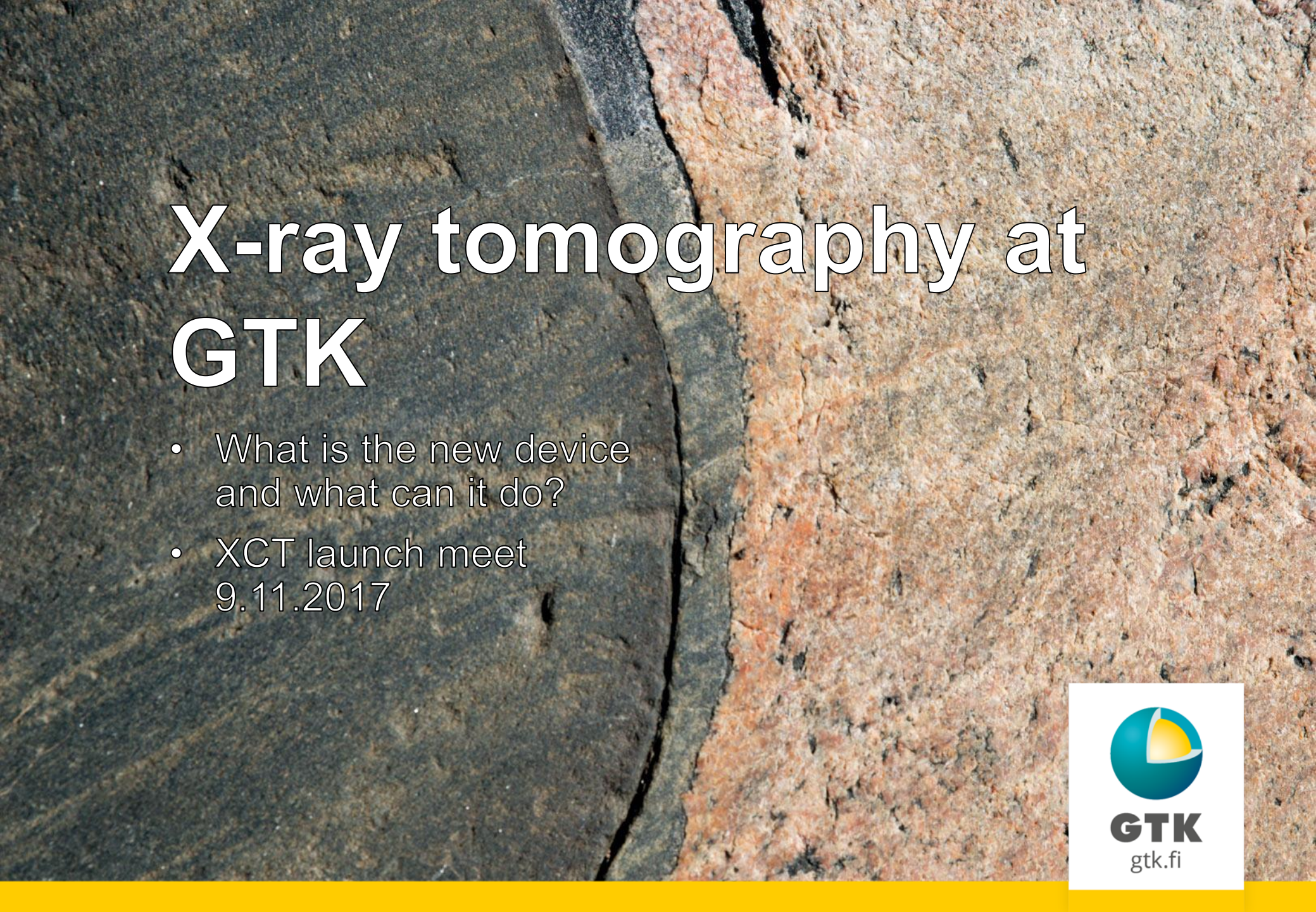

X-ray tomography at GTK

- What is the new device and what can it do?
- XCT launch meet 9.11.2017

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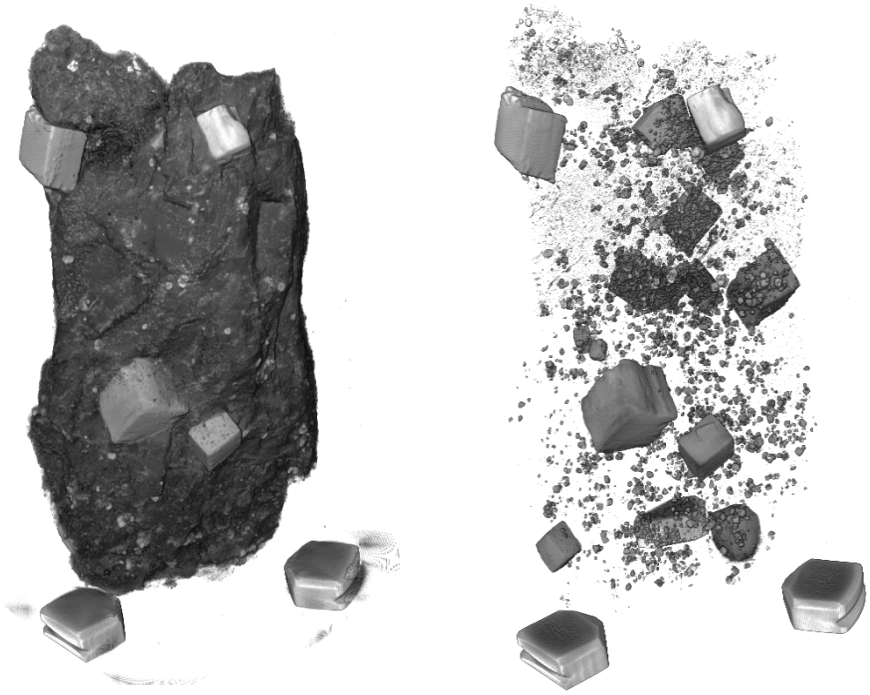
X-ray tomography - principles

- Sample is rotated and projections are recorded from all sides
- Projections can be reconstructed into a 3D absorption coefficient map
- Essentially a 3D density map
- Non-destructive



