Image processing #1

고급건설재료학

서울대 건설환경공학부 문주혁 교수

Contexts

- **#1. Introduction and Examples**
- #2. Basics of Matlab, Image Processing Toolbox
- #3. Segmentation, Edge detection, Transformation

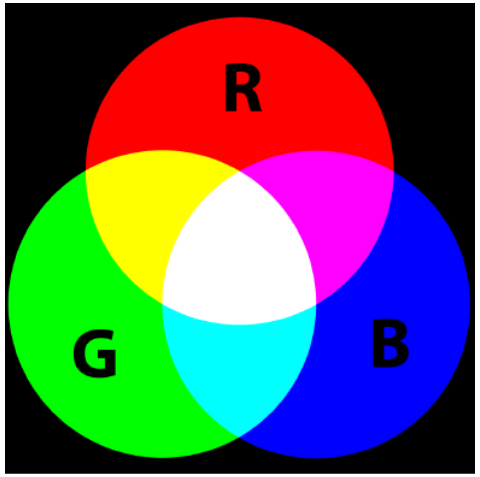
- Matlab code (Image processing toolbox)
- Project introduction

Introduction and Examples

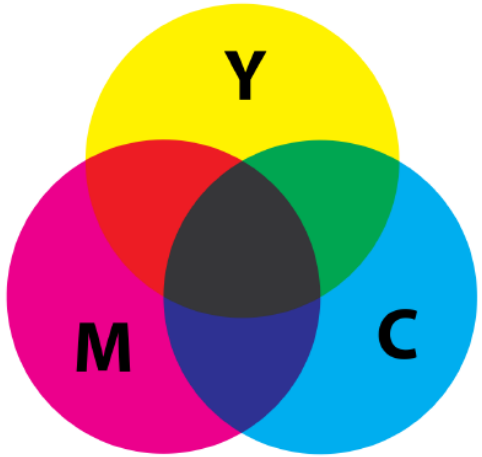
RGB color cube

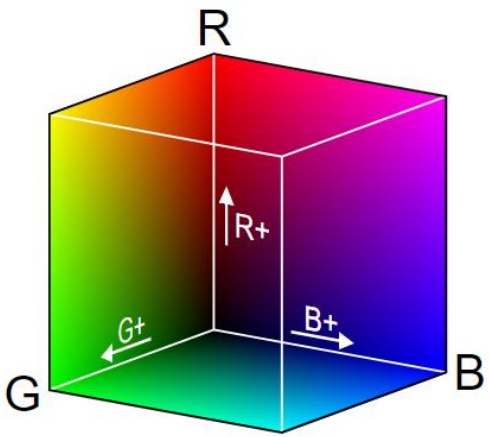
White (255,255,255)

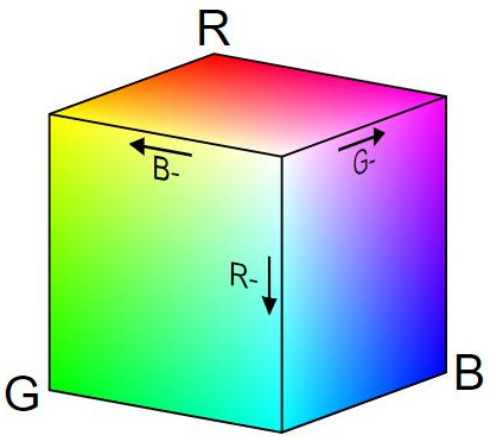
Black (0,0,0)

