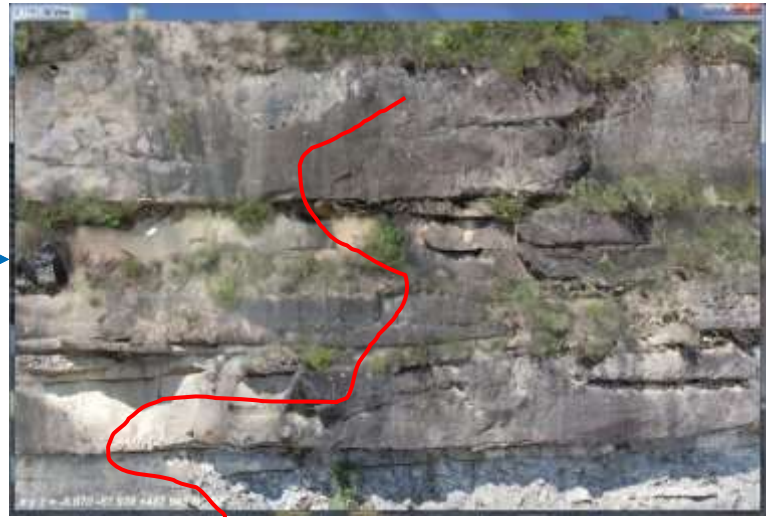
Δx = 2.36 m Δy = 0.48 m Δz=1.63 m

MultiScale & multi focal acquisition

Sony NEX7 – 19mm lens

Canon5D – 24mm lens

Limits of the air/ground texture



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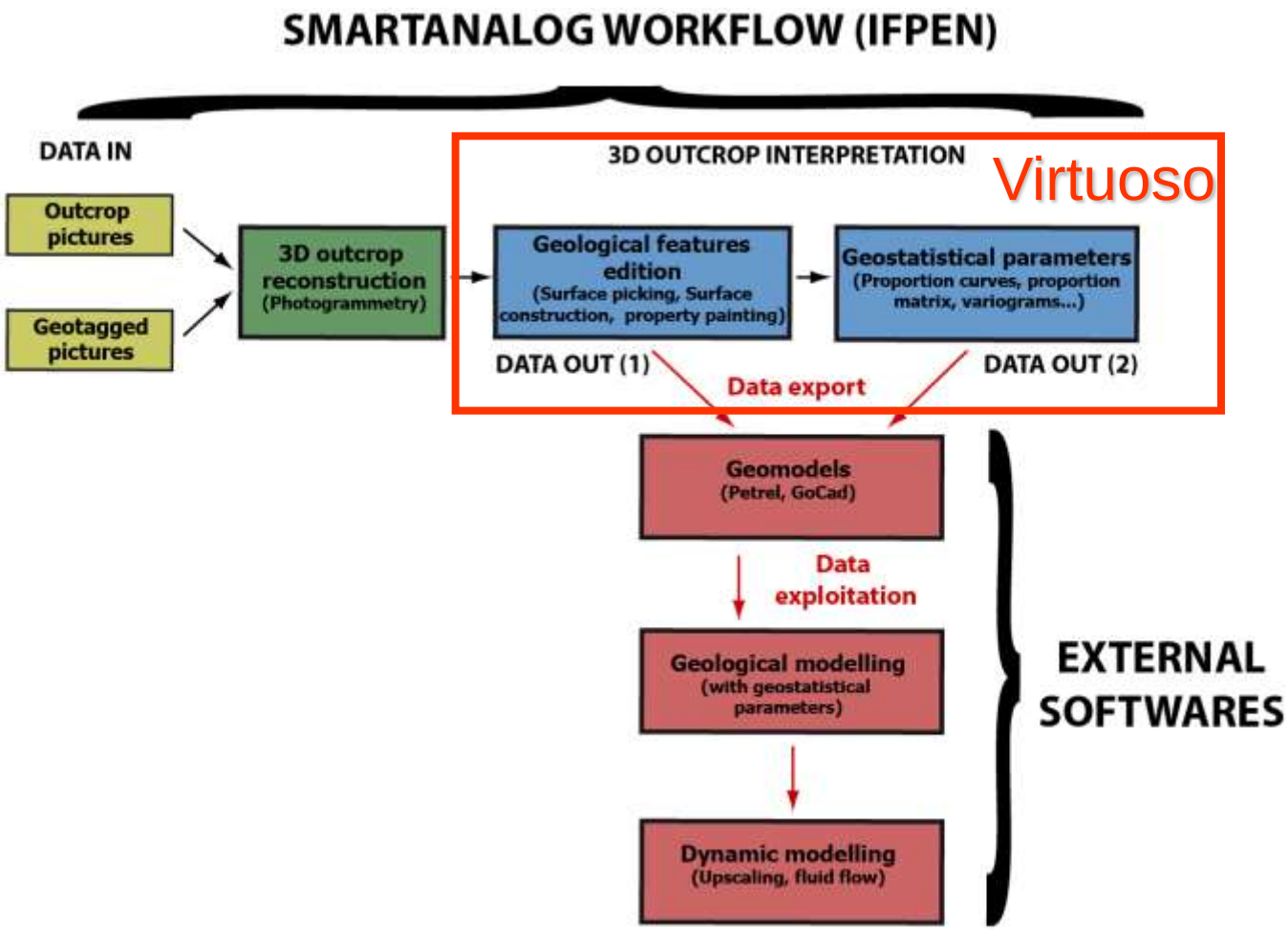
VIRTUOSO (Virtual Outcrop Analysis Software)



