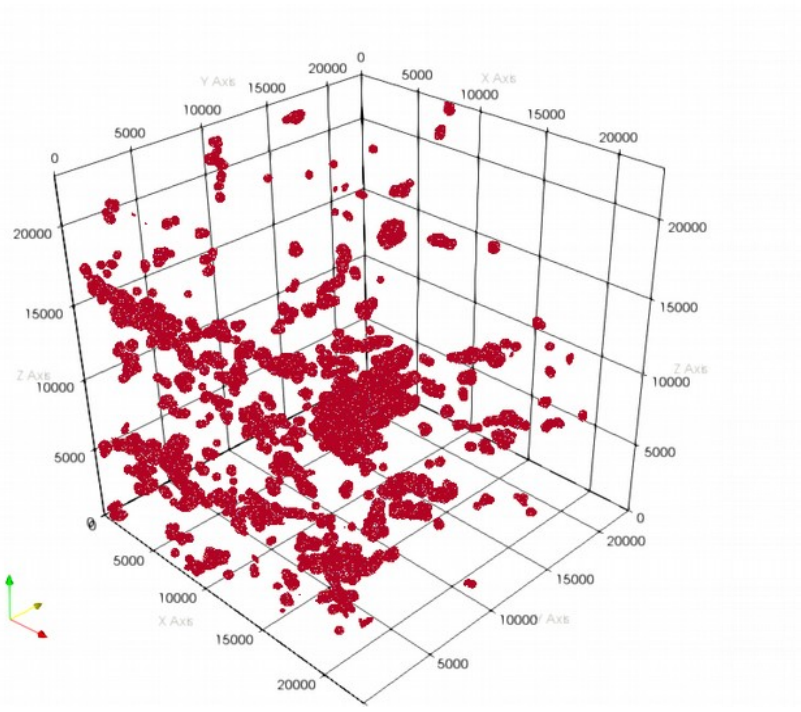
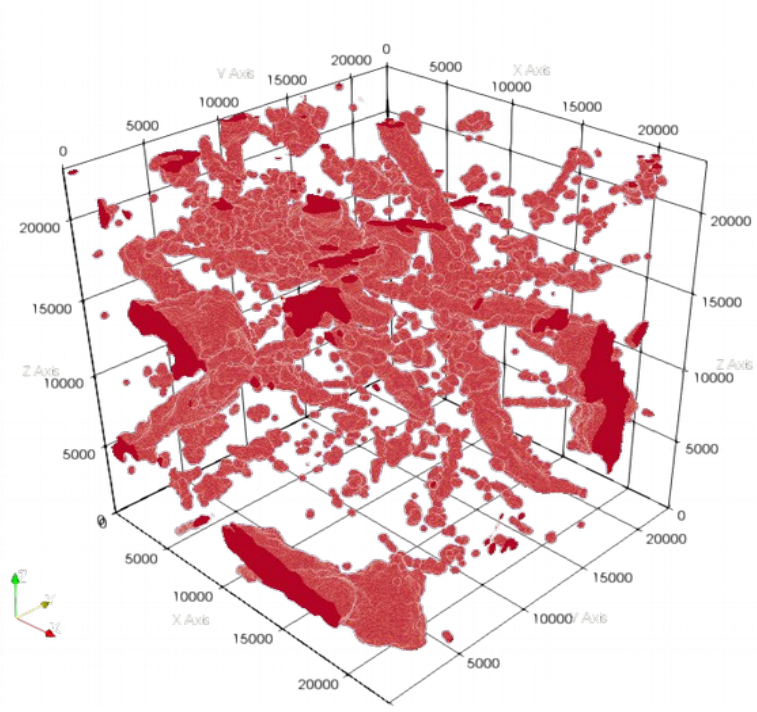
Applications of synchrotron radiation tomography to soil sciences – from the microaggregate to the centimeter scale





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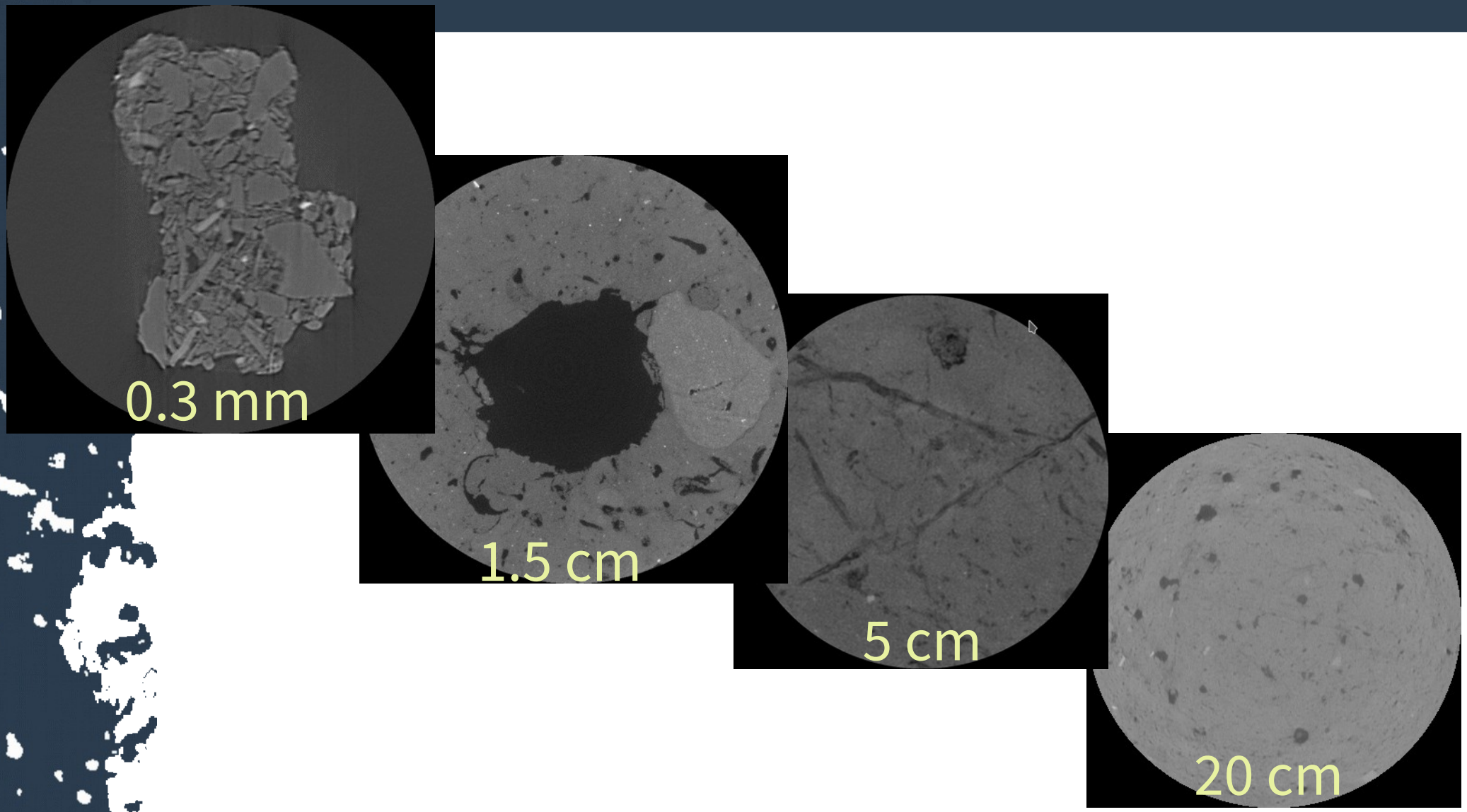
BODENKUNDE

Diversity of soils

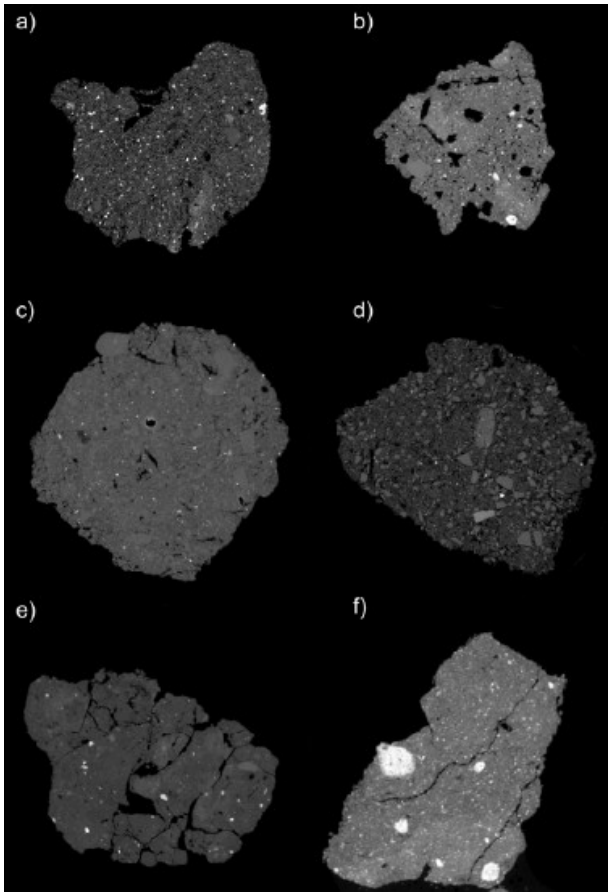
- Soils are diverse
- Many properties
- High variability
- Scale dependency

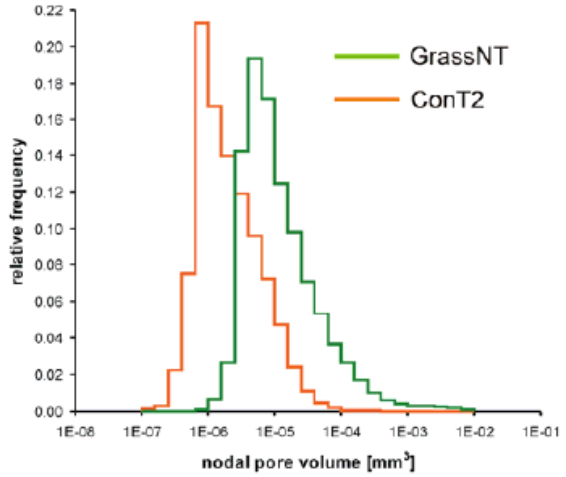
Broad scale range

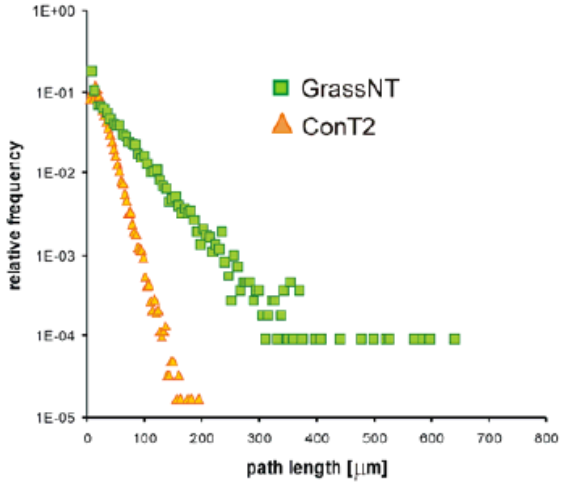


First approaches

Search for structure patterns...