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Existing tomography devices in Finland

- Stora Enso, JYU and UTU were first
- Now devices at least in
  - Helsinki
  - Tampere
  - Kuopio
  - Oulu
- 6 Bruker Skyscan (1072, 1172, 1272)
- 3 Zeiss Xradia (microCT-400, nanoCT)
- Several PET/CT devices

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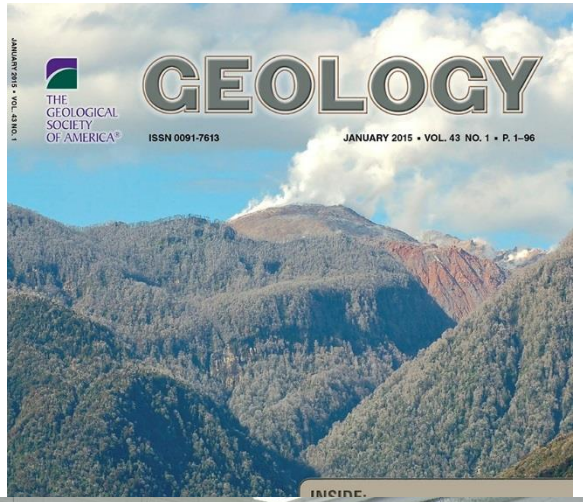
How and why was the GTK device acquired?

