Thin Section Analysis

A short introduction


SEIR
materialeanalyse A/S

Outline

- Sampling
- What is a thin section?
- What can we use a thin section for?
- Dissecting af material

Sampling

- Sampling is the basis for the material analysis.
- During the material examination, a small part of the facade is brought home to the laboratory.
- The material analysis can only provide answers to the questions that the tests permit to be answered.
- What do we want to know about the ”patient”?

- Prior to the sampling, the sampling should be planned.
- Any sketches or outline drawings can be helpful.
- Information regarding the building's history can often be found in archives or similar.
- Find older photos
- Google streetview

17 NOV. 1977

U/U i$o7s

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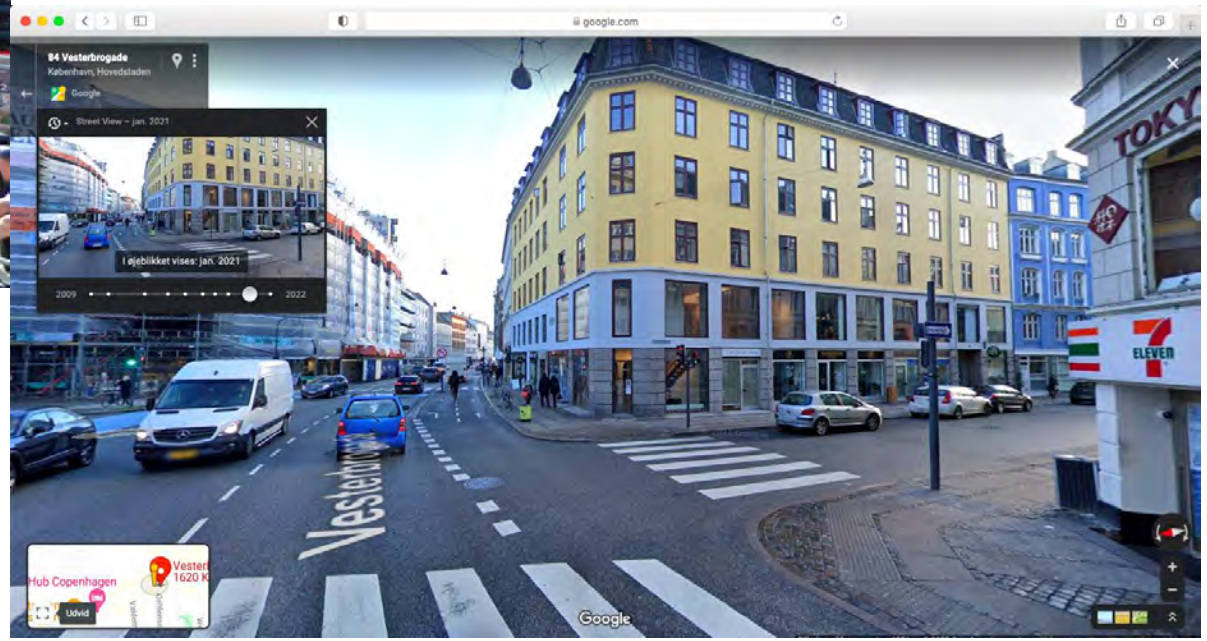
·If■J*

Goggle streetview




Carl Ipsens Ligkistefabrik
Begravelse besørges
Carl. Ipsens
Ligkiste-Fabrik
Begravelsesforretning
besørges.
Billige Priser
Elegant
75
Solide Kister
Stort Udvalg
Rimelige Priser.
Det bedste Blad.

Ældre fotos

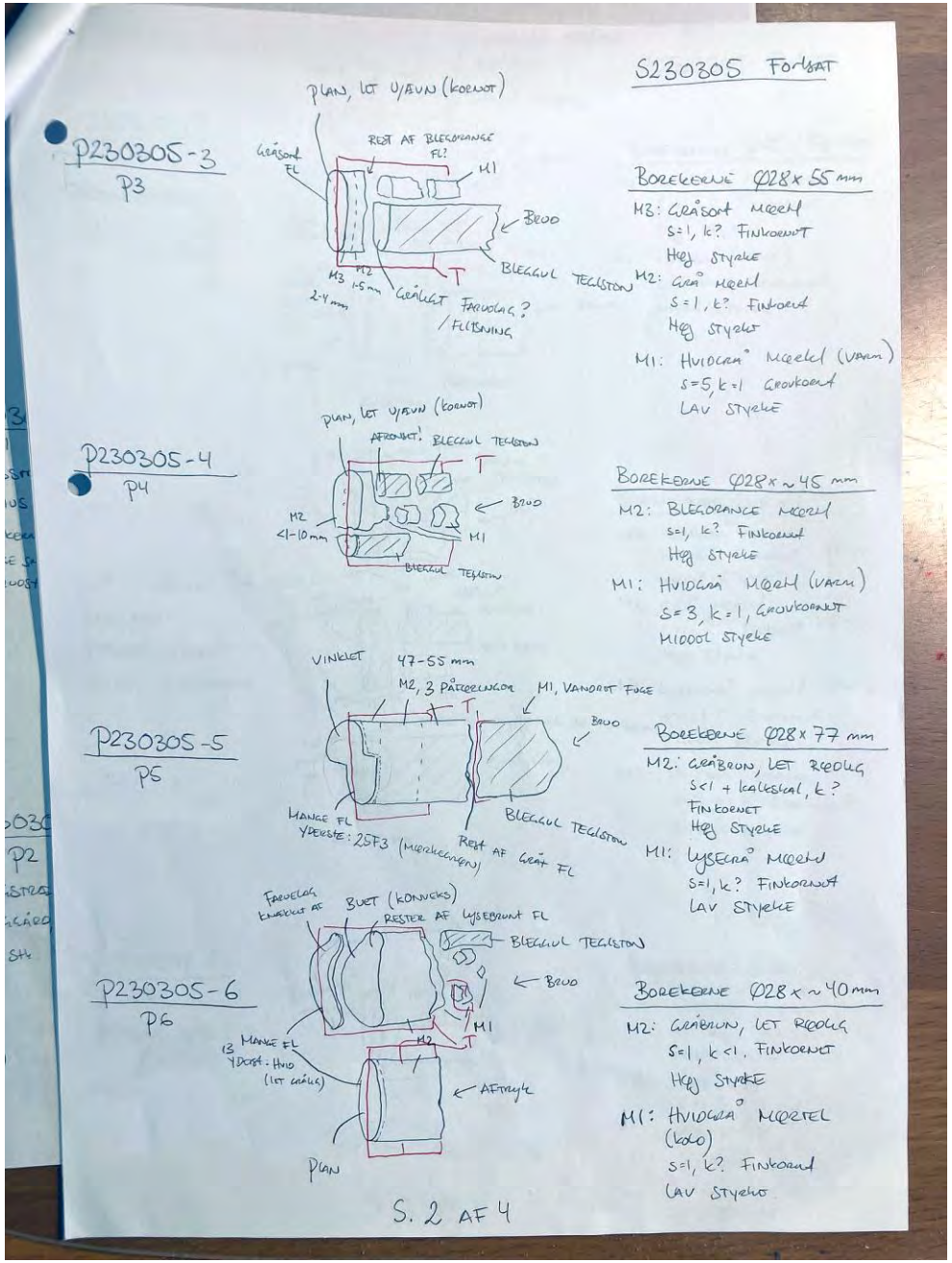
26/08/2023

Sampling – Guide lines

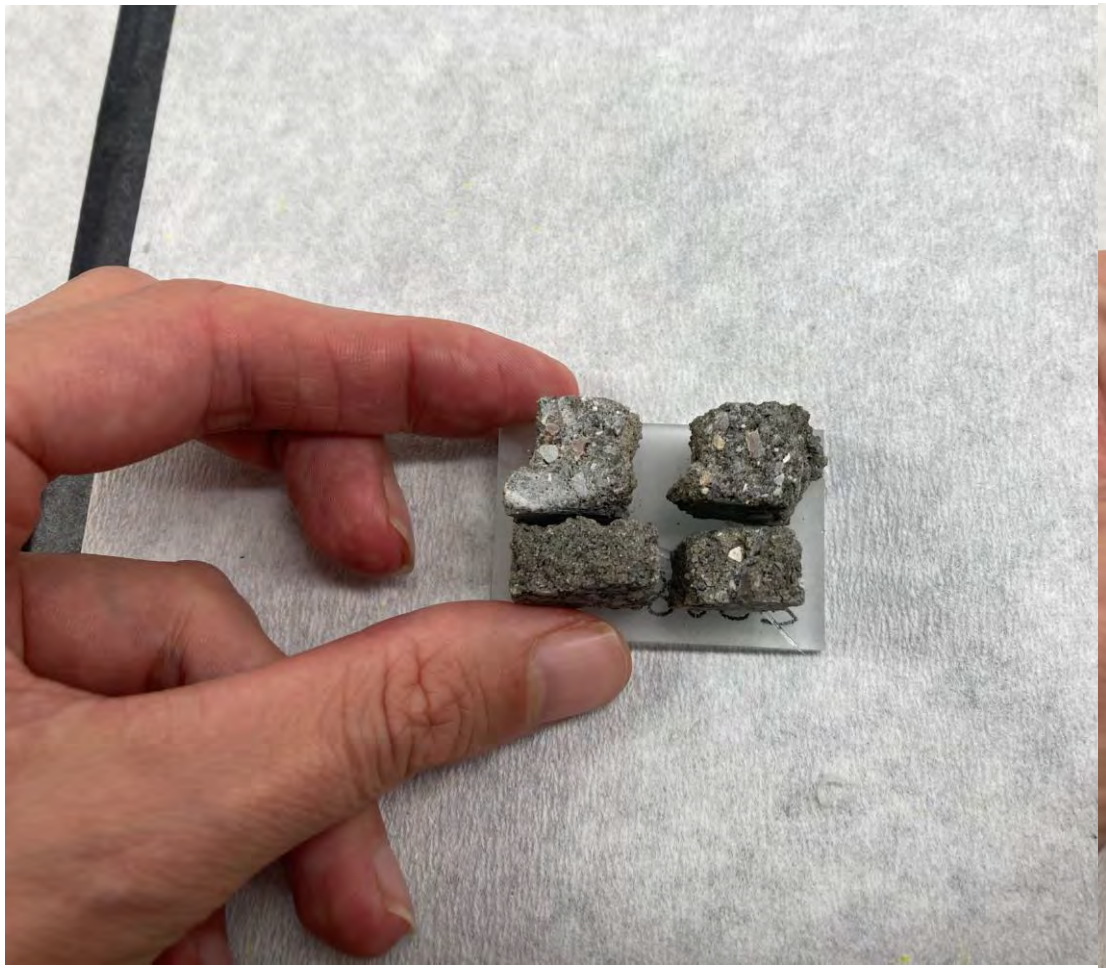
- Avoid lose bits – These are often repairs.
- Try to get a sample that represent a cross-section through the plaster/render including the underlayer.
- Try to maintain the contact between the different layers.
- Even small samples measuring 1x1x1 cm can be used.
- If you want information about old plaster/render/paint layers, choose a pretected area on the facade.