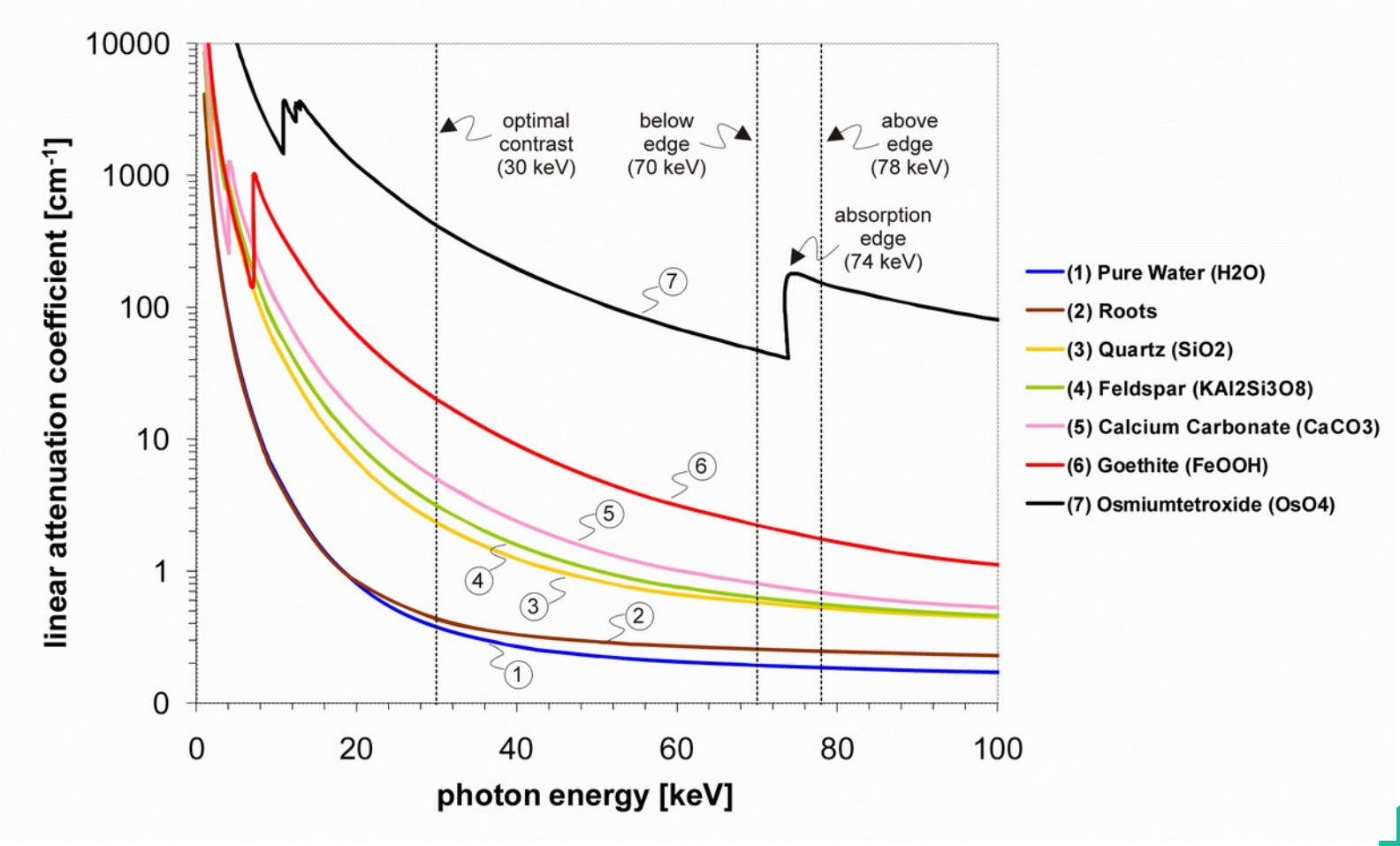




Peth et al. 2008

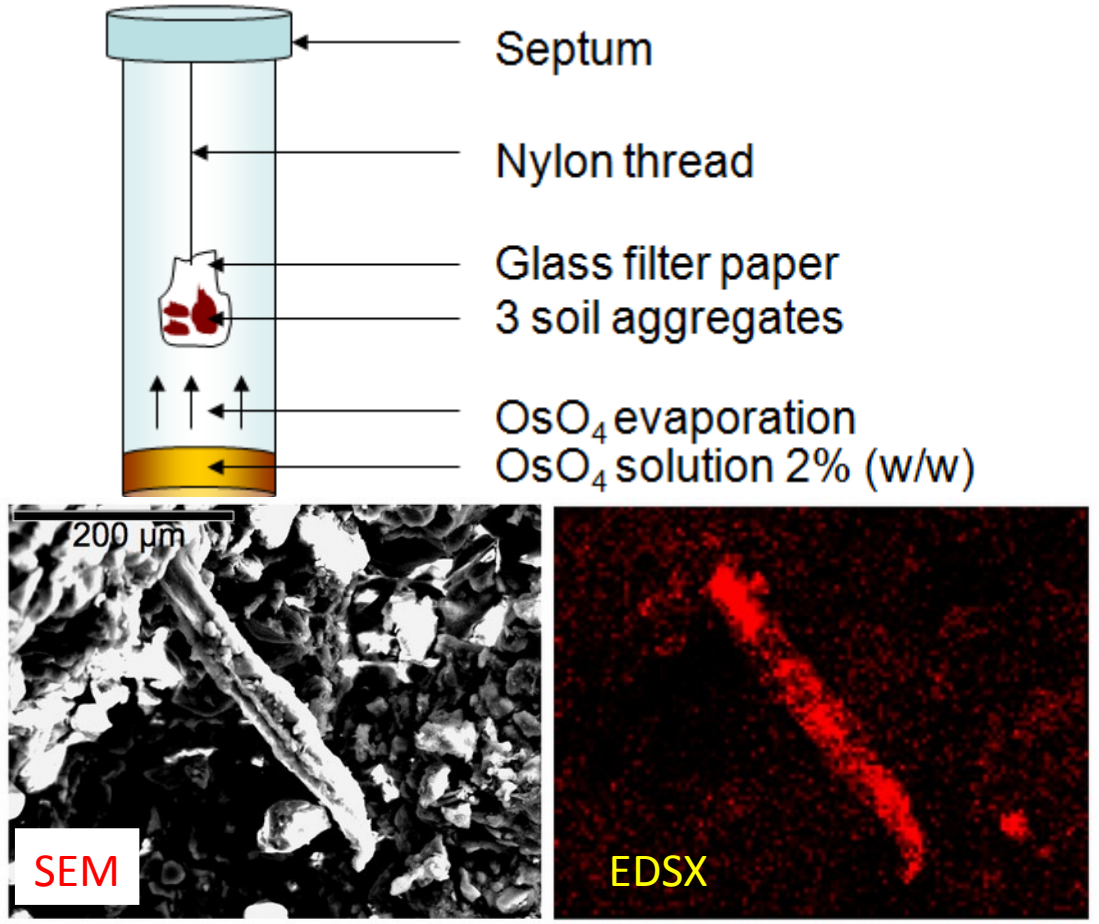
3D organic matter localization

Osmium staining



3D organic matter localization

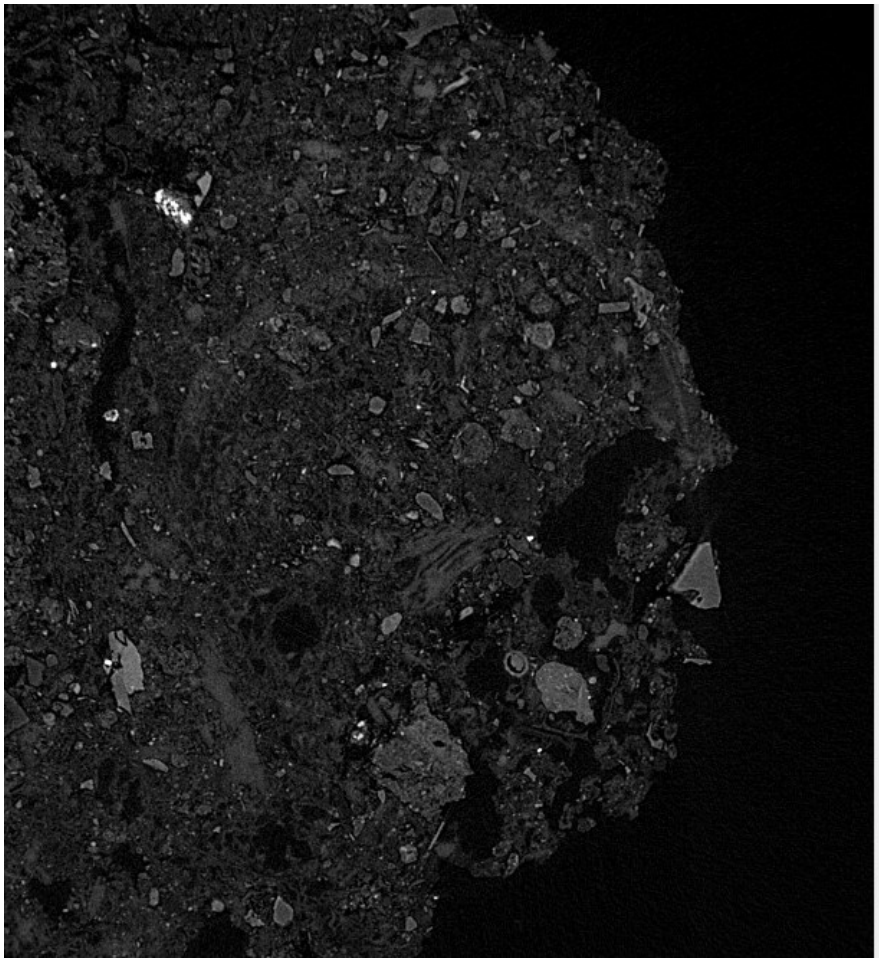
Staining OM with OsO_4

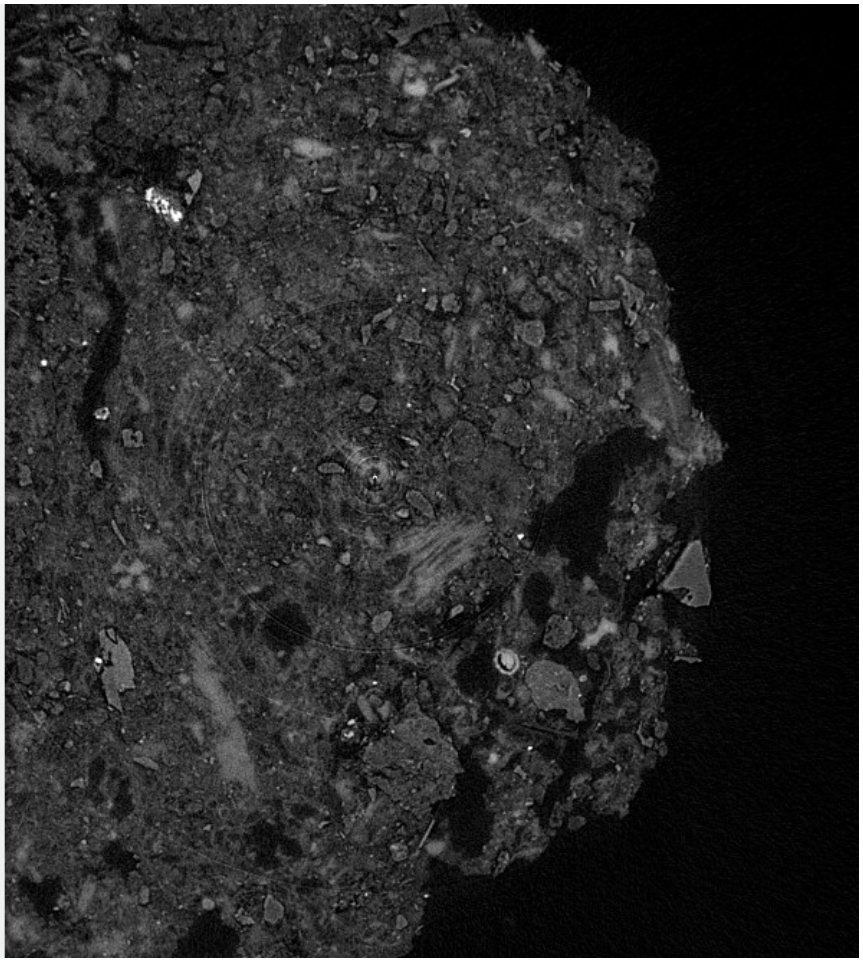


(Chenu & Plante, 2006)

