SPE International
Hungarian Section

Applied Technology and Best Practices in CEE

Conference

Sedimentological study of Szőreg-1 reservoir (Algyő Field, Hungary): a combination of traditional and 3D sedimentological approaches

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Overview

ACTUALITY OF THE RESEARCH:

The object database of geological 3D modeling processes requires understanding rock body geometry. For modeling purposes mostly analogies (comming from e.g. norvegian fields) are used to apply. The fundamentals of the inner heterogeneity of petrophysical properties of reservoir rock bodies were occured.

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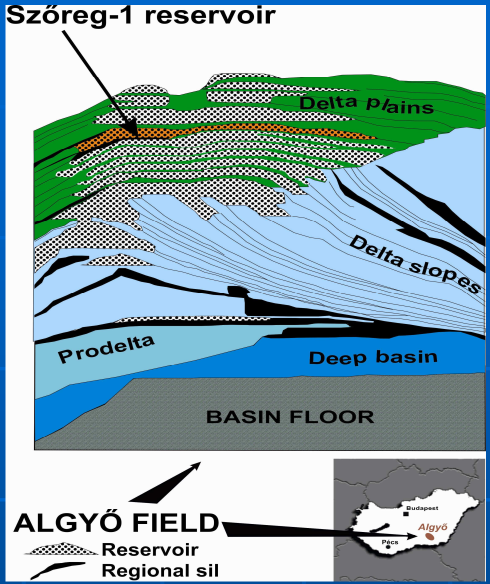
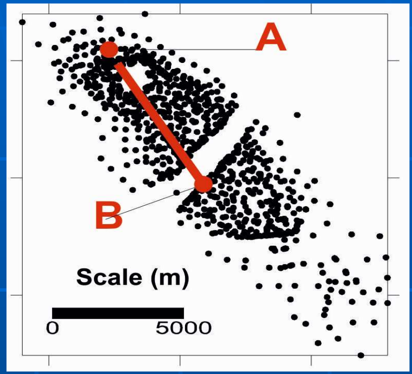
Reveal the real 3D geometry of some depositional evironment of a delta plain using 3D contouring of quantitative well log properties.

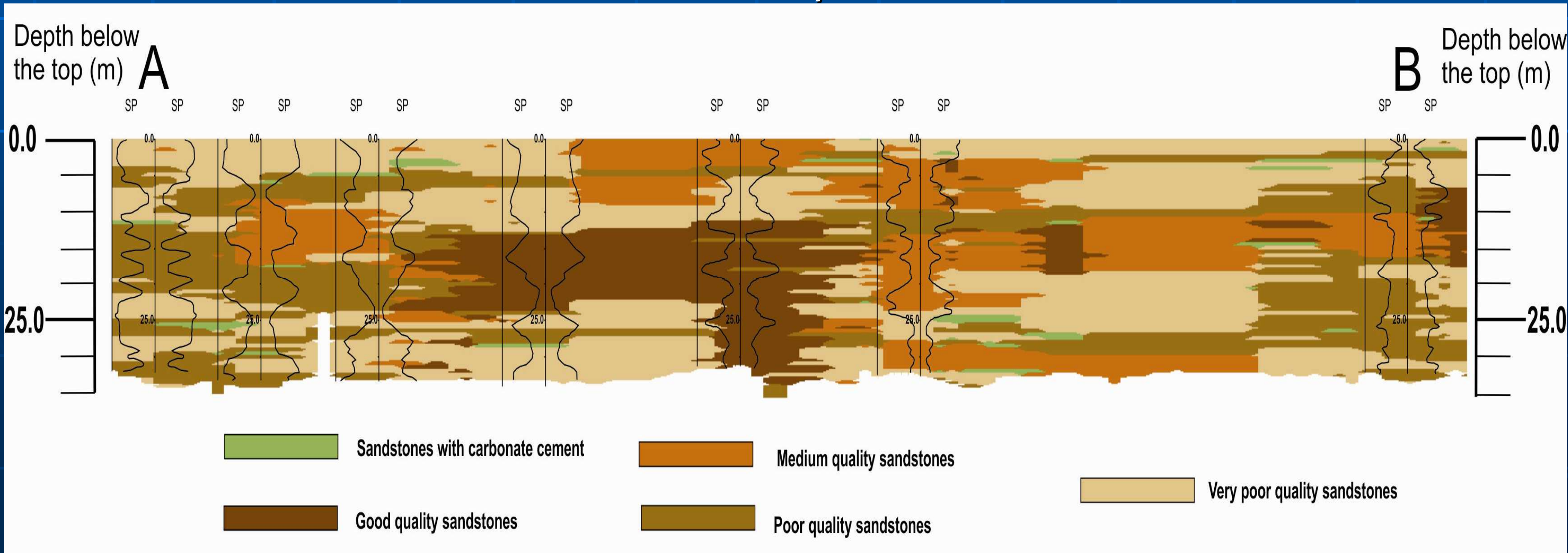
1. Short **geological introduction** of Szőreg-1 reservoir
2. **Methods**
3. **Results**
   - Sedimentary structures and deposional facieses
   - Appearance of depositional facieses on sand isopach and facies distribution maps
   - Porosity, sand content and 3D geometry of the most significant depositional environments
   - Depositional history of Szőreg-1

Short geological introduction of Szőreg-1 reservoir



- Pannonian delta system: delta slope+ delta plain
- Sills:abandonment phases (time horizons)
- Szőreg-1: avg. Gross thickness: 35 m, locally 50m
- Considerable inner heterogeneity : rock types can not form laterally continuous layers