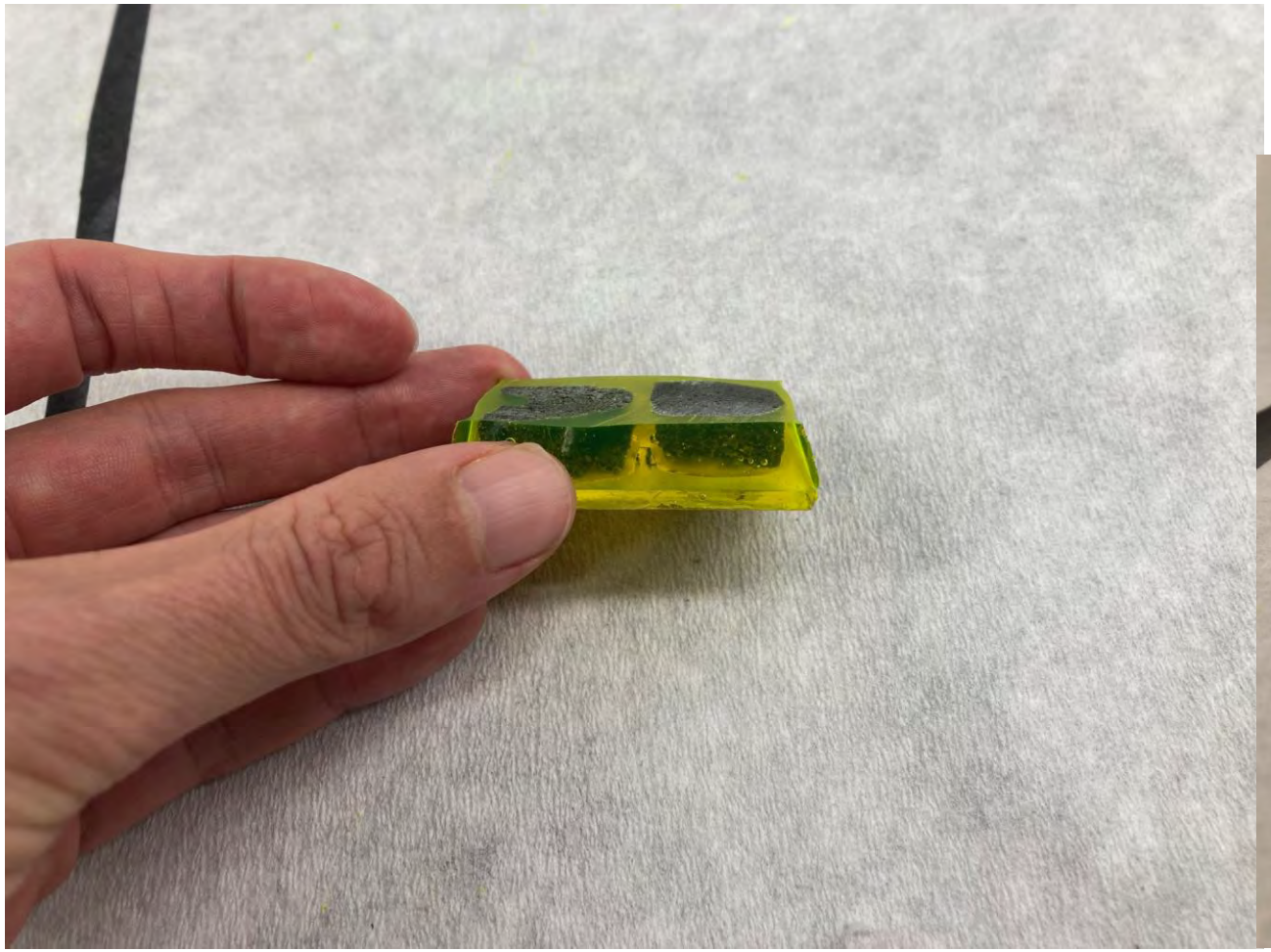
Sampling

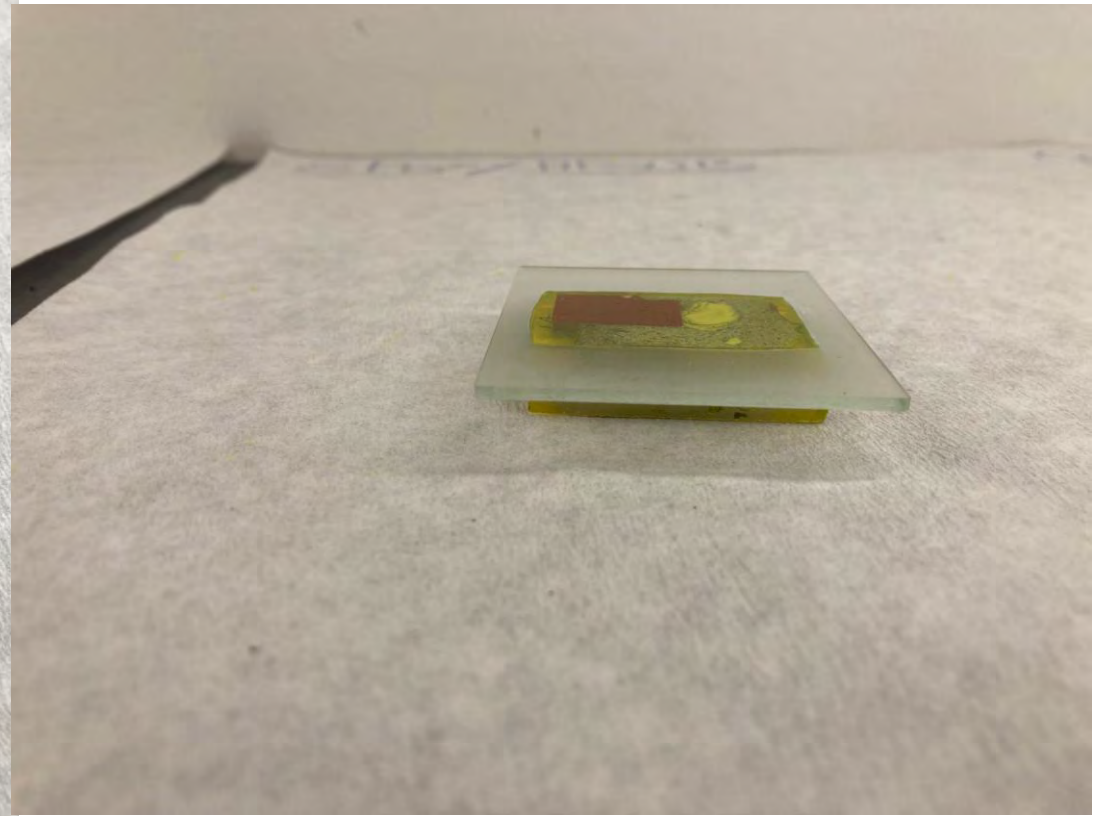
Drilled core


S230305 Forts
P230305-3
P3
PLAN, LET U/ÆVN (KOERNET)
REST AF BLEGORANGE FL?
GRÅSORT FL
M1
BRUD
BLEGGUL TEGLSTEN
M2
M3 1-5 mm
2-4 mm
GRÆLIGT FARVELAG? / FLYDNING
BOREKERNE Ø28 x 55 mm
M3: GRÅSORT MØRTEL
S=1, k? FINKORNET
HØJ STYRKE
M2: GRÅ MØRTEL
S=1, k? FINKORNET
HØJ STYRKE
M1: HVIDGRÅ MØRTEL (VARM)
S=5, k=1 GROVKORNET
LAV STYRKE
P230305-4
P4
PLAN, LET U/ÆVN (KOERNET)
AFBRUDT!
BLEGGUL TEGLSTEN
BRUD
M2
<1-10 mm
M1
BLEGGUL TEGLSTEN
BOREKERNE Ø28 x ~45 mm
M2: BLEGORANGE MØRTEL
s=1, k? FINKORNET
HØJ STYRKE
M1: HVIDGRÅ MØRTEL (VARM)
S=3, k=1, GROVKORNET
MIDDEL STYRKE
P230305-5
P5
VINKLET
47-55 mm
M2, 3 PÅTRÆNGNINGER
M1, VANDRET FUGE
BRUD
MANGE FL
YDERSTE: 2SF3 (MØRTELBRUDSTYKKER)
BLEGGUL TEGLSTEN
REST AF GRÅT FL
BOREKERNE Ø28 x 77 mm
M2: GRÆBRUN, LET RØDLIG
S<1 + kalkstykker, k?
FINKORNET
HØJ STYRKE
M1: LYSEGRÅ MØRTEL
S=1, k? FINKORNET
LAV STYRKE
P230305-6
P6
FARVELAG KNÆKKET AF
BUET (KONVEKS)
RESTER AF LYSEBRUNT FL
BLEGGUL TEGLSTEN
BRUD
M1
M2
13 MANGE FL
YDERST: HVID (LET GRÅLIG)
AFTRYK
PLAN
BOREKERNE Ø28 x ~40 mm
M2: GRÆBRUN, LET RØDLIG
S=1, k<1, FINKORNET
HØJ STYRKE
M1: HVIDGRÅ MØRTEL (KALK)
S=1, k? FINKORNET
LAV STYRKE
S. 2 AF 4