3D organic matter localization

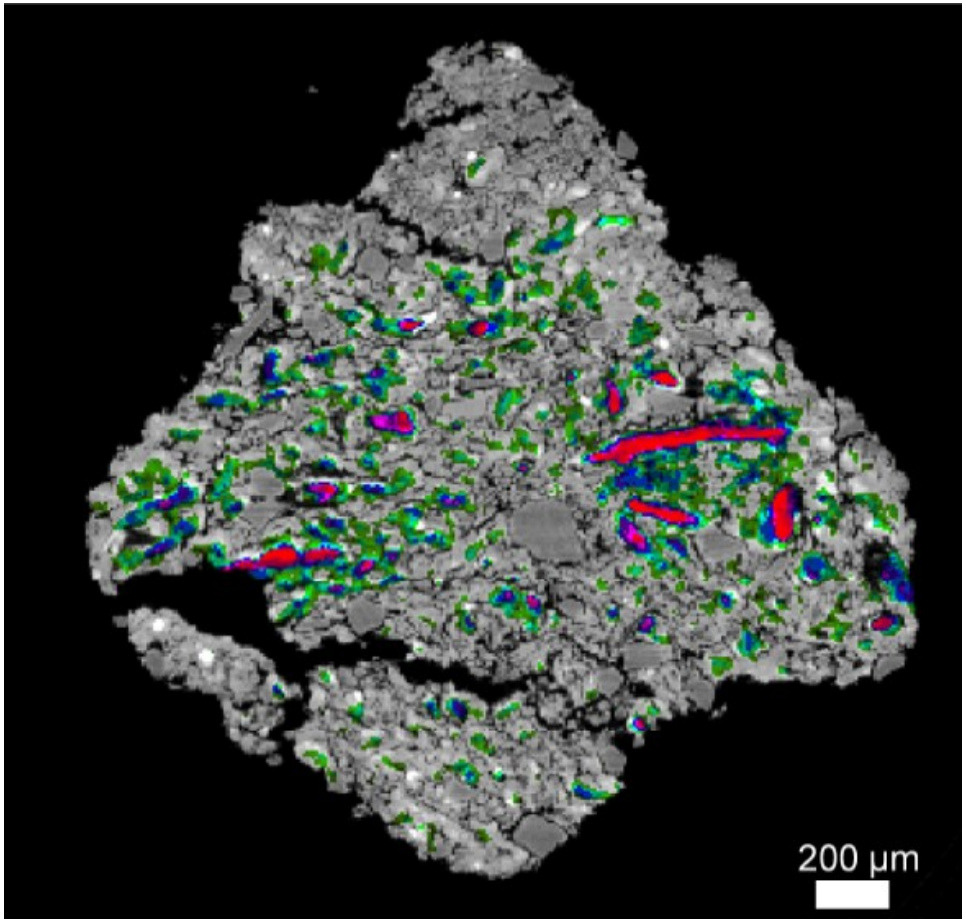
Image contrast

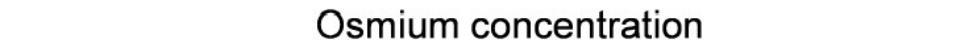




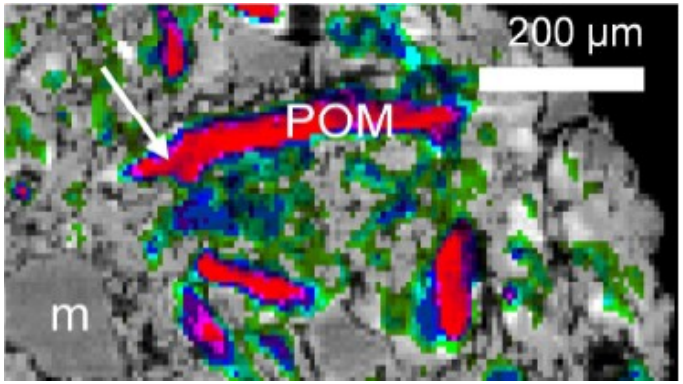
Peth et al. 2014

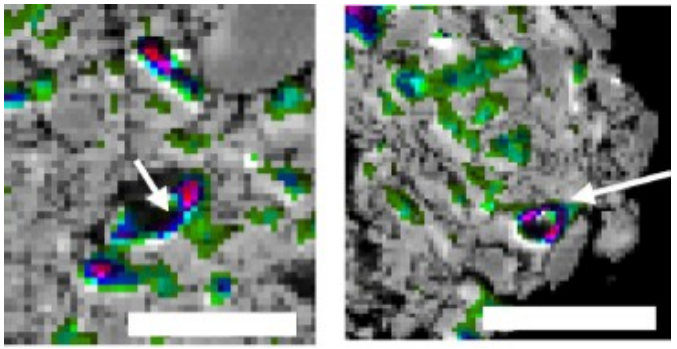
3D organic matter localization

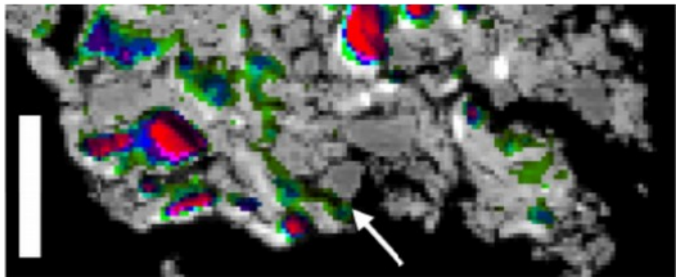




Osmium concentration





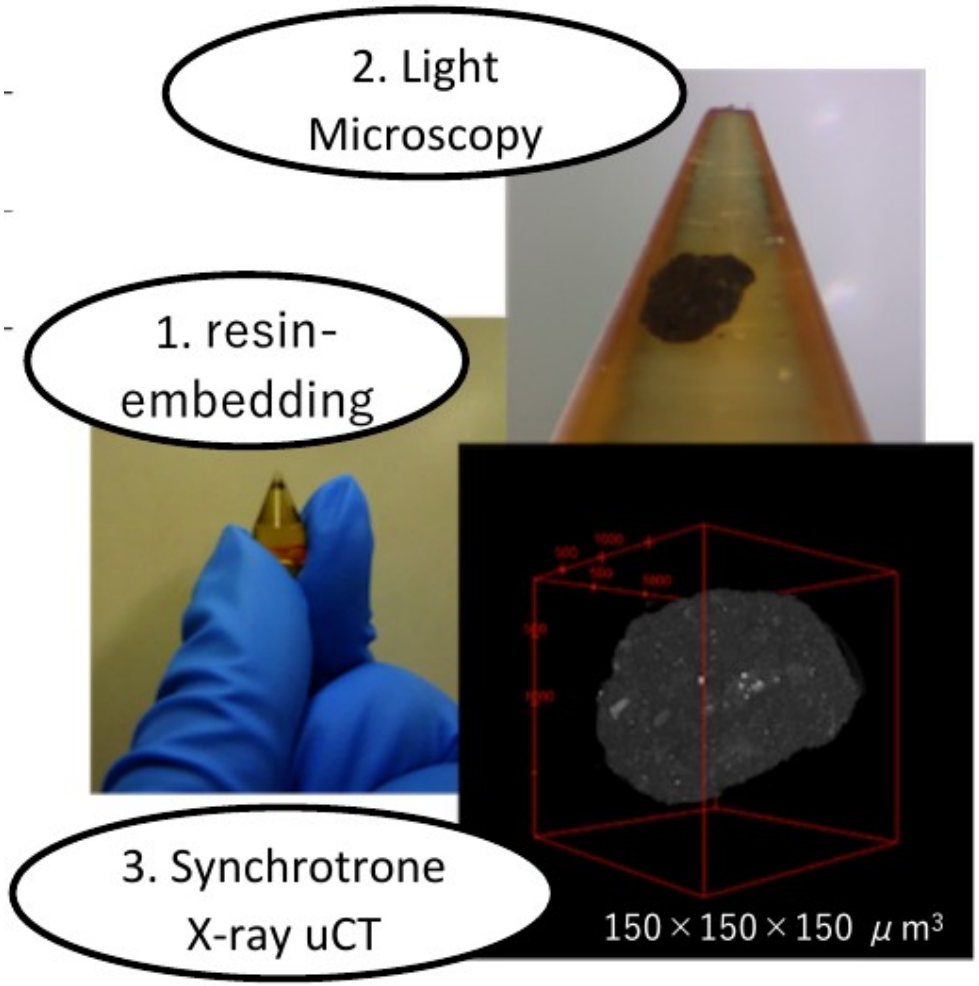


Peth et al. 2014

3D organic matter localization (Wagai et al.)