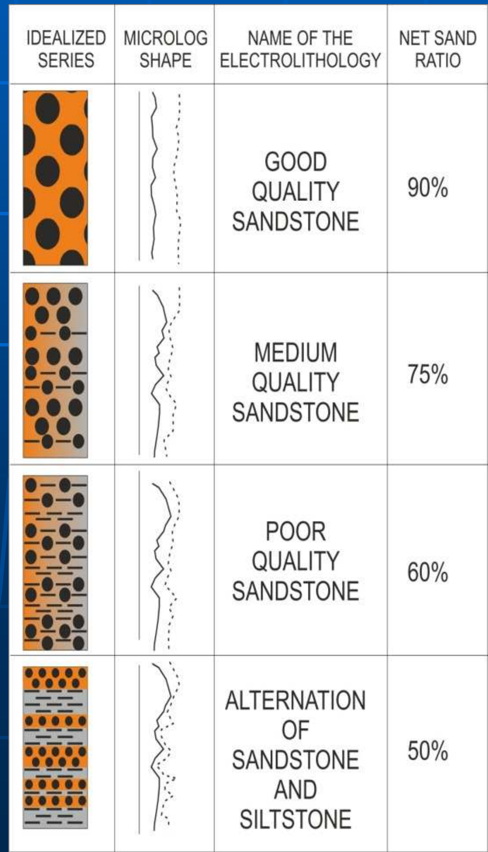
Methods

382 grainsize analyses(53 wells)
291 routine petrophys. analyses (356 wells)
156 Hg-capillarity measurements (126 wells)

1. Development of **data base**
   - Macro sedimentological analysis
   - Geophysical logs and their petrophysical interpretations (512 wells)
   - Mega scale sedimentological analysis
2. **Facies identifications** based on core descriptions and genetic interpretations of sedimentary structures and textures
3. Multivariate **statistical analyses** of grain size distributions (Q-mode cluster , R-mode factor analysis)

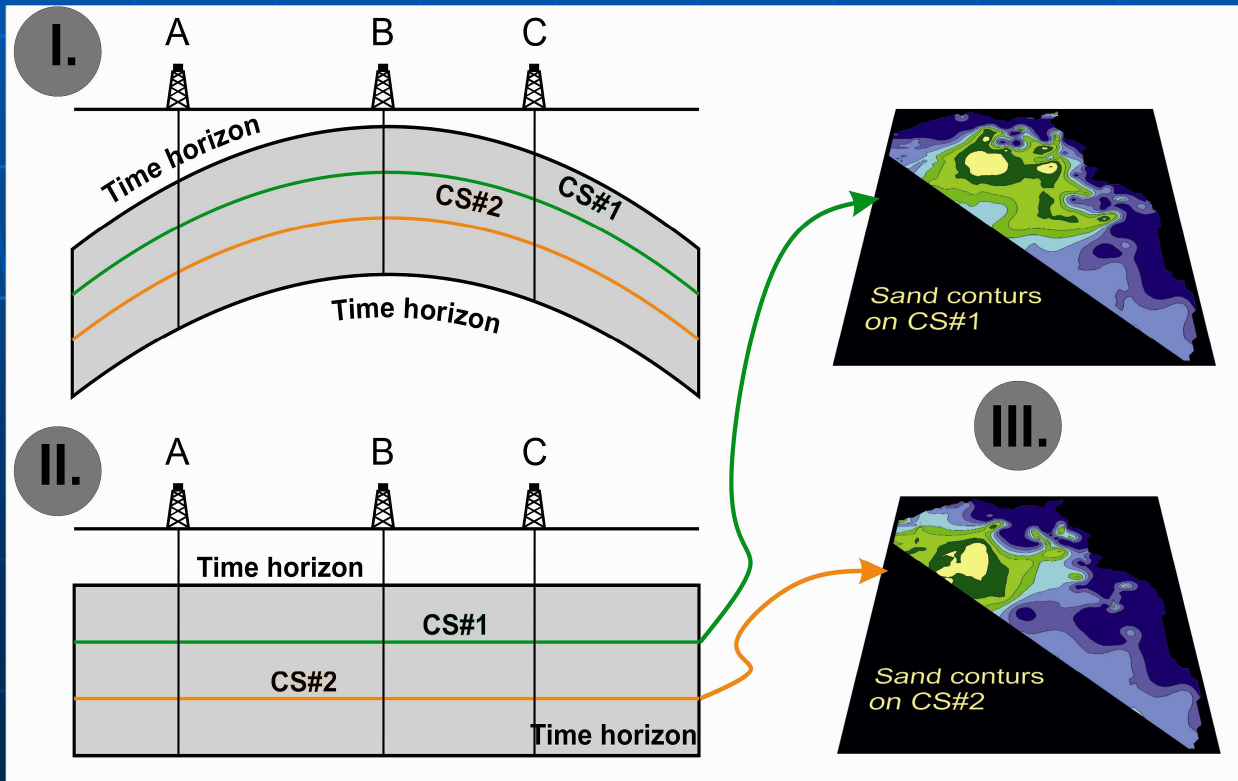
4. Calibration of well log responses to cores (total recovery): Microlog, SP, gamma logs → electrolithological units + sand content → extend the rock types to uncored regions

5. 3D modeling and **high resolution facies analysis**



3D geo-cellular modeling process

- Goal: emphasizing the stratiform characters of depositional systems within the reservoir thickness
- 1. Parallel surfaces with the bottom of the sill
- 2. Lateral parameter estimations on surfaces
- 3. Build a 3D model

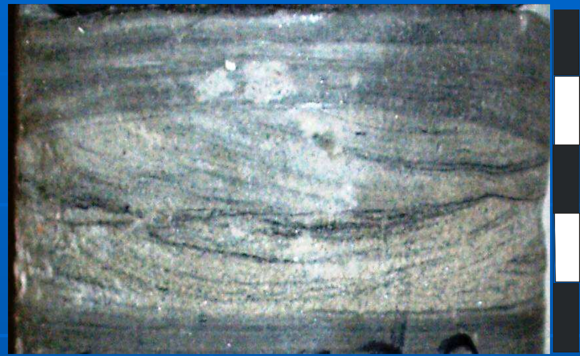


-Topmost surface should be time surface
- No tectonic movement

(Geiger J., 2002)