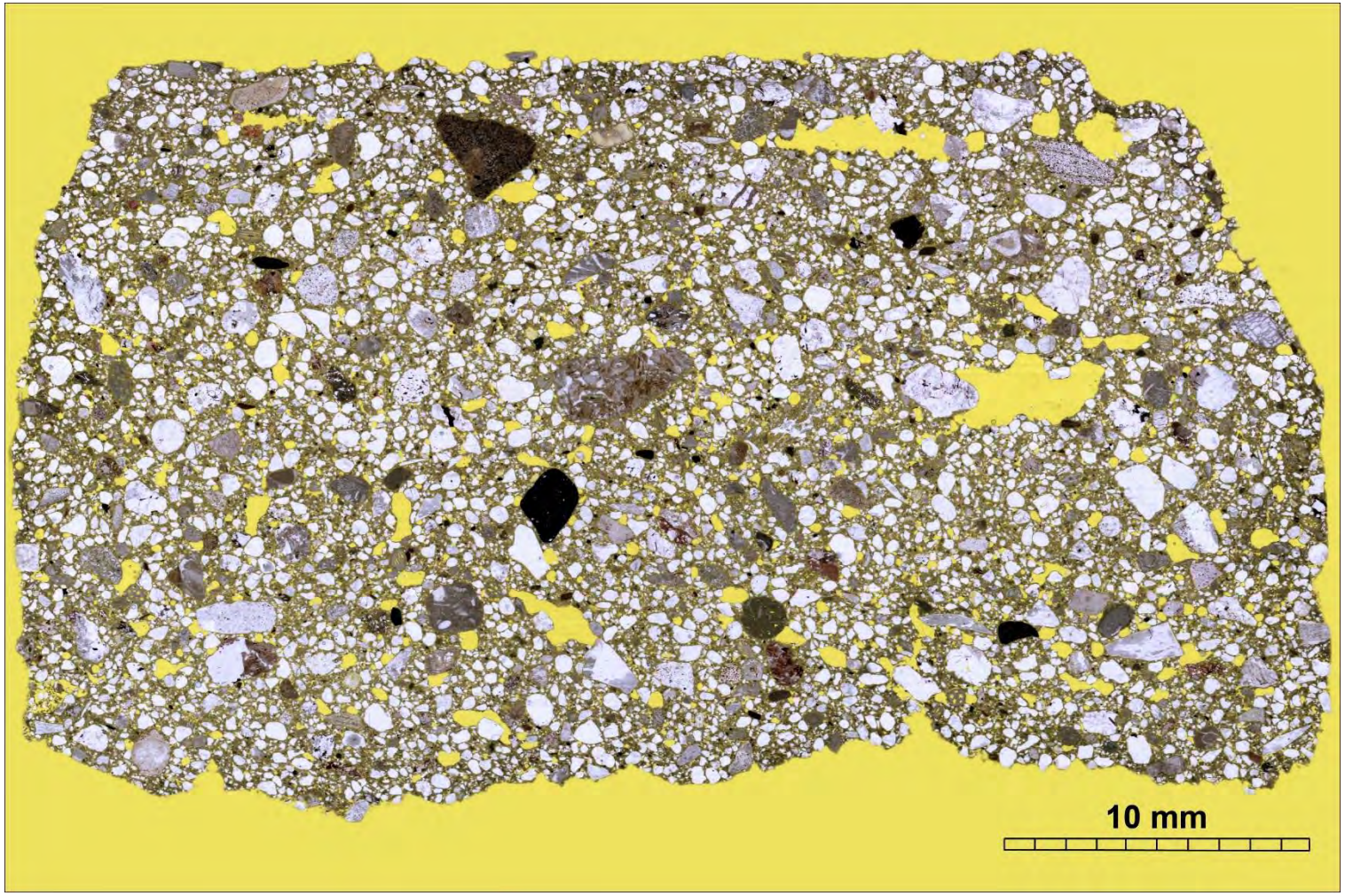
Making a thin section







- 30 my = 0.03 mm

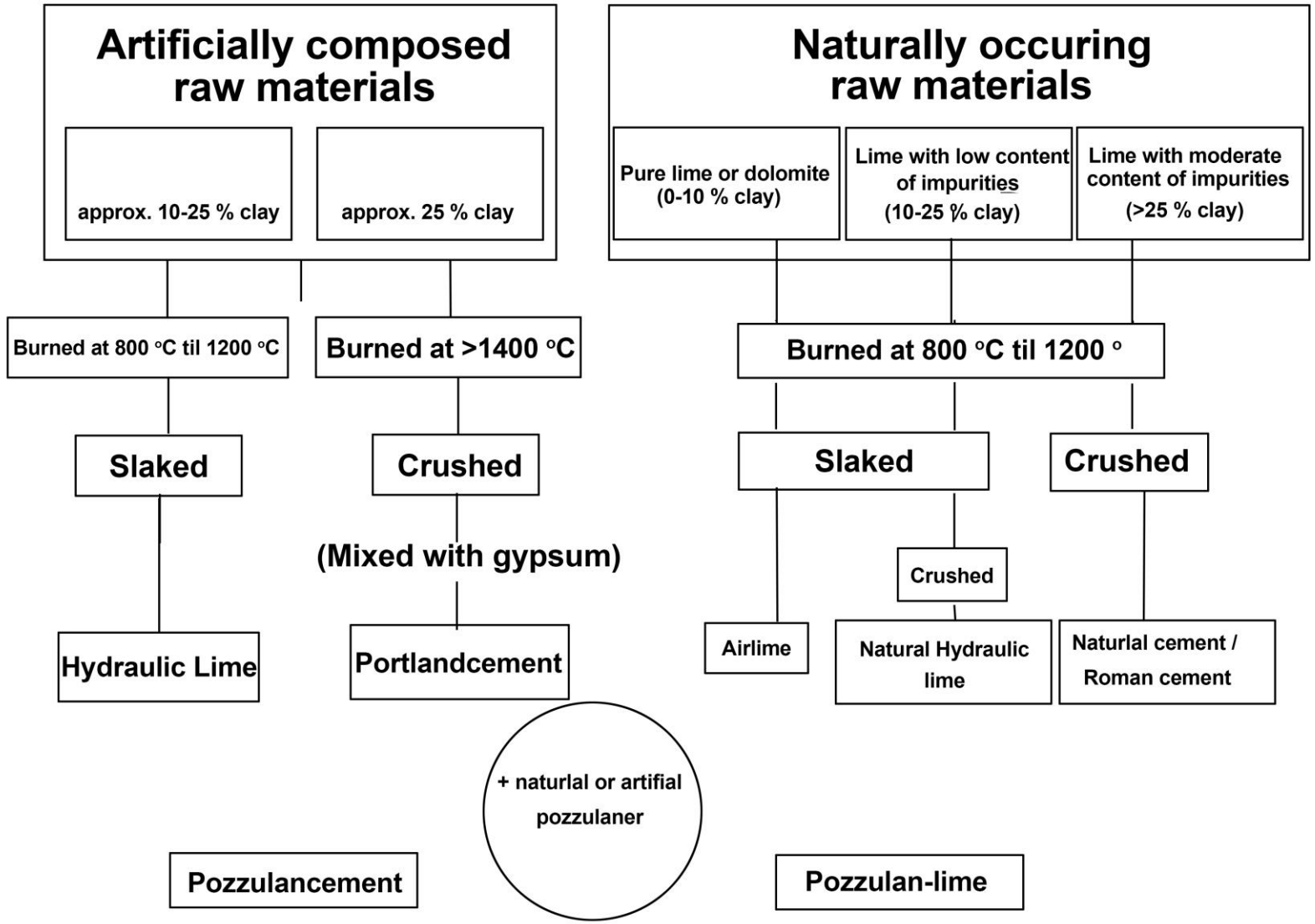

10 mm

What can we use a thin section for?

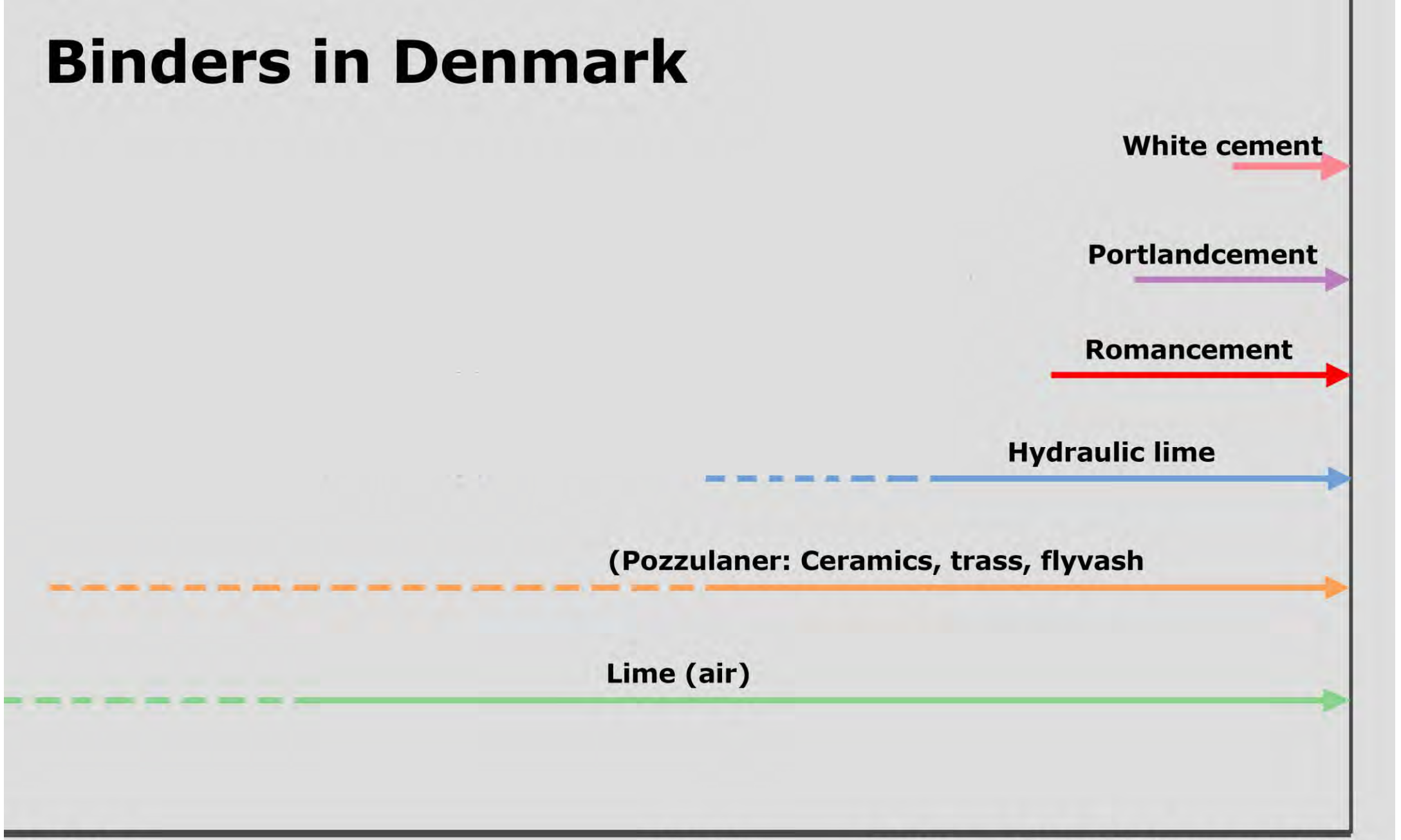
- Determining the layers in the sample:
- - Plaster layers, paint layers
- Determining the different components in the mortar.
- Determining the different components in the paint layers.
- Determining the mortar composition with respect to content of aggregate, bunder and air voids. Binder, aggregates, pigment
- Evaluate signs of weathering, deterioration, or other anomalous transformation of the materials