Virtuoso : Virtual Outcrop Analysis software

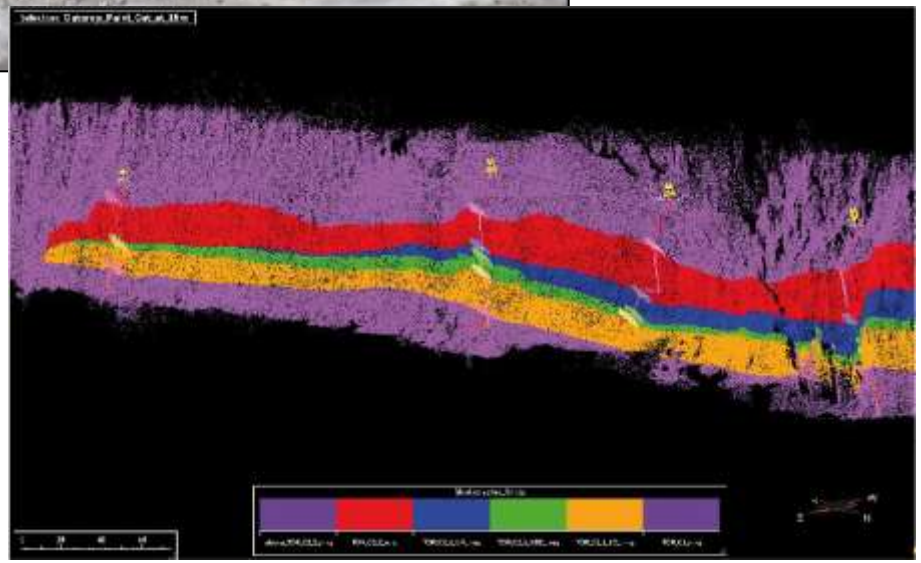
- Polylines digitalization (illustrating geologic horizon, fault and fracture
- Property painting (e.g. Facies)
- Strike/Dip measurement
- Distance measurement
- Polylines & Facies Export in ascii format – Easy to import in Gocad/Petrel
- Object transparency control (Display enhancement)

