



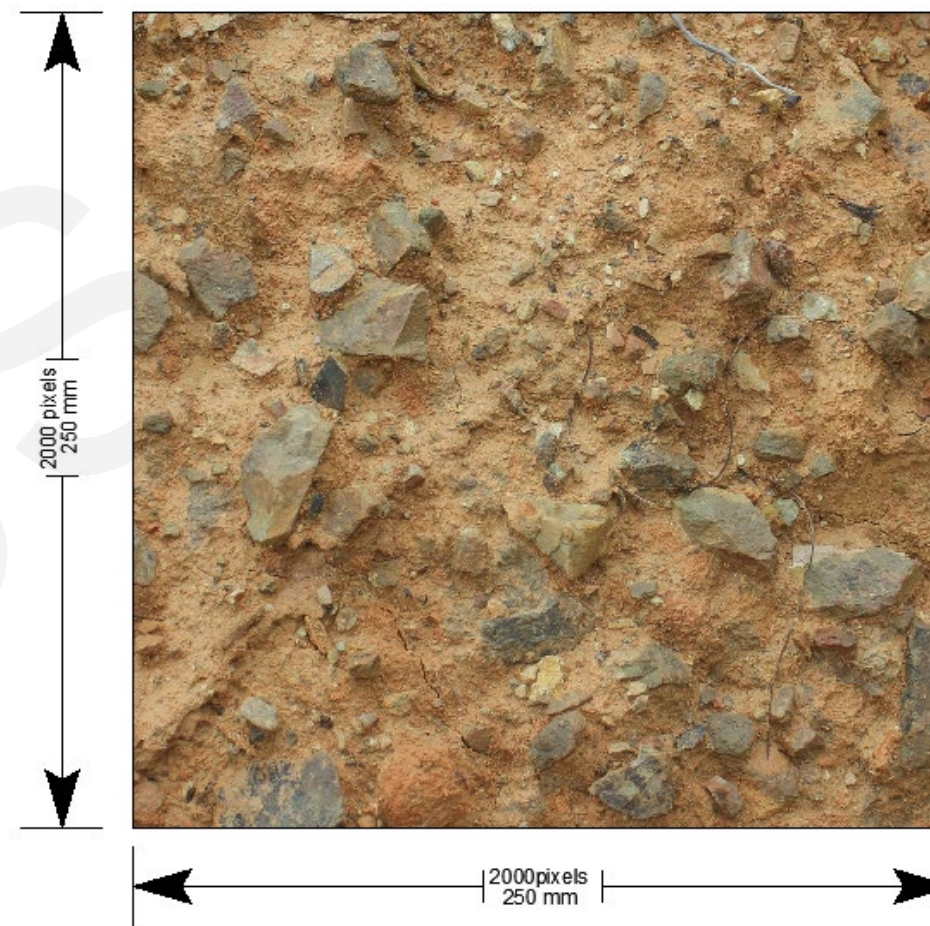
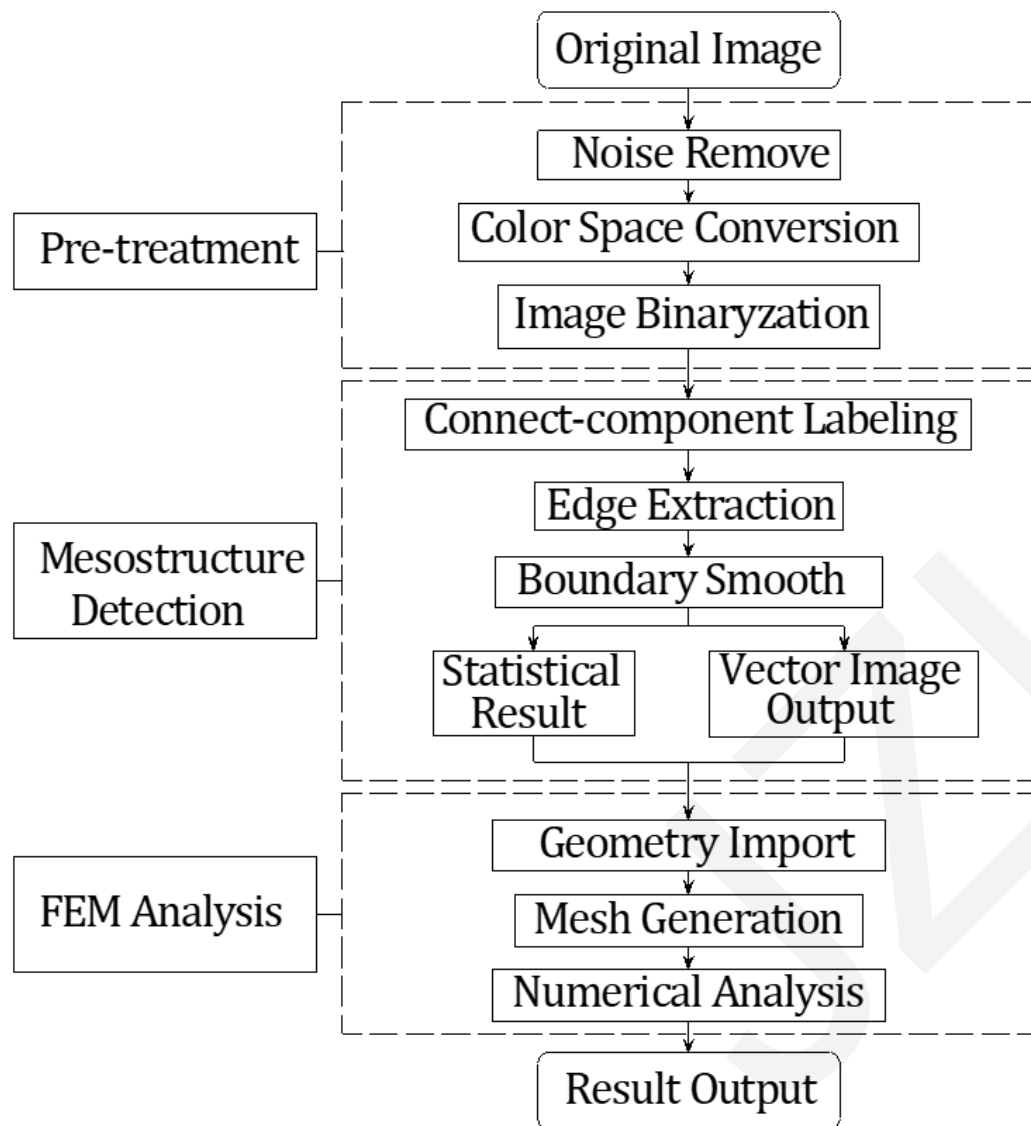
A numerical method for analyzing the permeability of heterogeneous geomaterials based on digital image processing

