Finding the Evolution law of Representative Elementary Volume Convergence

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Introduction

- The Representative Elementary Volume (REV) is the smallest volume that accurately describes the mean constitutive response for larger scales.
- Determining the REV is a fundamental exercise in Digital Rock Physics.
- Yet, remains a challenging task, due to many and large simulations which are computational expensive.

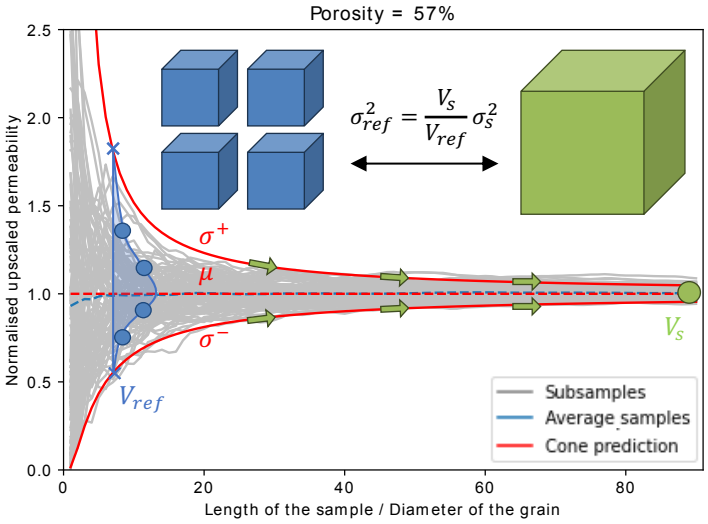
➢ Determining the evolution law will simplify exercise.

Generic evolution law of convergence

By tracing the convergence of permeability in idealized rock microstructures, specifically random packings, the characteristics of the REV convergence are analysed to determine the generic evolution law.

Characteristics of the convergence:

- The evolution REV convergence is in the shape of an asymmetric cone.
- The cone is statistically described with a log-normal distribution, composed of a variance (σ) and mean (μ)
- Samples can be split into subsamples, which correlates the different distributions, depending on the volume (V).



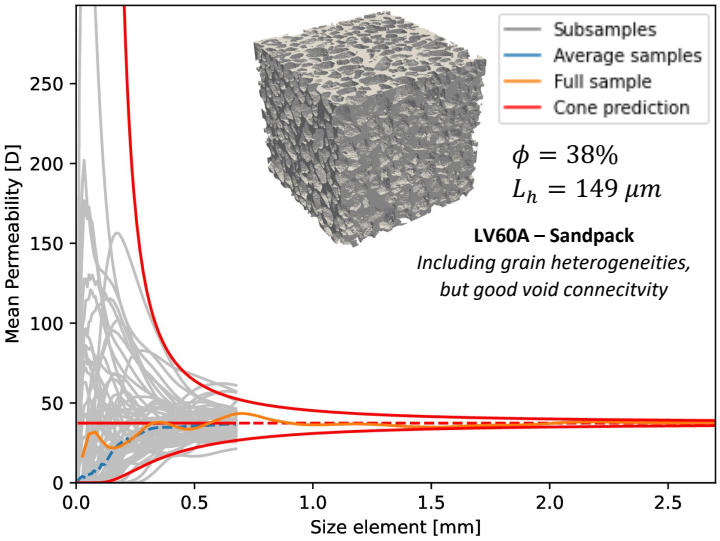
Therefore, the evolution law is described as follows:

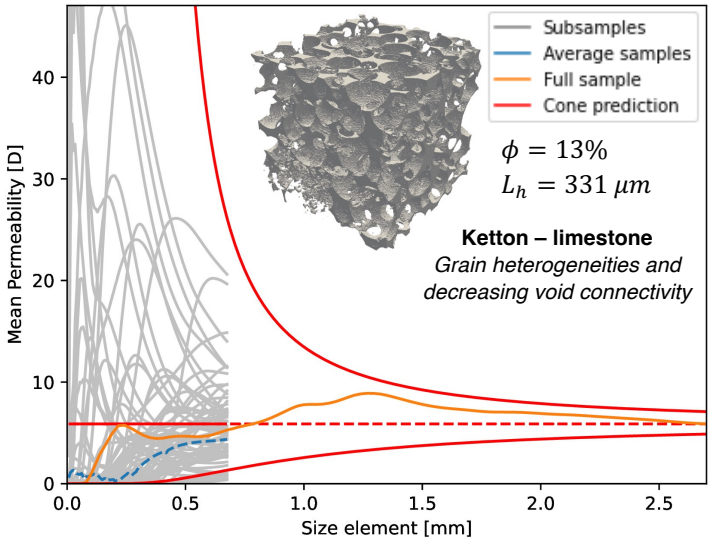
$$y = \mu \cdot \exp\left(\pm 2 \frac{\sqrt{V_{ref}}}{\sqrt{V_s}} \sigma_{ref}\right)$$

References

[1] S. Zwarts and M. Lesueur, Homogenisation Method Based on Energy Conservation and Independent of Boundary Conditions, 2023, Advances in Water Science

Application on real samples





Findings

- The determined evolution law is applicable for different types of microstructures.
- Splitting into subsamples unlocks working with high resolution samples.
- The evolution law provides information about error within the homogenized parameter and REV size.

Recommendations

- Identify the required characteristics for the subsamples, such as the percolation threshold.
- Run the simulations in parallel to save computational resources.

➢ For example, utilizing the law on the sandpack reduced the simulation time with a factor of 231.