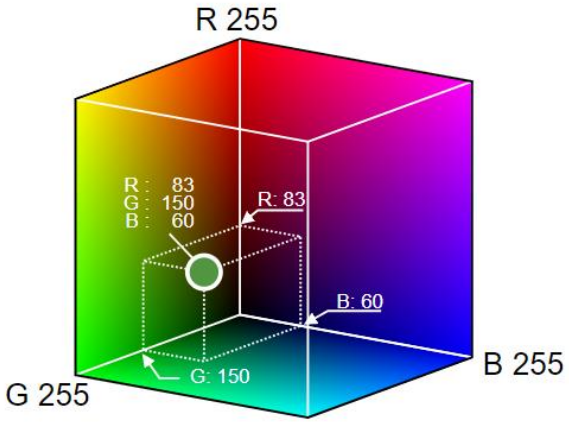


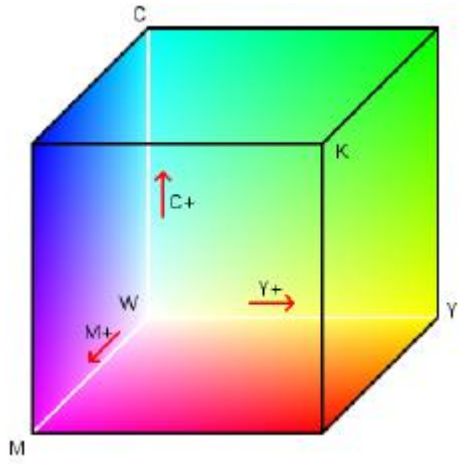
CMYK Color Space







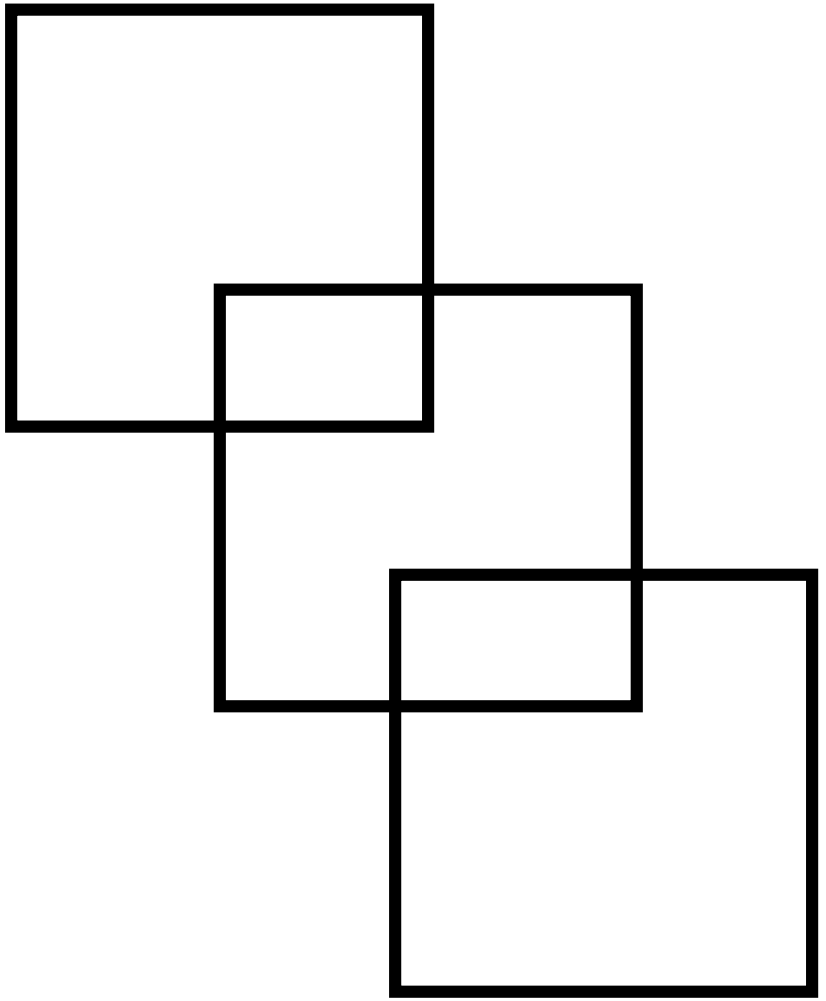




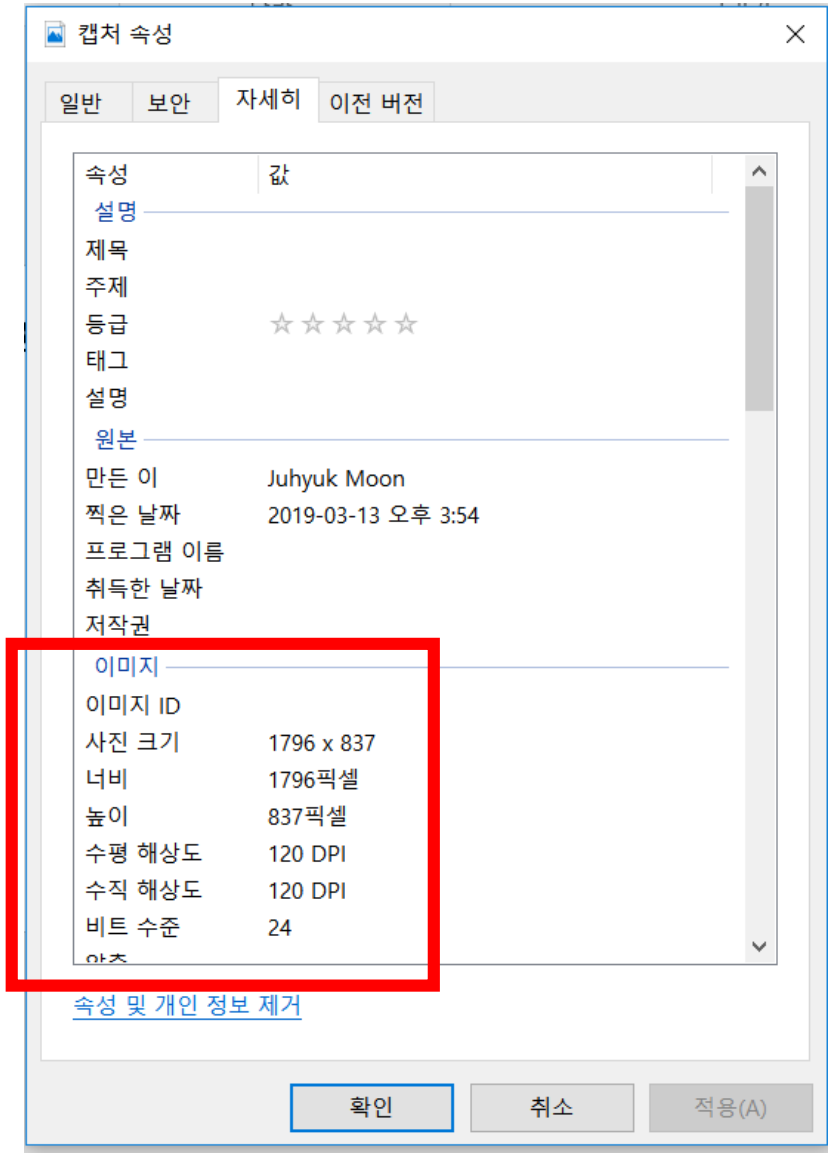
Introduction and Examples

Pixel

Resolution



Introduction and Examples



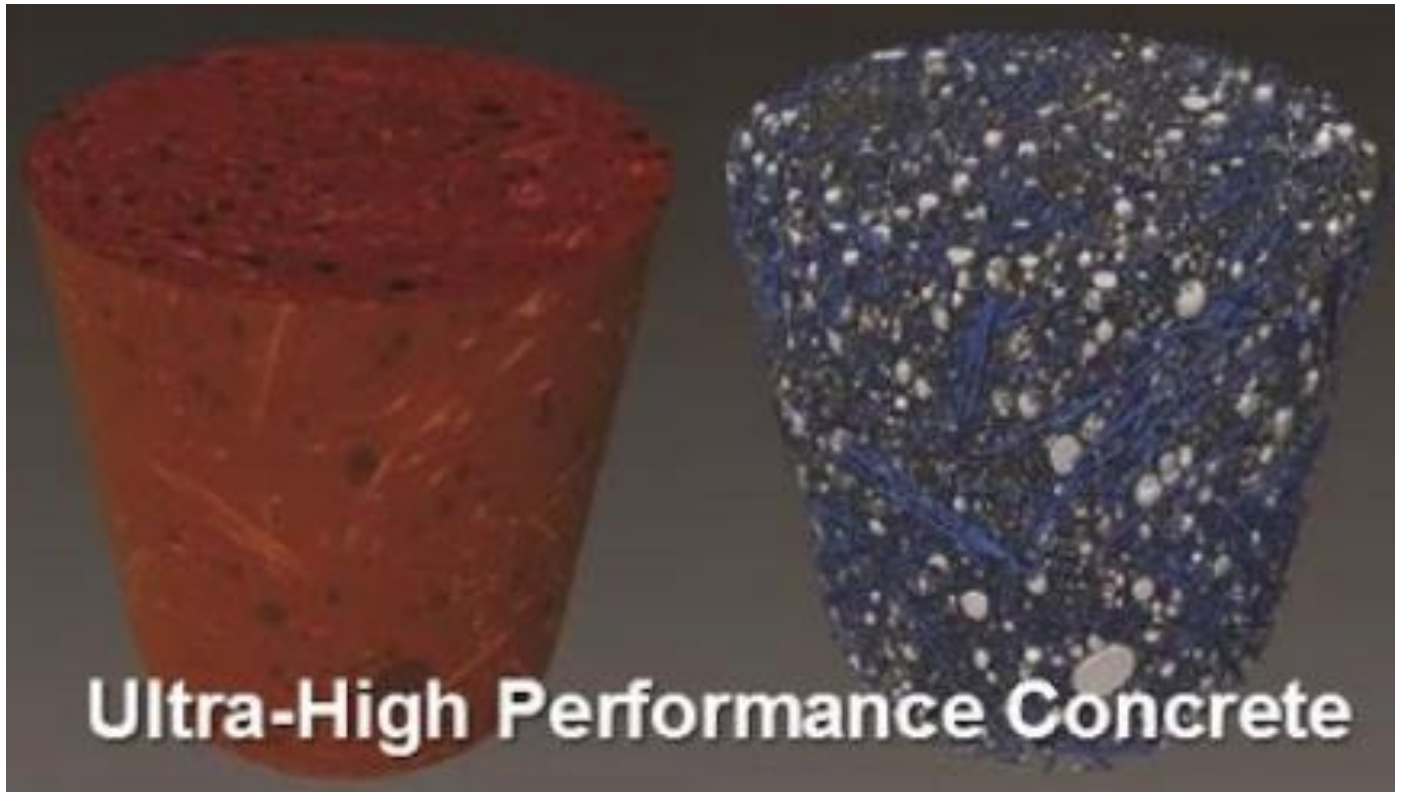
Pixel info but,

no resolution info

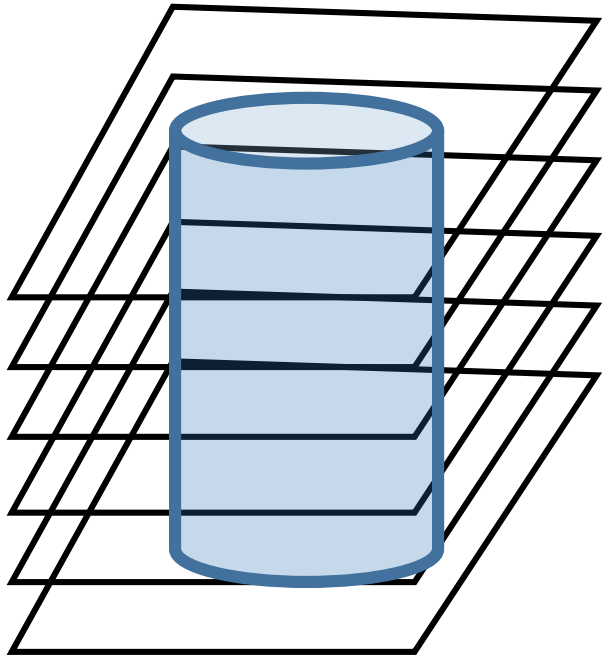
Introduction and Examples

Voxel

Resolution



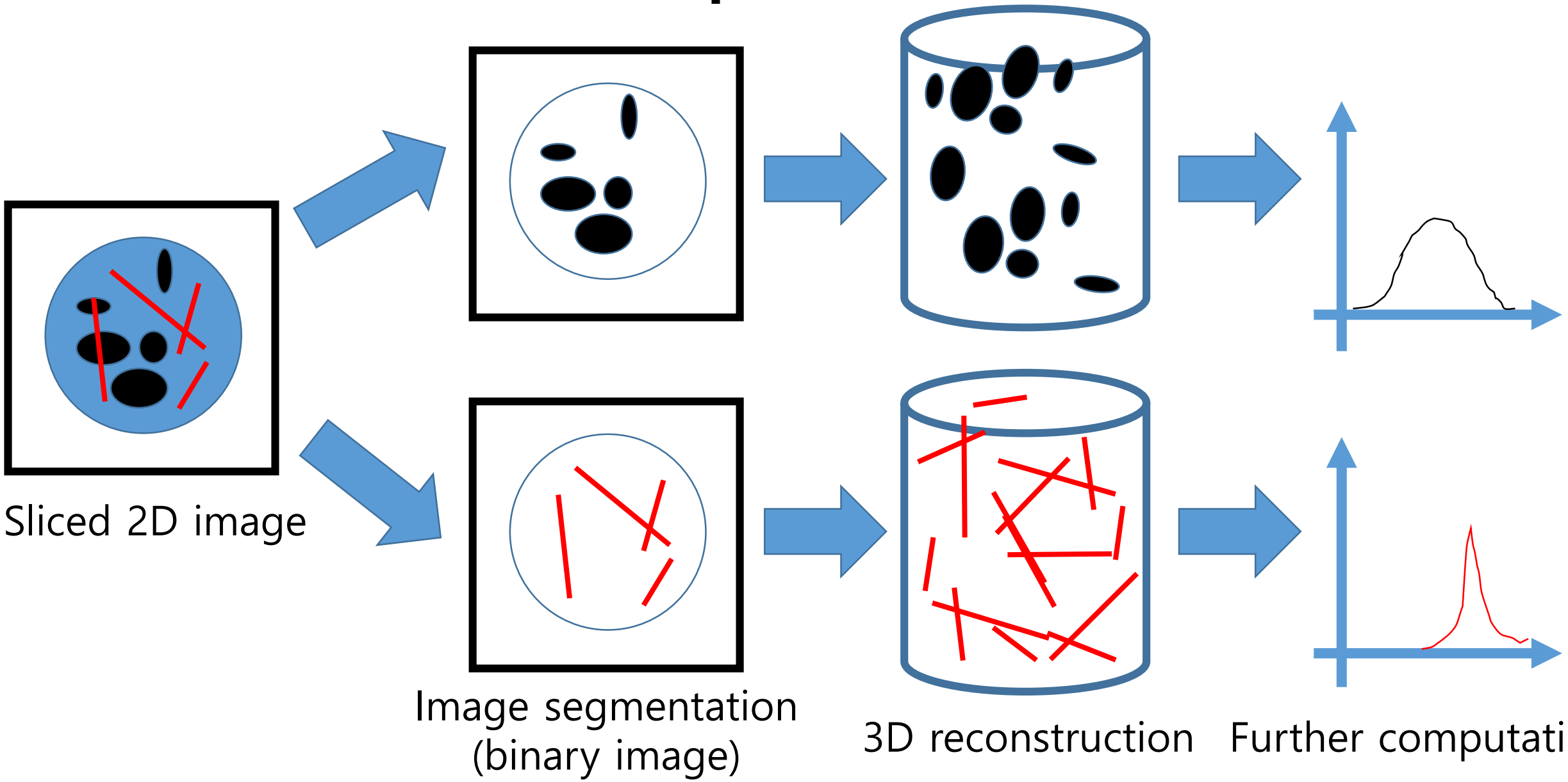
https://www.youtube.com/watch?v=MIM4r59y4bQ