User Interface

Display

Outcrop interpretation

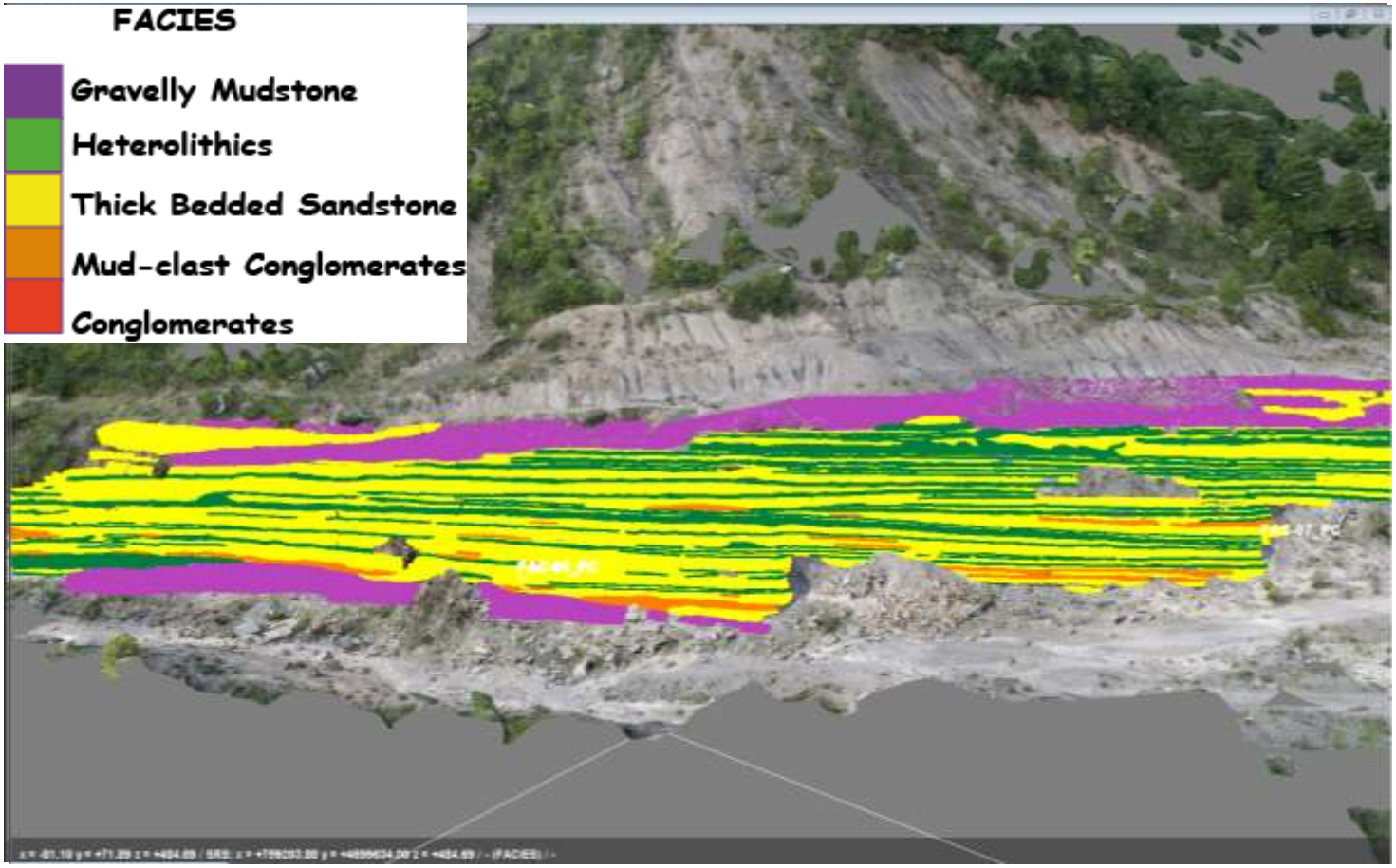
- Horizon picking



- Litho-units definition
- Export in geomodel
  - Surface construction
  - To build the reservoir grid