- 2013 Sayab Muhammad joins GTK
  - Idea about investigating rock morphology with XCT
  - First sample scanned at Helsinki University
  - Sayab, et al., High-resolution X-ray computed microtomography: A holistic approach to metamorphic fabric analyses. ***Geology*** 43 (1): 55-58 (2015)
- 2014 a talk about using XCT to decipher microstructures
  - Interest within GTK
- Academy application within the RAMI network
  - 2015 funding granted
  - 2017 device installed



GE phoenix v|tome|x s 240

- Manufactured in Wunstorf, Germany
- 240 kV / 320 W microfocus tube
  - Most powerful in Finland!
- 180 kV / 15 W nanofocus tube
- 400×400 mm^2 4 Mpix detector

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GE phoenix v|tome|x s 240

- 240 kV / 320 W microfocus tube
  - Resolution up to 5 µm
  - Allows imaging of complete drill core samples
- 180 kV / 15 W nanofocus tube
  - Resolution up to 900 nm
- 400×400 mm^2 4 Mpix detector
  - Max. sample size 26×41 cm^2 / 10 kg
  - FOV width = 2000 pix
- fast|scan module
  - Along with high power enables short scan times when necessary (<30 min)

Deben sample stage

- Compression and tension
  - Force up to 5 kN
  - Displacement up to 10 mm
- Cooling and heating
  - Peltier elements at both ends of the sample
  - Elements controlled independently
  - -20 to 160 °C

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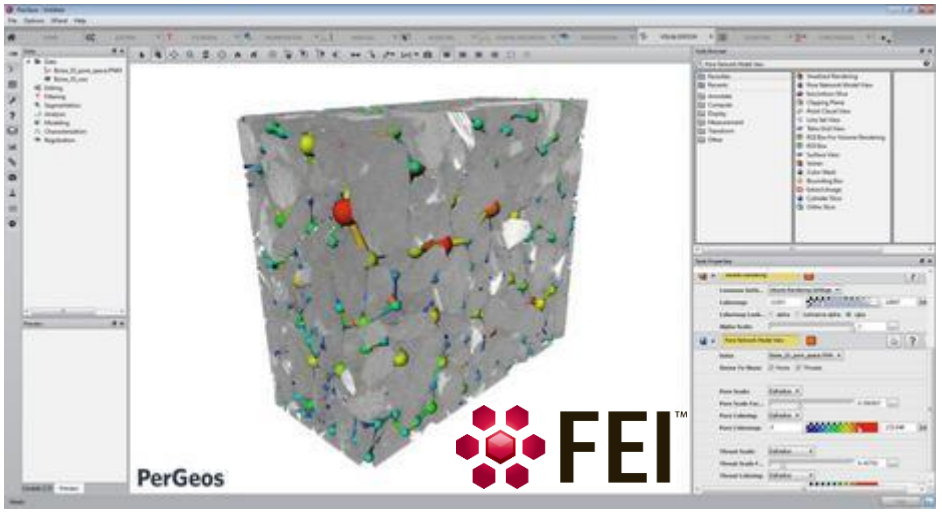
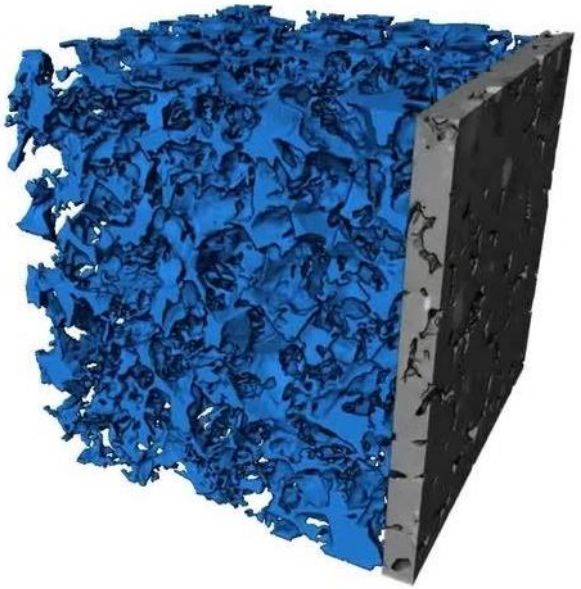
FEI PerGeos