Under the microscope

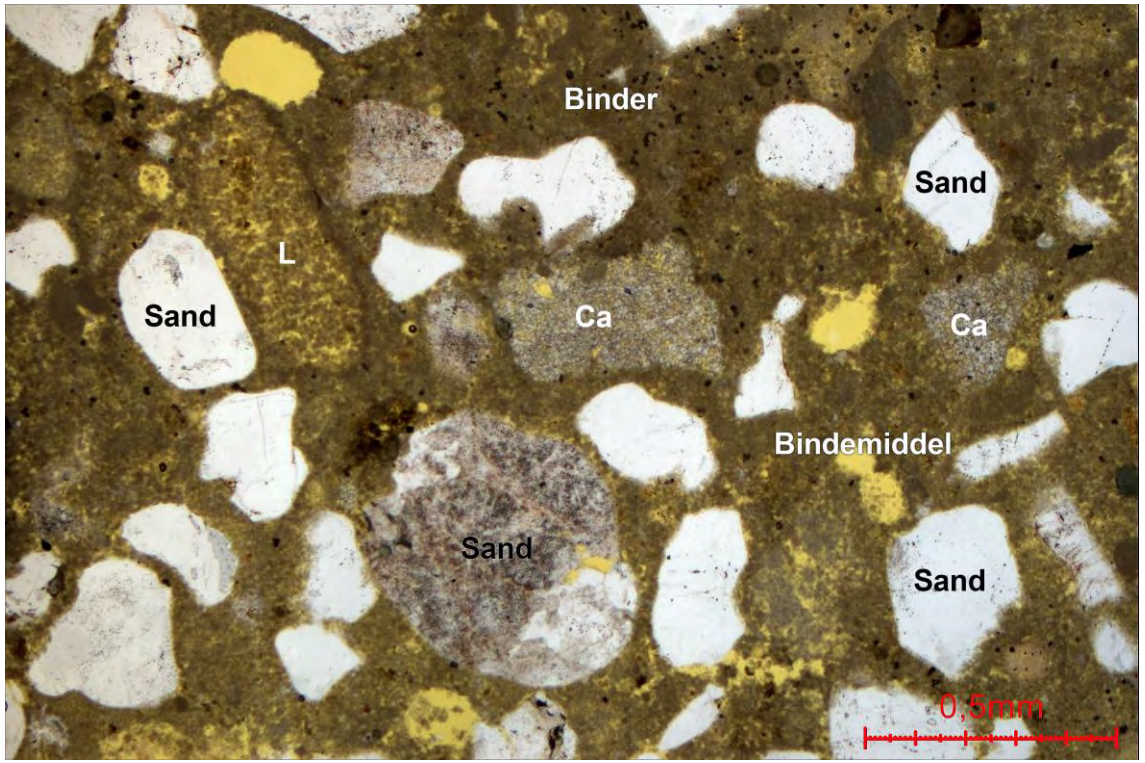
Classification of lime binders

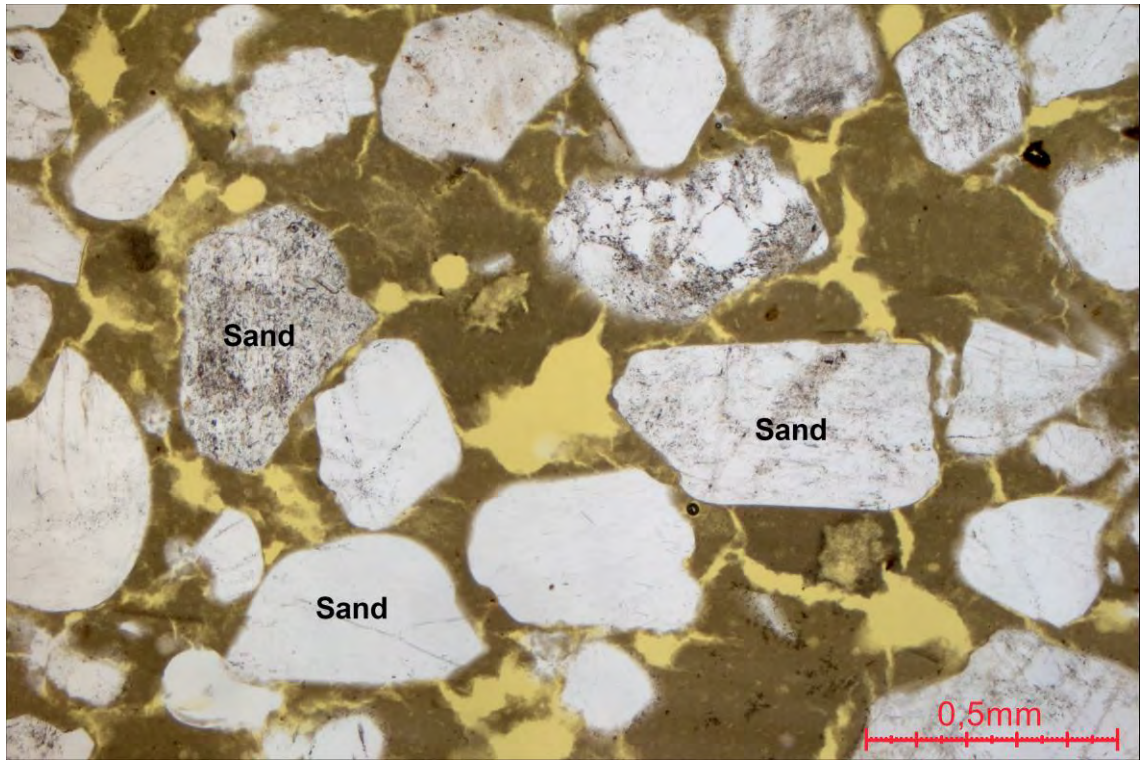


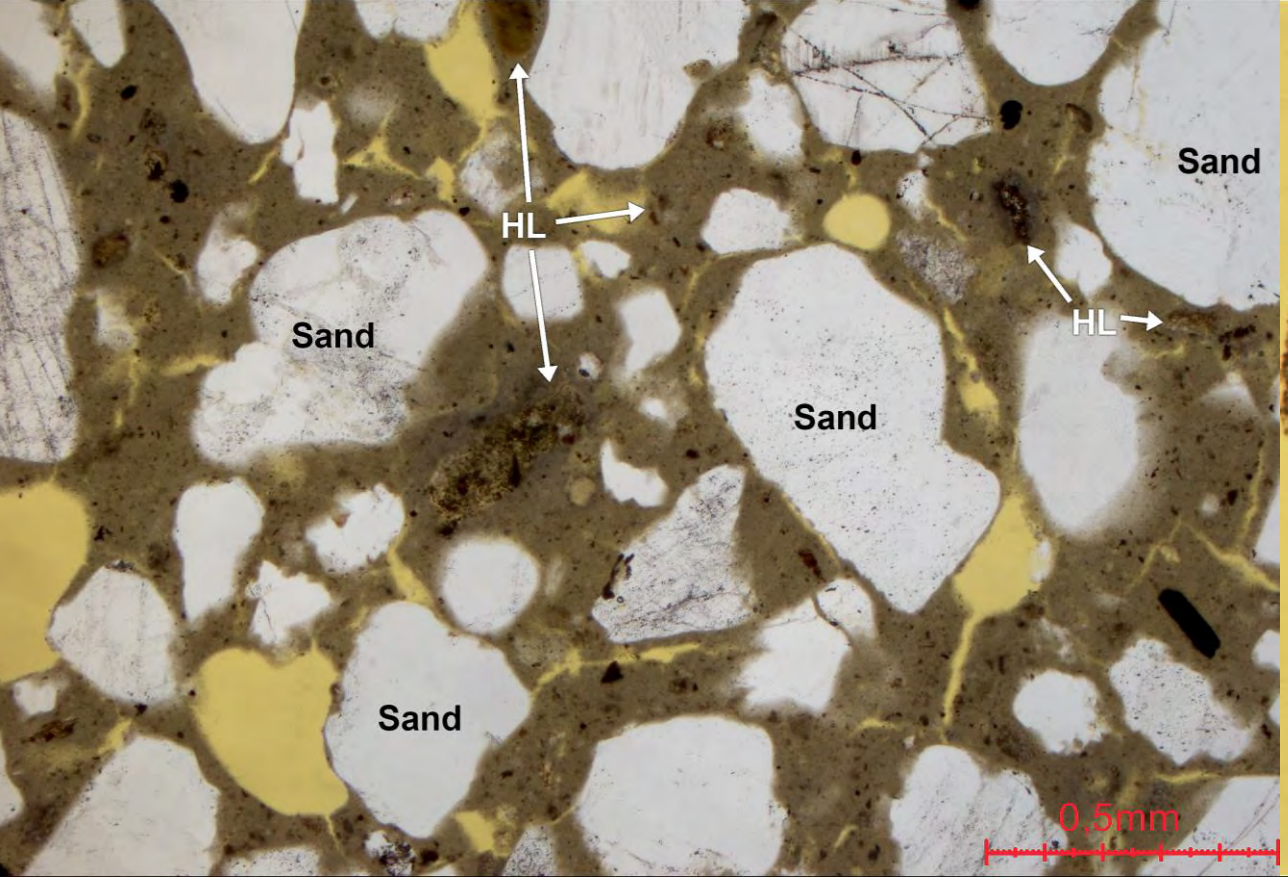
Binders in Denmark

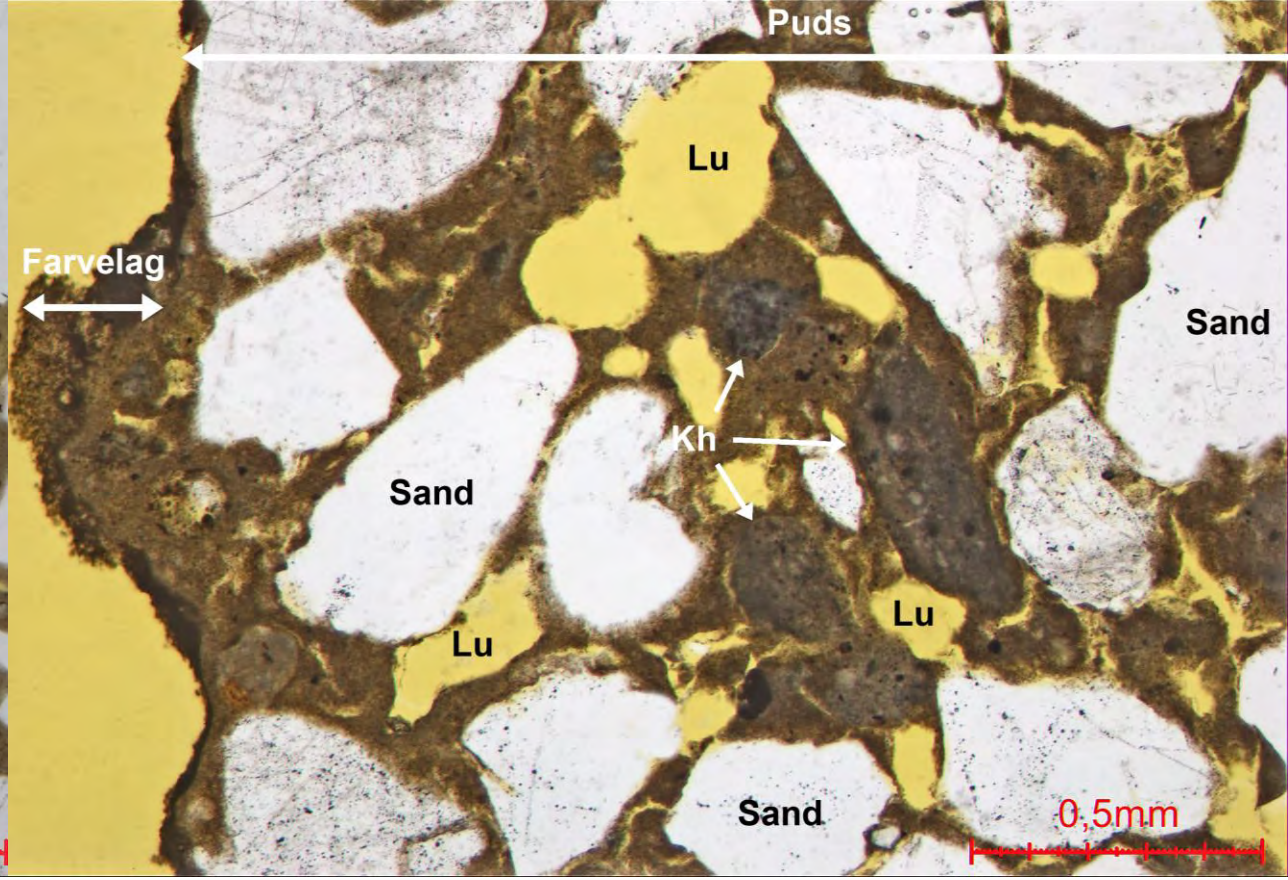


Lime (air)