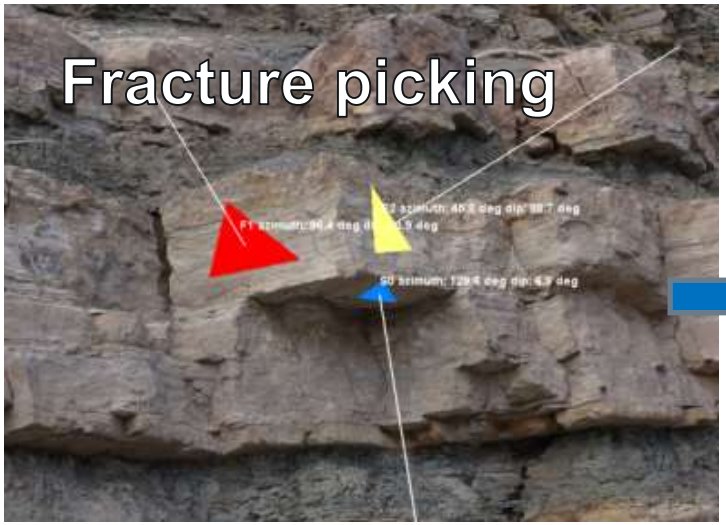
Outcrop interpretation

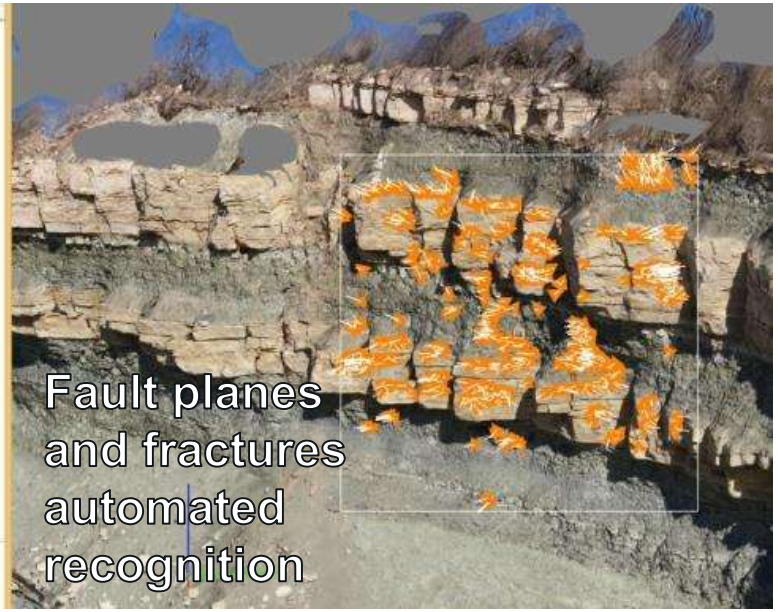
- Property painting (facies)



Outcrop interpretation

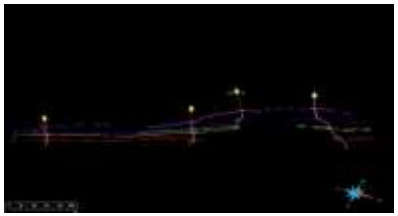
- Fracture picking & semi-automated recognition



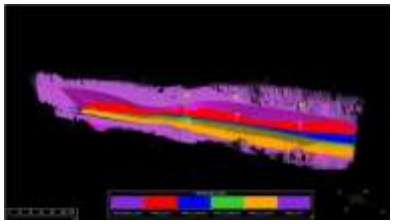


Model construction

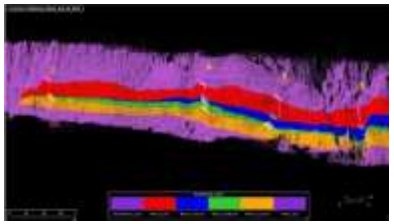
Geomodel



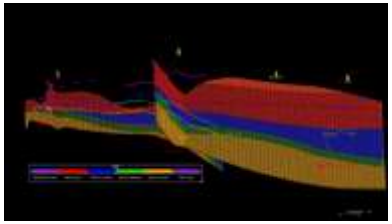
1 - Bounding horizons picked directly on the 3D outcrop model