- Powerful tool for image processing
- Noise filtering
- Segmentation
  - Watershed reduces operator-dependency
  - Recipes increase efficiency
- Analysis
  - Grain orientation
  - Pore size distribution
- Visualization





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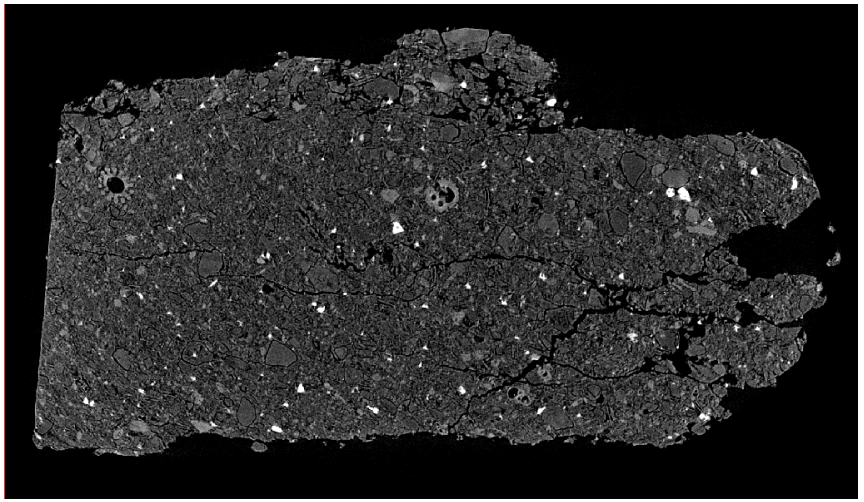
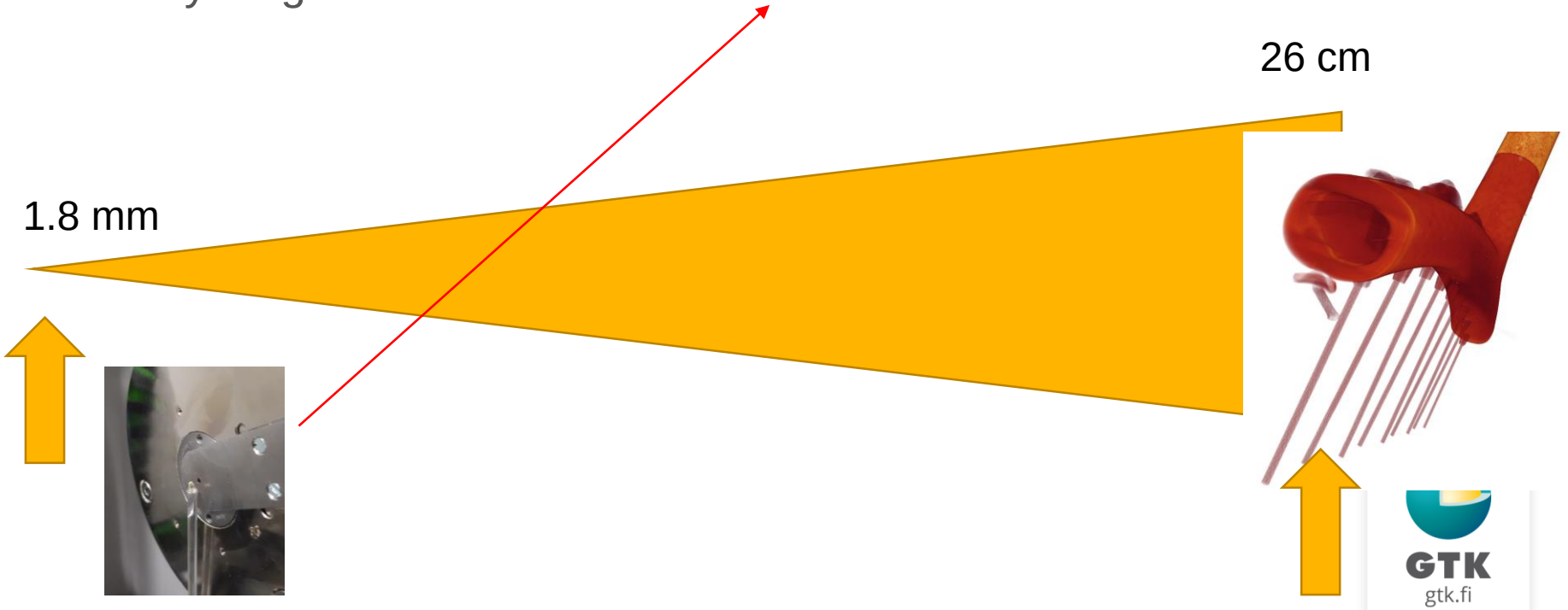
Sample sizes