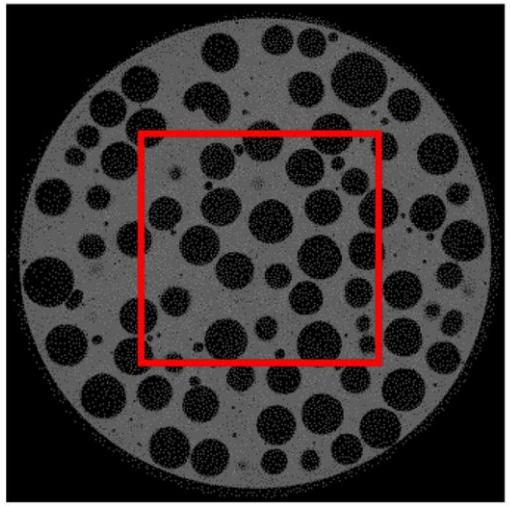
A stack of 2D images

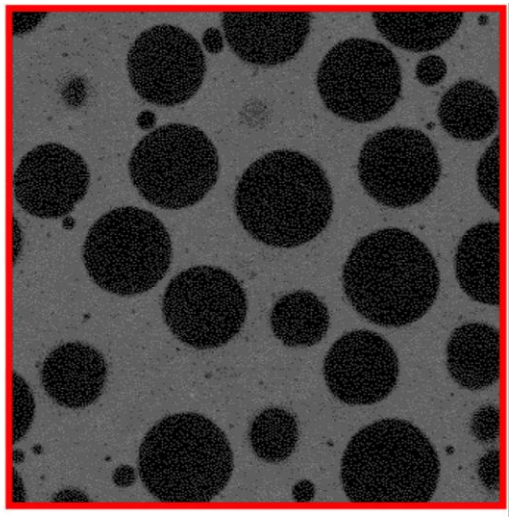
3D reconstruction

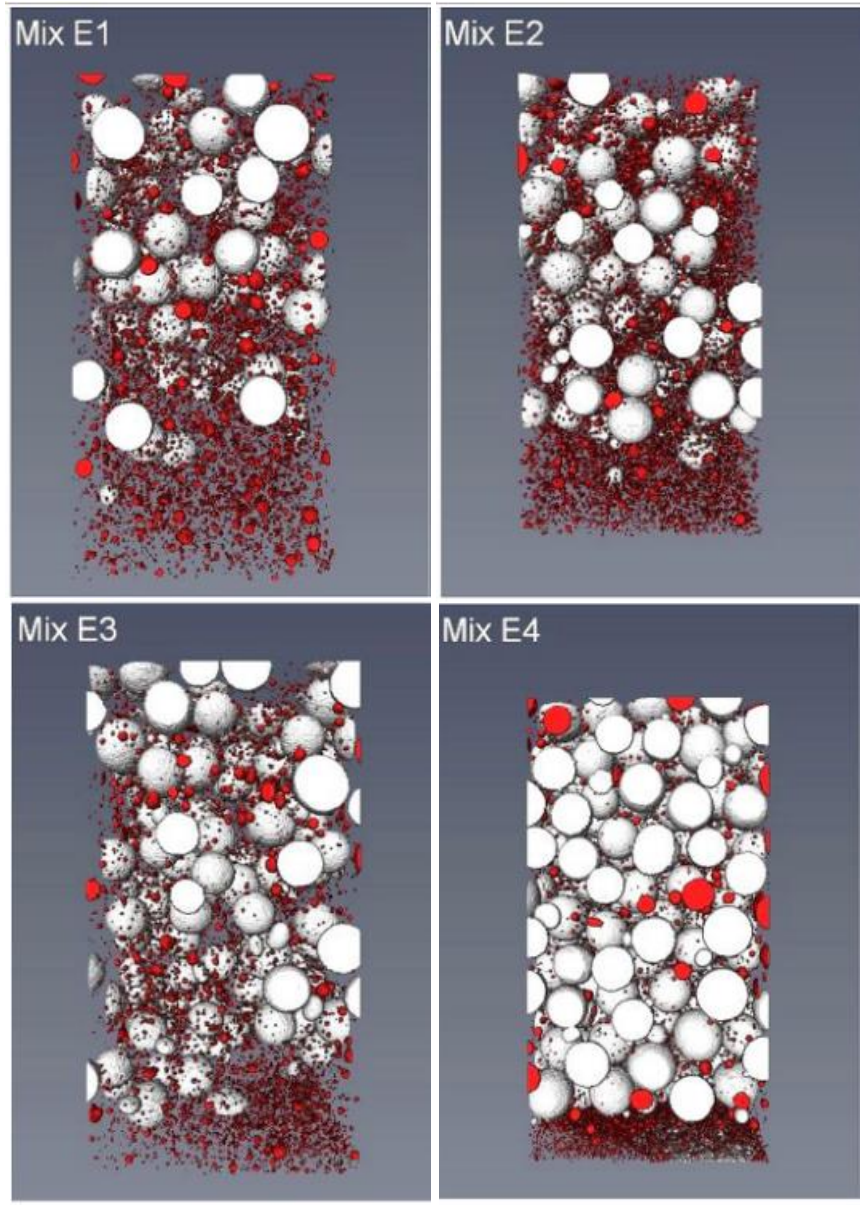
Introduction and Examples



Introduction and Examples

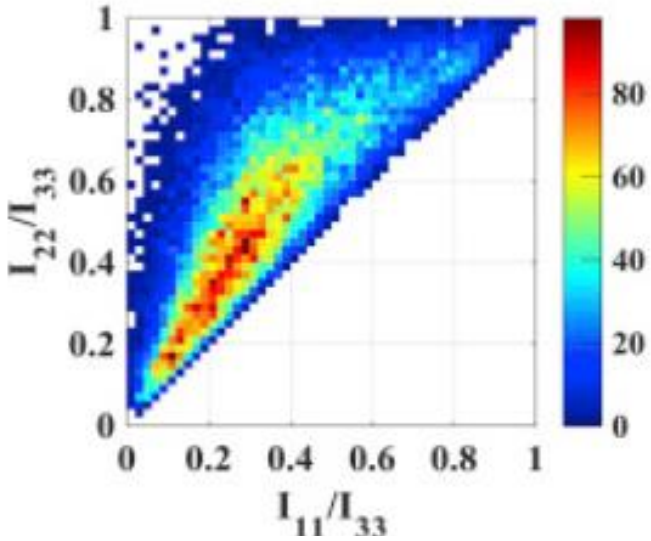


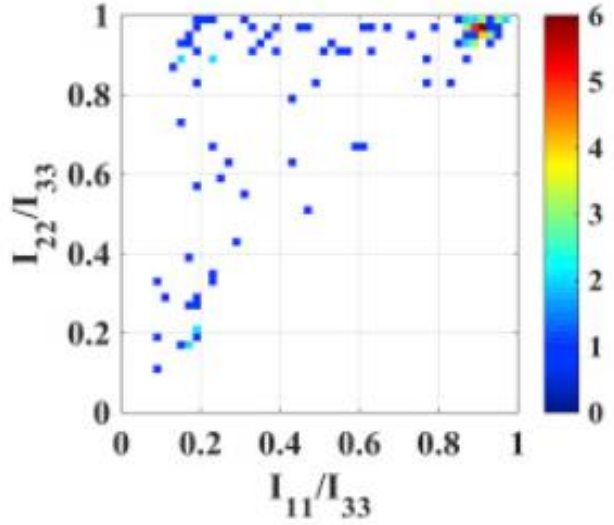




Pixel = 2240 by 2240

Resolution = 24.15 um/pixel





Introduction and Examples

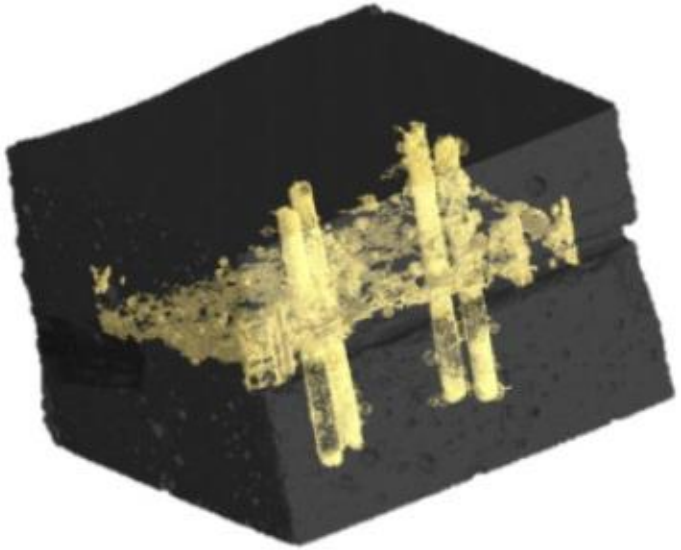
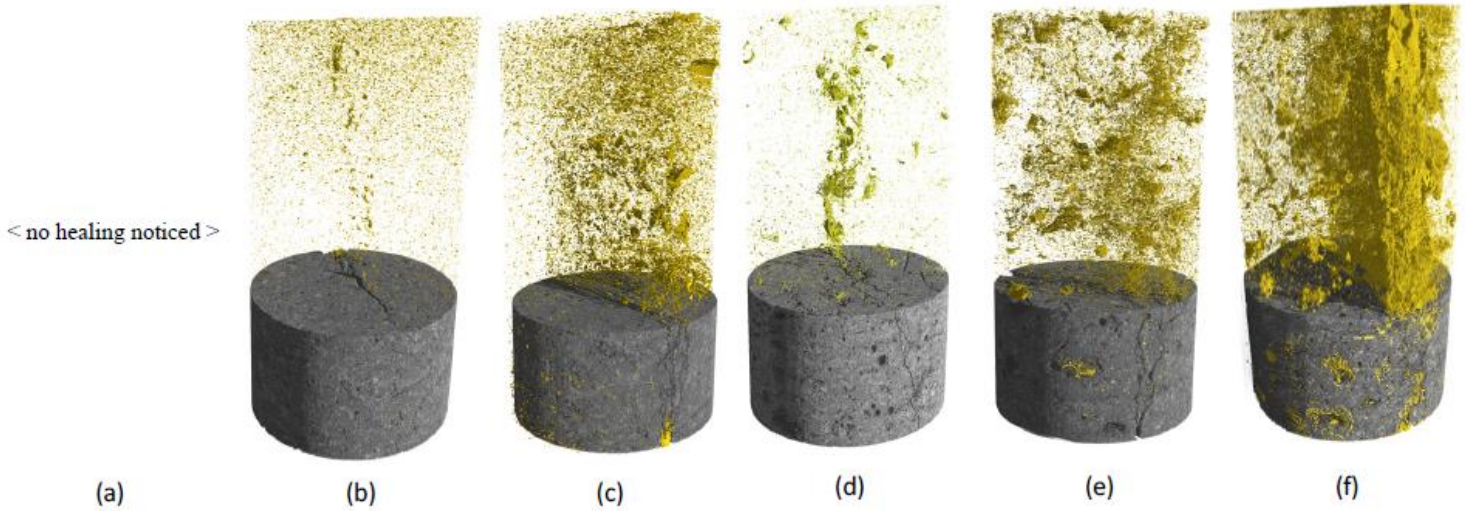


Fig. 4. Two-component polyurethane healing after crack formation visualized by means of X-ray computed microtomography, after Van Tittelboom et al. (2011).



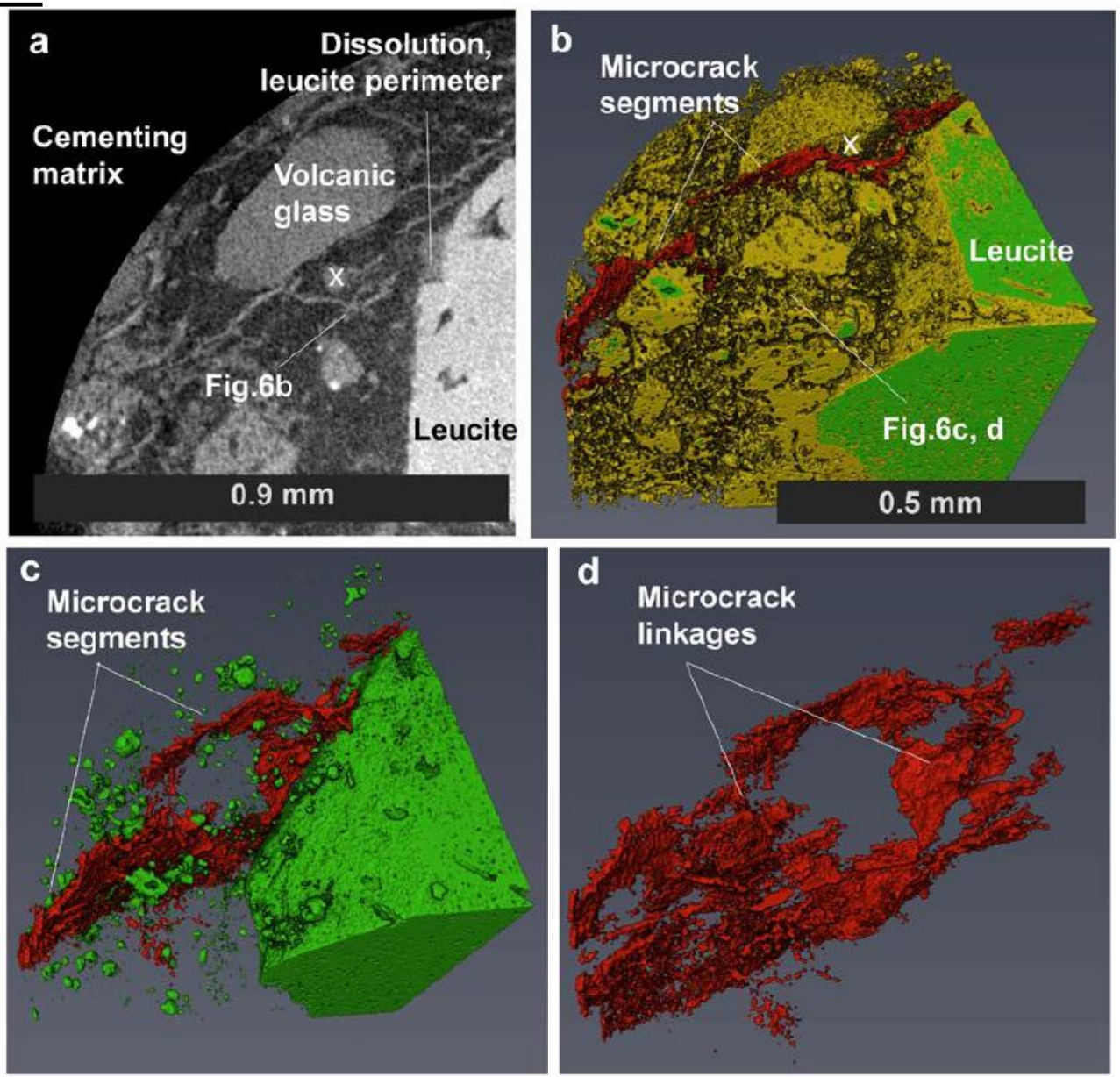
(Dider S., RILEM Technical Letter 2018)

Amount of healing products (yellow) in 28 days old specimens without (a-c) and with SAPs (d-f) stored at a relative humidity of 60 ± 5% (a, d), 95 ± 5% (b, e) and in wet/dry cycles (c, f).

