The user manual for StrataTrapper software

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The purpose of the software:

Accurately considering the heterogeneity, particularly the capillary pressure heterogeneity, in reservoir characterisation, which is utilized for multiphase flow simulation.

The source of the software:

Github project (s.an@imperial.ac.uk)

The version of StrataTrapper:

StrataTrapper for Windows system.

Pre-installed the software:

Image Processing Toolbox in Matlab.

Optimization Toolbox in Matlab.

Steps to run StrataTrapper

 As following algrothm

Algorithm 1: Pore to Core to Field Scale Upscaling

**Input** : The fluid properties in *Fluid_transport_properties.mat*

The structure and petrophysical properties in *A_input.txt*

The specific relations from report stored in *A_input_report.m*

**Output :** The upscalled model for simulation

1 Load reservoir & petrophysical properties. Define upscaling, and do the interpolation.

   A1_1_Generate_global_parameters .m

2 Generate the correlated porosity field (Figure. 1) in the fine-scale grid, which is utilized

   to calculate the permeability distribution (Figure. 2), as well as derive the entry capillary

   pressure field (Figure. 3) using the Leverett-J function. *A2_1_Gene_data_stru_fine.m*

3 Polygon transect fitting to reveal on-site geo-structure. *A2_1_Gene_shift_structure_fine2.m*

4 Construct the data structure and calculate the porosity distribution in the upscaled gid

   (Figure. 4). *A2_2_Generate_data_structure_upscaled.m*

5 **for** $k \in$ *all coarse cells* **do**

6   **for** $i = 1 \cdots n$ *(All aimed saturation points)* **do**

7   Calculate capillary pressure (P_c) at $S_{w,aim}$ using the Brooks-Corey equation with

           average entry pressure in the coarse cell. Set P_c as the initial guess for the

           macroscopic boundary pressure, P_b. And define an initial S_w.

8   **while** $(S^i_{w,aim} - S_w) > E_{thresh}$ **do**

9   Perform Macroscopic Invasion Percolation (MIP): the local system is invaded

               with non-wetting phase at P_b starting from the boundary cells and working

               inwards. A fine-scale cell is invaded if 1) it is connected to a cell which is

               connected to the boundary and 2) P_b is greater than the cell's entry pressure.

10   Once all accessible cells are invaded, calculate the upscaled S_w (the fine-scale

               saturation distribution is inverted from the fine-scale capillary pressure

               distribution. The upscaled saturation is volume averaging one).

11   Update P_b based on the updated S_w.

12   **end**

13   The fine-scale relative permeability distribution is calculated using the known

           fine-scale saturation. *A3_1_Perform_MIP_upscaling.m*

14   **end**

15   Simulate the single-phase flow in each direction using the fine-scale system. CMG

       based. *A4_1.m & A4_2.m* (**6 hours, 750 cells**)

16   The macroscopic relative permeability at each phase saturation is calculated with

       Darcy's Law. The data points are subsequently fitted with a functional form.

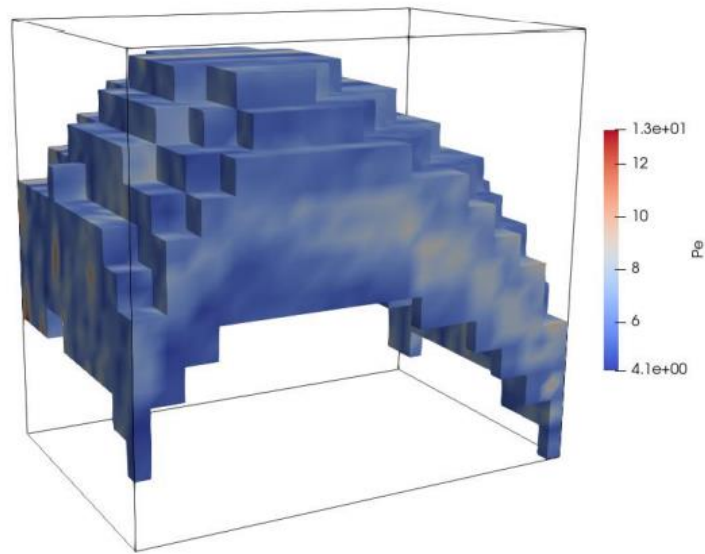   *A4_3_Post_process_single_phase_files.m*