- Diameter 1,8 mm for best resolution
- Max. Diameter 26 cm and height 41 cm
- Everything in between!





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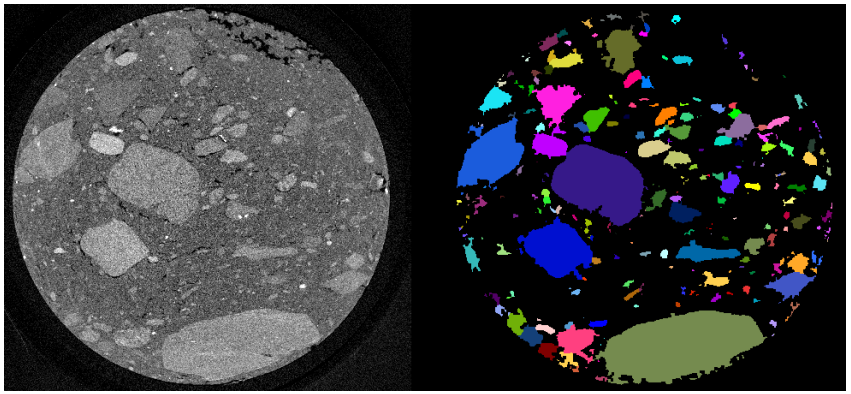
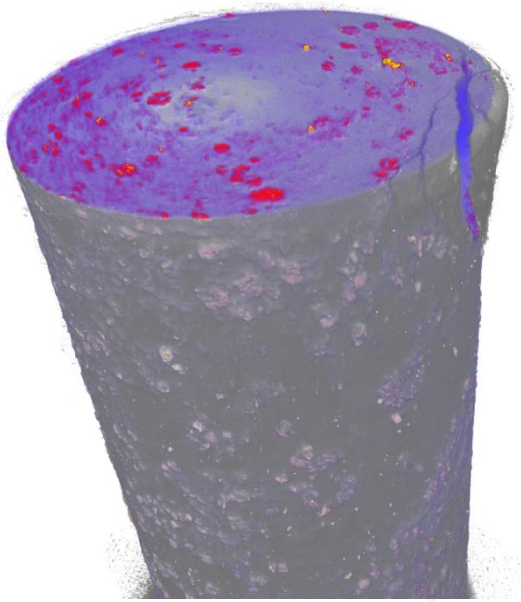
Applications

- Grain orientations of gravel samples through the sample holder
- Orientation analysis for high density inclusions
- Lake sediment layer analysis through the sample holder
- Non-destructive imaging of invaluable samples
- Before – after analysis for rock fractures
- 3D shape inspection