Long YAN

Key words:

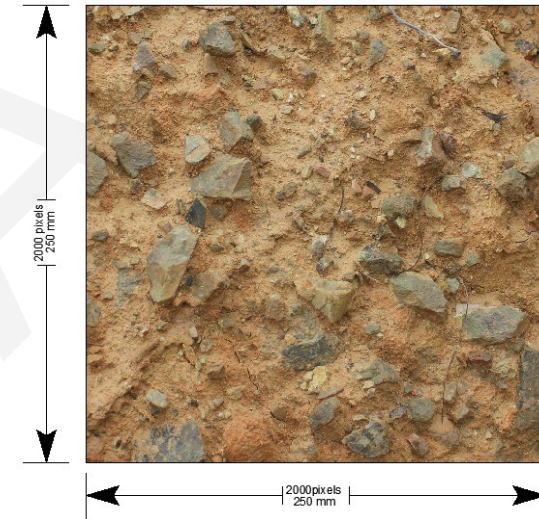
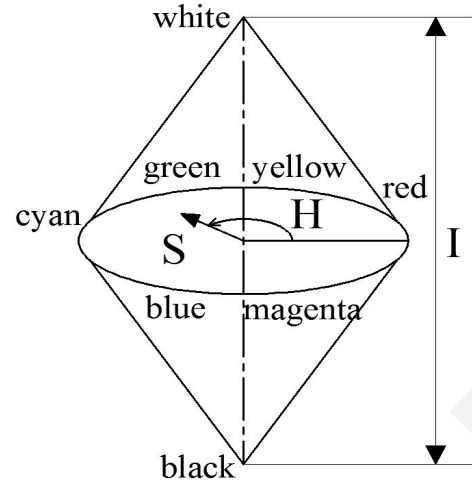
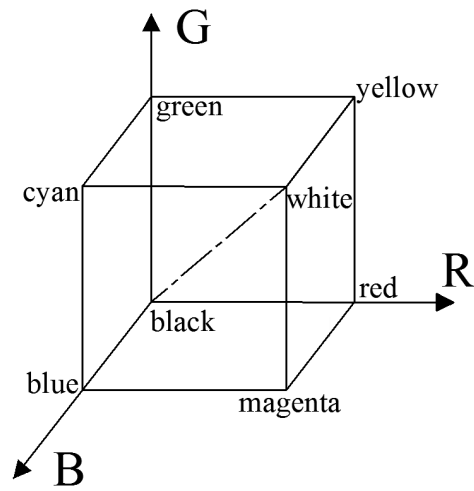
Heterogeneous geomaterials; Digital image processing; Macro permeability coefficient; Scale dependence

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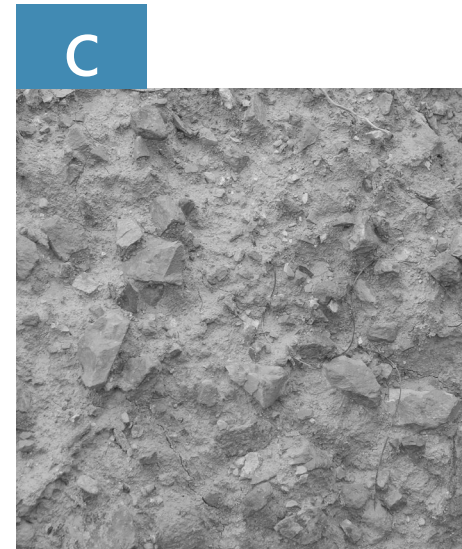
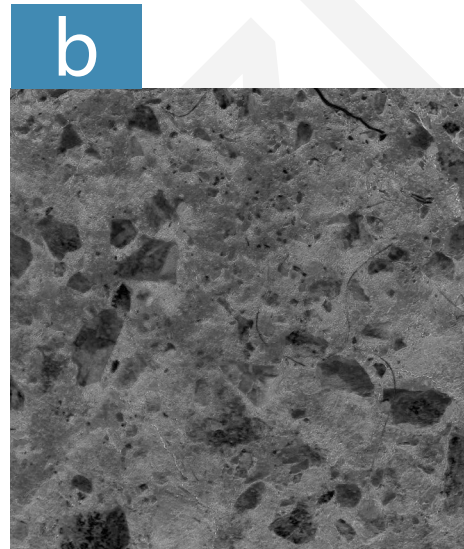
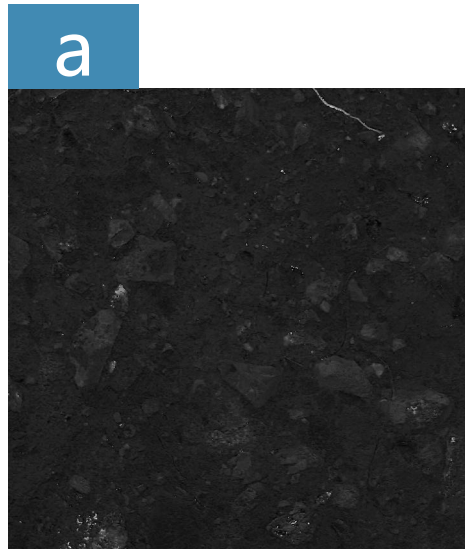