2 - Surfaces reconstructed from polylines and structural dips



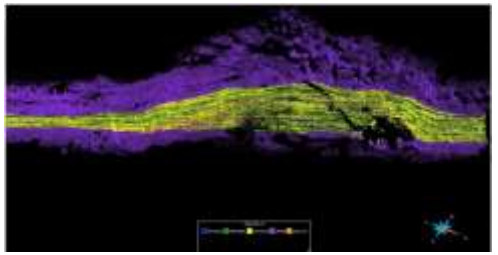
3 - Pointset extracted from the photogrammetric model

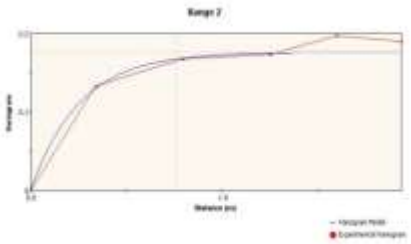


4 - Geological grid built from the surfacic model

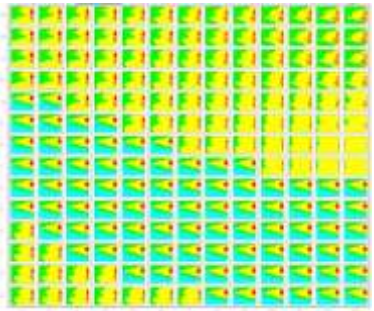
Geostatistics

1 – Computed from data interpreted on outcrop, directly from the interpretation (exported cloud of points)





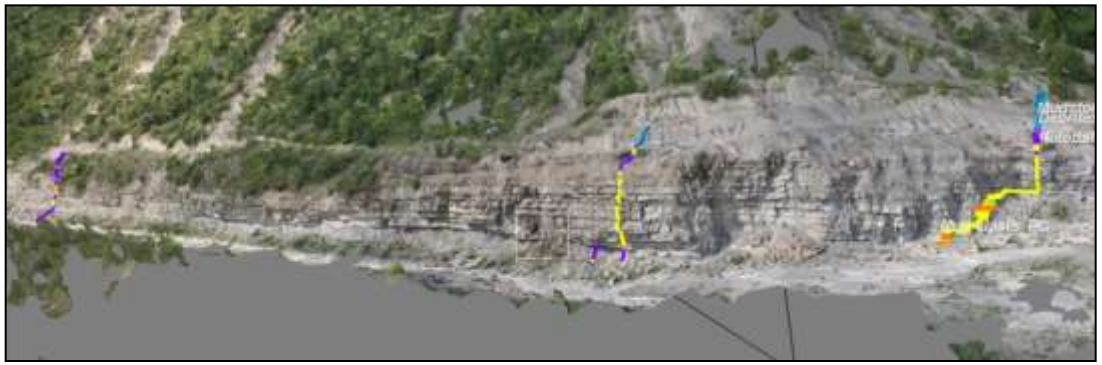
2 - Variograms are computed from the facies pointsets



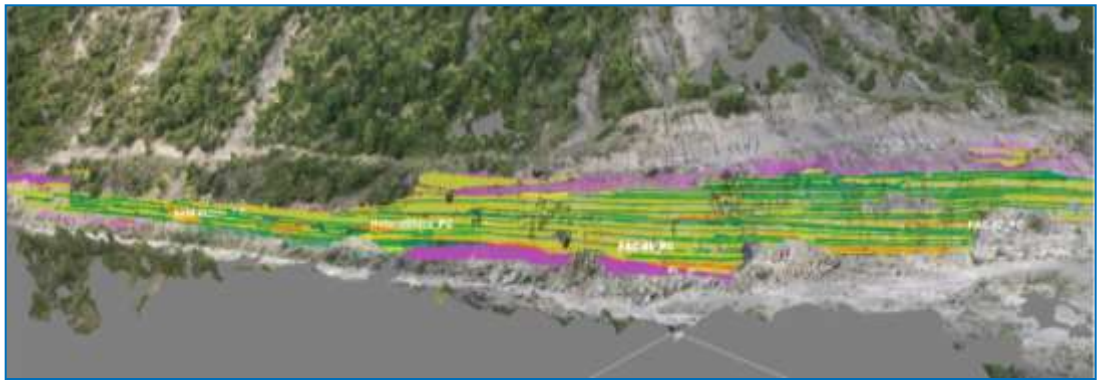
3- Vertical proportion curves and matrix of proportion computed from local VPC for each unit