Sedimentary structures and depositional facieses

Horizontal planar lamination



Chute-like cross bedding

Massive sandstone

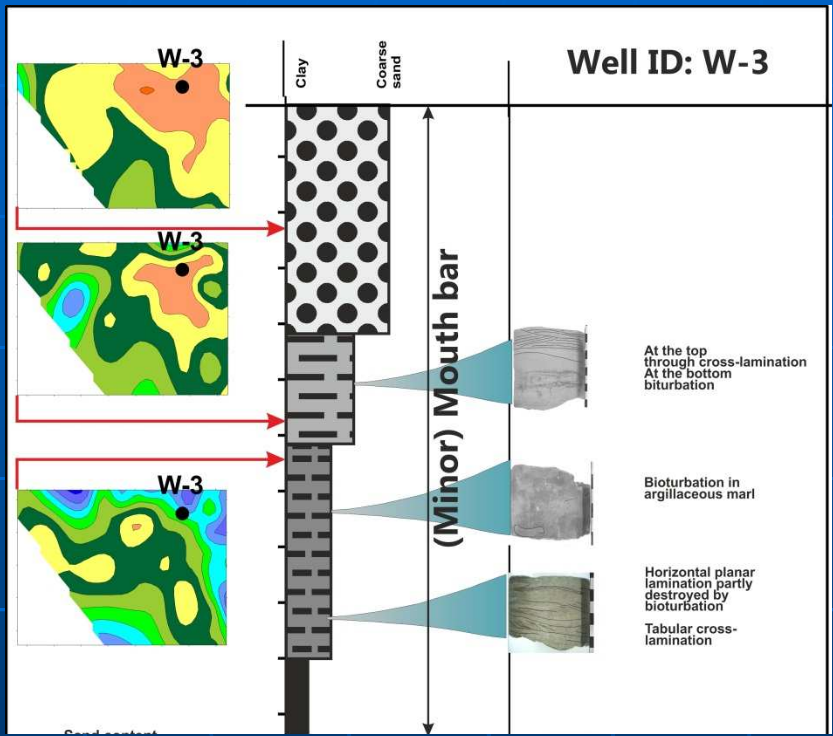
Chaotic, convolute structures

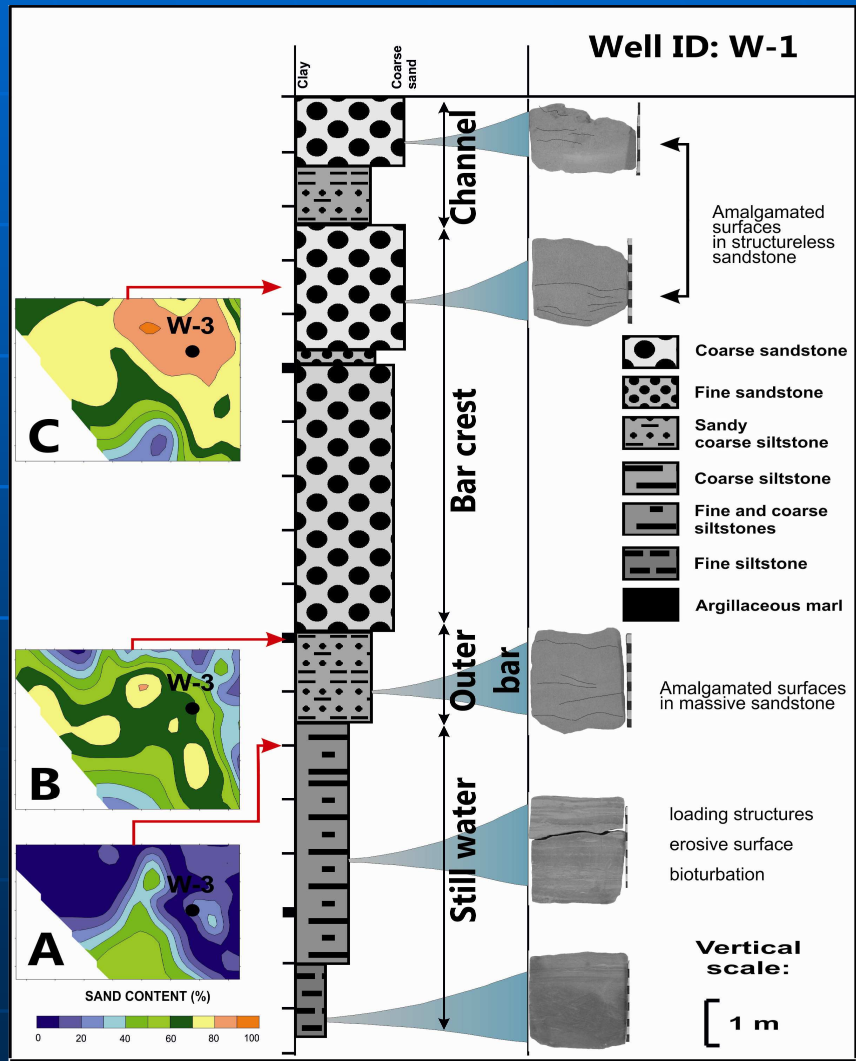
Bioturbation

Statistical analysis of grain size distributions

- **SANDSTONES with amalgamated surfaces and intraclasts**
  - **Deposition from traction currents and wavy movements**
    - Sands reworked by weak wavy movement
    - Desposition at the top of mouth bars (mixtures of waves and linear streams)
  - **Deposition from traction currents**
    - Channel lag depositis
    - Distributary channel deposits
- **Sandy coarse SILTSTONES**
  - **Deposition from traction currents**
    - Rolling and saltation
      - Short channels
      - Crevasse splays
    - Strong turbulence
      - Distributary channels
  - **Deposition from quiet water**
    - Interdistributary bay