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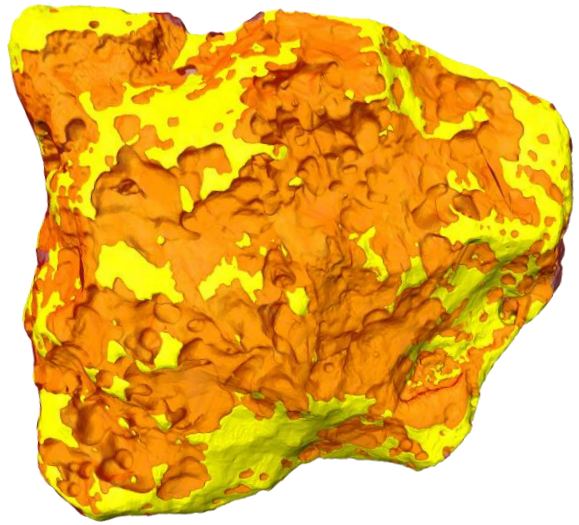
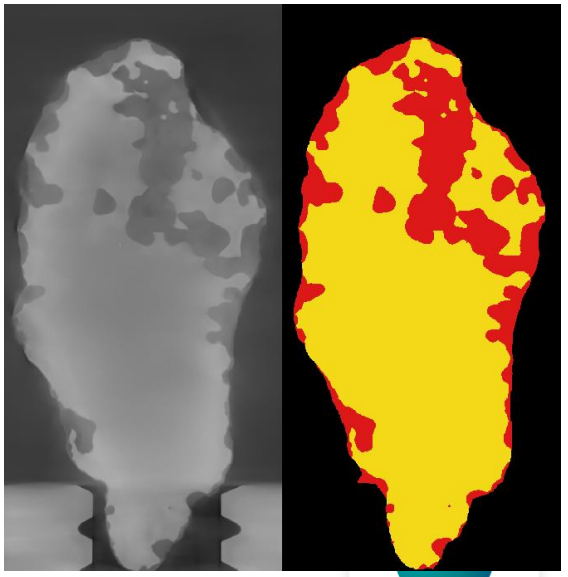
Case: Lieksa iron meteorite

- First iron meteorite found in Finland
- Max. thickness 6,6 cm, mostly Fe-Ni compound
- 220 kV / 48 W: Inner structure along with volumetric fractions of iron and silicate phases – unattainable by any other method





Case: Suaspalo gravel orientations

- Gravel samples inside a plastic tube
- Traditionally orientation is determined by hand from at least 100 rocks
- Tomographic investigation takes a few hours
    - Orientation determined from thousands of rocks

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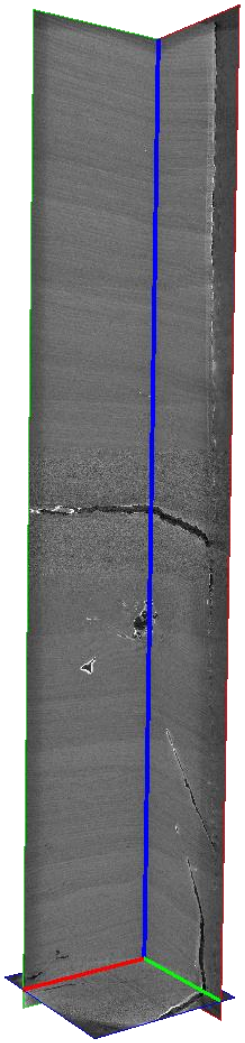
Case: Nurmijärvi lake sediment

- Lake sediment samples in a plastic tube
- Traditional analysis is manual and time consuming
- Tomographic investigation can be done with a rate of 30 cm / h.



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What’s ahead?