Geological modelling

Objectives: Compare models using conventional dataset and 3D outcrop interpretation



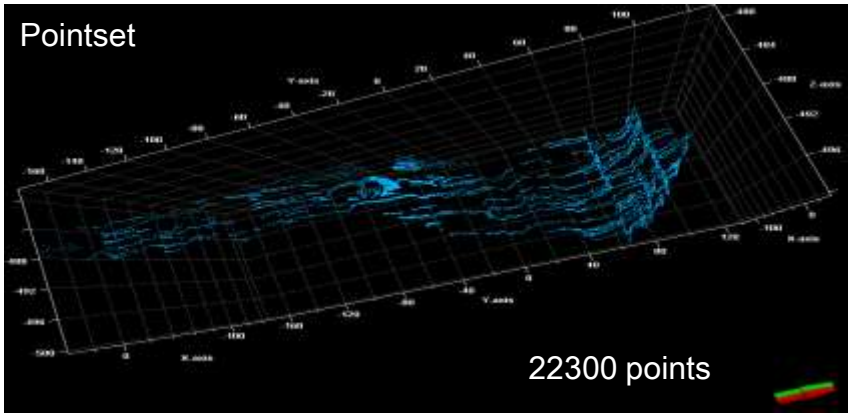
VS



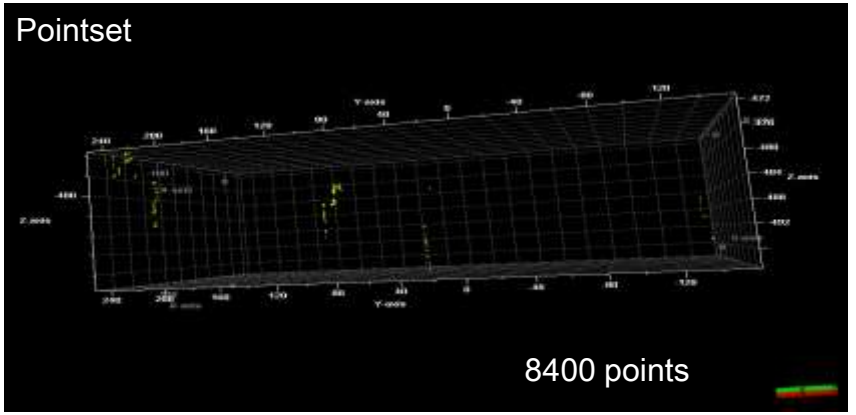
- Pseudo 1D dataset
  - 3 pseudo-wells with facies interpretation
- Fully interpreted outcrop