The domain of the photo for research

General flowchart for DIP based analysis on permeability of heterogeneous media

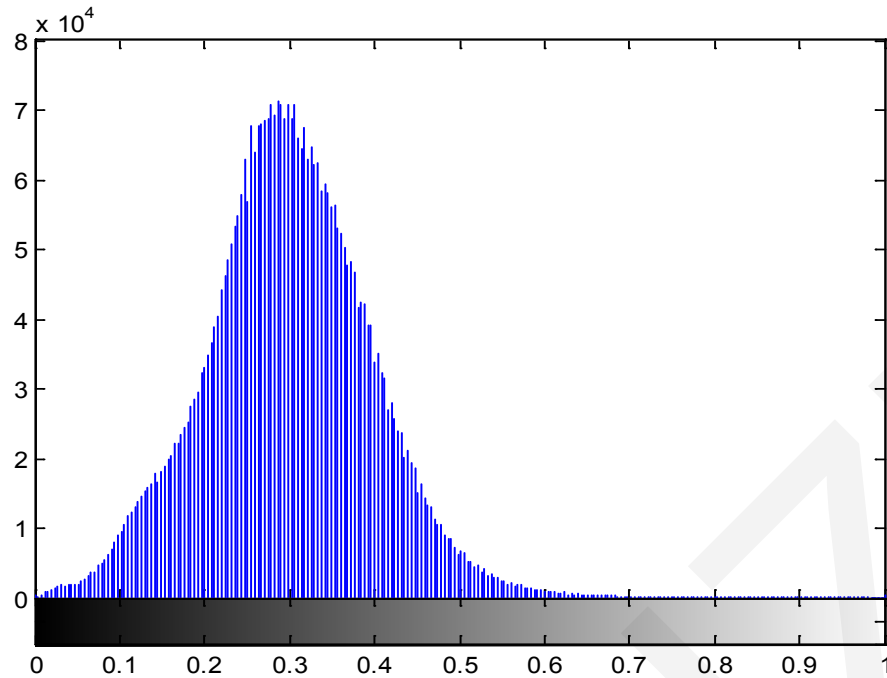


Color space conversion

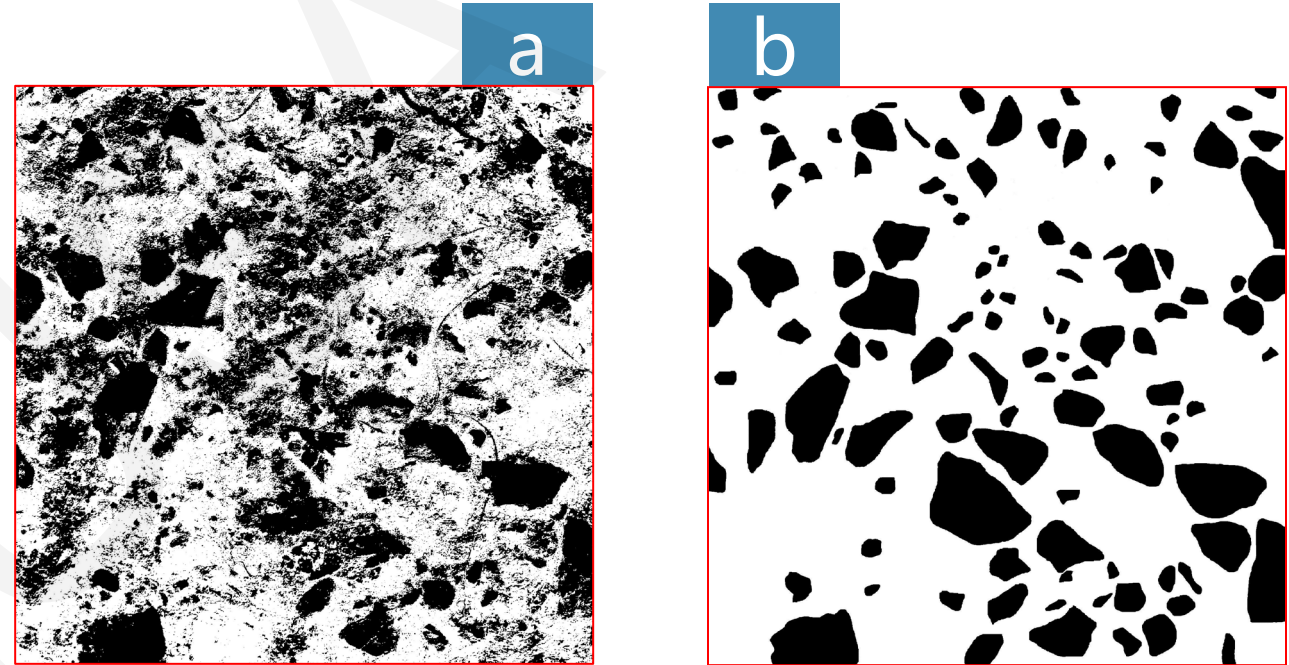


Grayscale of HSI components of the image of the SRM(a)The grayscale of H; (b)The grayscale of S; (c)The grayscale of I