- More users – we want to expand the userbase as much as possible
- More sample variety – main focus is on geological samples, but we want to explore the capabilities of the device
- Method development, user development – Moving forward through advanced userbase, increased sample variety and networking (FinTomo)
- Better tomography

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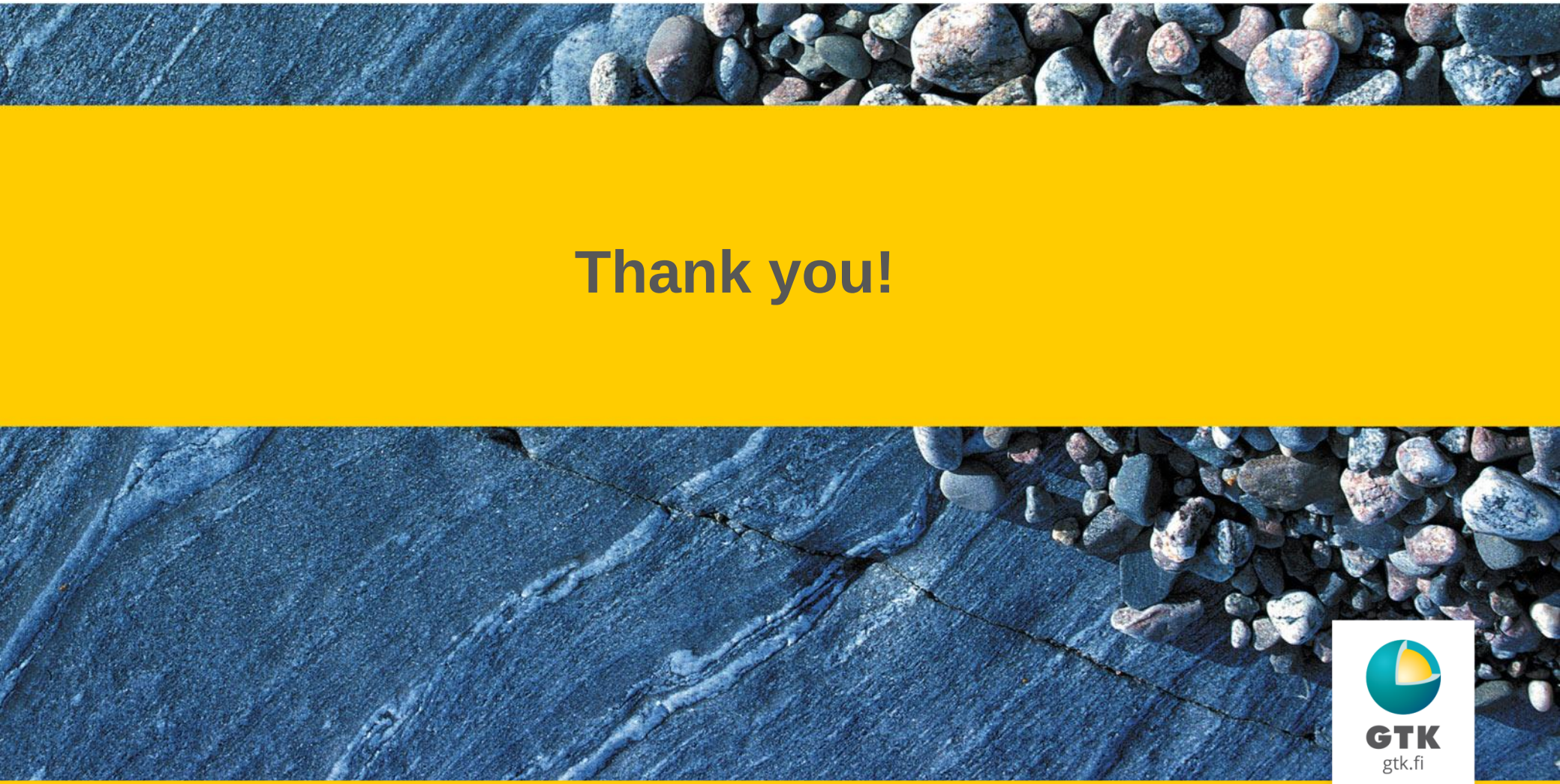

Thank you!

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