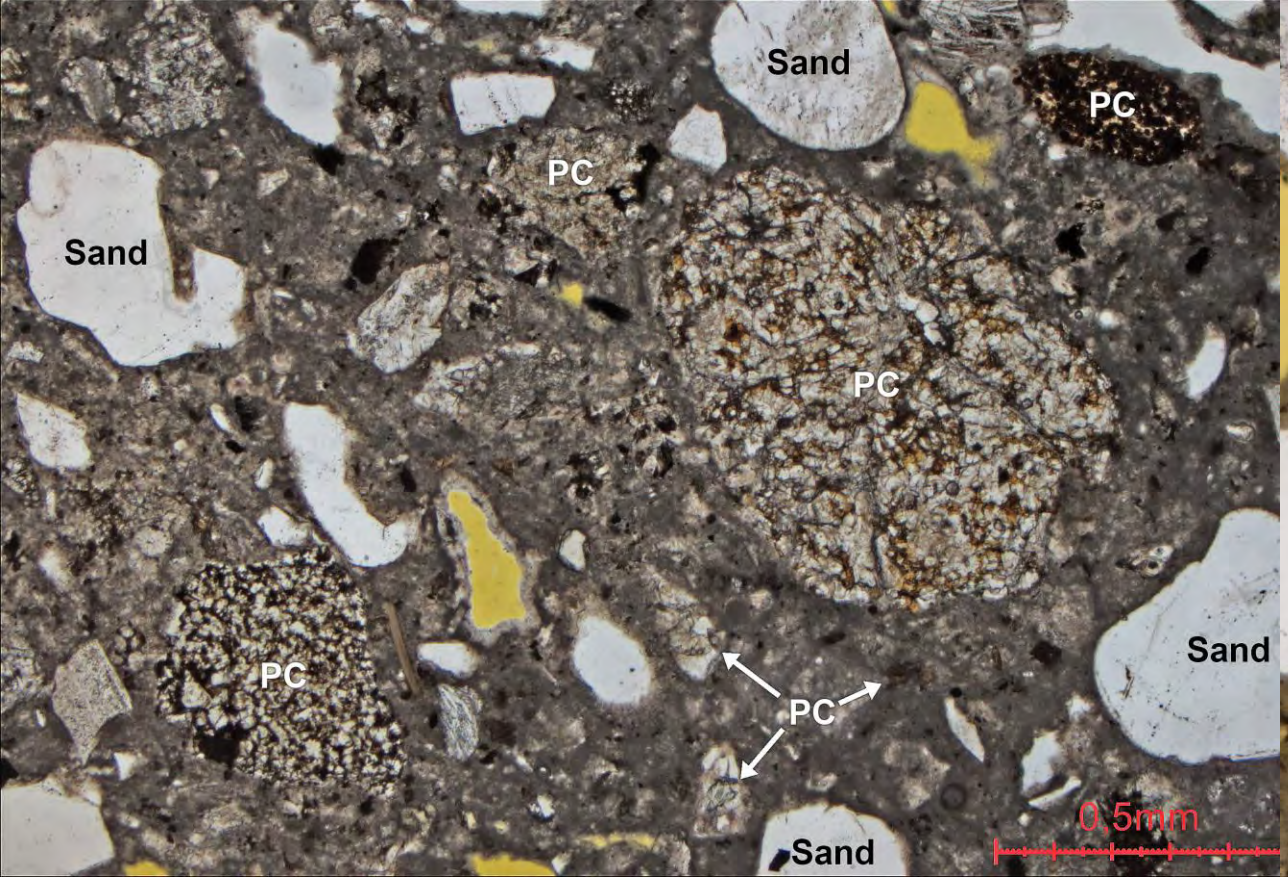

Binder
Sand
L
Sand
Ca
Ca
Bindemiddel
Sand
Sand
0,5mm

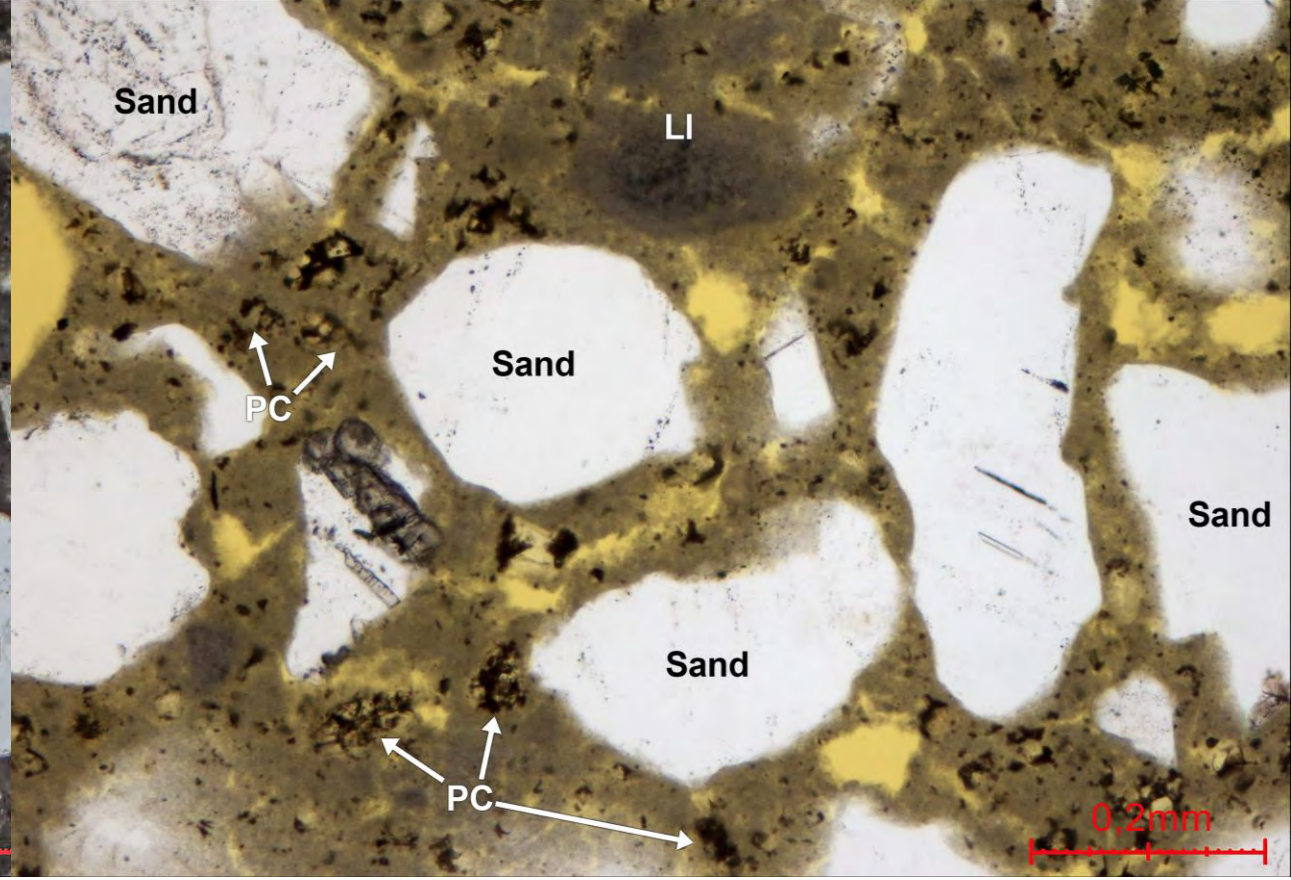

Sand
Sand
Sand
0,5mm





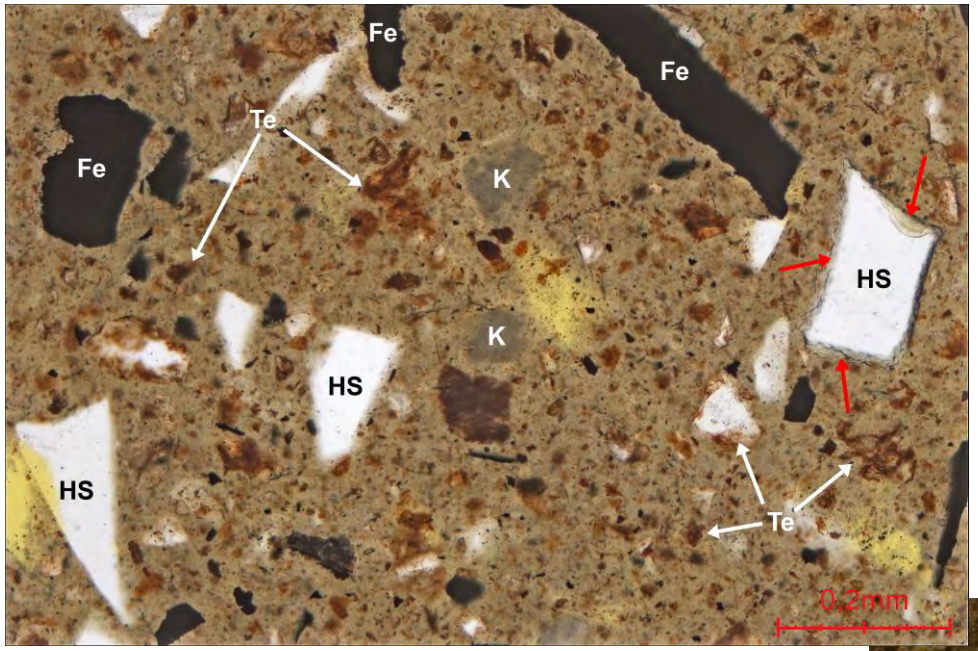
Hydraulic lime

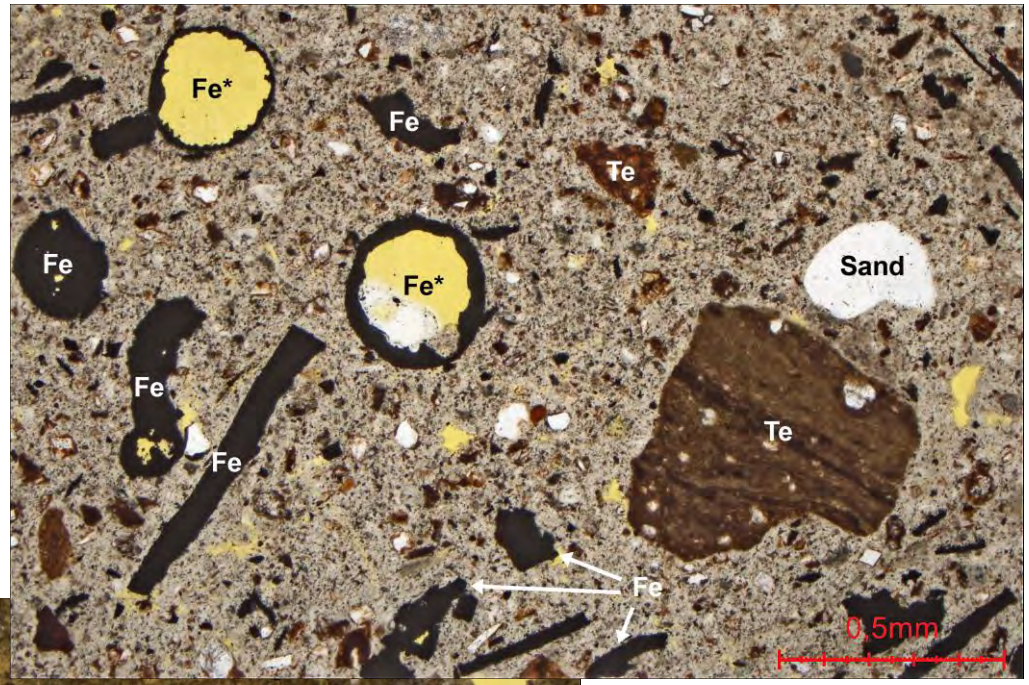




Portland Cement

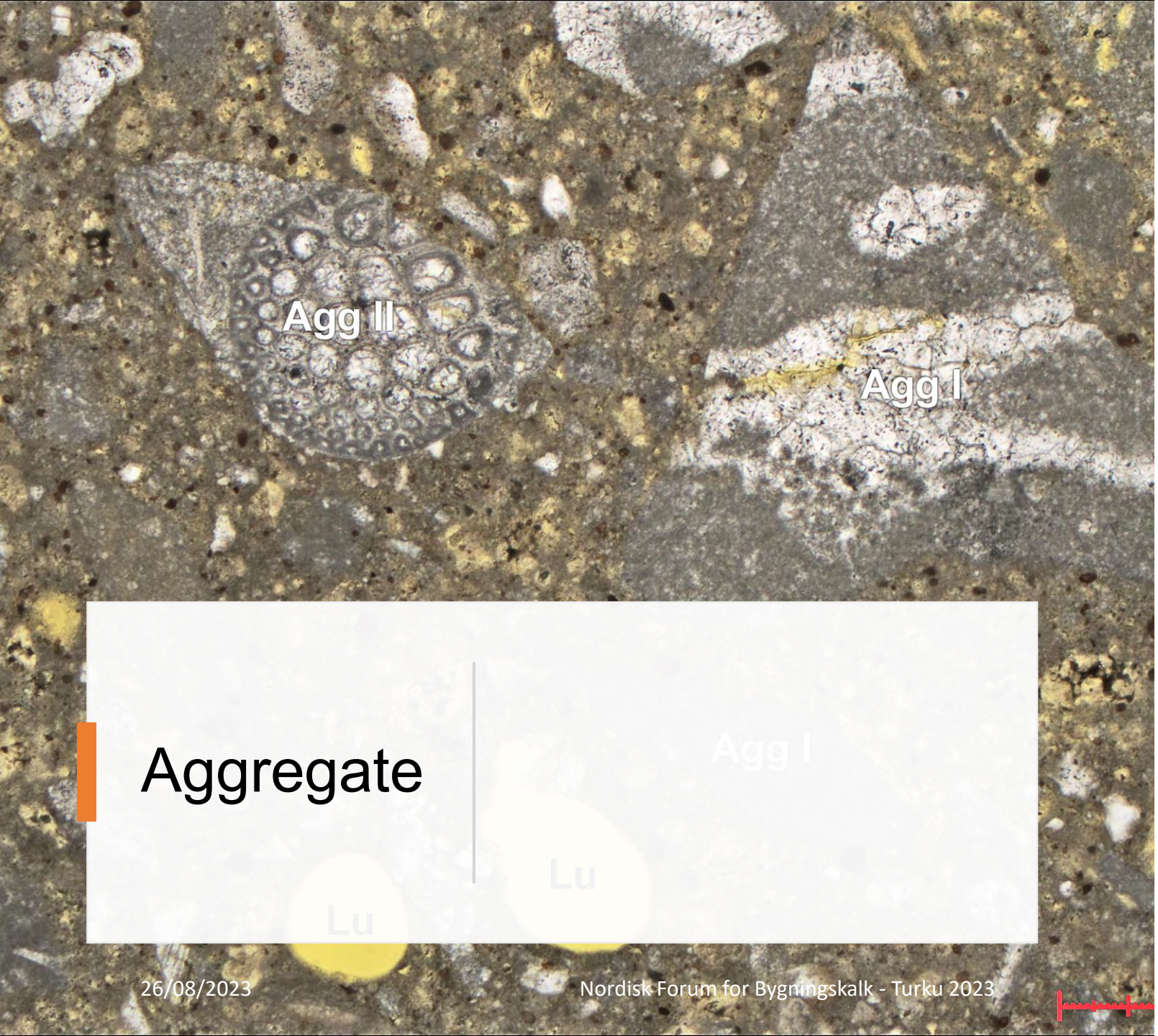
Pozzolan