Image binaryzation

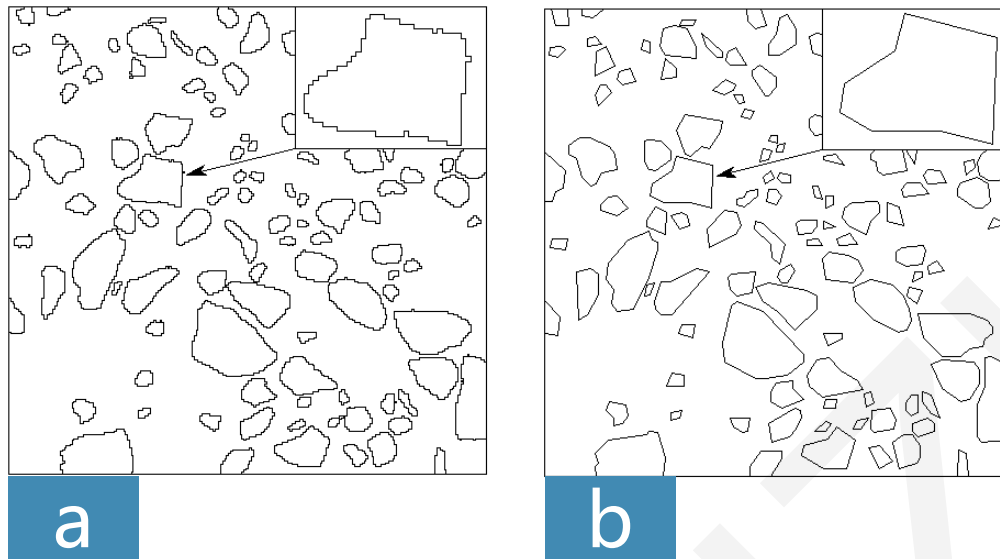


Histogram of S value in HSI color space



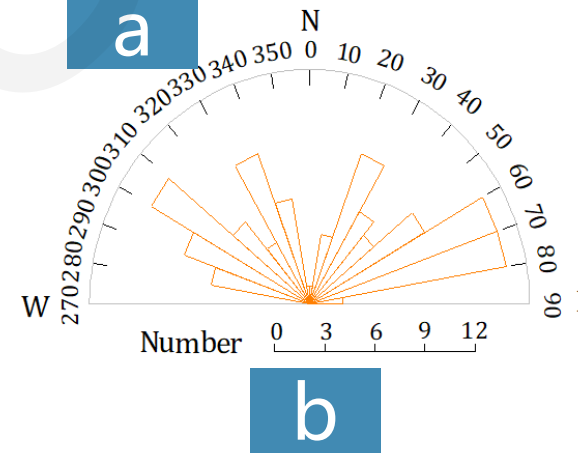
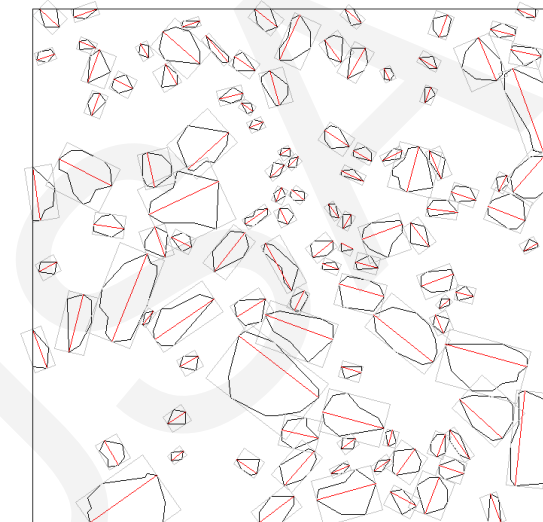
Automatic binaryzation image and manual refinement picture (a)The automatic binary image; (b)Manual refinement binary image

Geometry vectorization of binary image

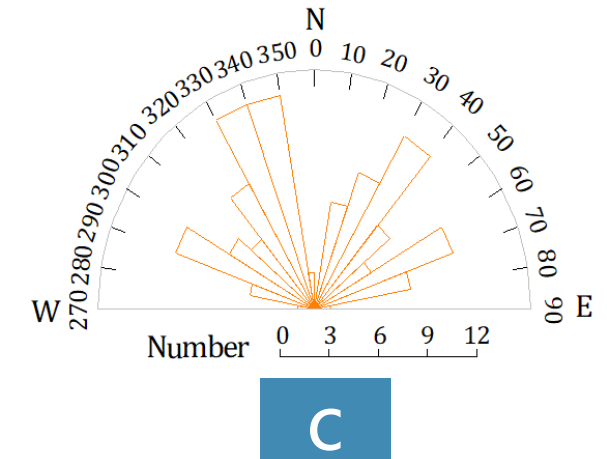


Edge detection of the rocks in SRM (a) Edge extraction without boundary smoothing; (b) Edge extraction after boundary smoothing

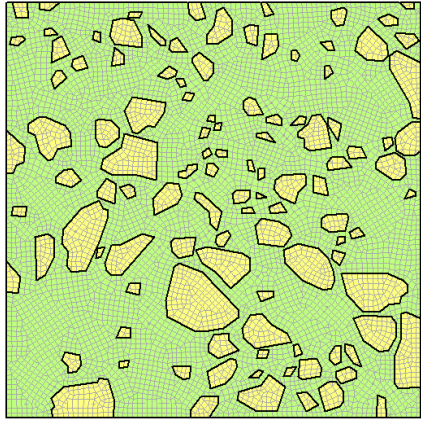
Distribution information of microstructures



Rose diagram of rock aggregates in SRM
(a) The major and minor axis of rock aggregates;
(b) The major axis rose diagram;
(c) The minor axis rose diagram