Introduction and Examples

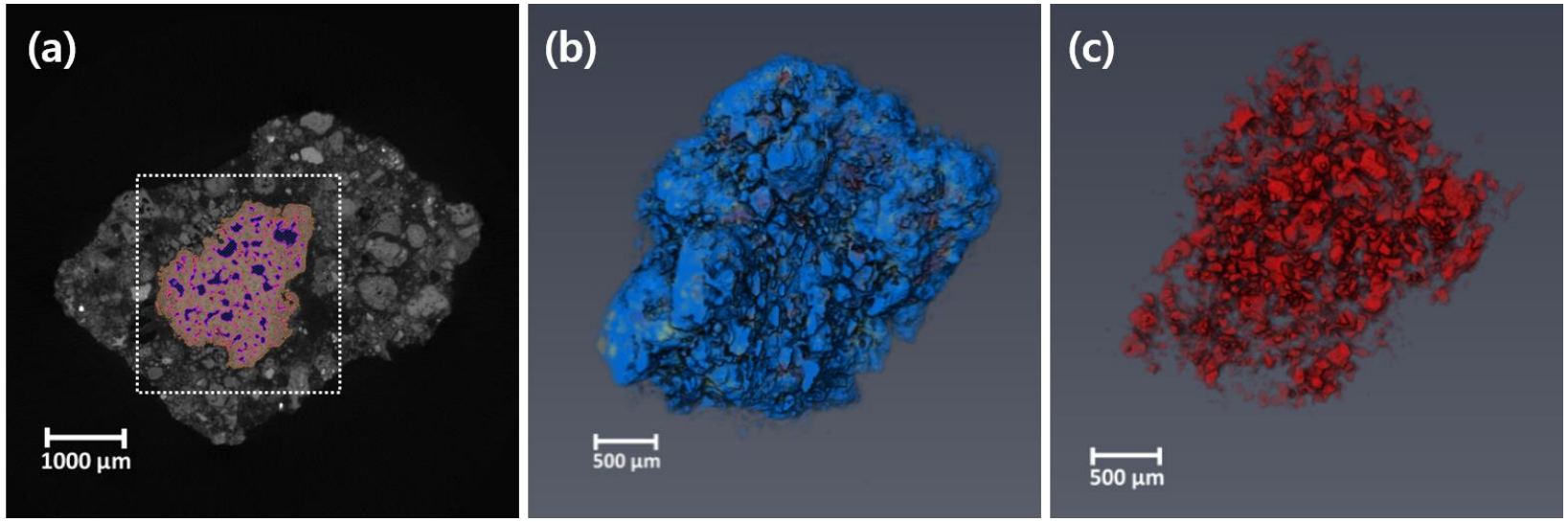
Self-sealing crack phenomenon in

Ancient Roman Concrete

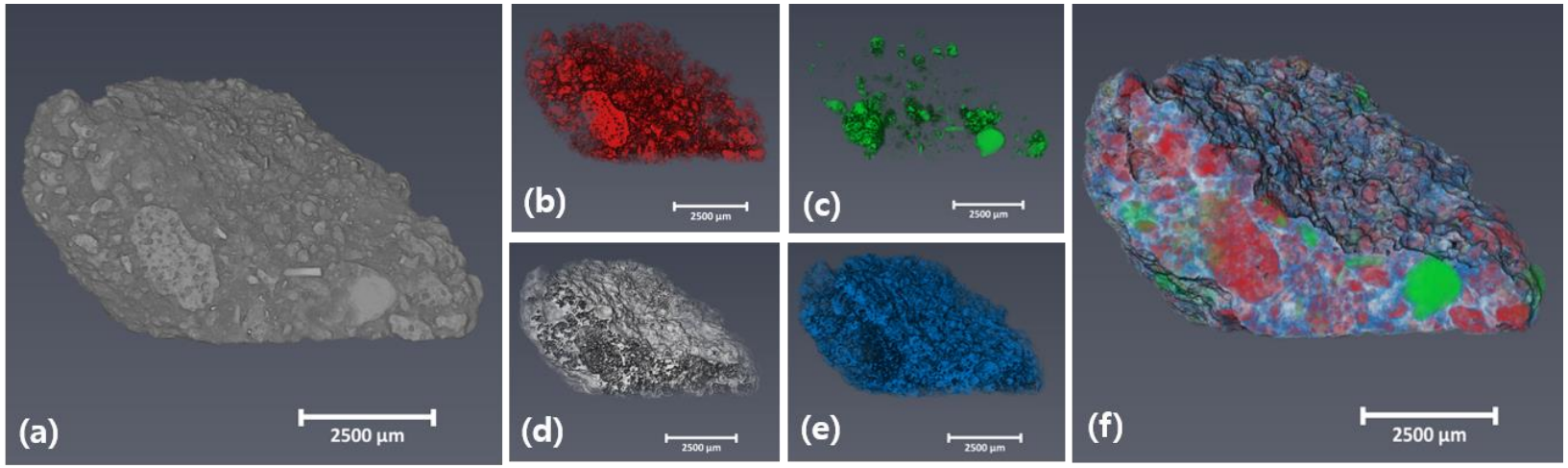


Introduction and Examples

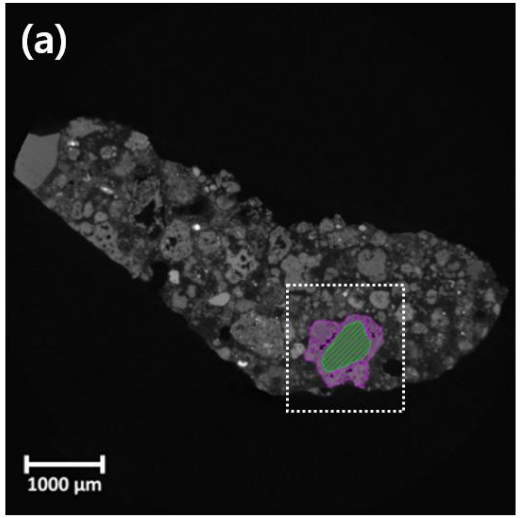
3D Porosity of an aggregate in Roman concrete