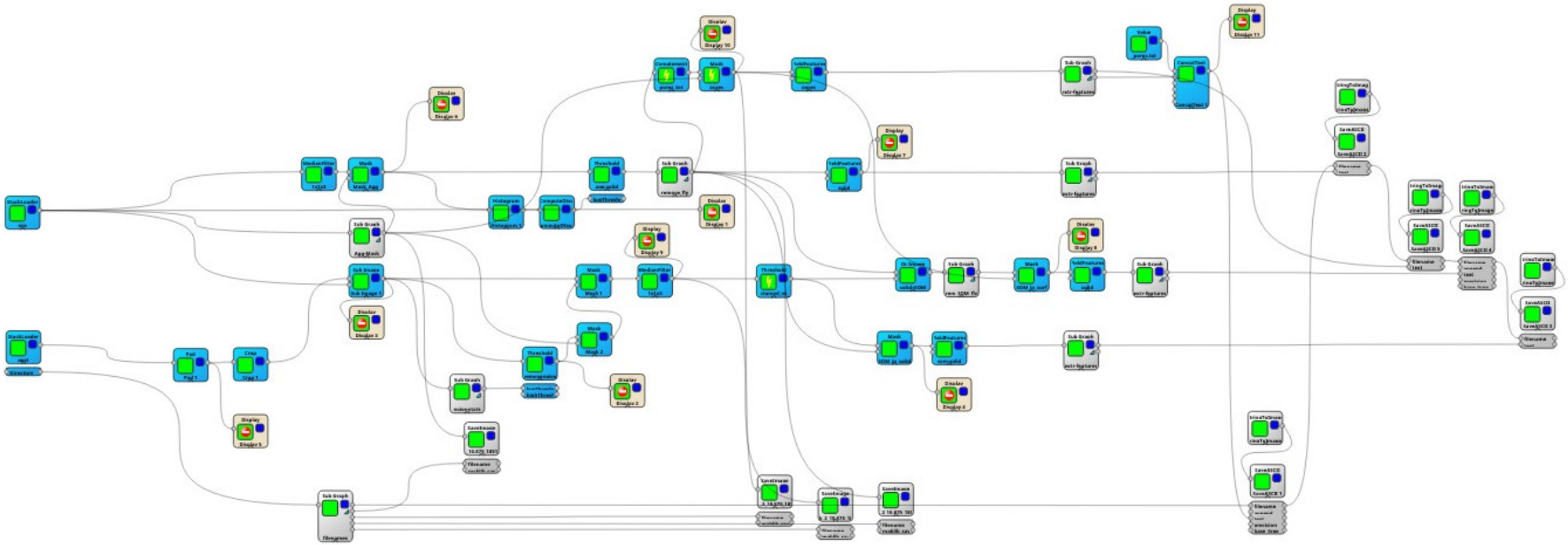
Osmium staining at SPring-8 beamline

- Andosols
- NT / CT



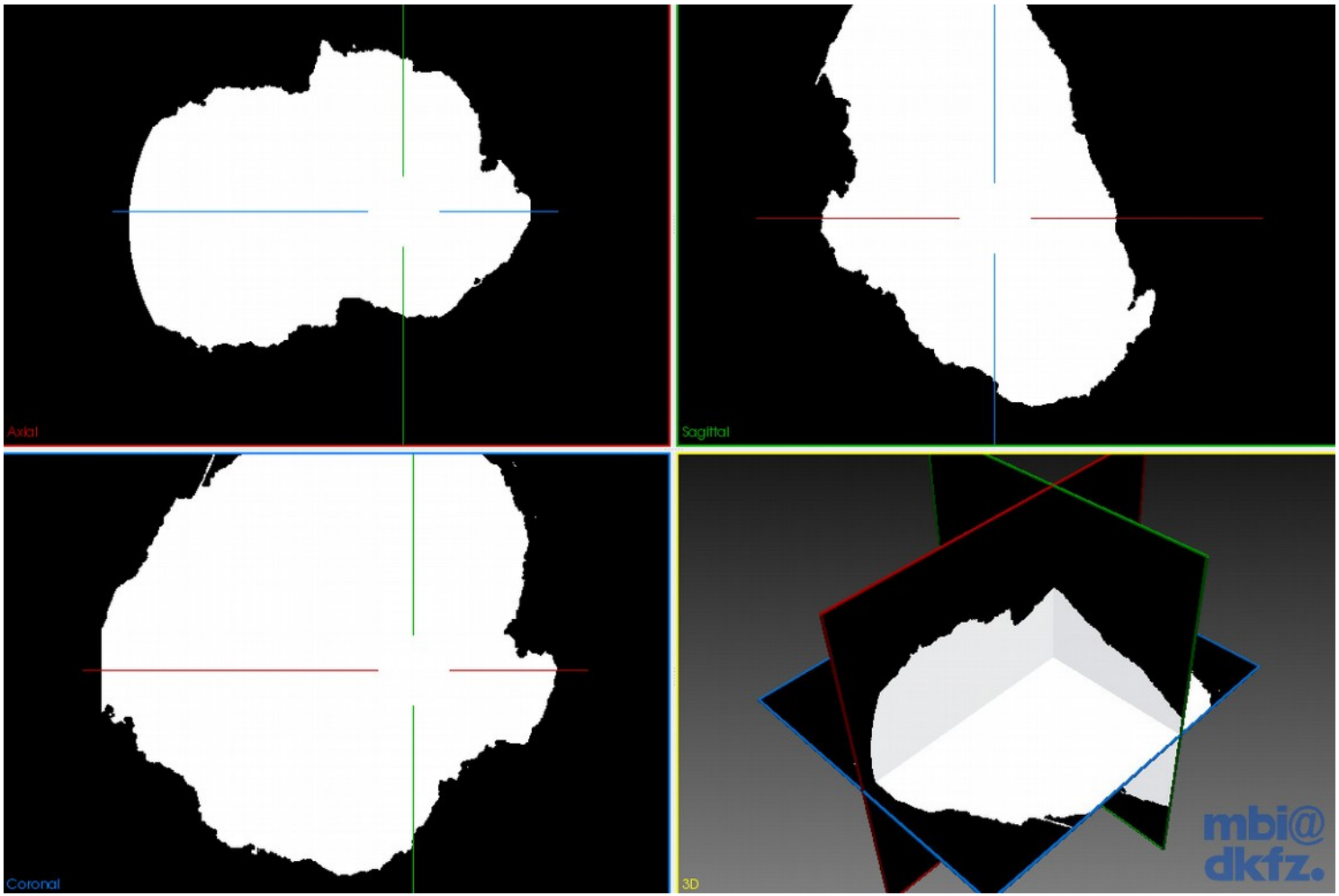
3D organic matter localization

ToolIP Workflow



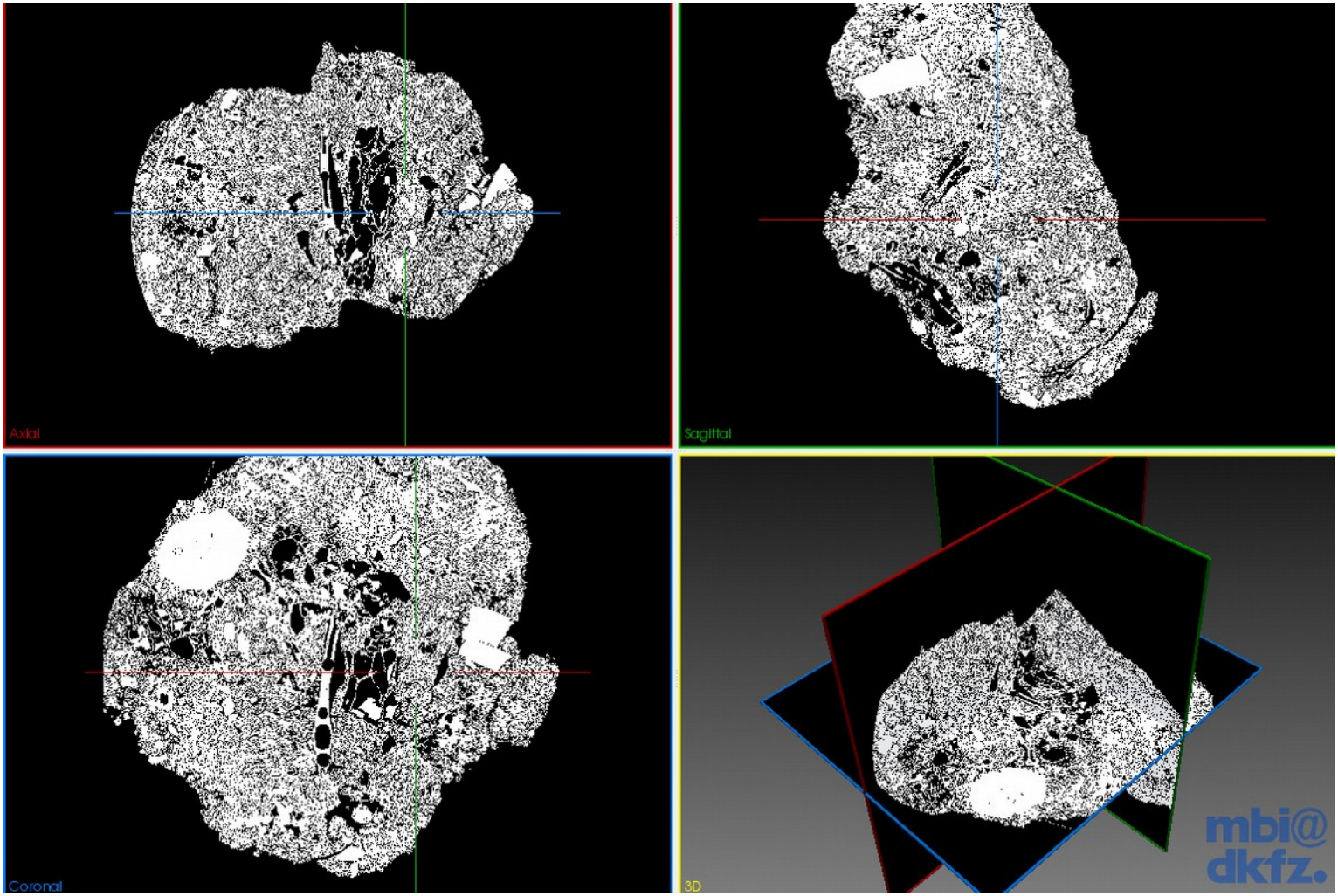
3D organic matter localization

ToolIP Workflow - Mask



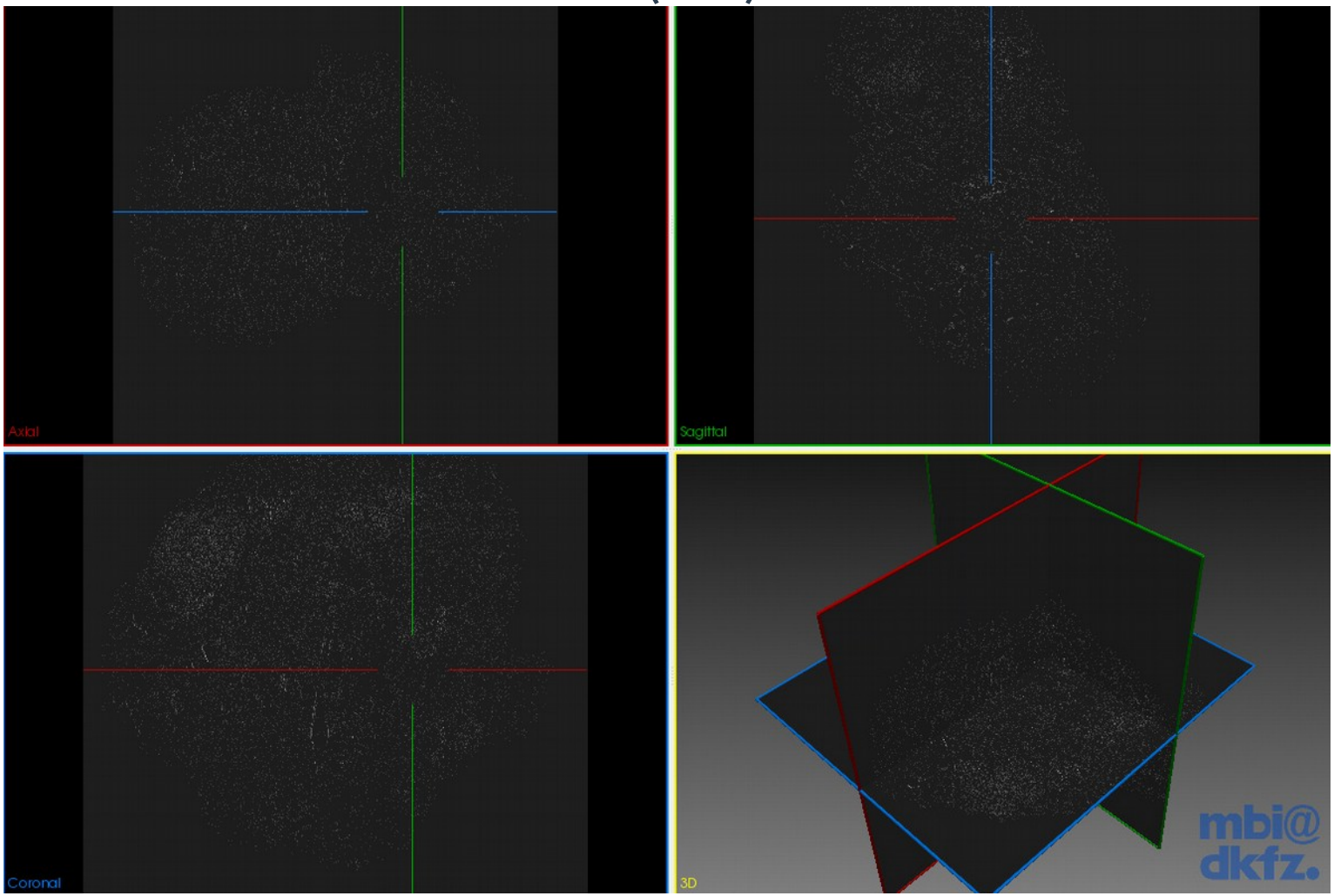
3D organic matter localization

ToolIP Workflow - Matrix



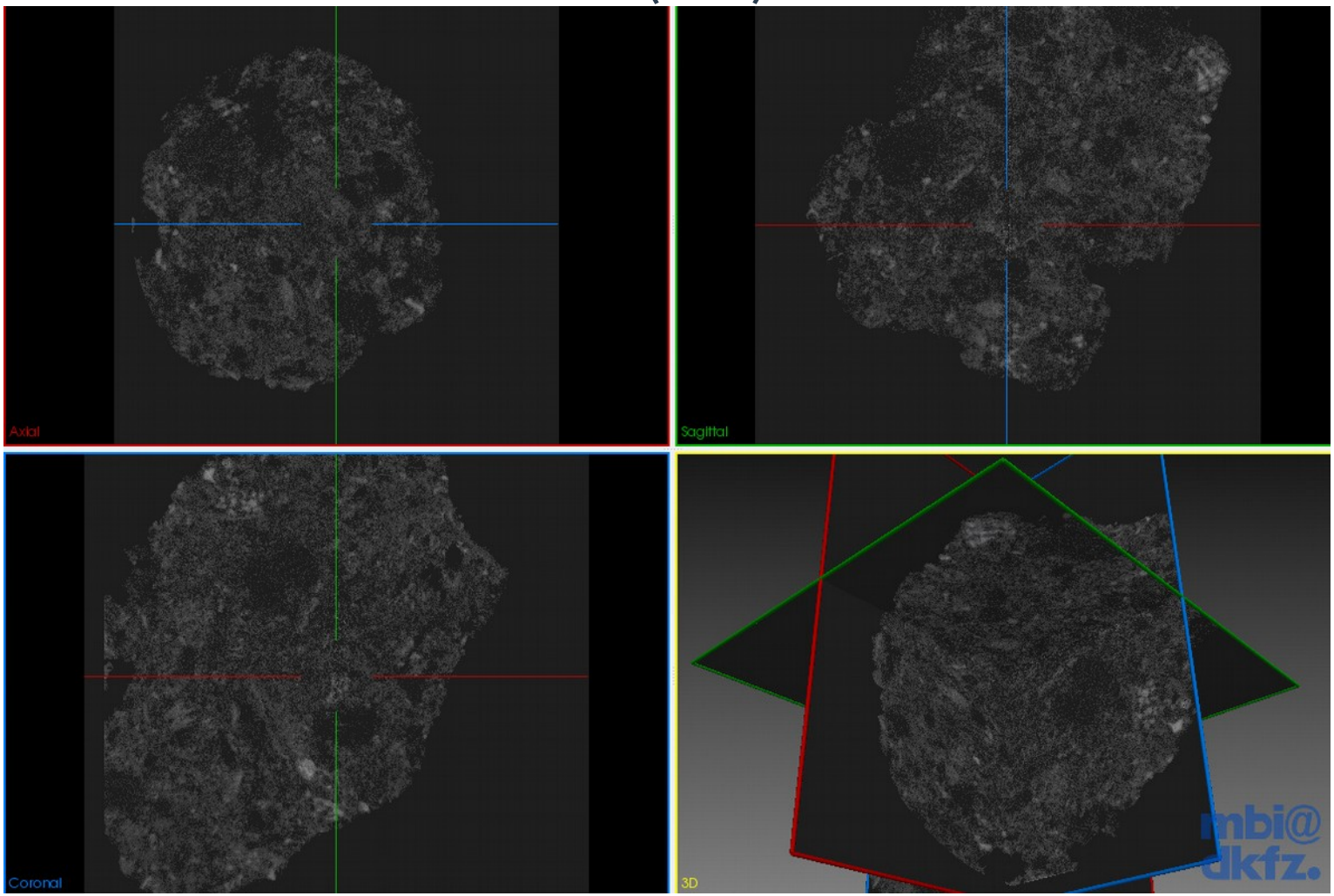
3D organic matter localization

ToolIP Workflow – SOM (CT)