Application of digital image processing in seepage analysis



Finite element mesh

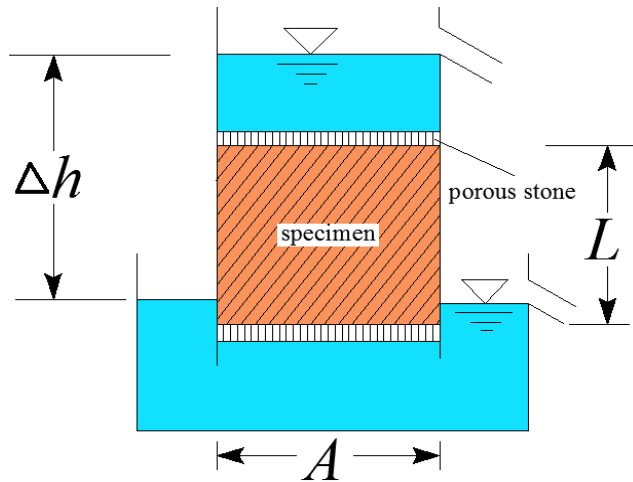
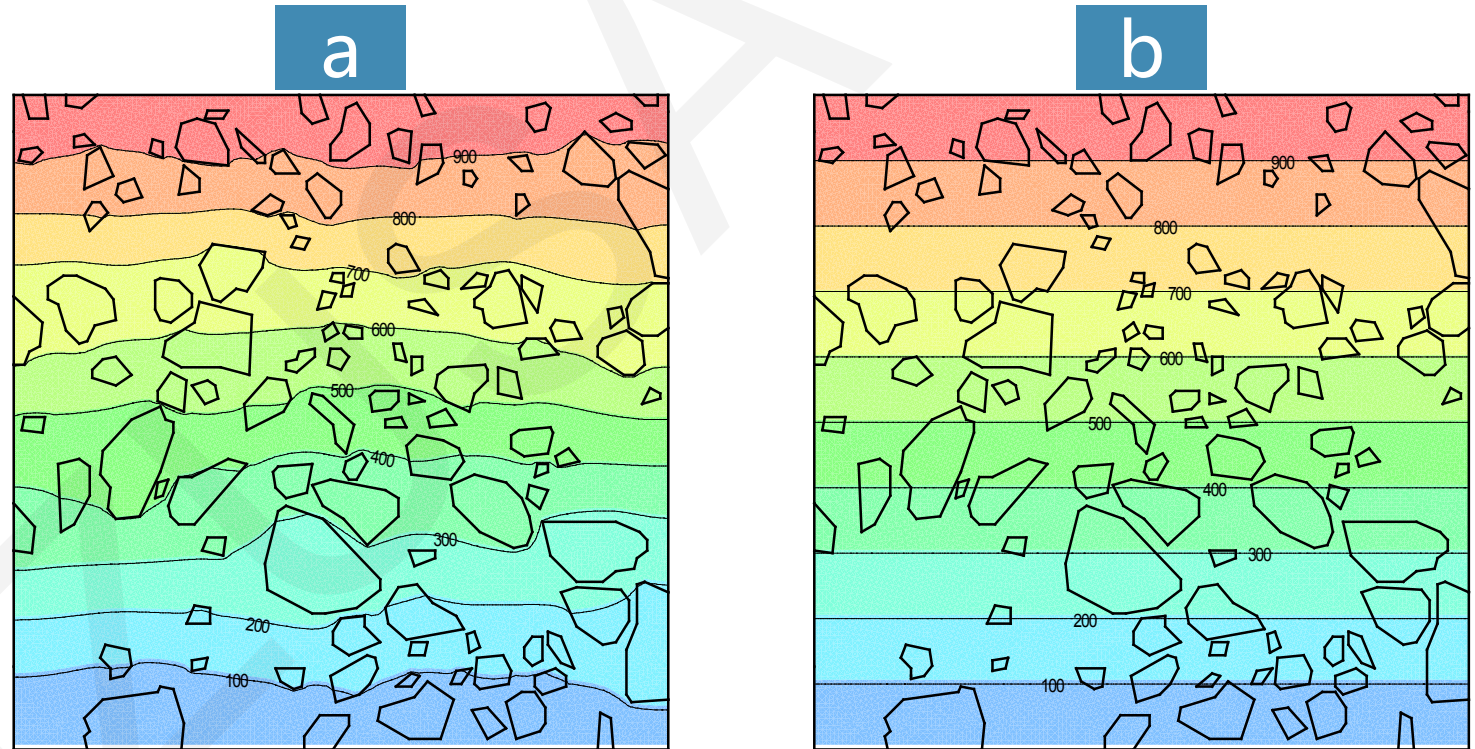