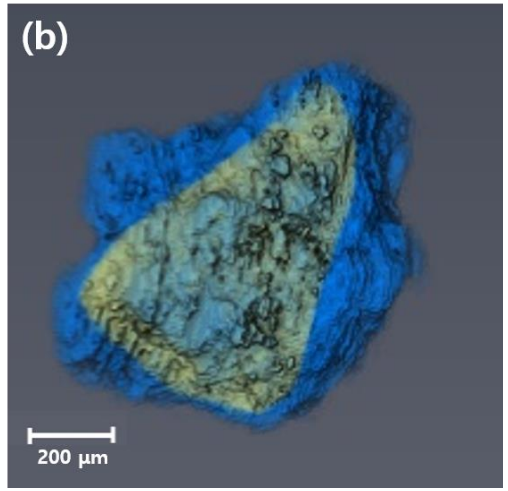


3D Phase quantification



Reaction rim around certain component

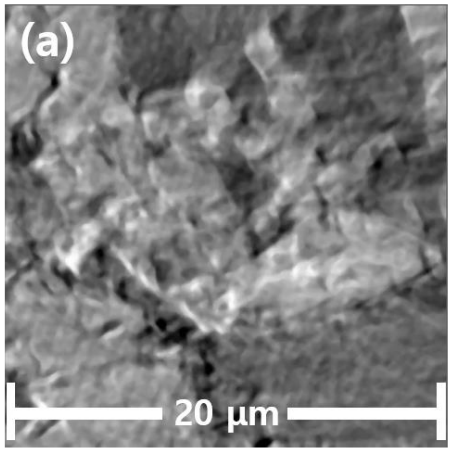


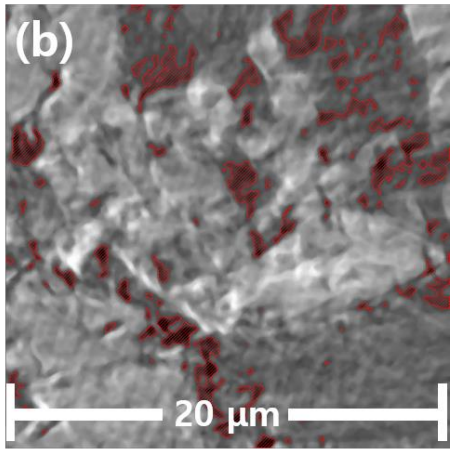


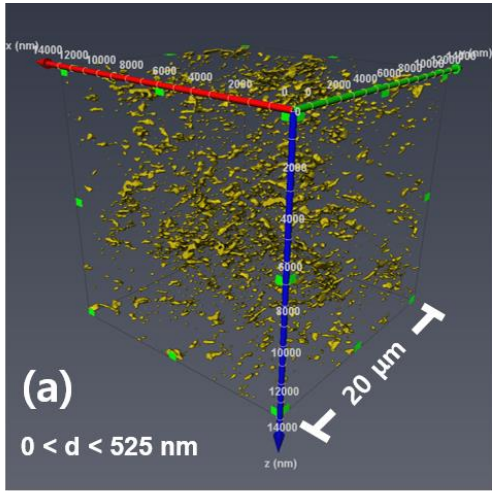
Introduction and Examples

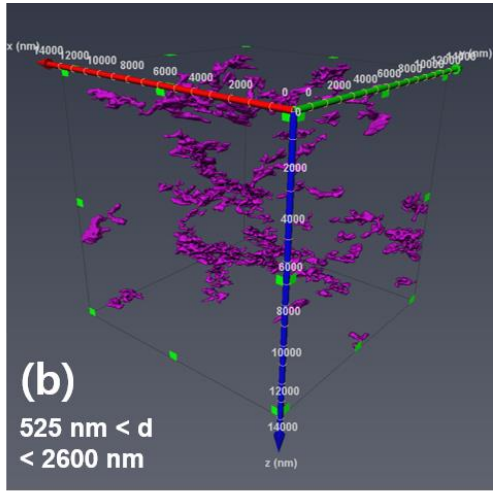
Synchrotron-based Nano-Tomography

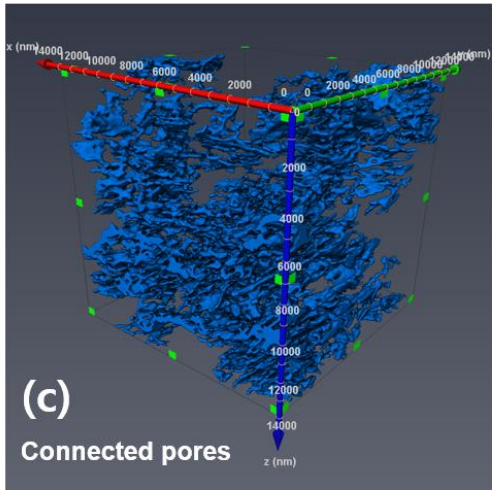
Resolution: 20 nm/pixel

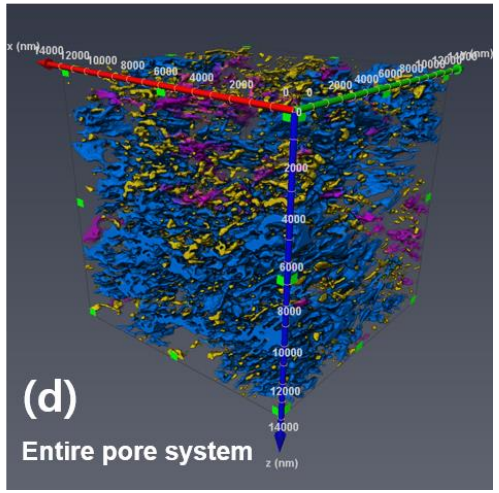


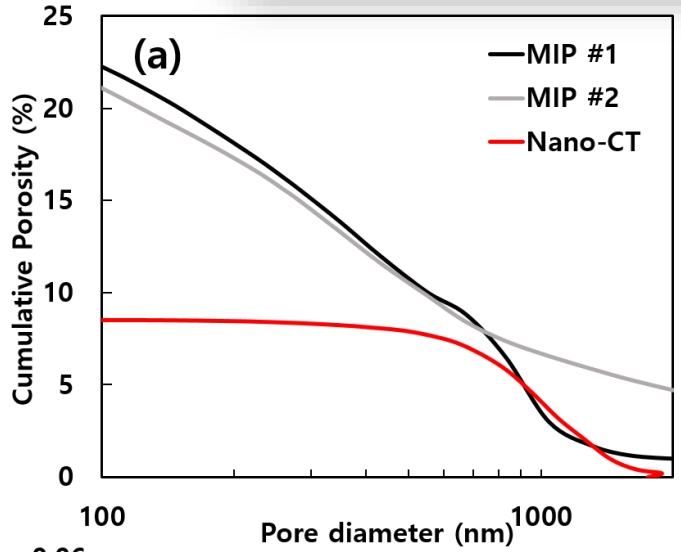


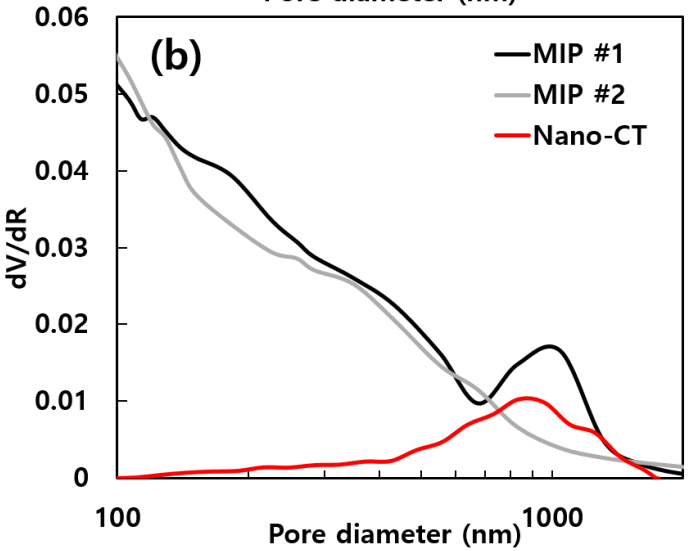








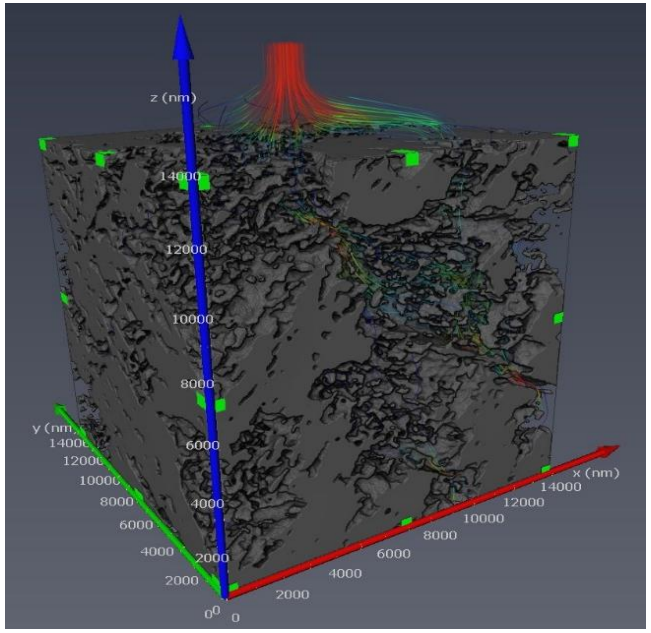


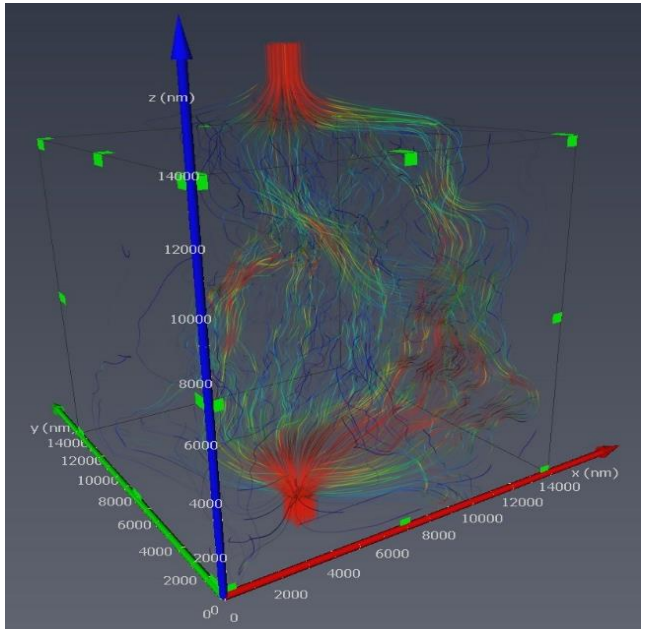


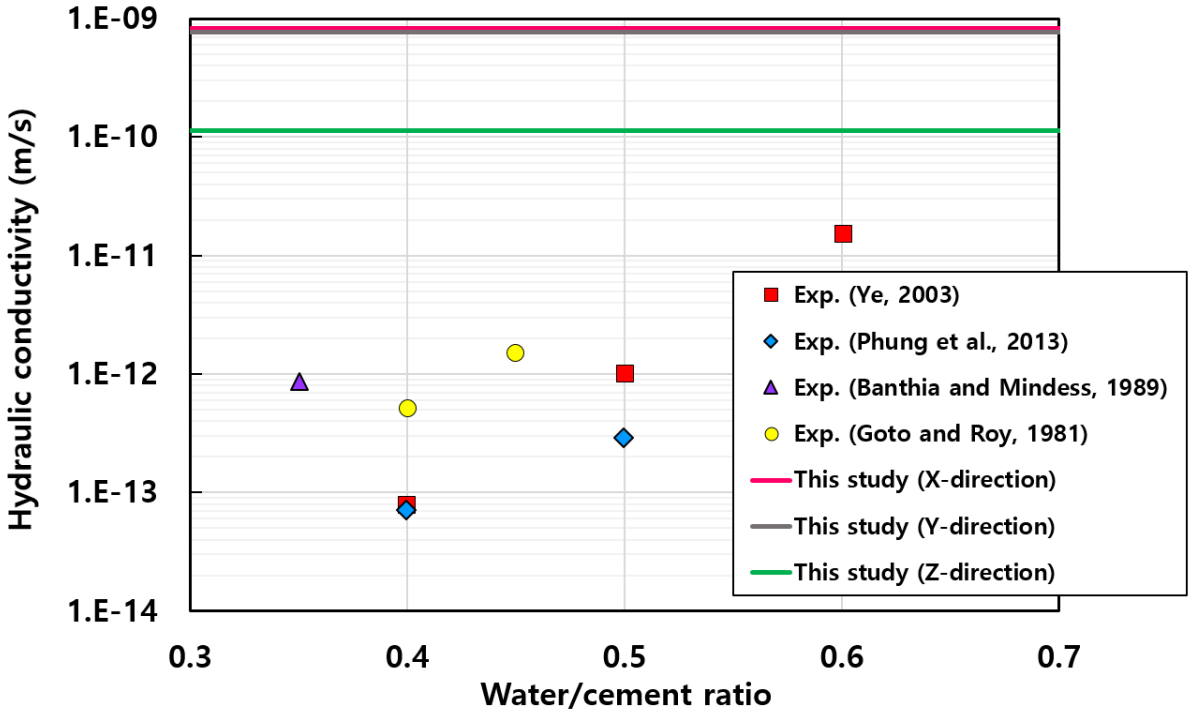
Introduction and Examples

3D water permeability simulation on

inter-connected structural segment



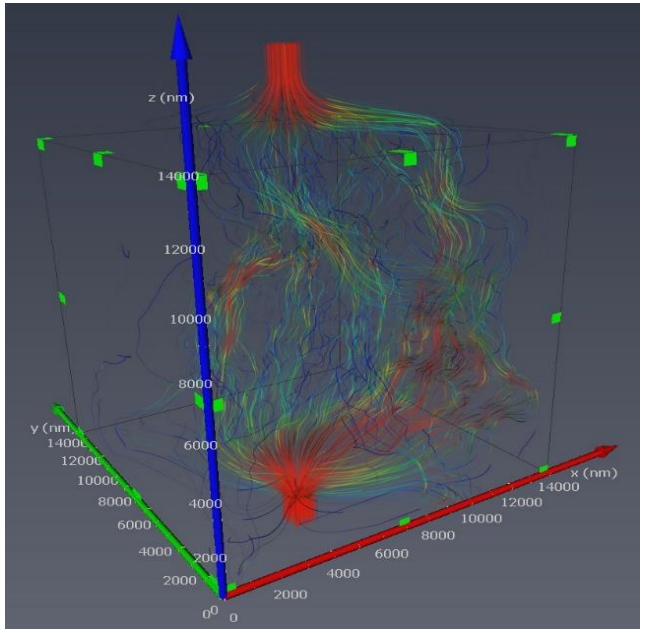


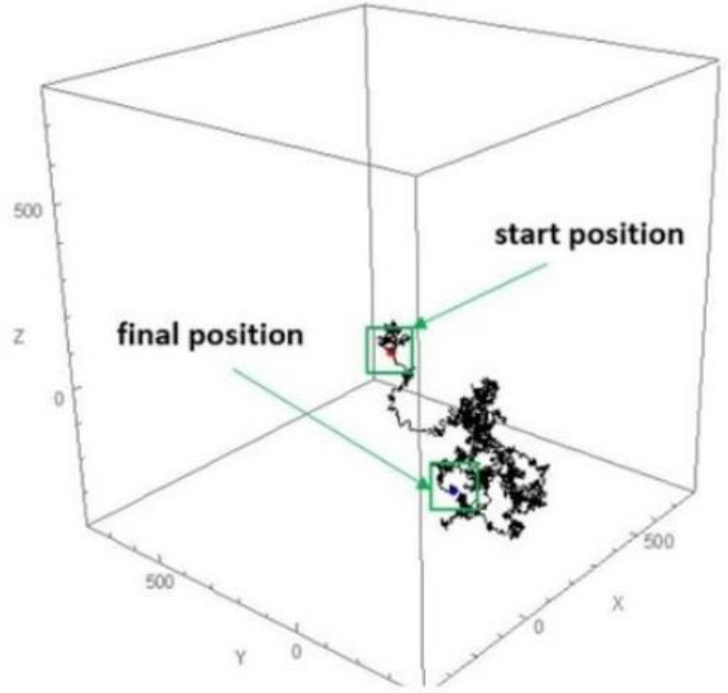


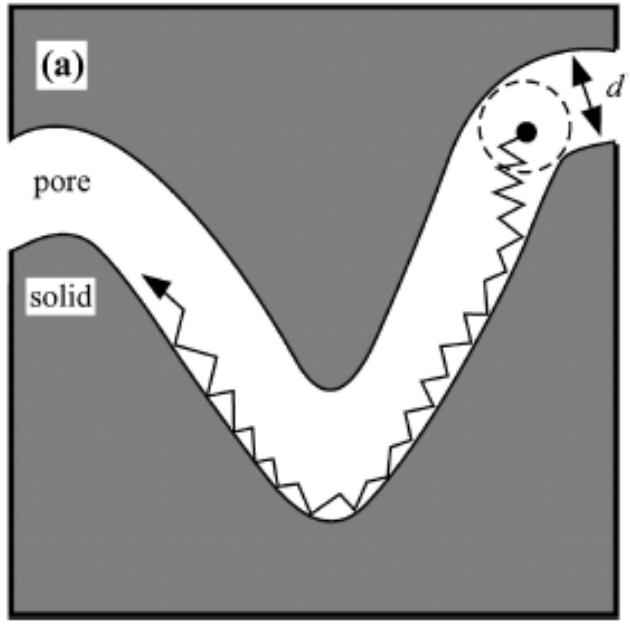
Introduction and Examples

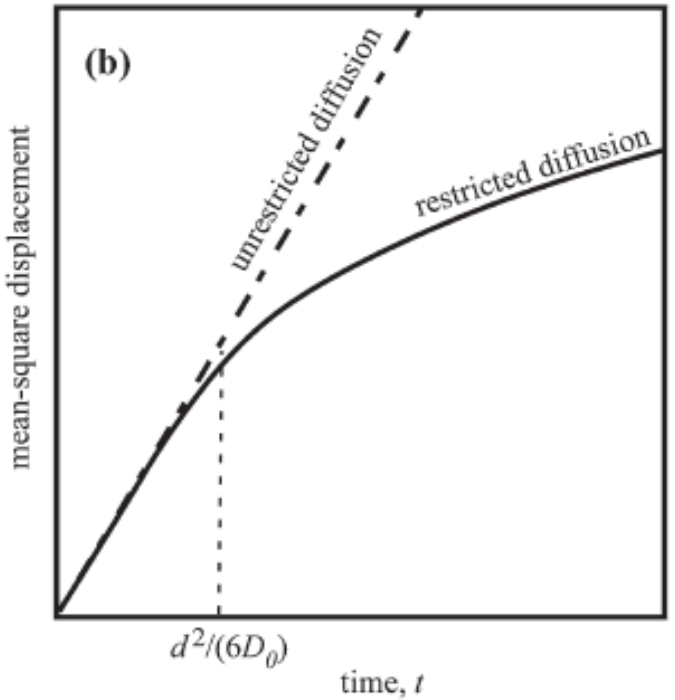
Random walk calculation
Tortuosity can be measured as the ratio of the self-diffusion of a walker in free space to the self-diffusion of a walker in the porous medium

$$\tau_D = \frac{D_o}{D(t)} = \frac{a^2}{\frac{d(r(\tau)^2)}{d\tau}} \; as \; t \to \infty \cup \tau \to \infty$$