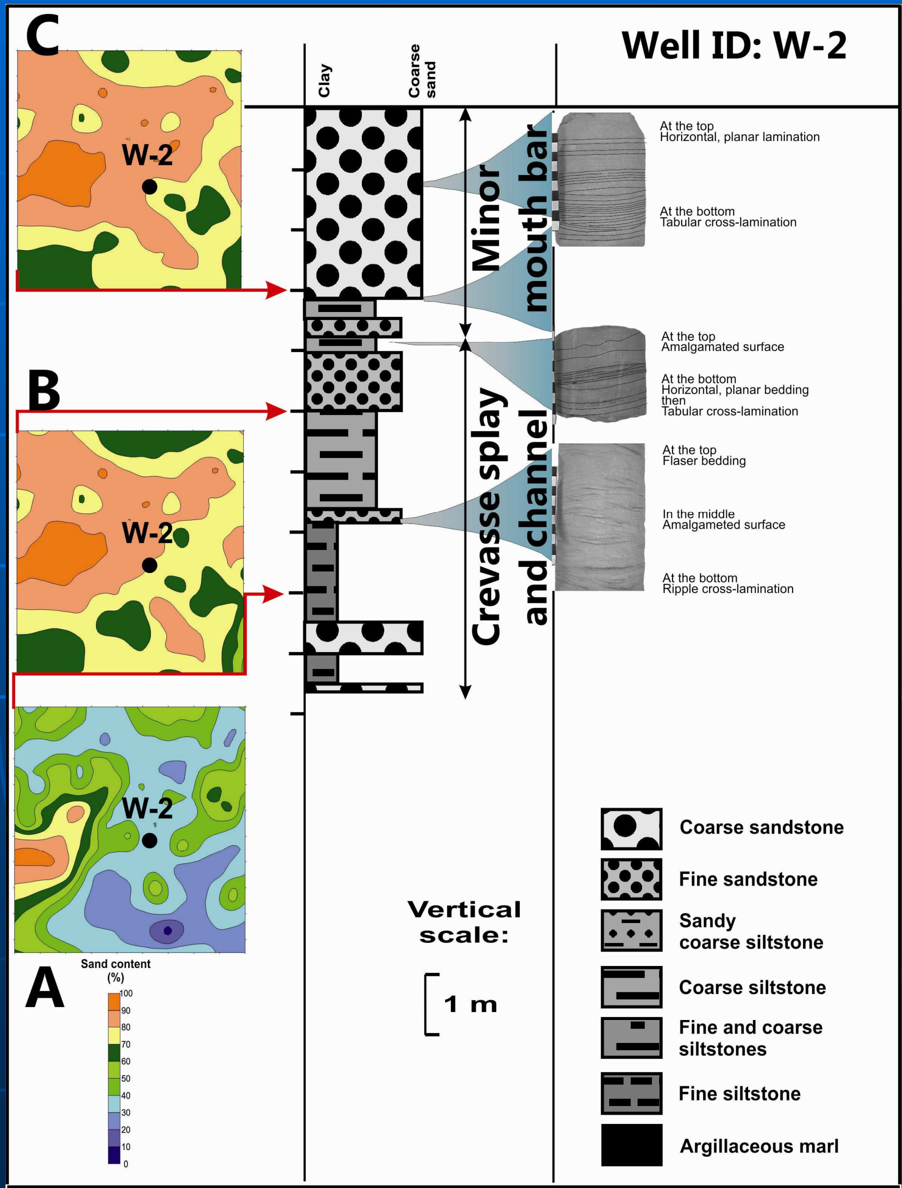
Vertical development of a distributary mouth bar and transition of a minor mouth bar to channel facies