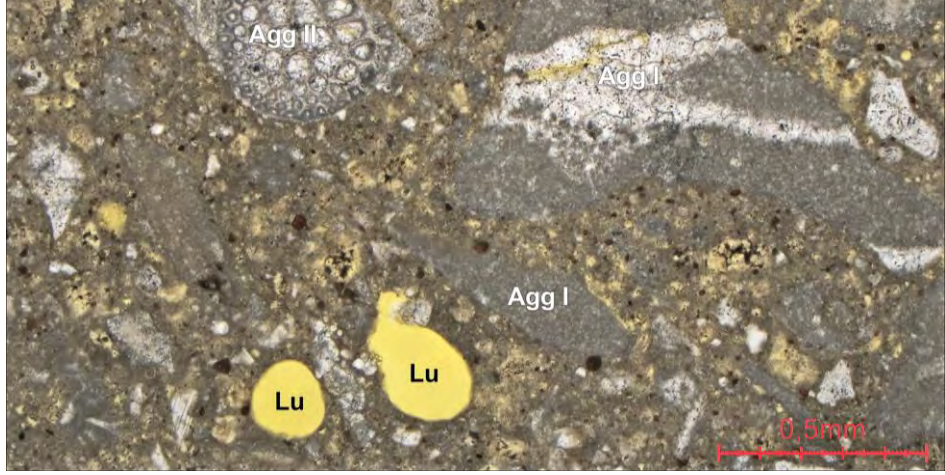

Fe
Fe
Te
Fe
K
HS
K
HS
HS
Te
0,2mm

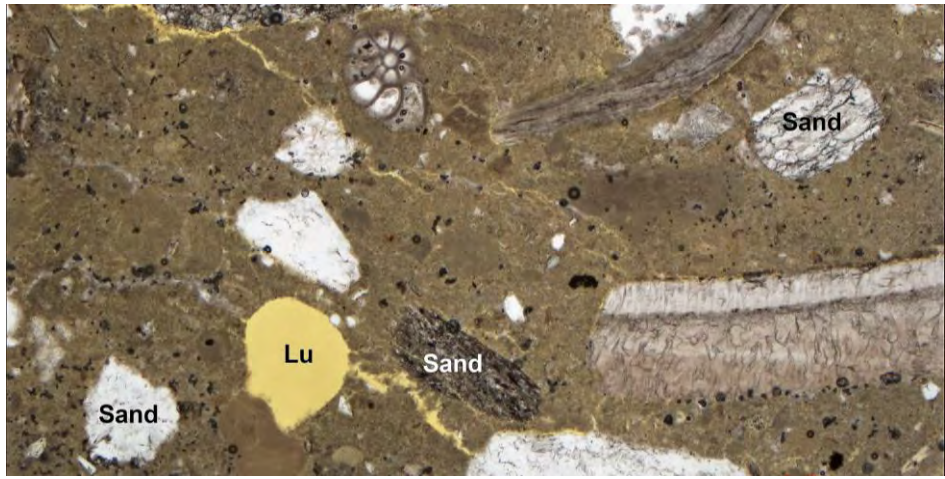

Fe*
Fe
Te
Fe
Fe*
Sand
Fe
Te
Fe
0,5mm

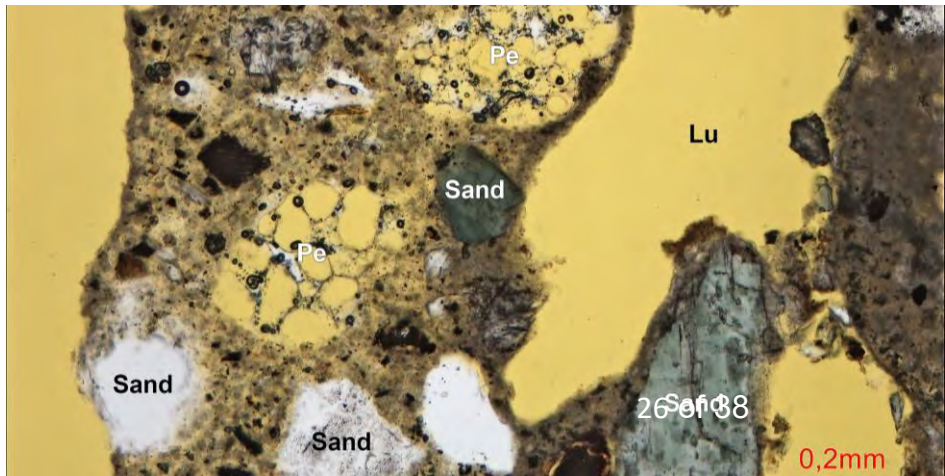

Tr
Am
Tr
Gl
K
Tr
Tr
Bindemiddel
0,5mm

Aggregate

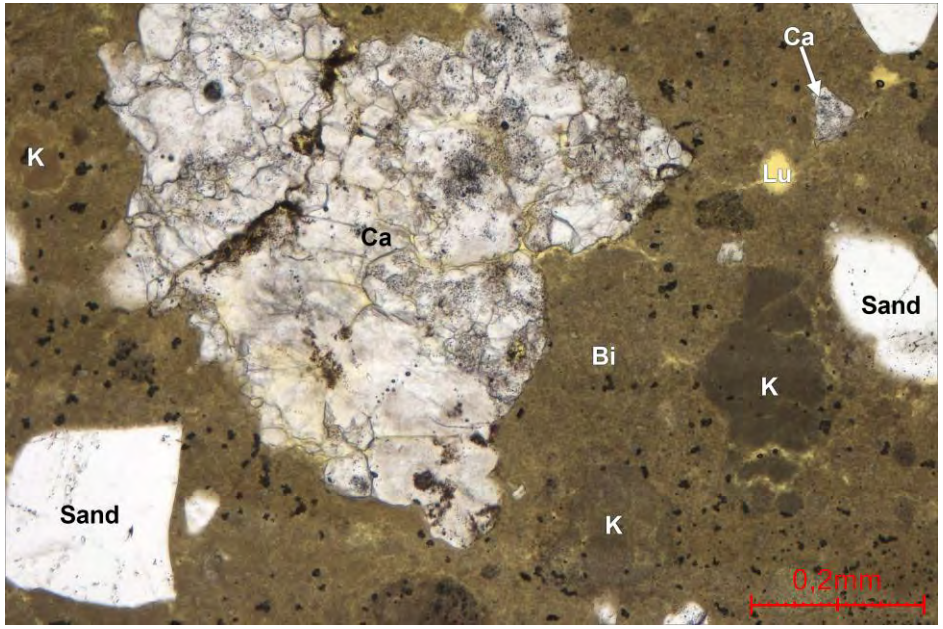

Agg II
Agg I
Lu
Lu

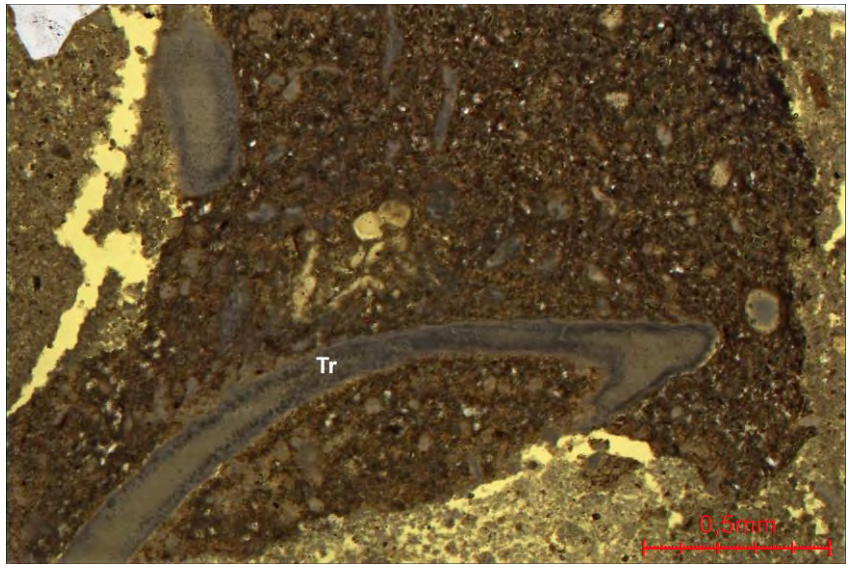