3D organic matter localization

ToolIP Workflow – SOM (NT)



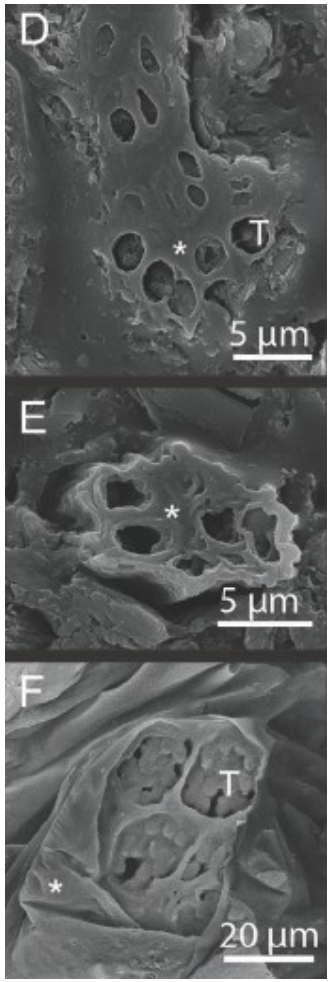
3D organic matter localization

Preliminary results

	Tillage	Not-Till
TOC [%]	5.1	9.7
d_B [g cm^{-3}]	0.78	0.59
SOM in surfaces [%]	37.3	45.6
SOM in matrix [%]	62.7	54.4
SOM connected to border at -300 hPa [%]	88.8	94.2
Pores connected to border at -300 hPa [%]	97.6	98.3

Cyanobacteria analysis

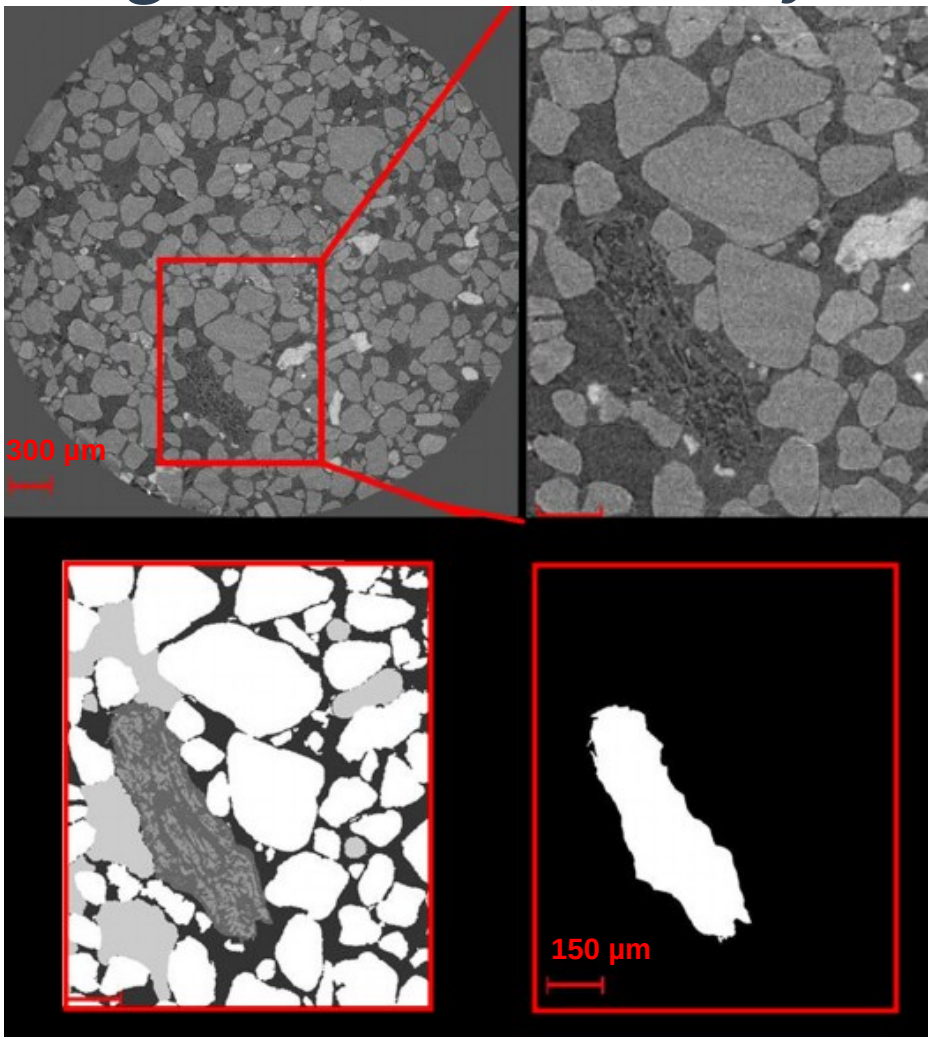
- Moab, Utah. Soil crusts examined on SRCT Berkeley