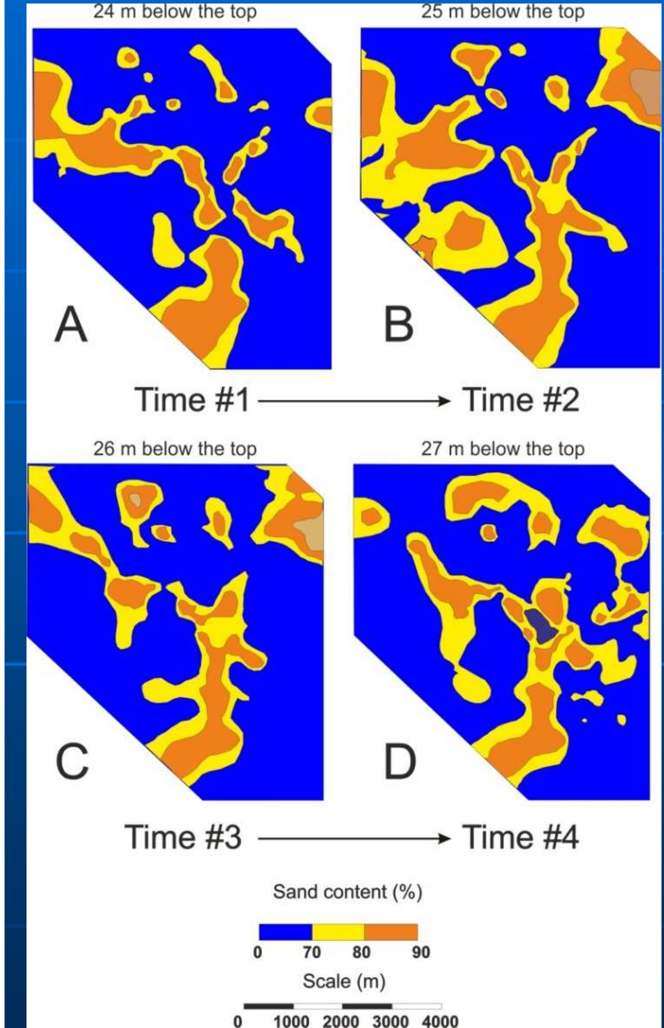


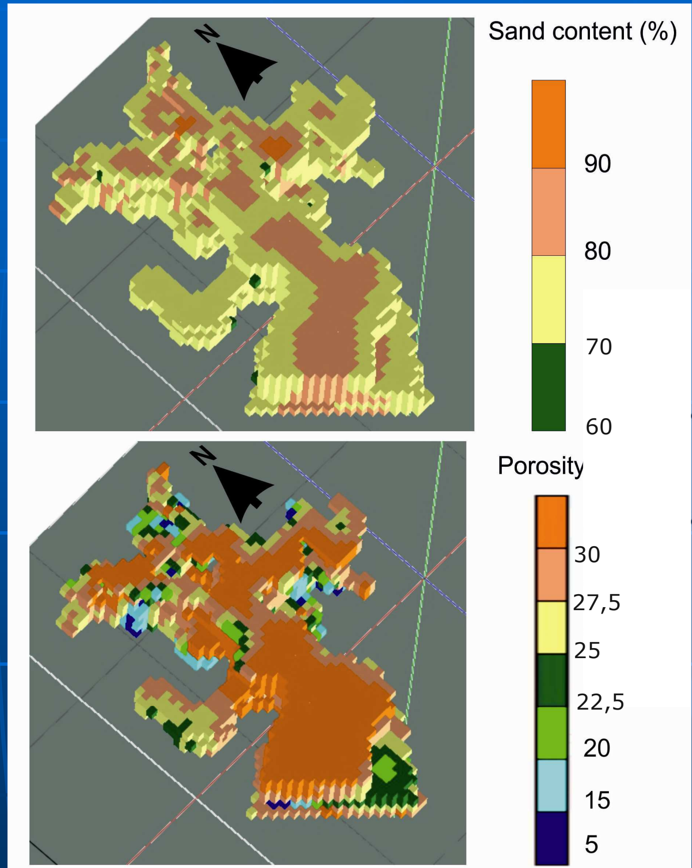
1. **Can occure on alone, or as transition between two facieses (e.g.combined with channel progradation). Upward coarsening grain size tendency**
2. **Still water sedimentation followed by bar crest development, and basinward progradation.**

Crevasse splay-crevasse channel-minor mouth bar transition



Porosity, sand content and 3D geometry of a channel system

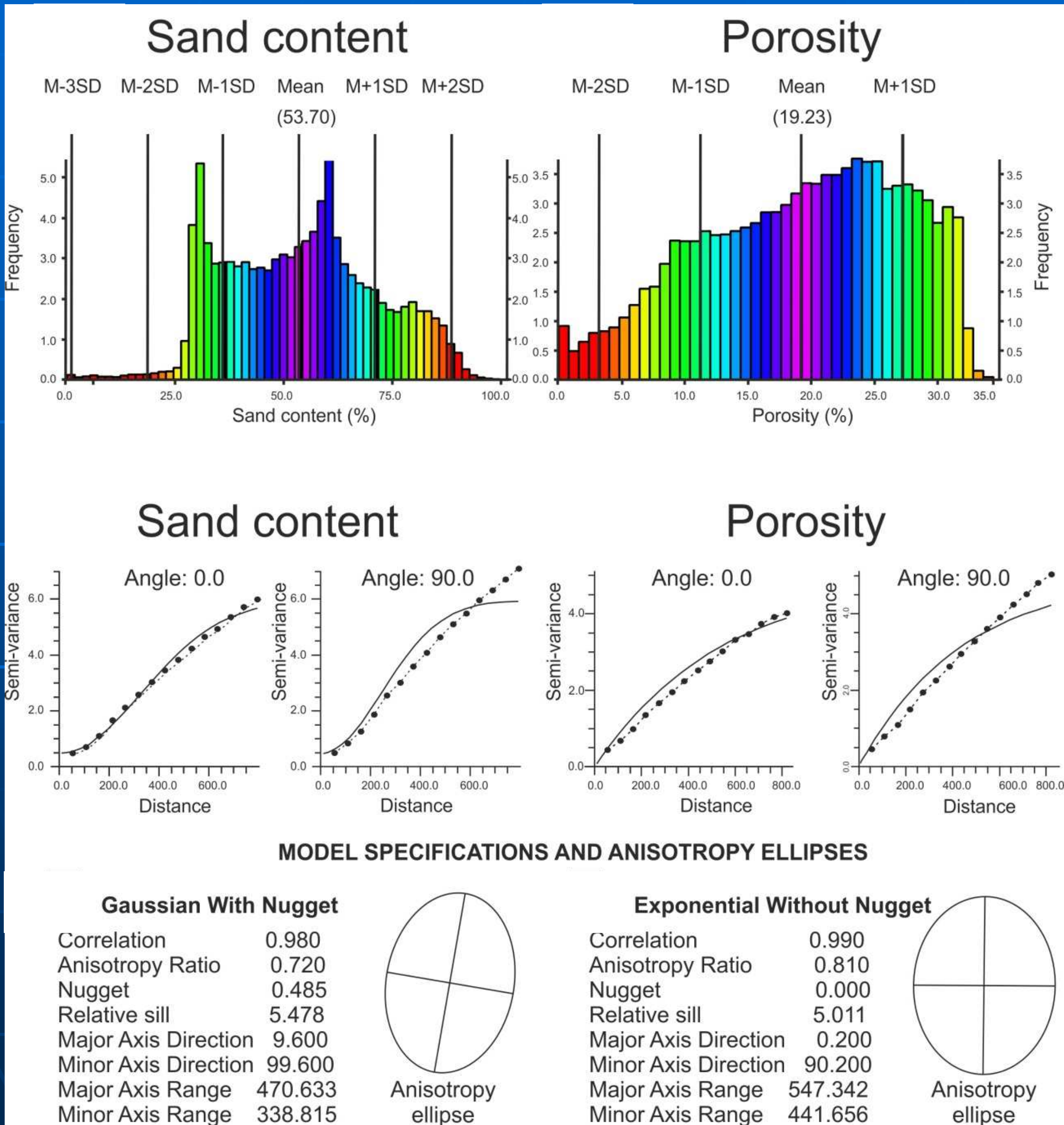




Lateral transitions of depositional processes:
1.Channel progradation
2. mouth bar evolution
3.Channel breaking out