Agg II
Agg I
Agg I
Lu
Lu
0,5mm

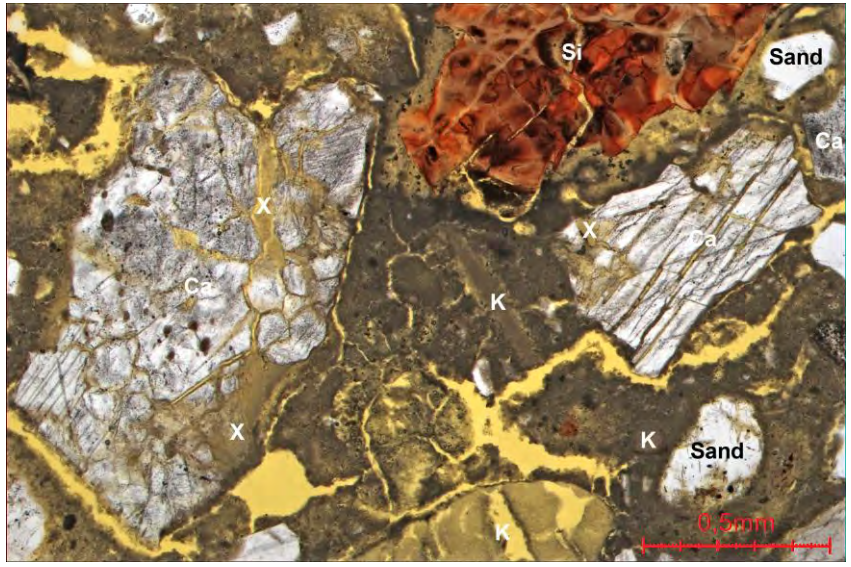

Sand
Lu
Sand
Sand


Pe
Lu
Sand
Pe
Sand
Sand
Sand
0,2mm

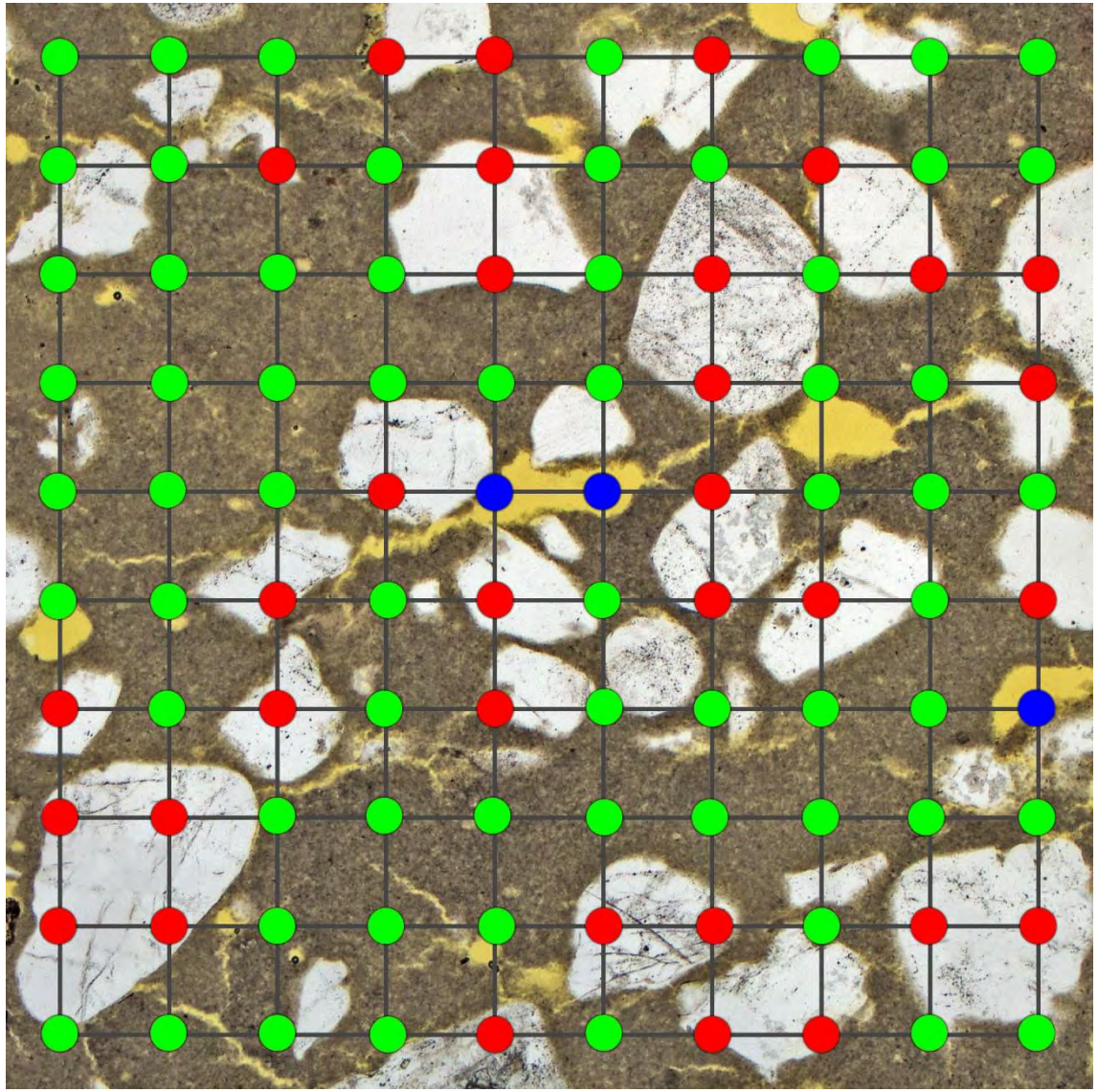
Provenance


Ca
K
Lu
Ca
Sand
Bi
K
Sand
K
0,2mm

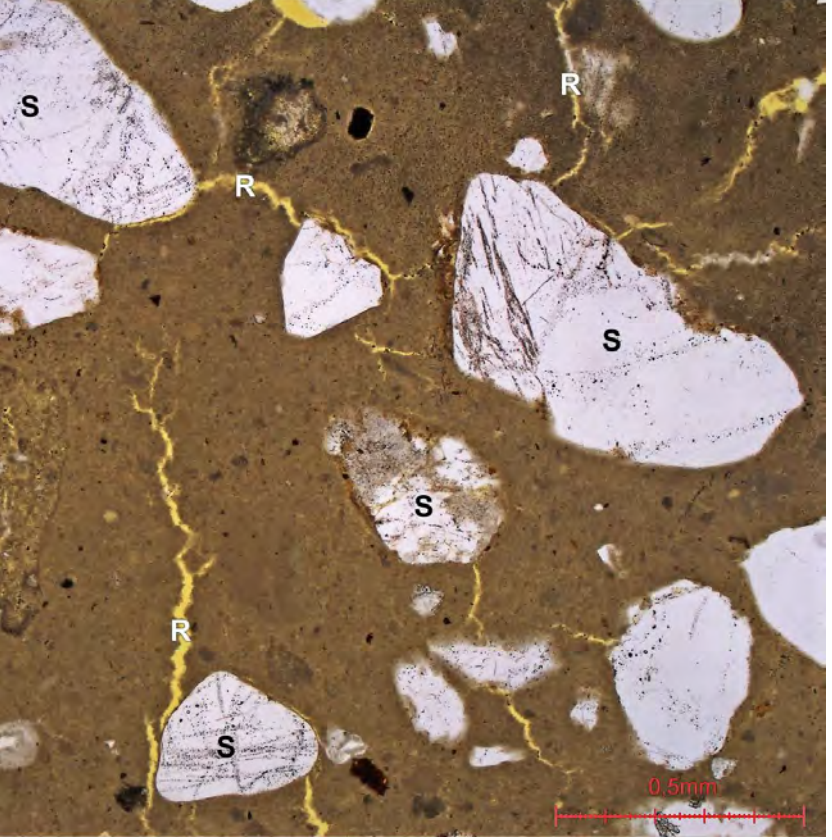

Tr
0,5mm

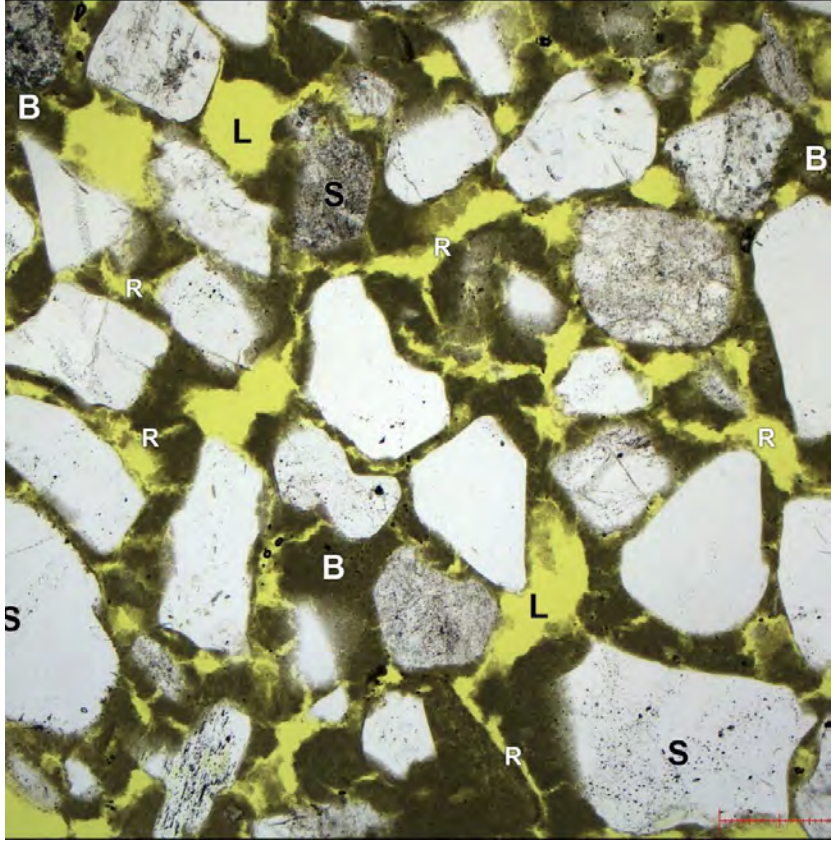

Si
