Rock-on-a-chip: A novel method for designing representative microfluidic platforms based on real rock structures and pore network modelling

Pablo A. Godoy,[a] Alirza Orujov,[b] Aurora Pérez Gramatges[a,c] and Saman A. Aryana *[b,d]

Supplementary Information

Initial mosaic PSD

Pore network is extracted from mosaic after the random assembly of the pore images, if the PSD is close enough to the subvolume, the mosaic is appropriate to be connected on further steps. Pores at the 2D mosaic are sparser than on the 3D network.

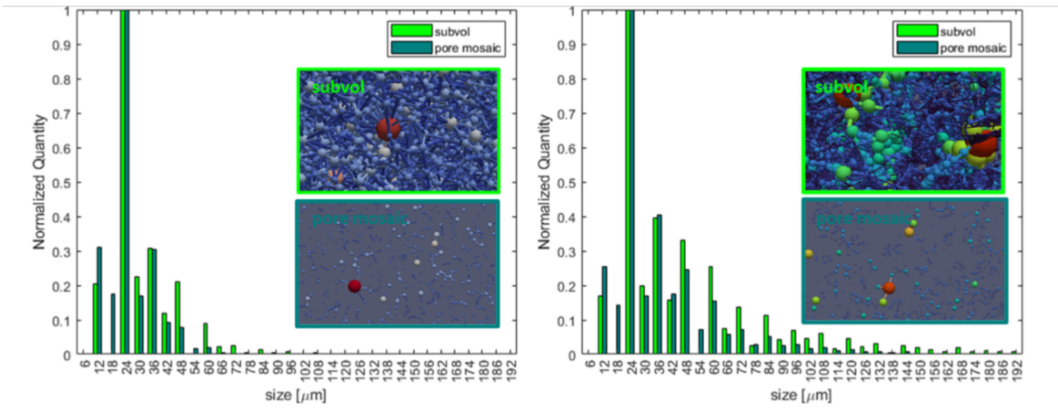

Figure S1. PSD comparison between pore space subvolume and mosaic: sandstone pattern (left) and carbonate pattern (right).

Uniformly added throats

Connecting the pores with uniform throats does not accomplish throat size representativeness, as only one category dominates the mosaic distribution.

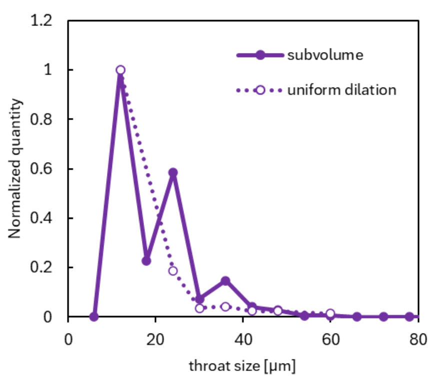

Figure S2. TSD comparison between pore space subvolume and mosaic: sandstone pattern with added throats (same width).

Dilation interval influence on PSD

Throats are randomly dilated by categories to create similar TSD between 2D and 3D networks. The more the throats are dilated, the more spurious pores are created, affecting negatively the PSD. The dilation interval that does not compromise the PSD is unique for each mosaic and should be tested thoroughly.

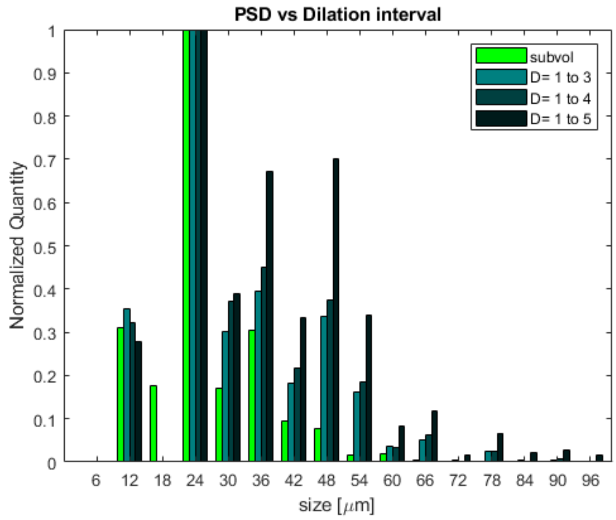

Figure S3. Pore size distribution altered by larger dilation interval

Thinning process addition

Because the previous dilation interval could create spurious pores, the new throats are thinned in order to blend better with pores without generating extra pore area. The thinning process is not exactly erosion (opposite to dilation) because it alters pixels from the entire object border, as erosion depends on the structuring element. Dilation was chosen as an alternative to thickening in the first place because applying a structure element of a square prioritizes one of the throat dimensions other than thickening its entire border.

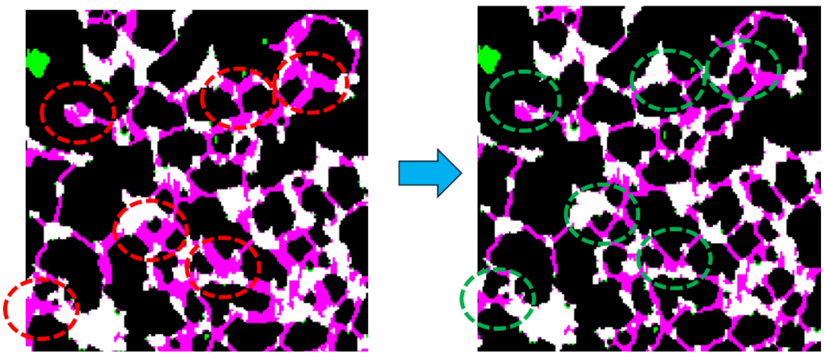

Figure S4. Thinning process after dilation during editing

Validation of Incompressible Flow Simulations (OpenPNM)

The sum of flow rates at the inlet were acquired for each experimental pressure drop solving a system of Hagen-Poiseuille equations. The simulated flow was tested against data from a random pattern network micromodel with 20 µm of depth. The simulation successfully reproduced a slope close to the experimental data meaning the simulated permeability is accurate. Accounting for a 10% error in experimental data[1], the simulated curve is validated for chips with 20 µm of depth.

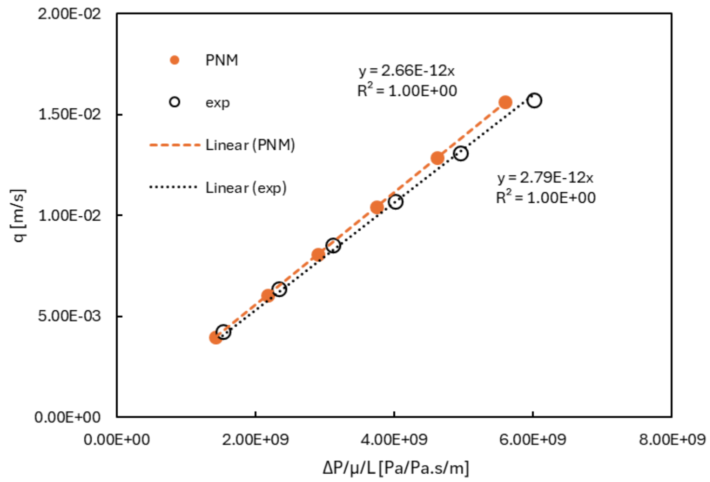

Figure S5. Simulated fluid flow data versus experimental for a commercial microchip.

References

1 S. Pradhan, I. Shaik, R. Lagraauw and P. Bikkina, *MethodsX*, 2019, **6**, 704–713.