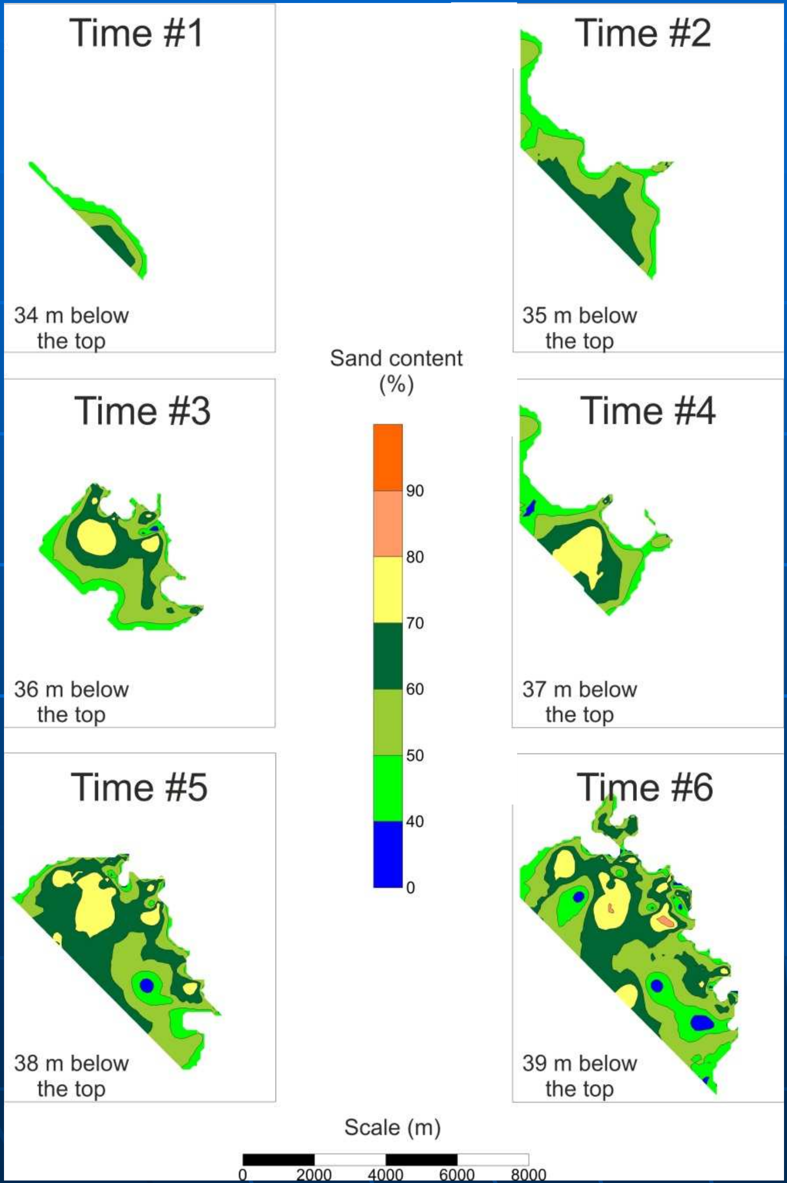
- Prograding channel system from SW to NE
- Max.length:5-6 km
- Width: 2-400 m
- Avg. thickness: 2-2,5 m
- Highest sand content:along the axis
- Highest porosity:upper part of the channel
- Lateral distributions of the properties are very similar

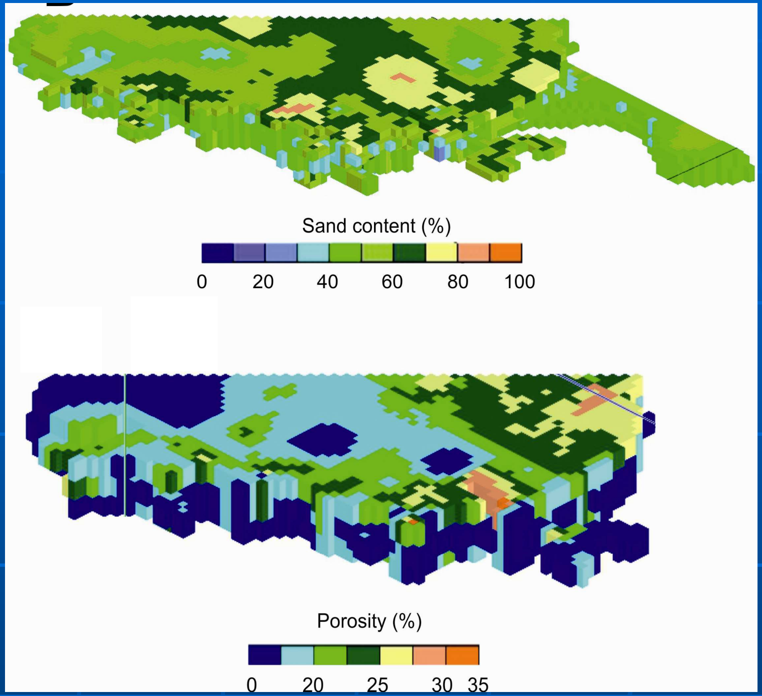
Statistical and geostatistical characters of sand content and porosity grids of the channel



- Frequency distribution of vertically averaged sand content and porosity: polymodal
- Variography analysis: lateral continuity of average sand content is high (Gaussian-type)
- Main continuity direction of sand contents is in harmony with the depositional strike of rock body.
- Range in the main direction: 471 m, perpendicular direction: 339 m