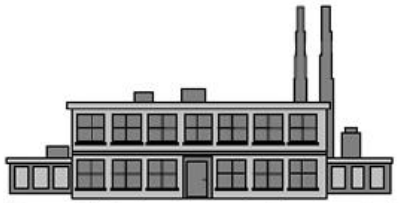




Introduction and Examples

Sulfur polymer concrete

Mercury Stabilization

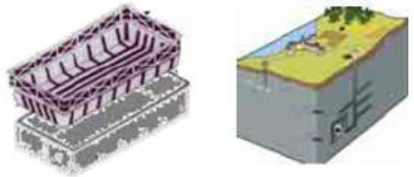


Refined to separate metals
Leaving Hg residuals

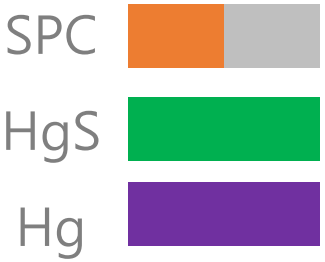
Ore containing Hg

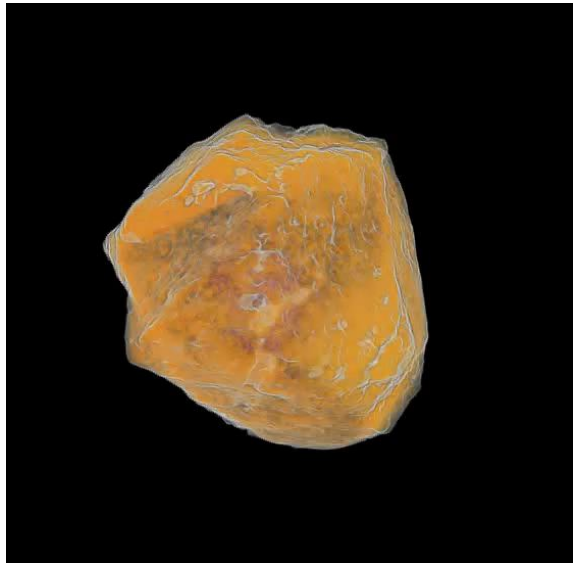
Gold and other mineral mines

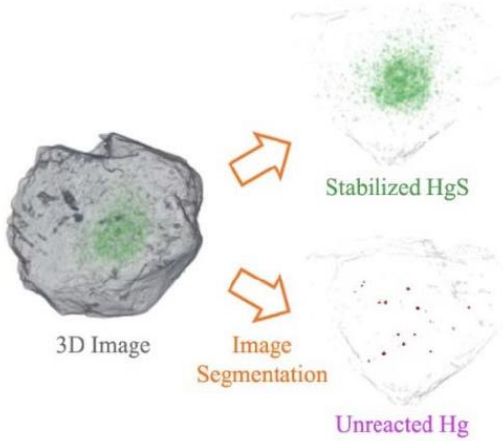
SPSS Hg Treatment
Process

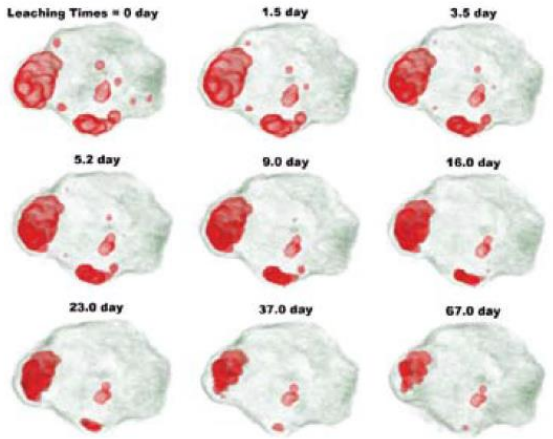


Disposal in hazardous
waste landfill or repository





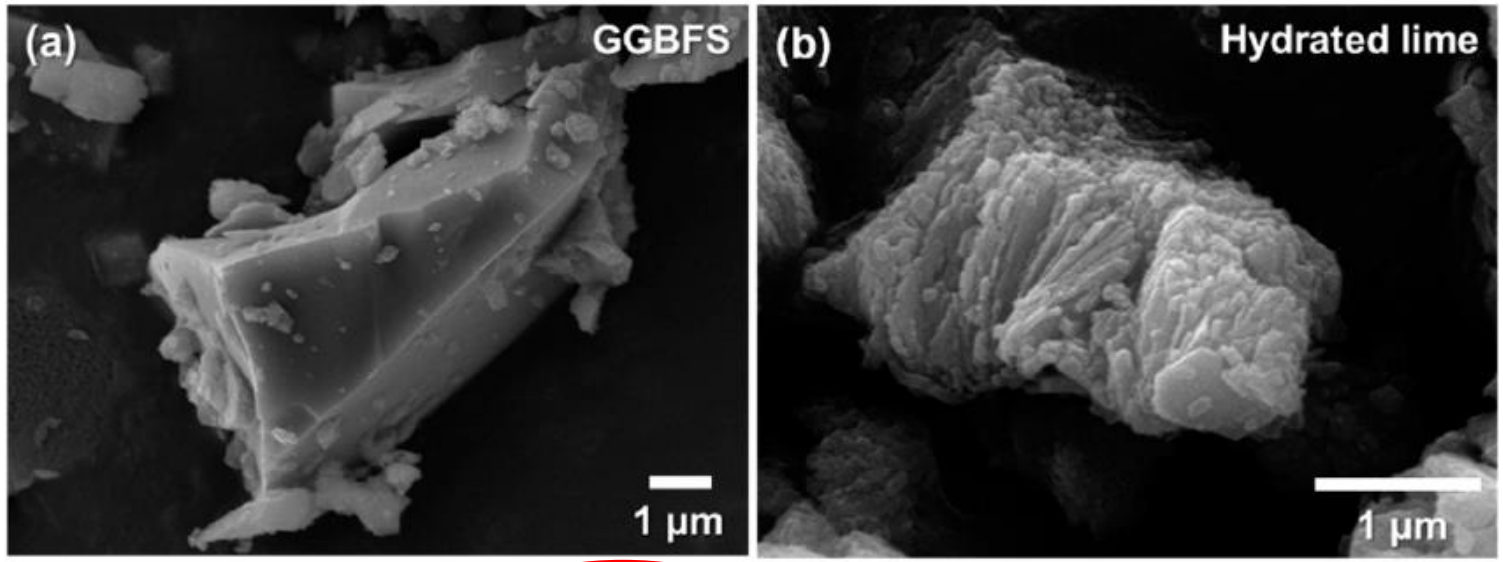


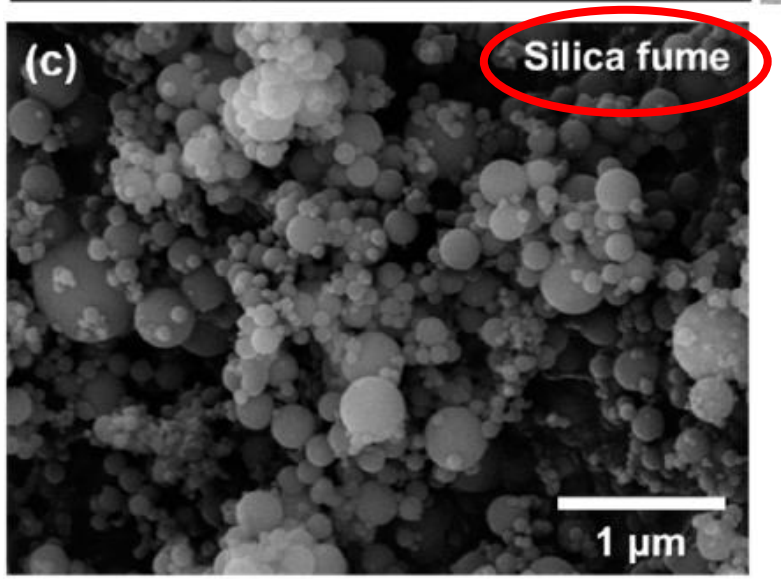


Introduction and Examples

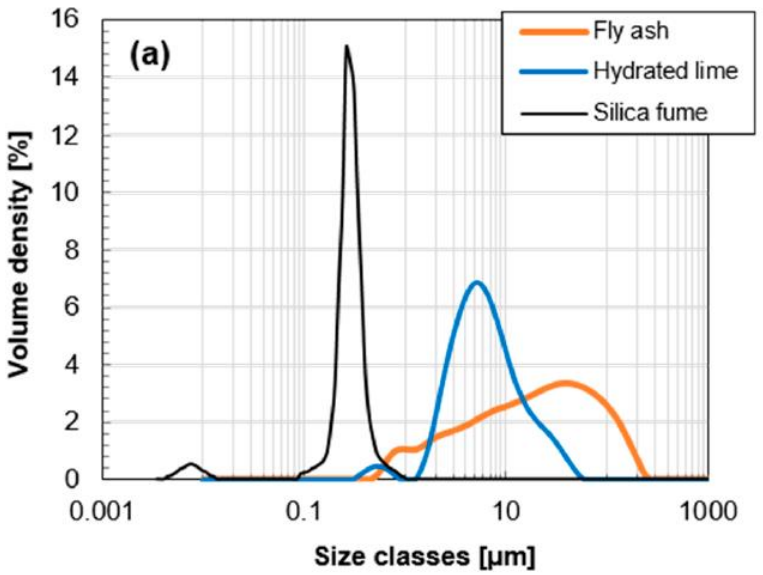
Pixel = 1000 by 1000

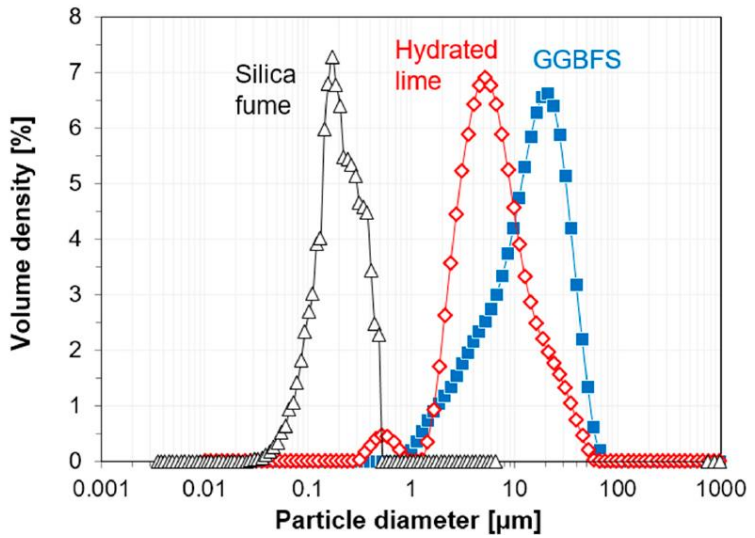
Resolution = 5 nm/pixel





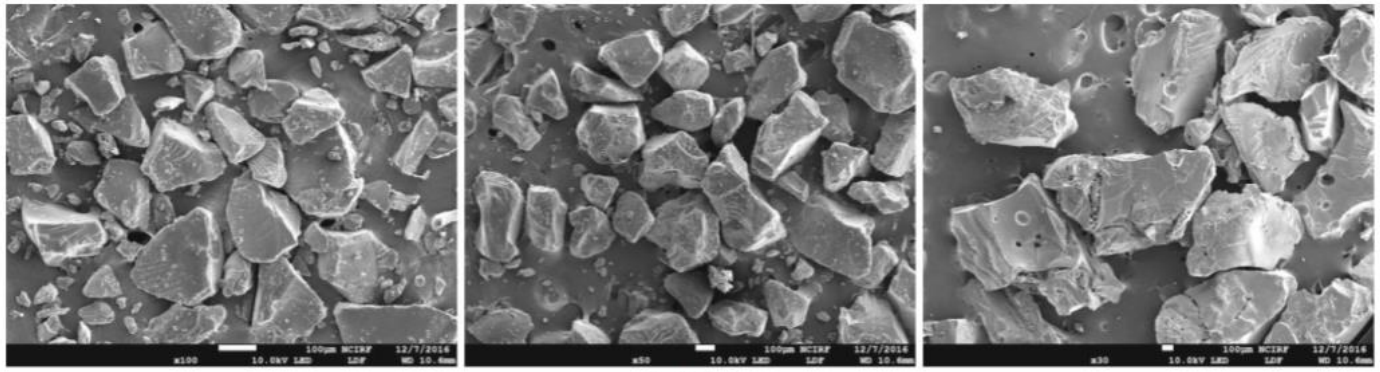
Silica fume is too small to be accurately measured by laser diffraction!