Couradeau et al. 2018

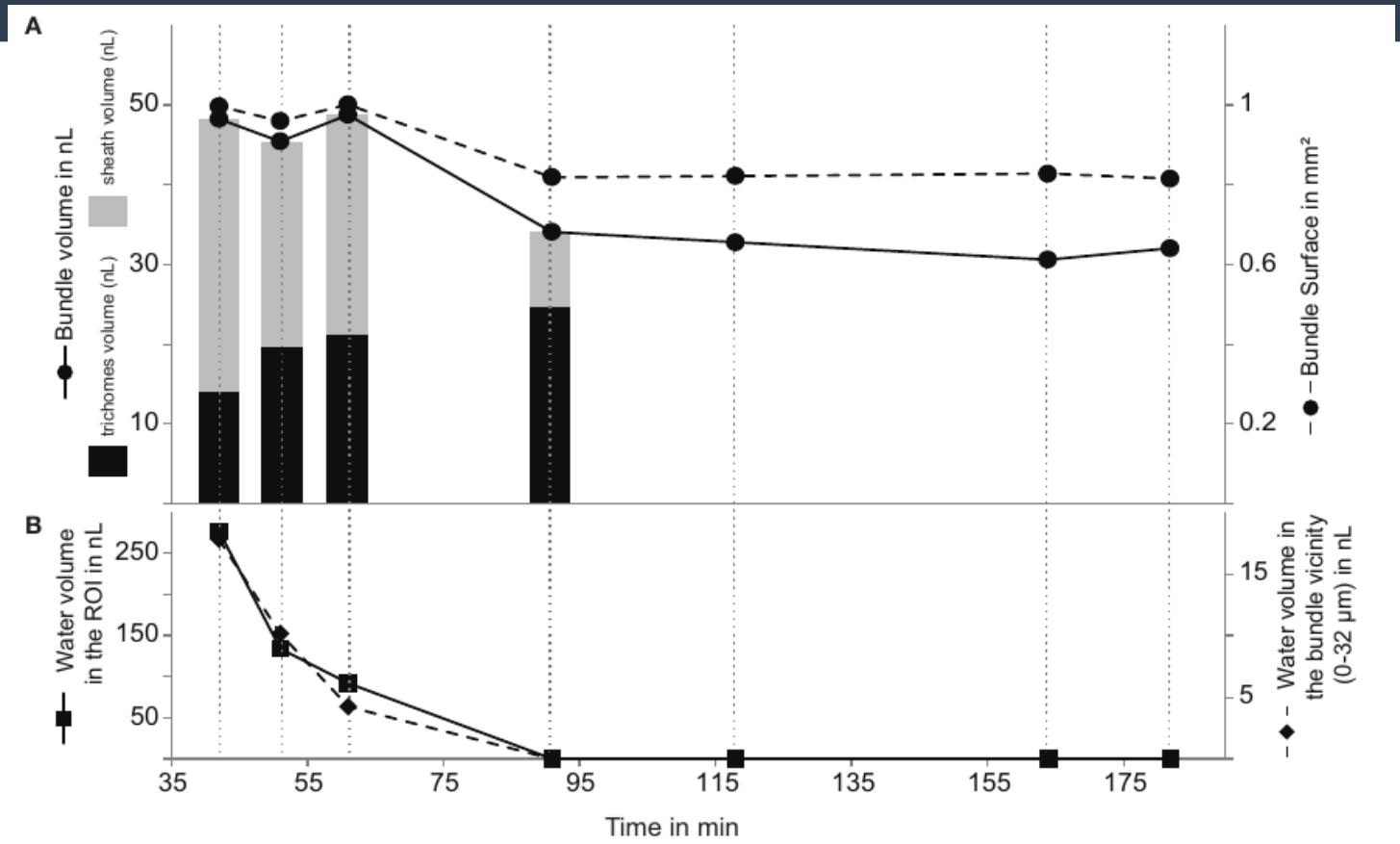
Cyanobacteria analysis

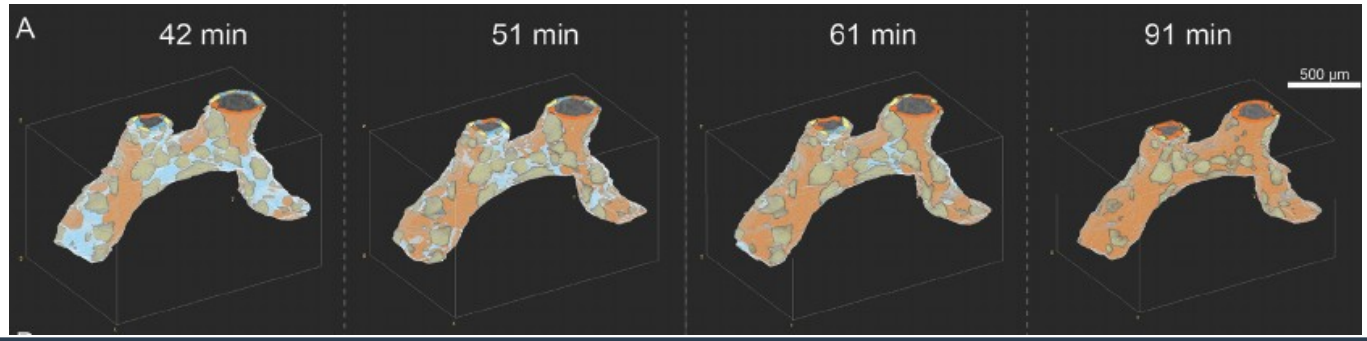
Segment, mask, analyze



Couradeau et al. 2018

Cyanobacteria analysis: dynamics

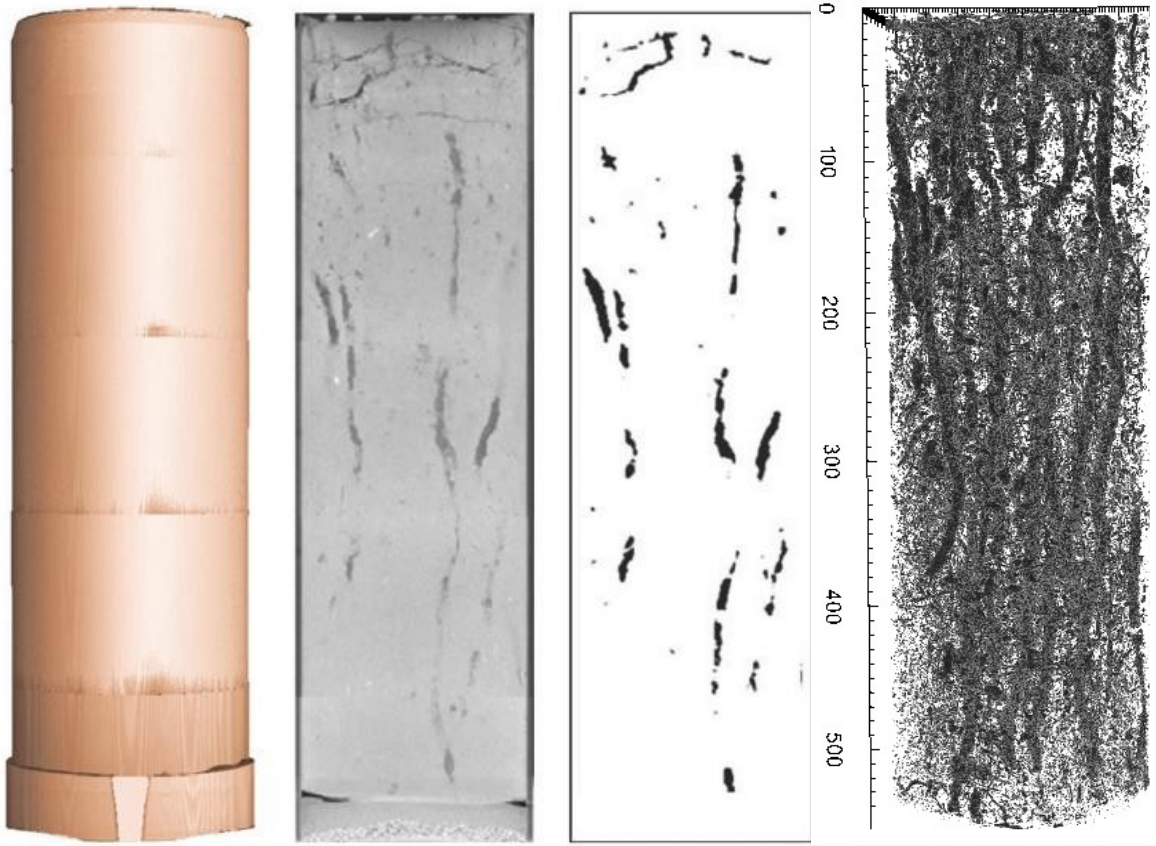




Couradeau et al. 2018

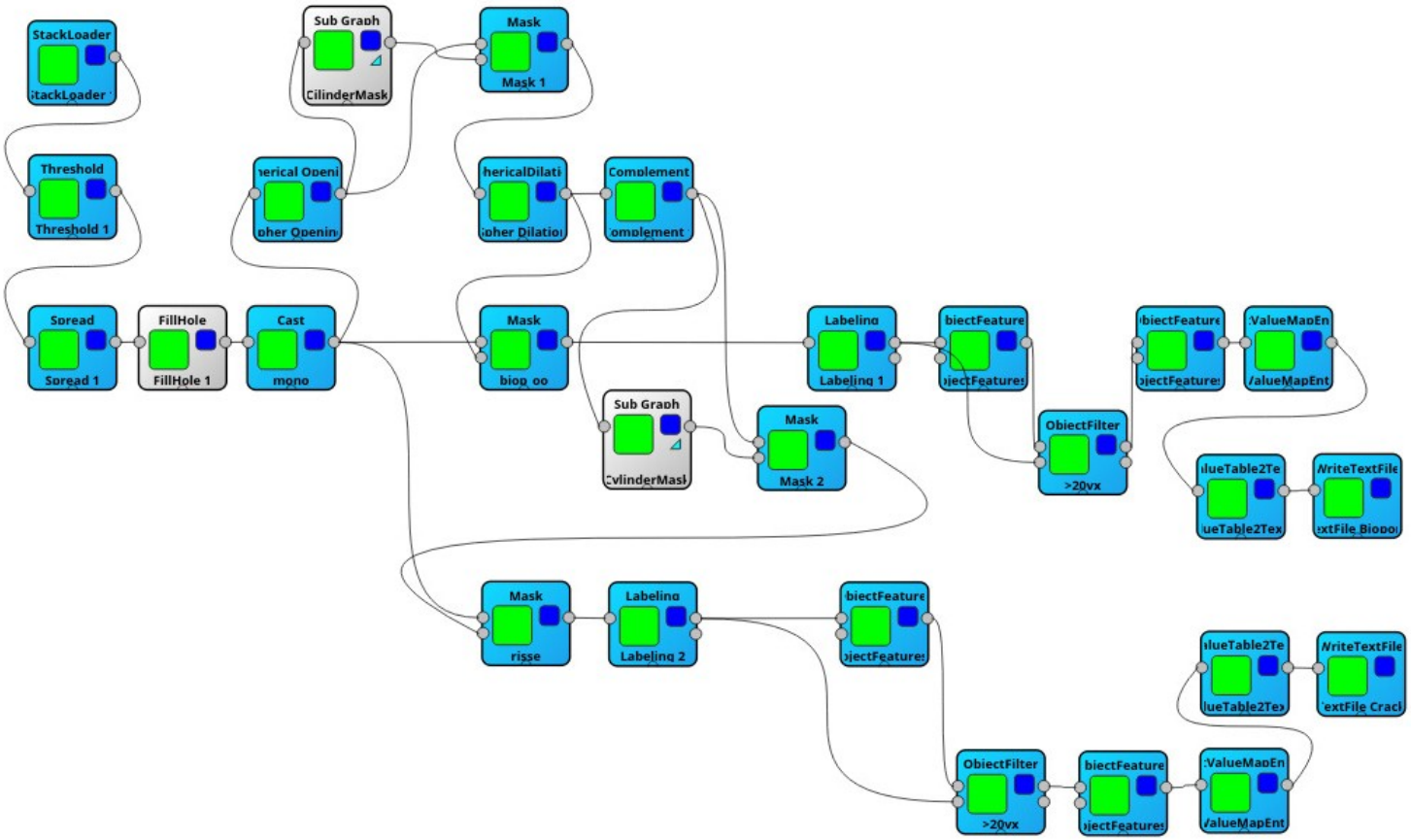
Going macro: Structure/Biopore segmentation

- 20 cm diameter x 70cm height soil columns



Structure/Biopore segmentation

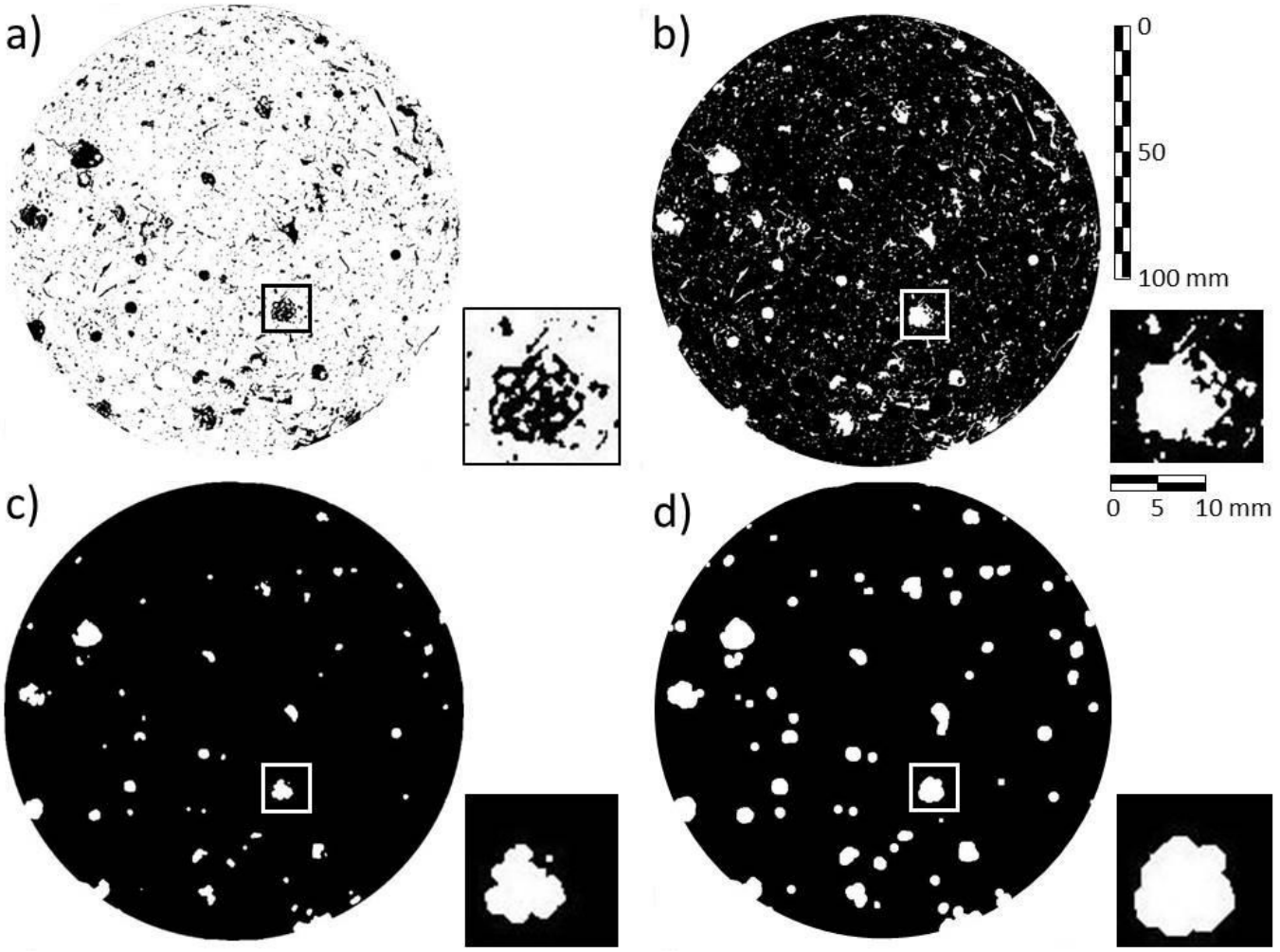
- Using morphological operators, labeling and masking