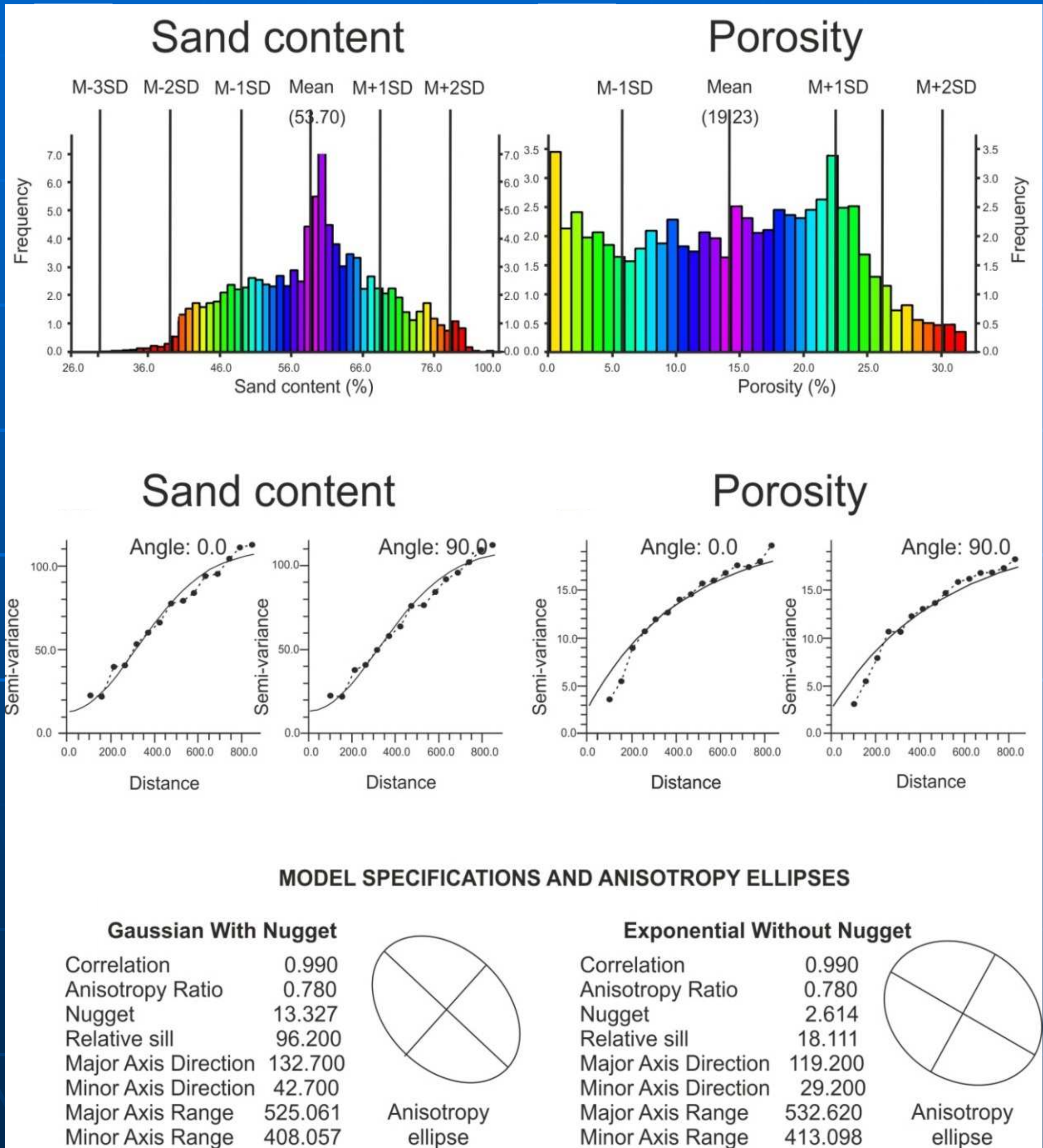
Porosity, sand content and 3D geometry of a distributary mouth bar environment





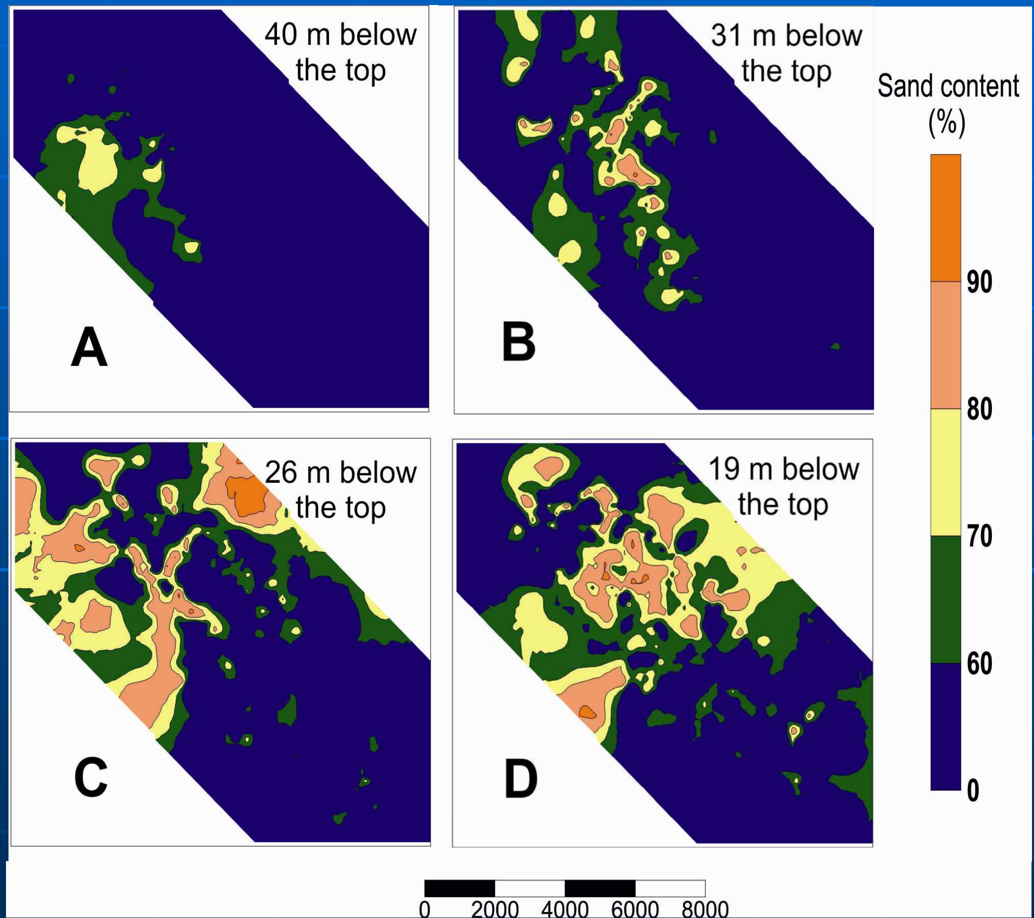
- Area:cca. 14 km^2
- Thickness: 5 m
- Upward coarsening
- Highest sand content: top
- Spatial distribution of porosity does not follow the spatial variation of sand content
- Upward increasing effective porosity