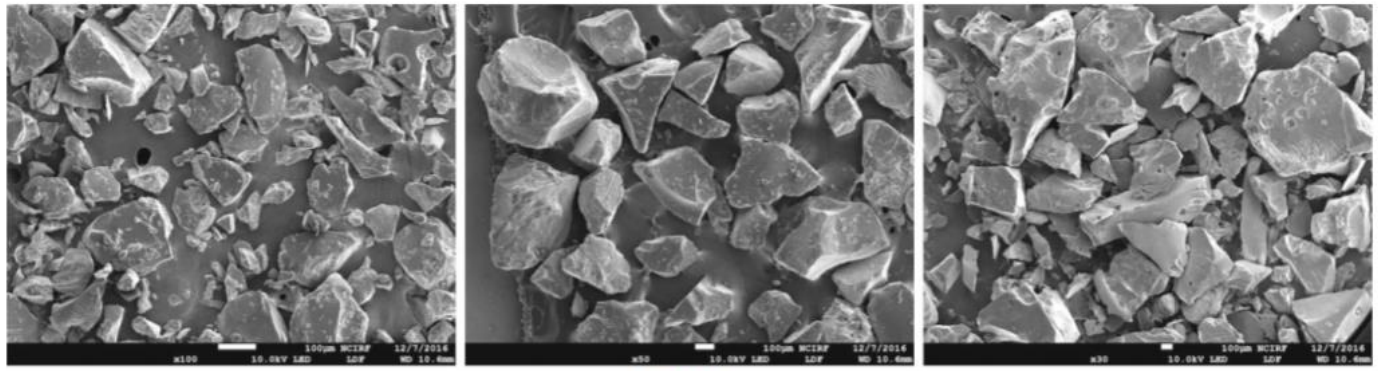
Introduction and Examples

Superabsorbent polymer (SAP) particle size distribution



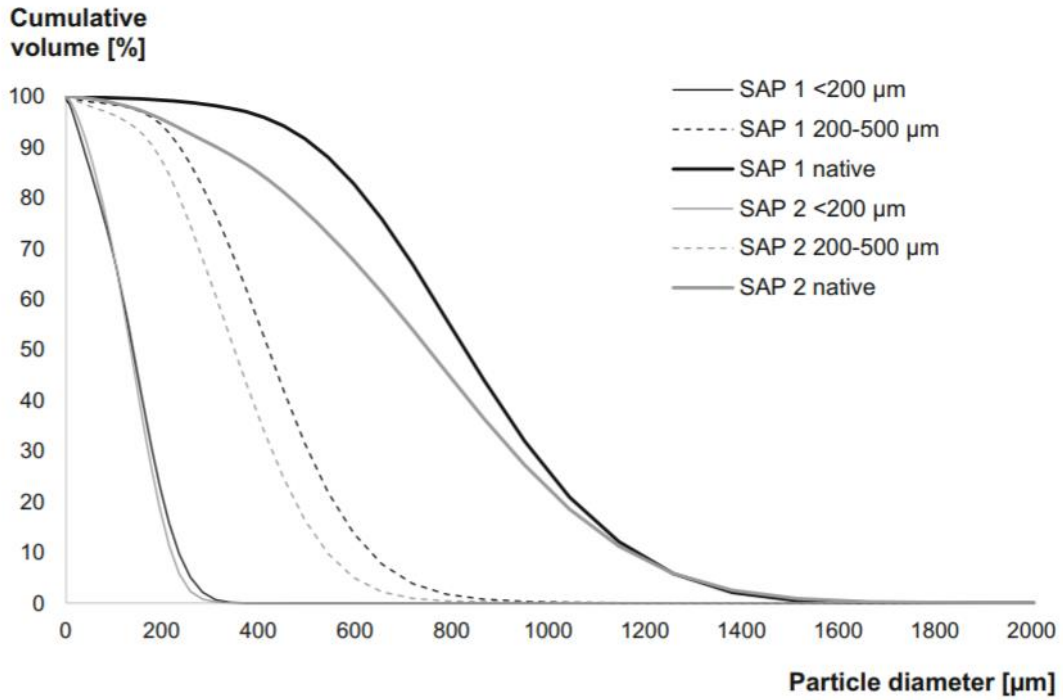
SAP 1

< 200 µm | 200 µm to 500 µm | Native grading



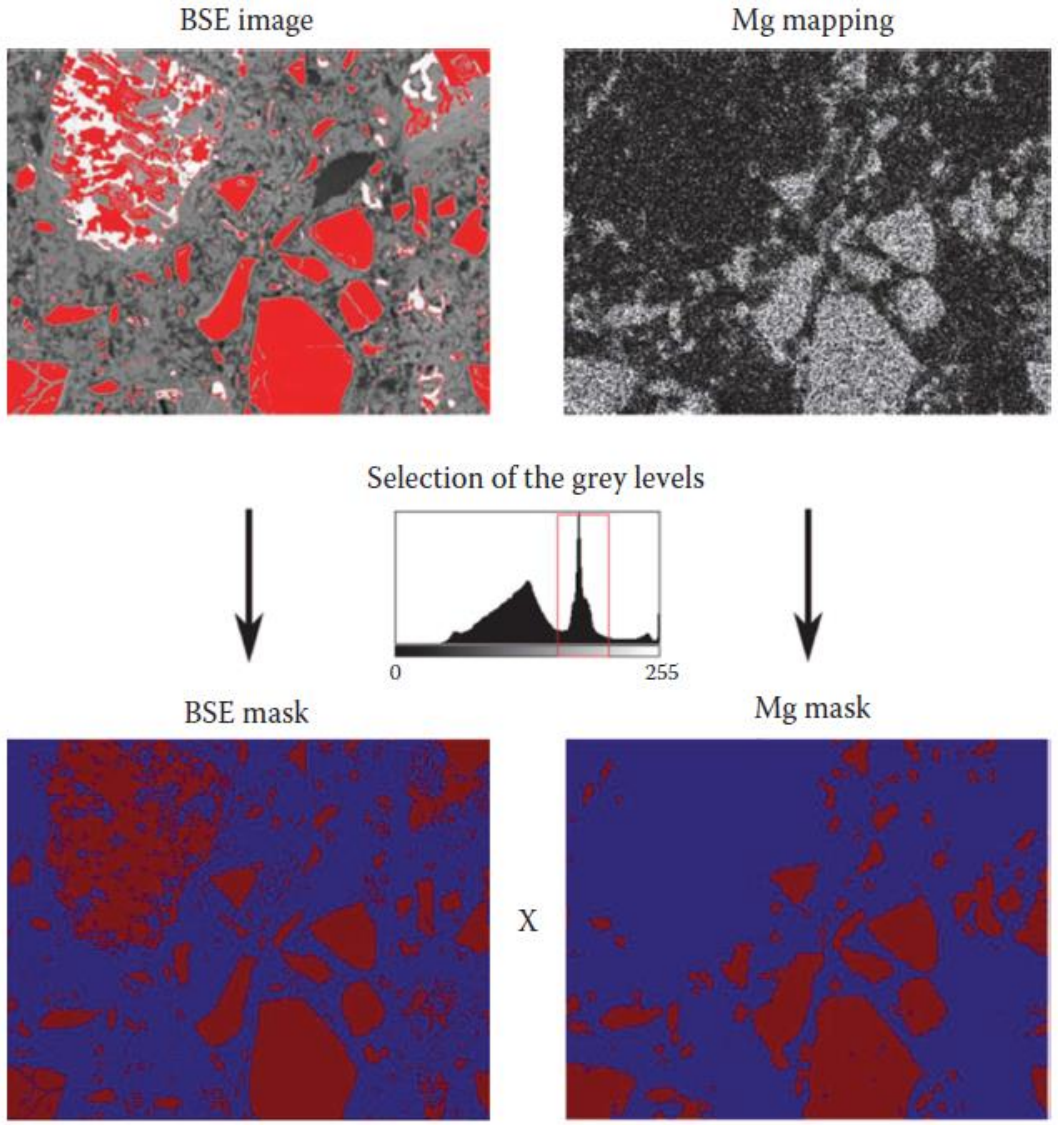
SAP 2

< 200 µm | 200 µm to 500 µm | Native grading



Introduction and Examples

Image processing combined with SEM analysis



Final result

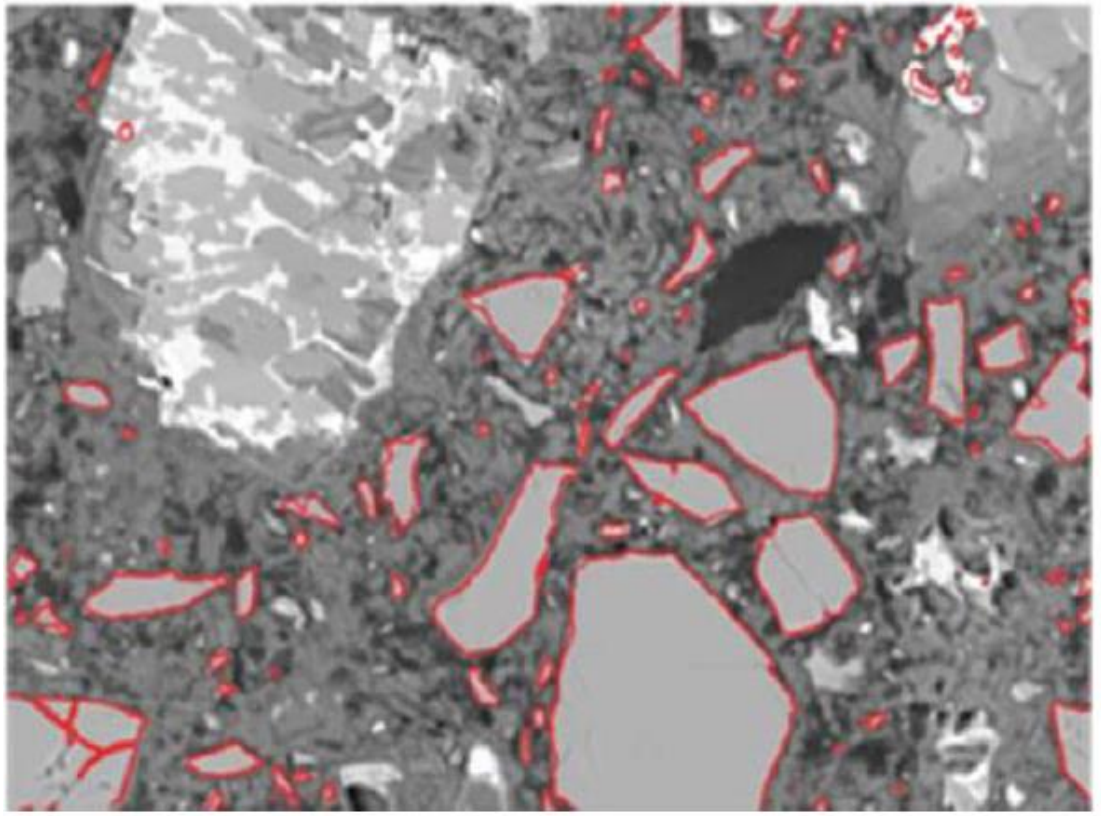


Figure 8.30 Description of the analysis by BSE and Mg mapping for CAC-slag systems. (Courtesy of Julien Bizzozero.)

(Scrivener, Snellings, Lothenbach, CRC Press 2017)

Introduction and Examples

Image processing combined with SEM analysis

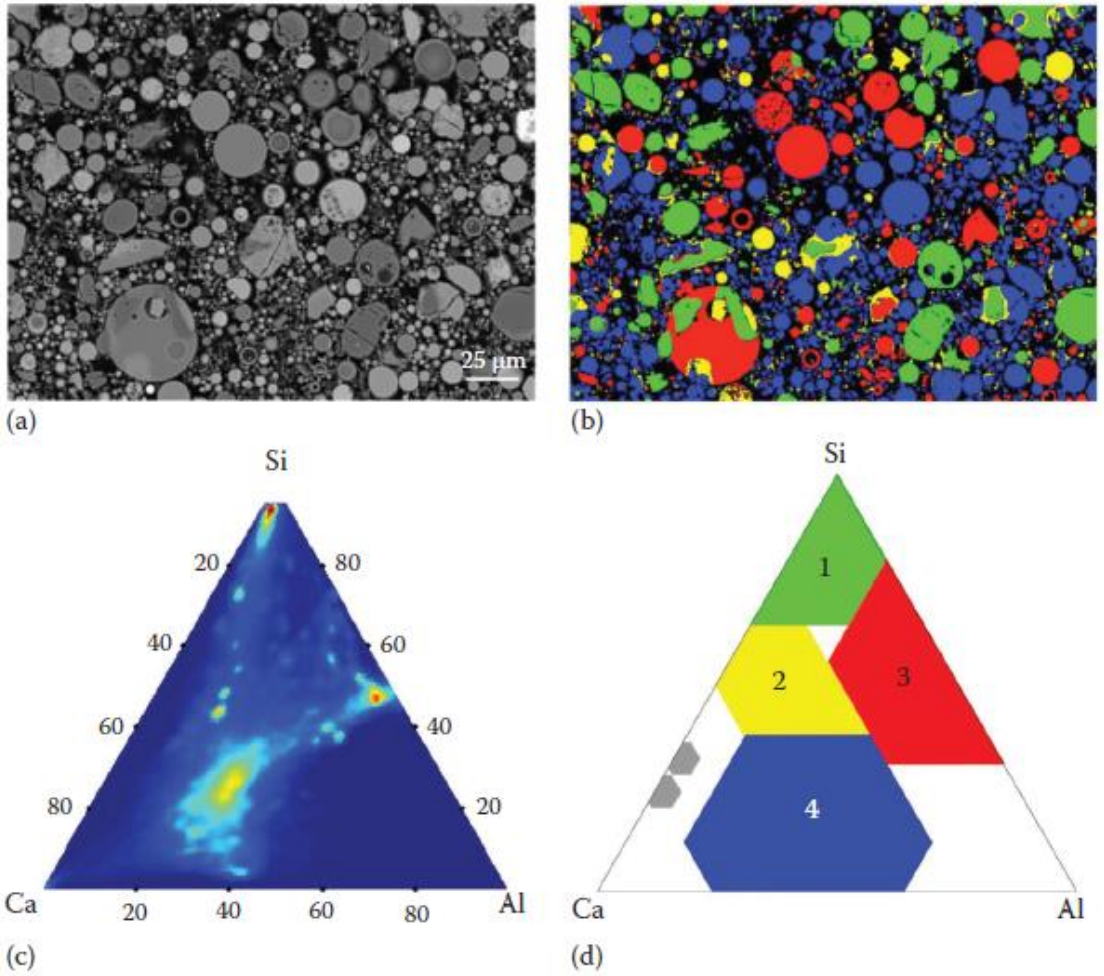
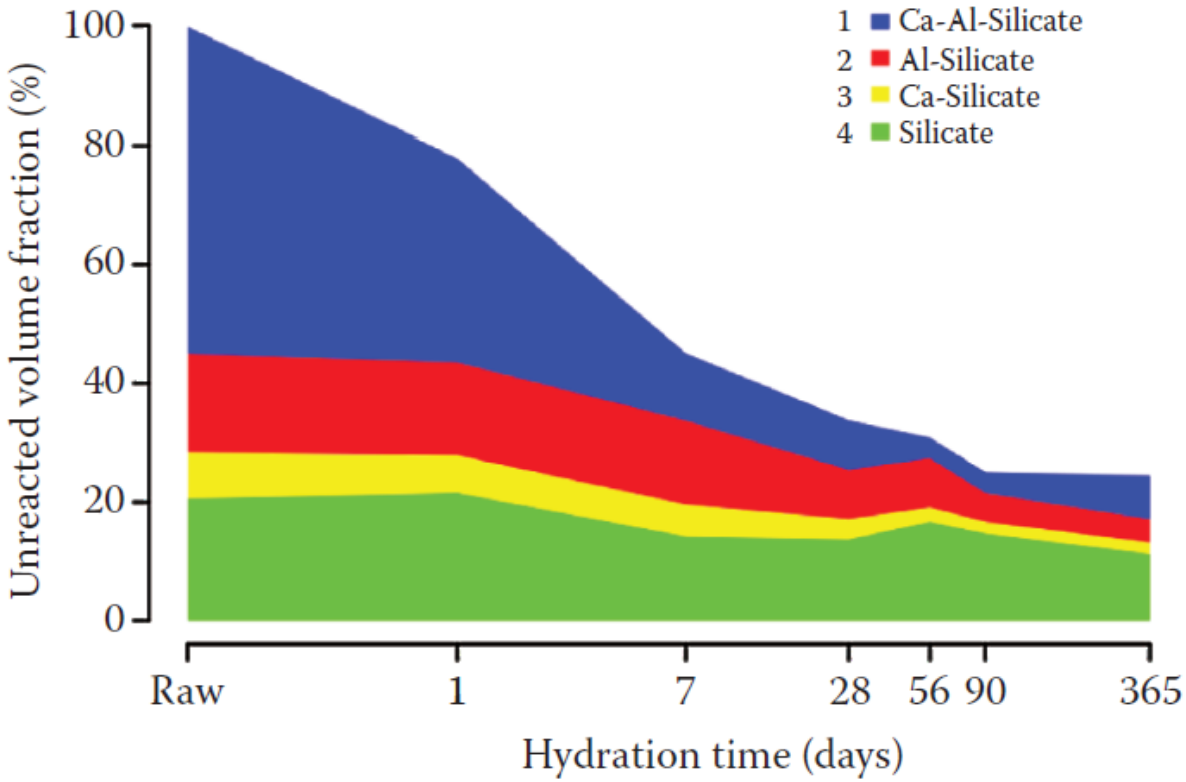