Leue et al. 2019

Structure/Biopore segmentation

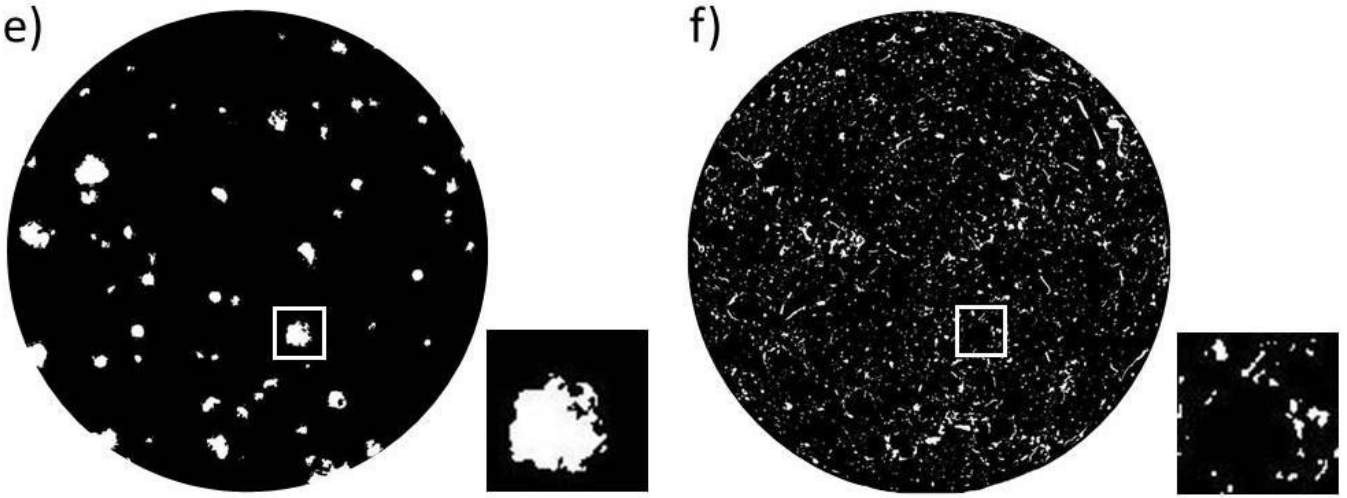
- Using morphological operators, labeling and masking