Geostat. parameters – Heterolithics

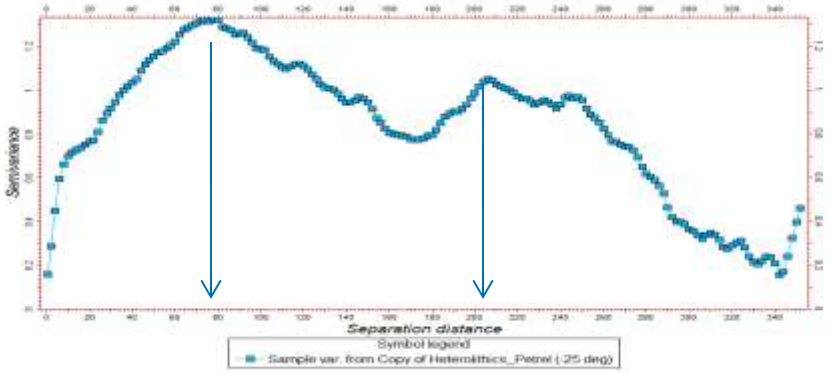
Full outcrop



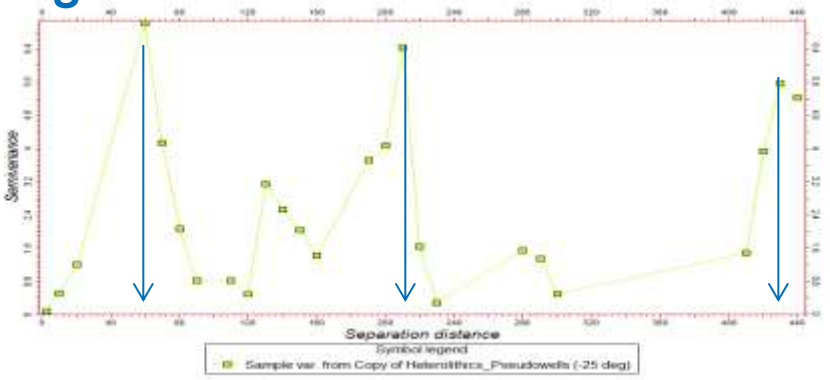
Pseudo-wells



Horizontal variograms



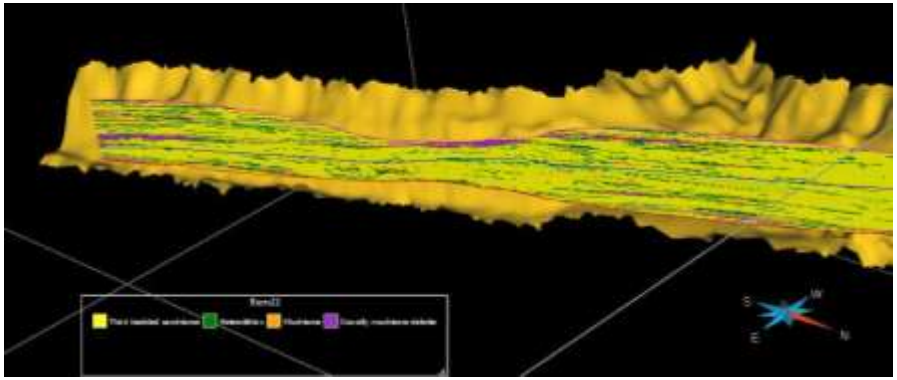
- 2 ranges corresponding to the outcrop configuration (channel bottom confinement)

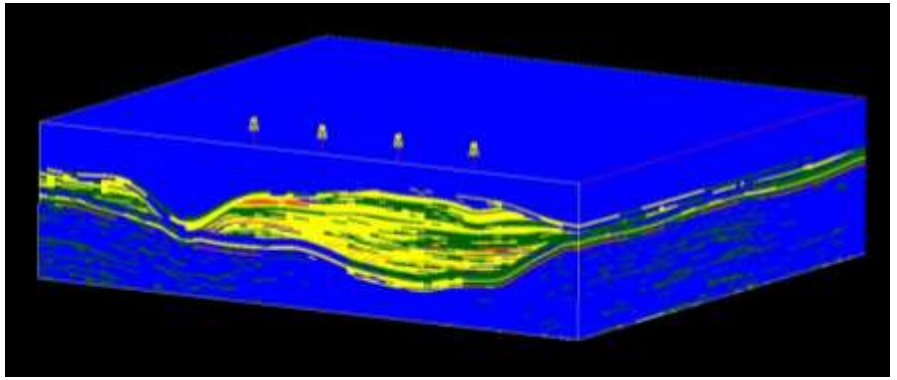


- Ranges difficult to interpret
- Picks corresponds to pseudowells

Results

Dataset: pseudowells vs. outcrop interpretation





- Full outcrop interpretation
  - Continuous dataset
  - Heterogeneity continuity well represented
- Pseudo 1D dataset
  - 4 pseudowells with facies interpretation
  - Very smoothed facies distribution
  - Heterogeneity continuity poorly represented

SmartAnALOG video

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