Statistical and geostatistical characters of sand content and porosity grids of a mouth bar



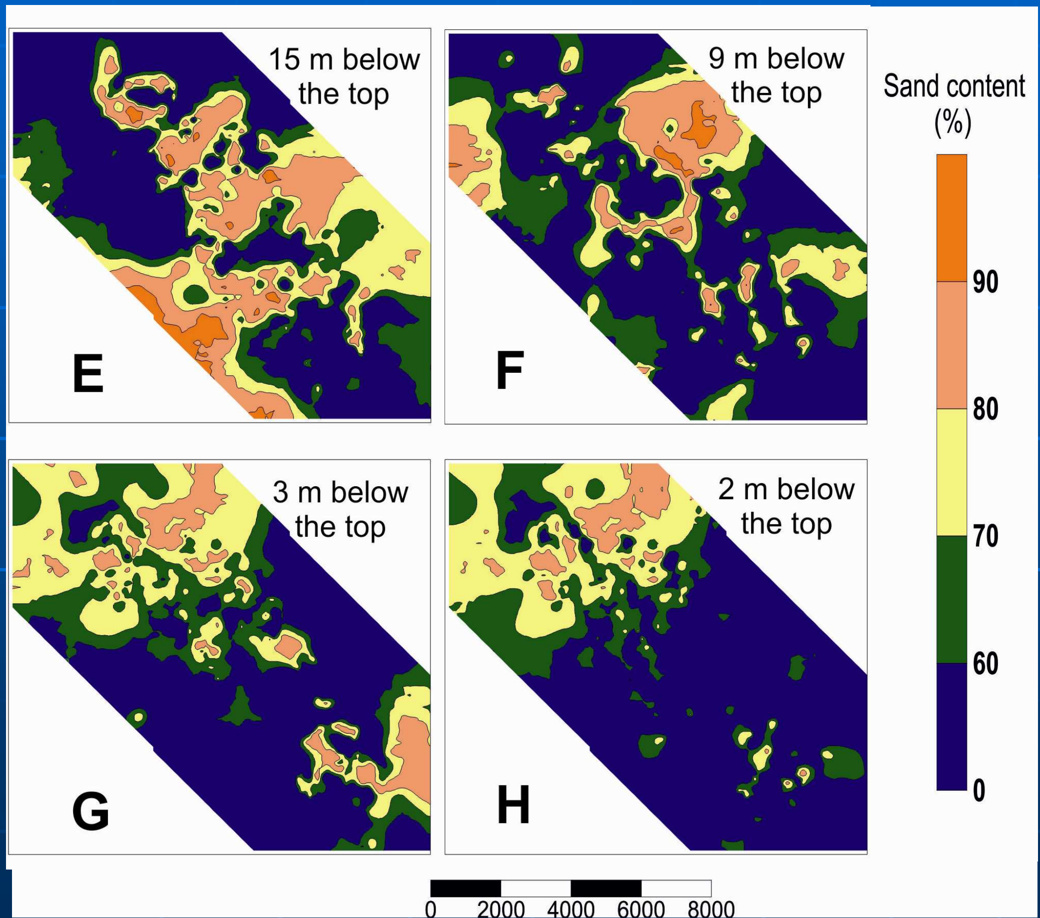
- Frequency distribution of vertically averaged sand content :unimodal, porosity:polymodal
- Variography analysis: lateral continuity of average sand content is stronger than in case of porosity (Gaussian type-exponential type)
- Main continuity direction of the properties coincides with the long axes of bar crest (perpendicular to the direction of bar progradation)

Depositional history of Szőreg-1 on sand isopach and facies distribution maps



- Volume of rock body: 45 m below the top
- Sectioned by surfaces , parallel to the top, 0,5 m apart vert.
- 40-45m: distributary mouth bar at SW (14 km^2),shallow bay
- Distributary channel NW with crevasse splays. Length:10-12 km, width: 200-300m, thickness:1-3 m
- 19-29 m: lateral extension of rock body ≥90% sand content
- Focal point: NE-SW zone
- Channel bifurcation, small distributary channels

Depositional history of Szőreg-1 on sand isopach and facies distribution maps



- 10-19 m below the top: largest spreading of sandy accumulation in central regions
- 7-10 m: focus of deposition shifted to NW
- Continuous sandy sheet developed
- SE: accumulation of siltstones, argillaceous marls, silty sandstones

Summary

DEPOSITION:

- 3 main depositional processes should be taken into account in the evaluation of the depositional history:
  - 1. Mouth bar at SW with a large distributary
  - 2. Mouth bar in the opposite direction
  - 3. Prograding distributary from NW to SE
- Several transport directions pointed from the borders to the center

EFFECT OF DEPOSITIONAL PROCESSES ON POROSITY:

- Significant effect on lateral distribution on porosity
- Sand content: from qualitative interpretations
- Porosity: from quantitative well log interpretations

Thank you for your kind attention!