Leue et al. 2019

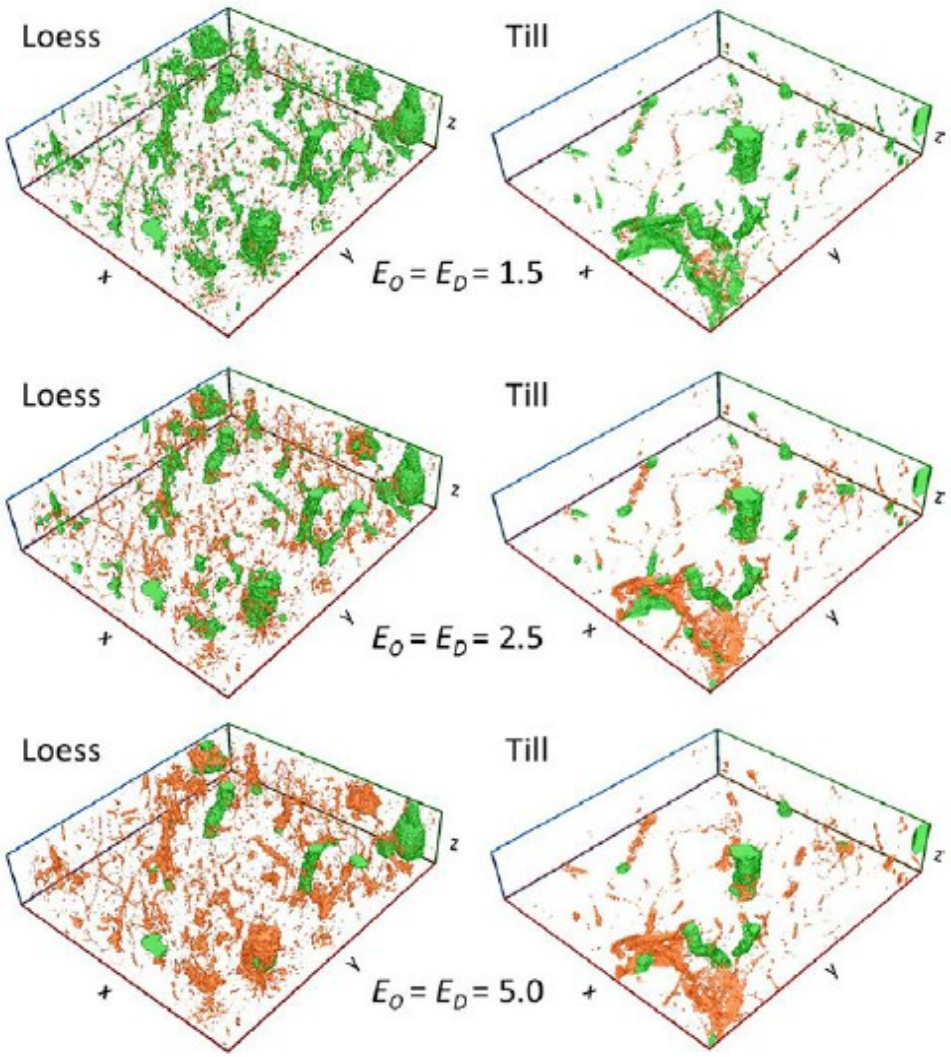
Structure/Biopore segmentation

- Using morphological operators, labeling and masking



Leue et al. 2019

Structure/Biopore segmentation



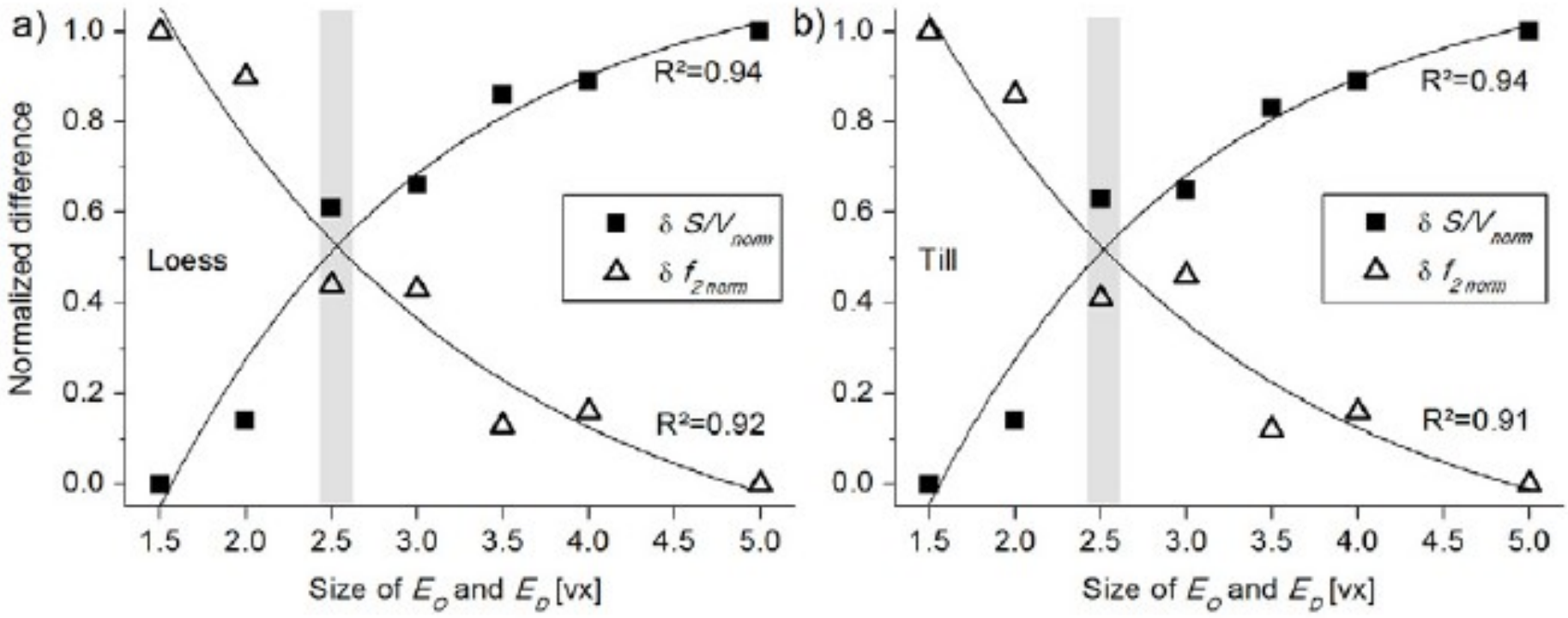
Green:
classified as biopore

Orange:
classified as structure pore

Leue et al. 2019

Structure/Biopore segmentation

Results: objective method to separate objects



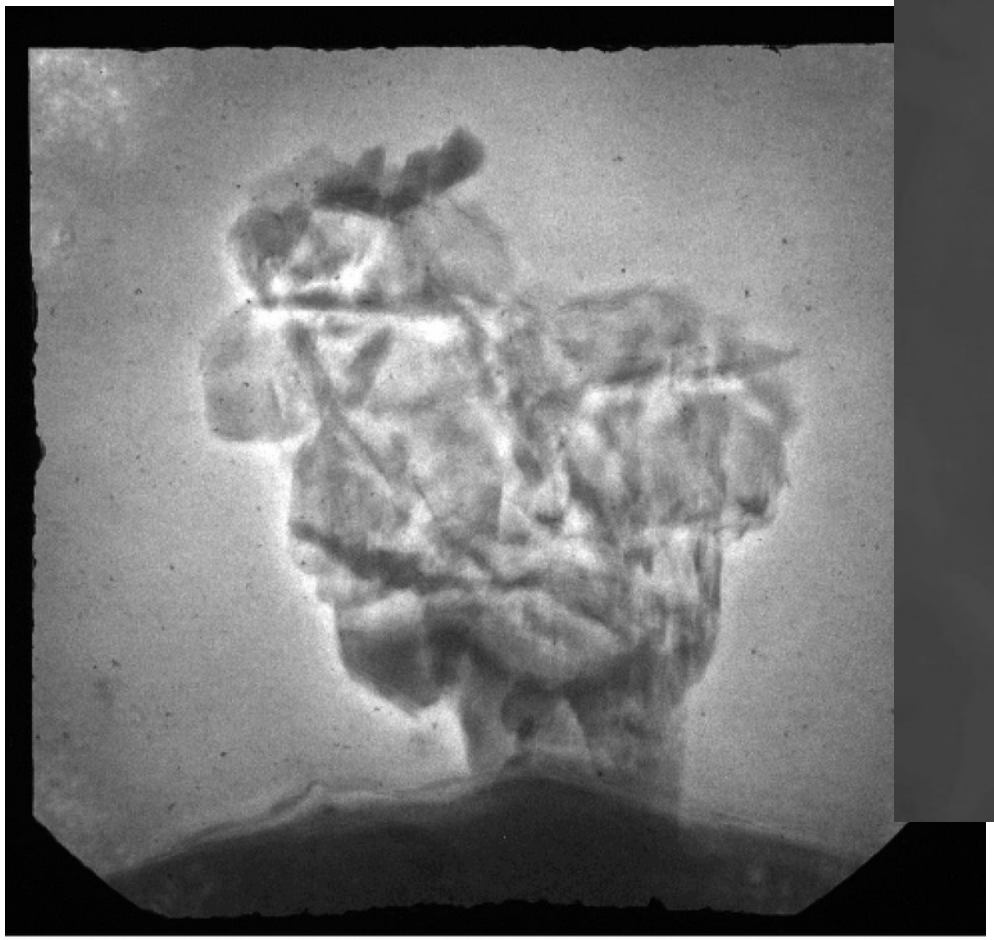
Leue et al. 2019

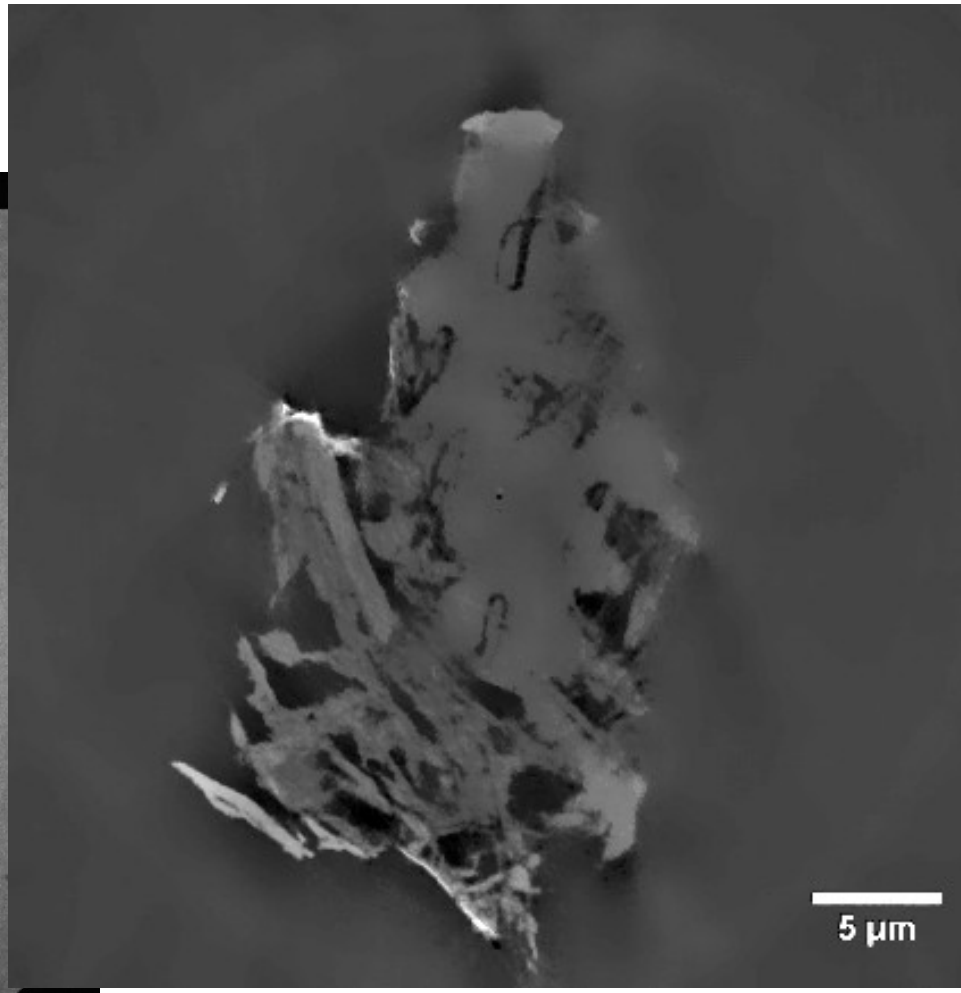
Further work to do...

Preliminary tests...

Nano-tomography

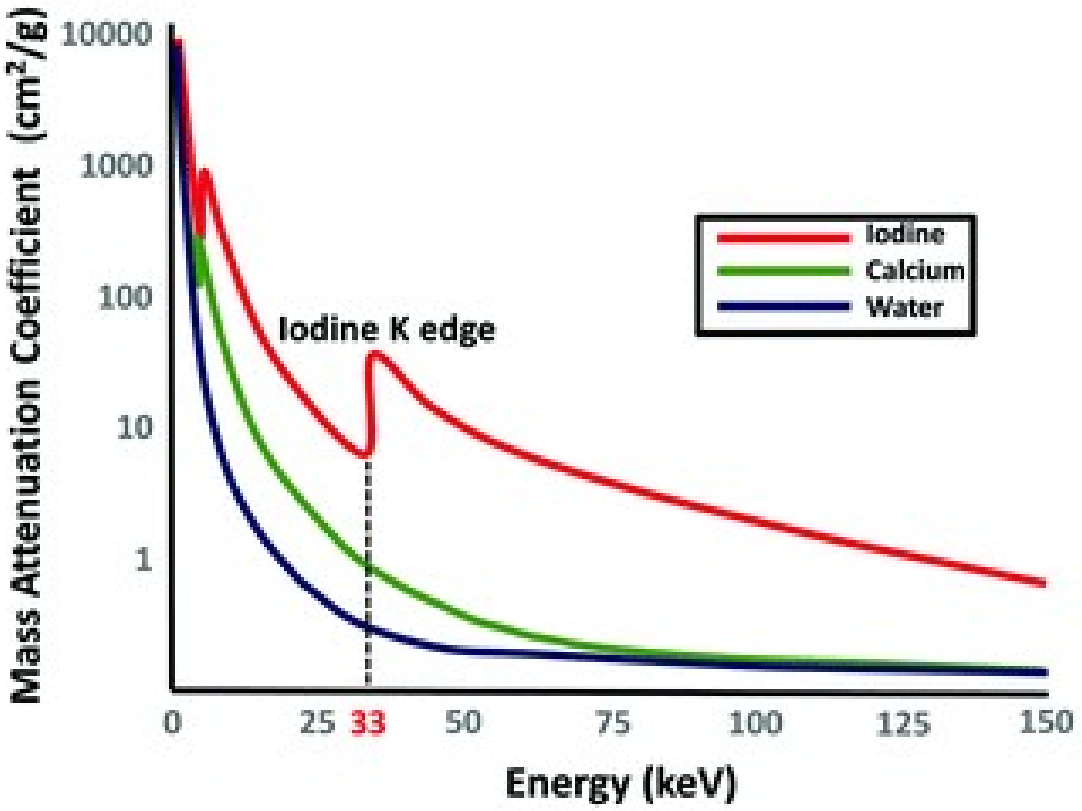
- Preliminary results





3D microbe localization

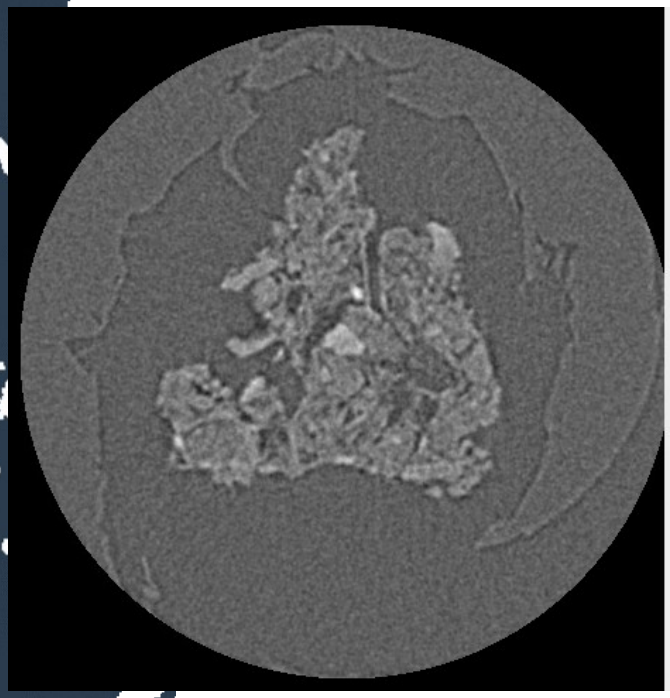
- Iodine staining (Propidiumiodine)



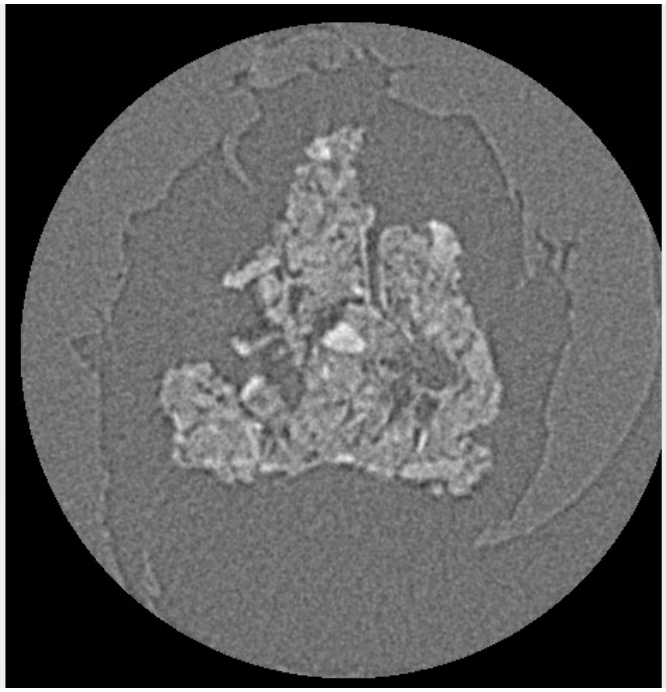
3D microbe localization

„High active“ µ-aggregate with staining agent

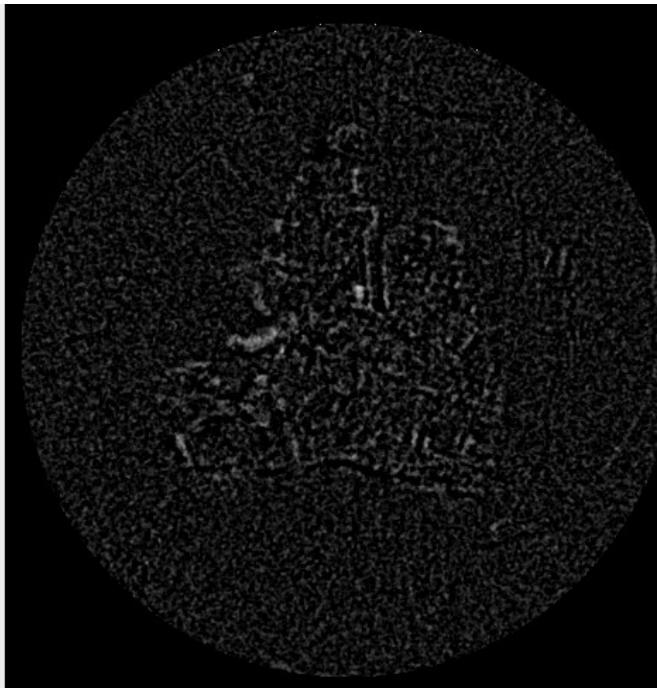
33 kV



35 kV



difference



3D microbe localization

- Preliminary results

  Iodine edge scanning → maybe possible
  Microbe localization → long way off

Thank you for your attention