Generation of Fracture Networks based on a Geostatistical Approach

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MOTIVATION

A stochastic approach, applied in fracture generators to create fracture networks, neglects the spatial variability of the networks.

=> Integrated geostatistical approach in the existing fracture generator FRAC3D [1]
(data obtained from outcrop "Pliezhausen", Germany)

BASIC IDEA

- **Indicator Field Obtainability**

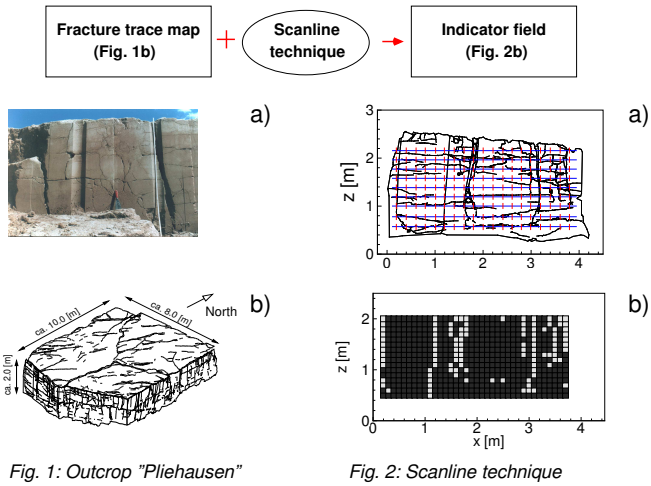


Fig. 1: Outcrop "Pliehausen" *Fig. 2: Scanline technique*

- **Effective Parameter Evaluation**

The spatial variability of the indicator fields is investigated. In the case of the vertical fracture cluster, three effective parameters are selected:

variogram:

$$\gamma_{\mathrm{I}}(h_i) = \frac{1}{2}\frac{1}{n(|h_i|)}\sum_{\alpha=0}^{n}[I(x_{i_\alpha}+h_i) - I(x_{i_\alpha})]^2$$

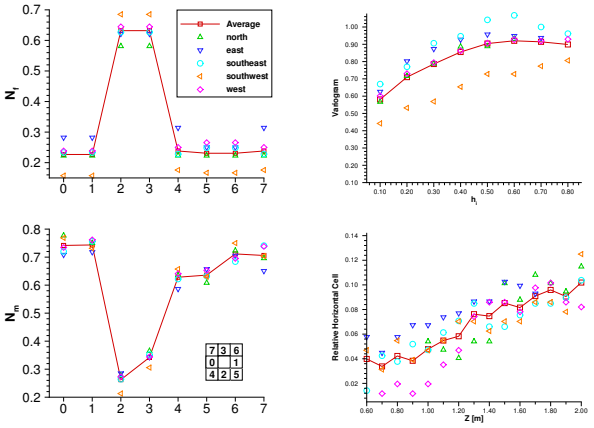
$$\text{where} \quad I(x_i) = \left\{ \begin{array}{ll} 1 & \text{existing intersection} \\ 0 & \text{no intersection} \end{array} \right\}$$

neighboring cell:

$$N_{\mathrm{f}}(h_i) = \frac{1}{n}\sum_{\alpha=0}^{n}[I(x_{i_\alpha}+h_i)] \quad if\ I(x_{i_\alpha}) = 1$$

$$N_{\mathrm{m}}(h_i) = \frac{1}{n}\sum_{\alpha=0}^{n}[I(x_{i_\alpha}+h_i)] \quad if\ I(x_{i_\alpha}) = 0$$

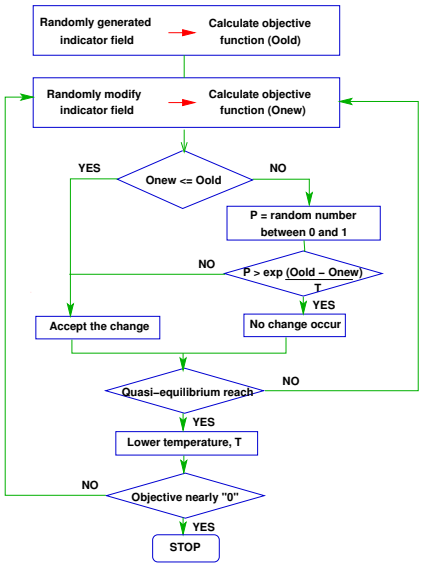
horizontal cell: number of fracture cells relative to the total number of cells in each horizontal array



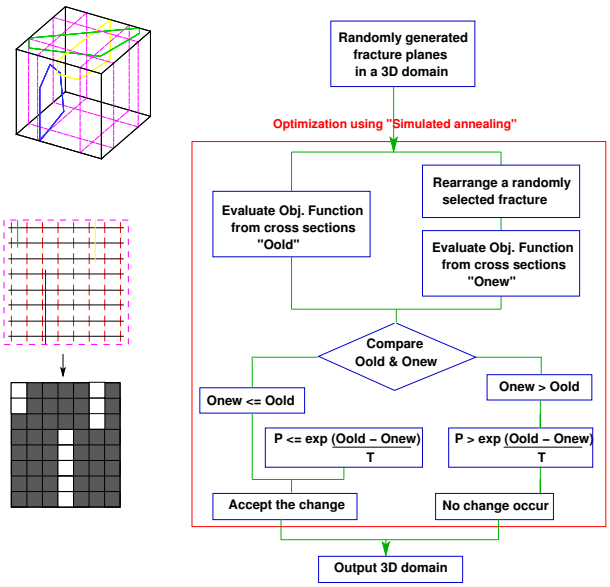
GEOSTATISTICAL APPROACH

- **2D Indicator Field Analysis**

Indicator fields are generated by using the optimization technique called Simualted Annealing (SA). In our case, we try to minimize the objective function, which is the difference between the effective parameter values from the outcrop indicator field and the generated indicator field. The output of the generated fields show similar characteristics compared to the outcrop indicator fields.



- **Application to 3D Fracture Network Generation**



FUTURE WORK

- Sensitivity analysis of the effective parameters
- Comparative study of flow and transport in fracture networks generated by a stochastic and a geostatical approach.

REFERENCES

[1] Silberhorn-Hemminger, A., Modellierung von Kluftaquifersystemen: Geostatistische Analyse und deterministisch – stochastische Kluftgenerierung, Dissertation, 2002