17 **end**
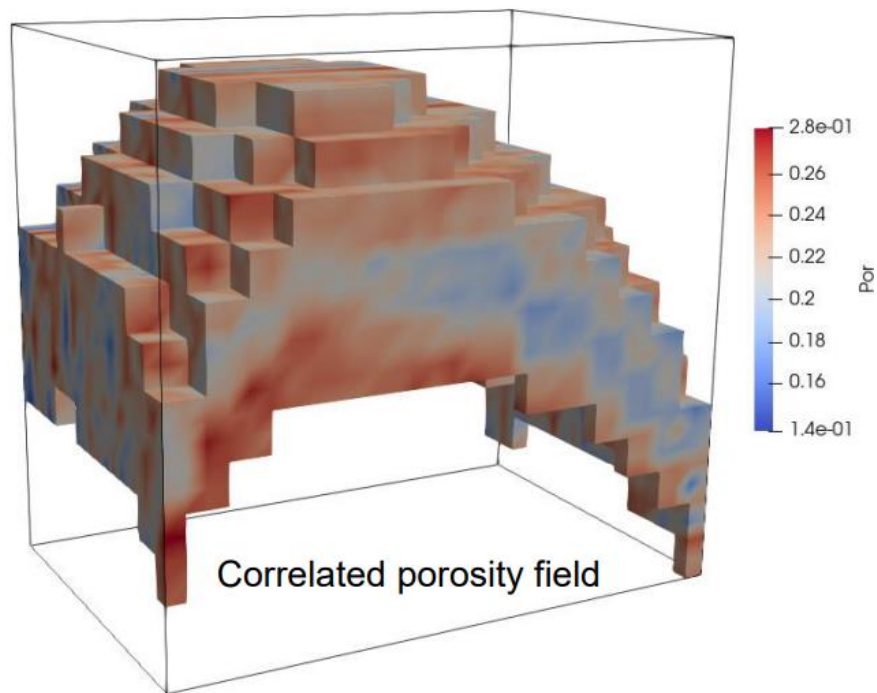
Figure 1. The correlated porosity field in fine-scale grid

$$\ln(K) \;=\; 52.544\phi \;-\; 6.4656$$
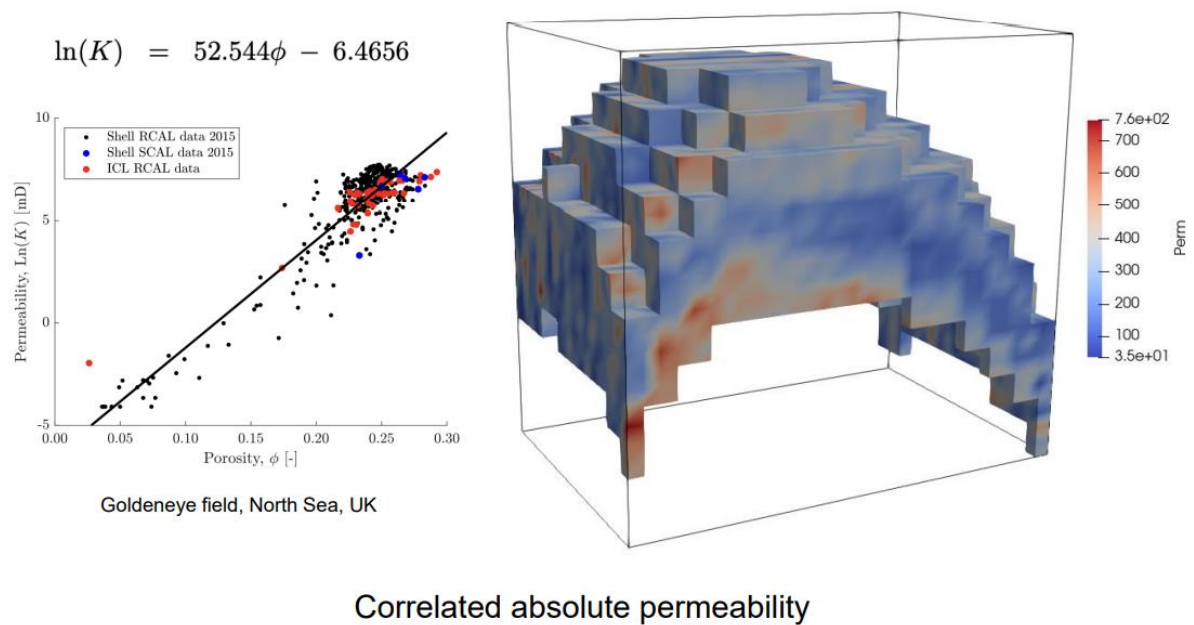
Figure 2. The correlated absolute permeability field in fine-scale grid
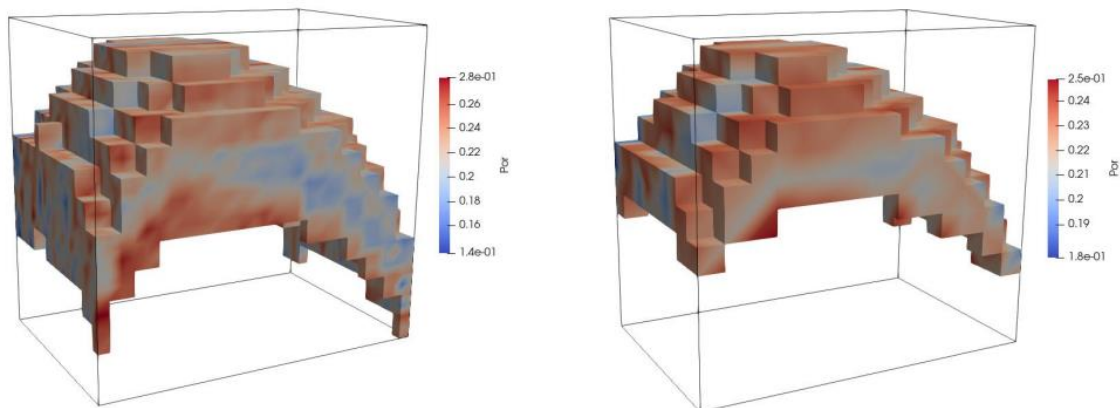
Correlated entry capillary pressure