Figure 8.32 (a) BSE image of fly ash; (b) classes of glass shown in original image; (c) presentation of the full spectral data in a ternary diagram; (d) definition of the different subclasses 1–4. (Courtesy of Paweł Durdziński.)



(Scrivener, Snellings, Lothenbach, CRC Press 2017)

Introduction and Examples

More Advanced Image processing

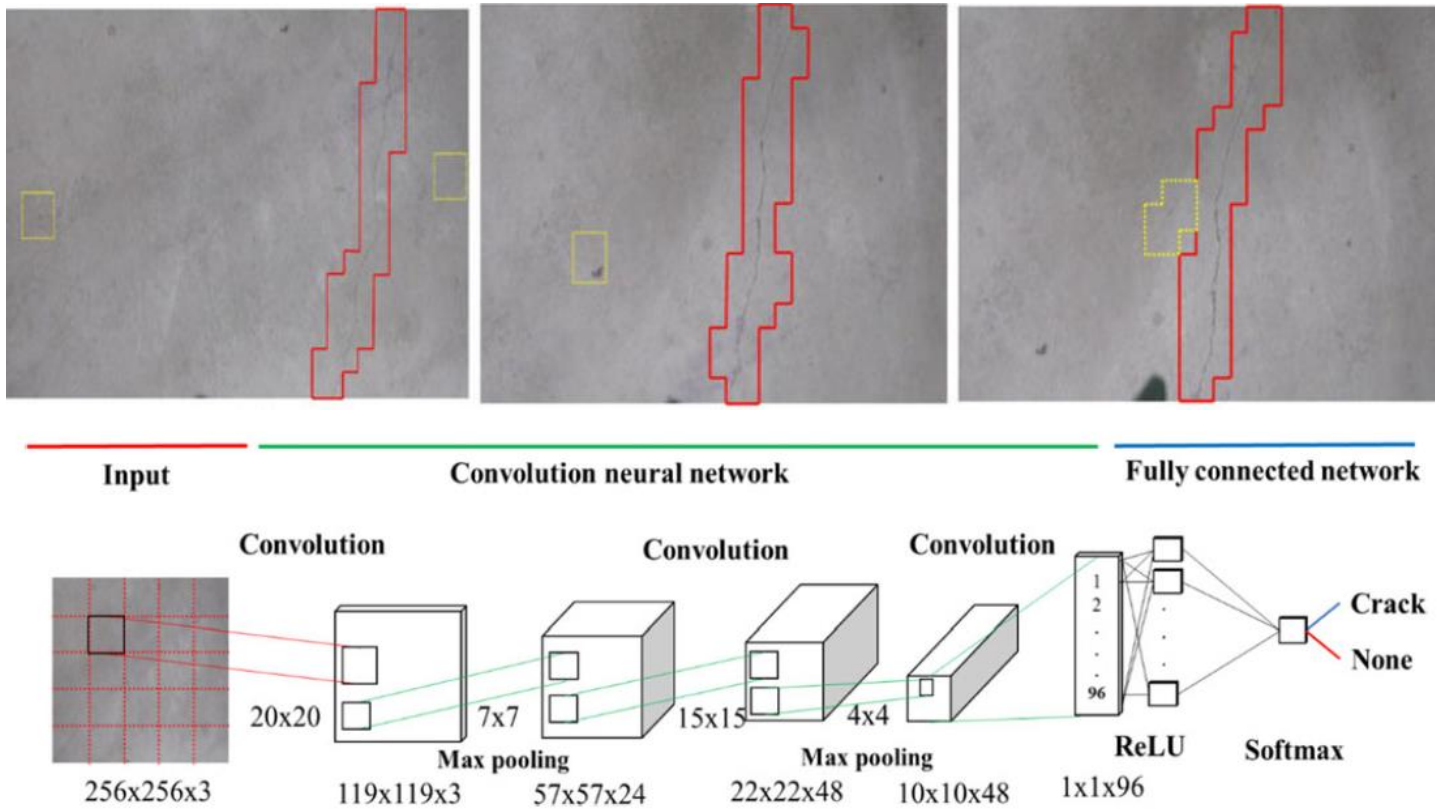


Fig. 7. CNN architecture.

(Kang and Cha 2018)

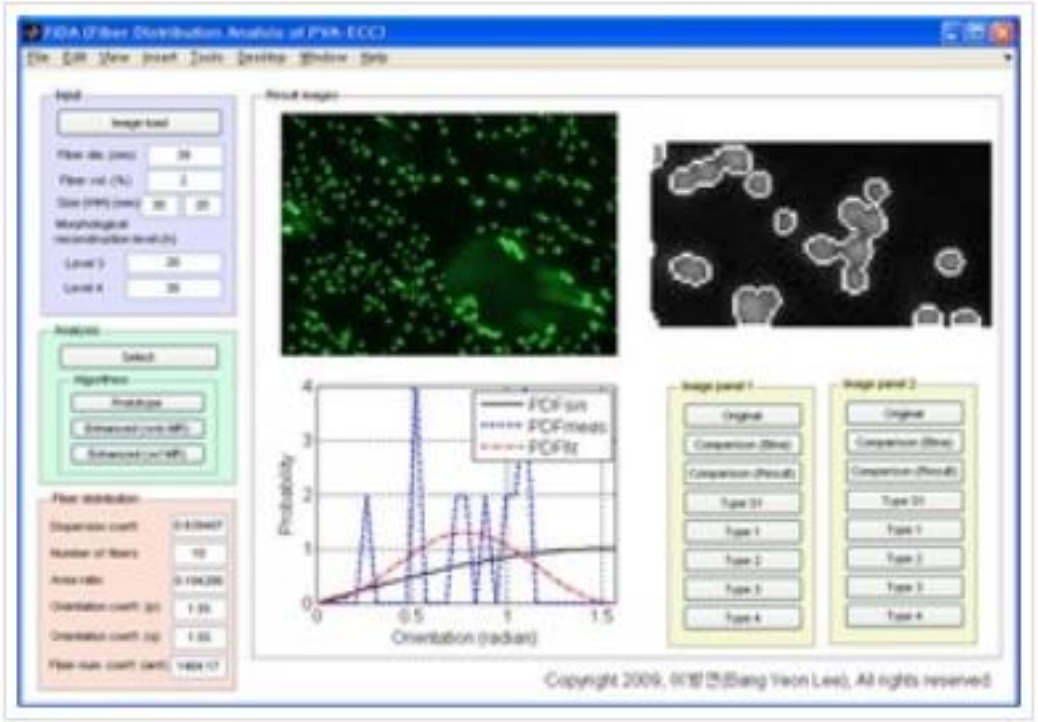


Fig. Fiber distribution analysis program

(전남대학교 이방연 교수)

(Class note from B. Militzer UC Berkeley, 2012)

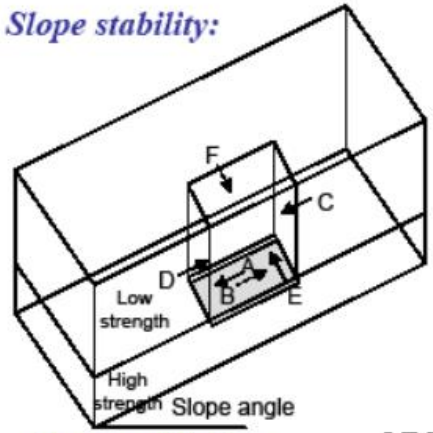
Introduction and Examples

Other applications

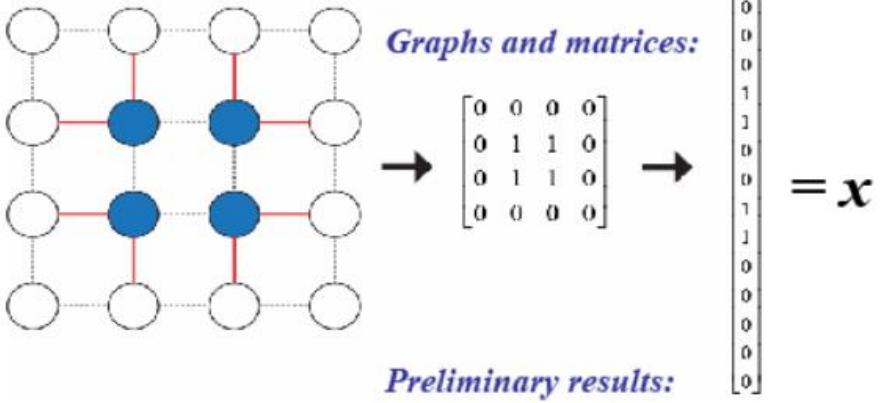
Edge detection

Predicting size and location of shallow landslides

Slope stability:



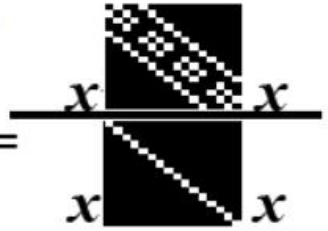
Graphs and matrices:



$$= x$$

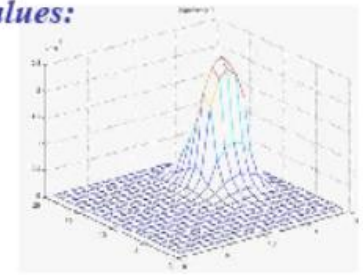
Factor of Safety:

$$FoS = \frac{x^T R x}{x^T F x} =$$



Eigenvectors and eigenvalues:

$$F^{-1/2} R F^{-1/2} y = \lambda y$$



Preliminary results:

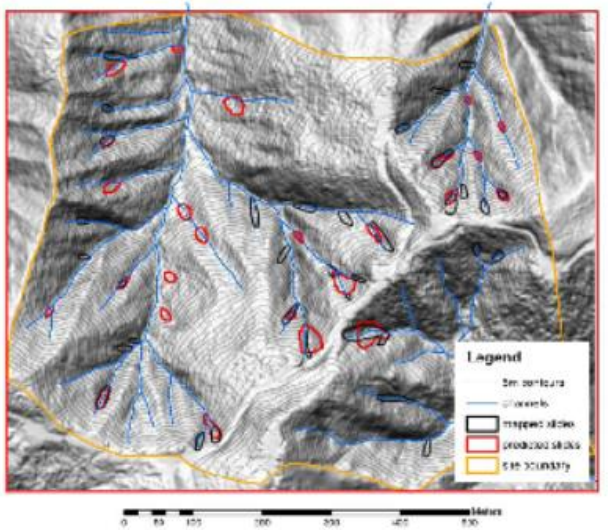


Figure 2. Prediction of size and location of shallow landslides: a 3-D slope stability model in matrix form, coupled with a spectral clustering minimization approach.