Illustration of laboratory permeability experiment with a constant water level



Total head contour of heterogeneous (a) and homogeneous (b) media (unit: mm)

Scale dependency and REV estimation



200² pixels



500² pixels



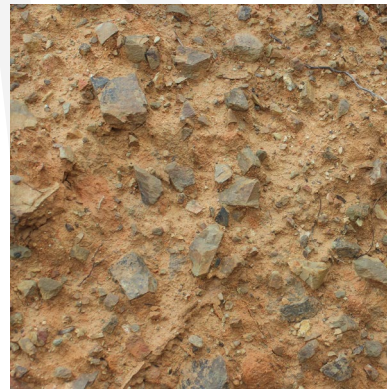
1000² pixels



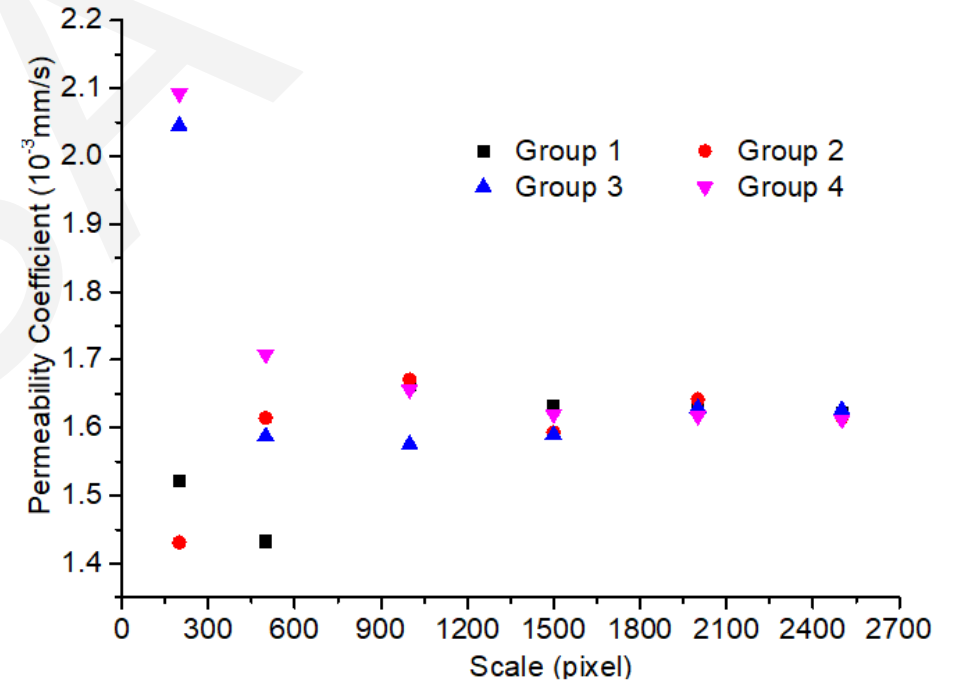
1500² pixels



2000² pixels



2500² pixels



Variation of permeability coefficient with the increase of pixels

Conclusions

1. By a series numerical analysis at different scales from 2002 pixels to 25002 pixels, it shows that the SRM have scale dependency and the REV size is about six times of the maximum major axis length;
2. Analyses on variation of macro permeability and inhomogeneity parameter are carried out to illustrate its influential impacts and the result shows that its effect is notable at the certain range;
3. Simulations on permeability analysis with different rock fraction imply its lowering effect on the macro permeability but not exactly. The distribution and shape of aggregate should be taken into consideration.

Thanks