$$J(S_w) = \frac{P_c}{\gamma cos\theta} \sqrt{\frac{K}{\phi}}$$

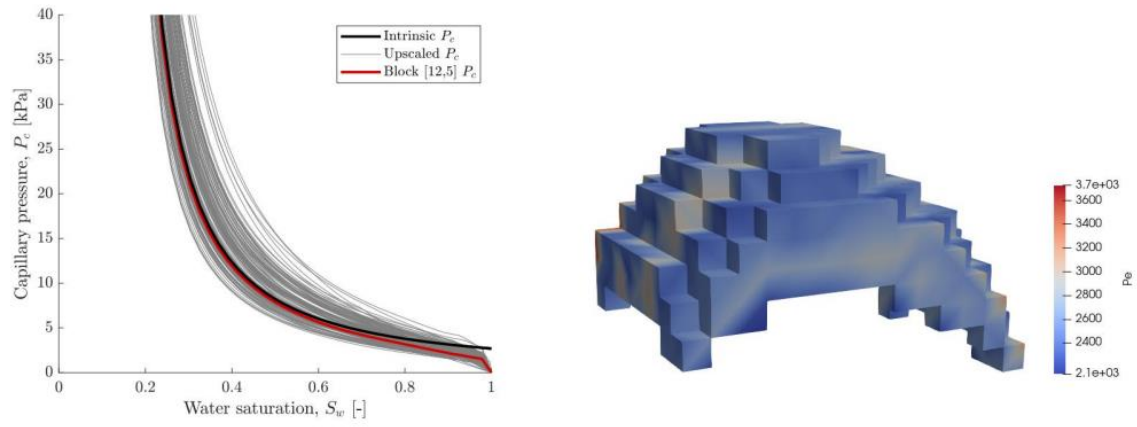**Figure 3.** The correlated absolute permeability field in fine-scale grid

Upscaled correlated porosity

Fine grid size (10,20,30) - - - - - - - - - - - -➤ Upscaled size (5, 10, 15) m
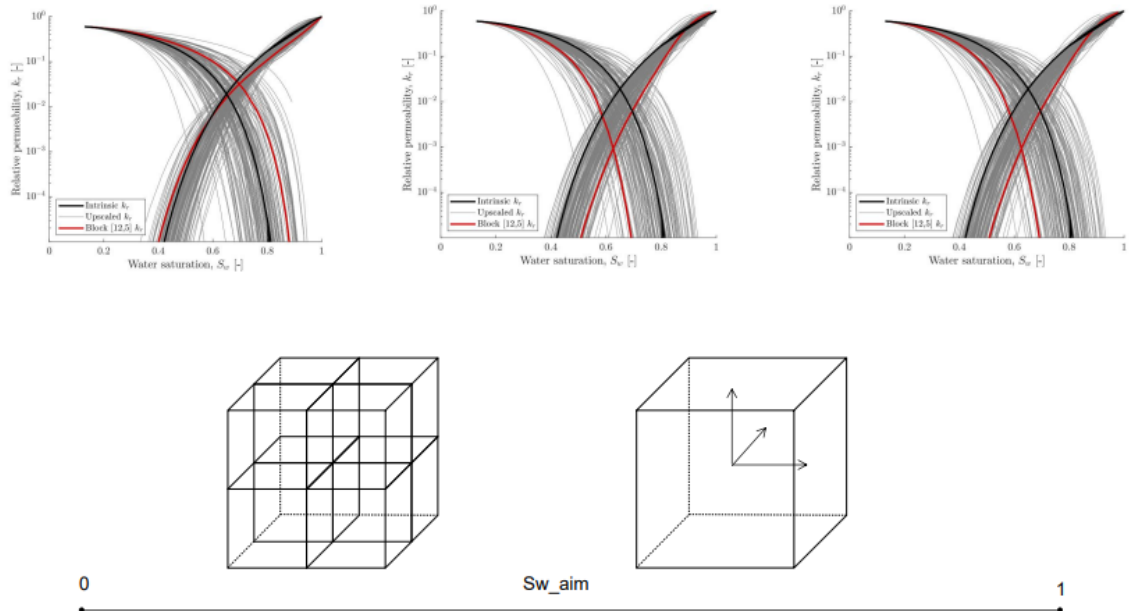
2 times in each direction

Figure 4. The upscaling of correlated porosity field

Upscaled capillary pressure in each block

Figure 5. Upscaled capillary pressure curve in each block

Upscaled relative permeability

Figure 6. Directionally upscaled relative permeability in coarsen cells