Sand
Ca
X
X
Ca
K
X
K
Sand
K
0,5mm

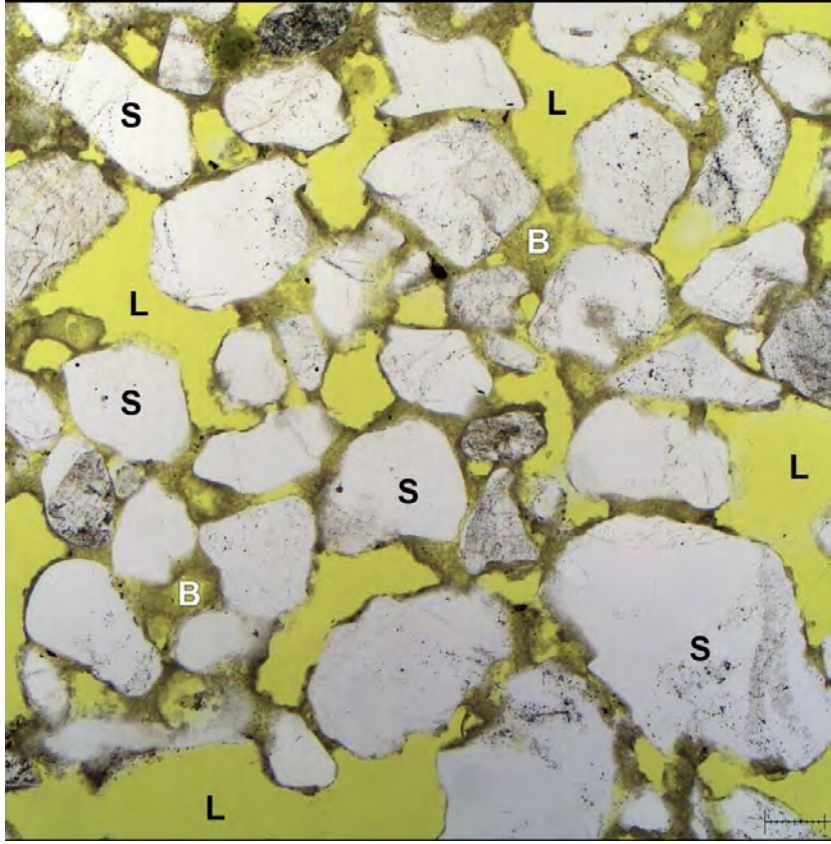
Determination of mortar composition



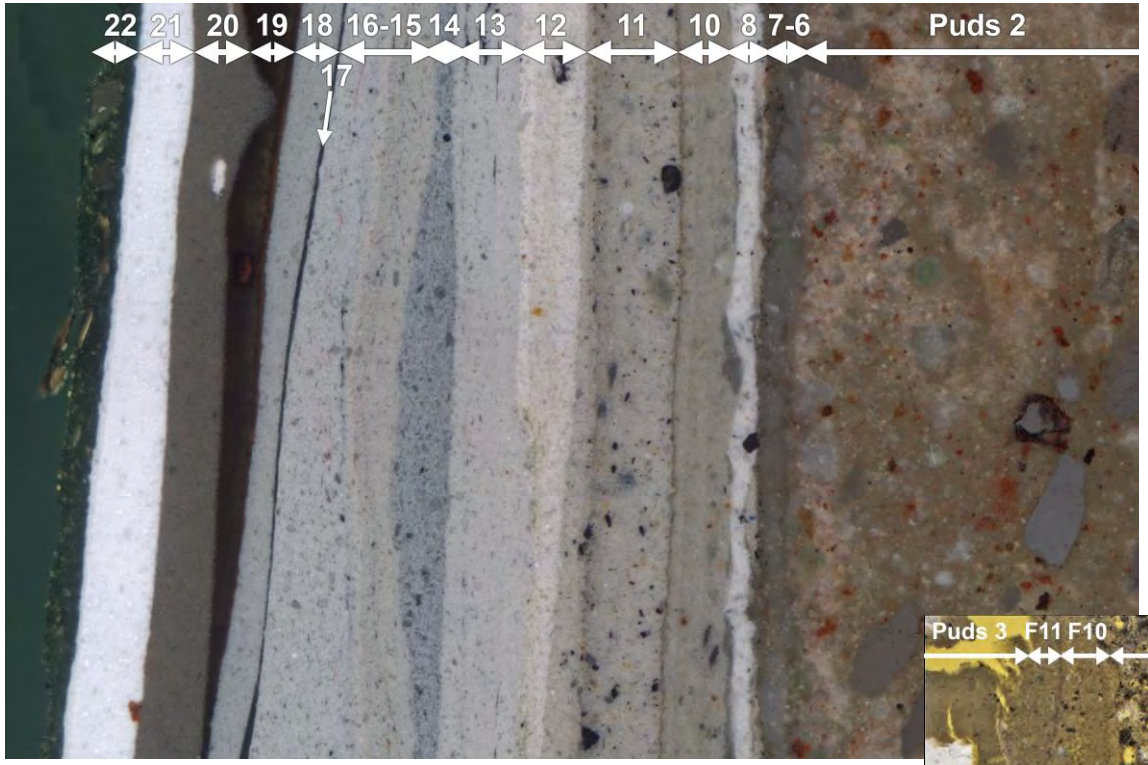
- Sand
  (33 pcs.)
  = 33 vol%
- Binder
  (64 pcs.)
  = 64 vol%
- Air
  (3 pcs.)
  = 3 vol%

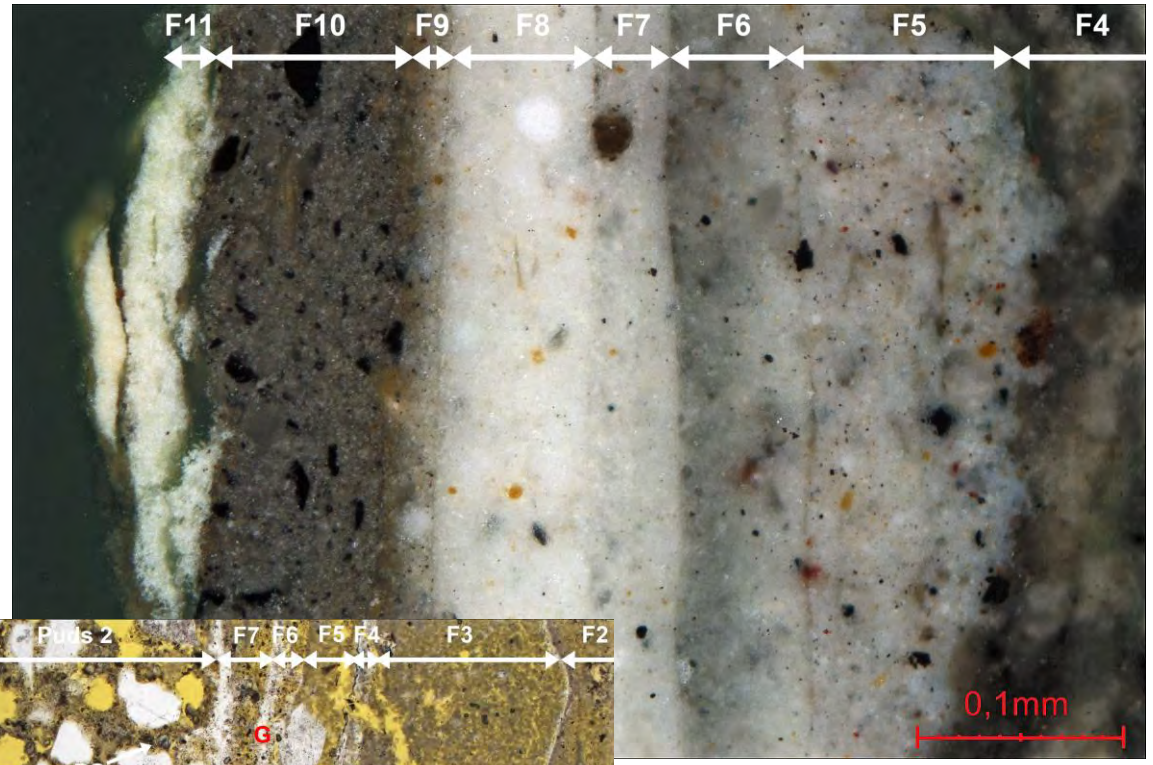


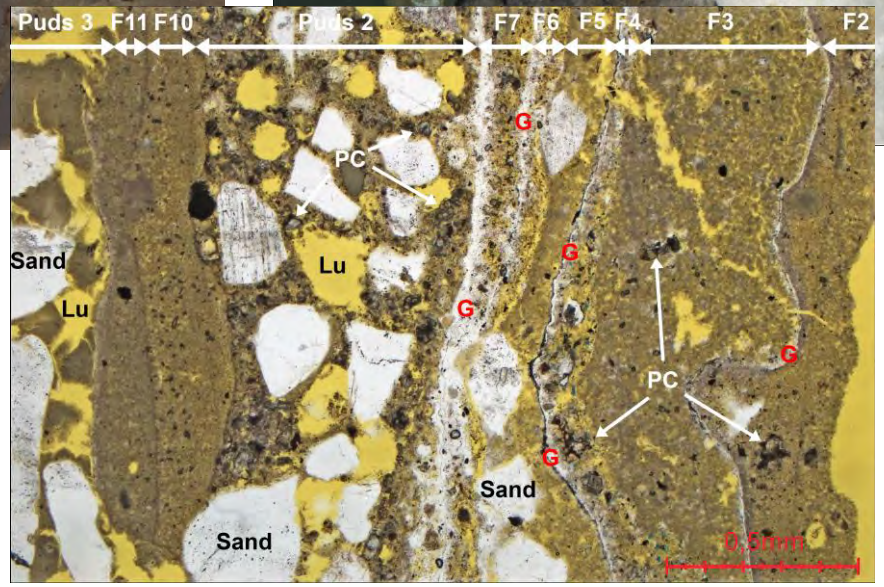




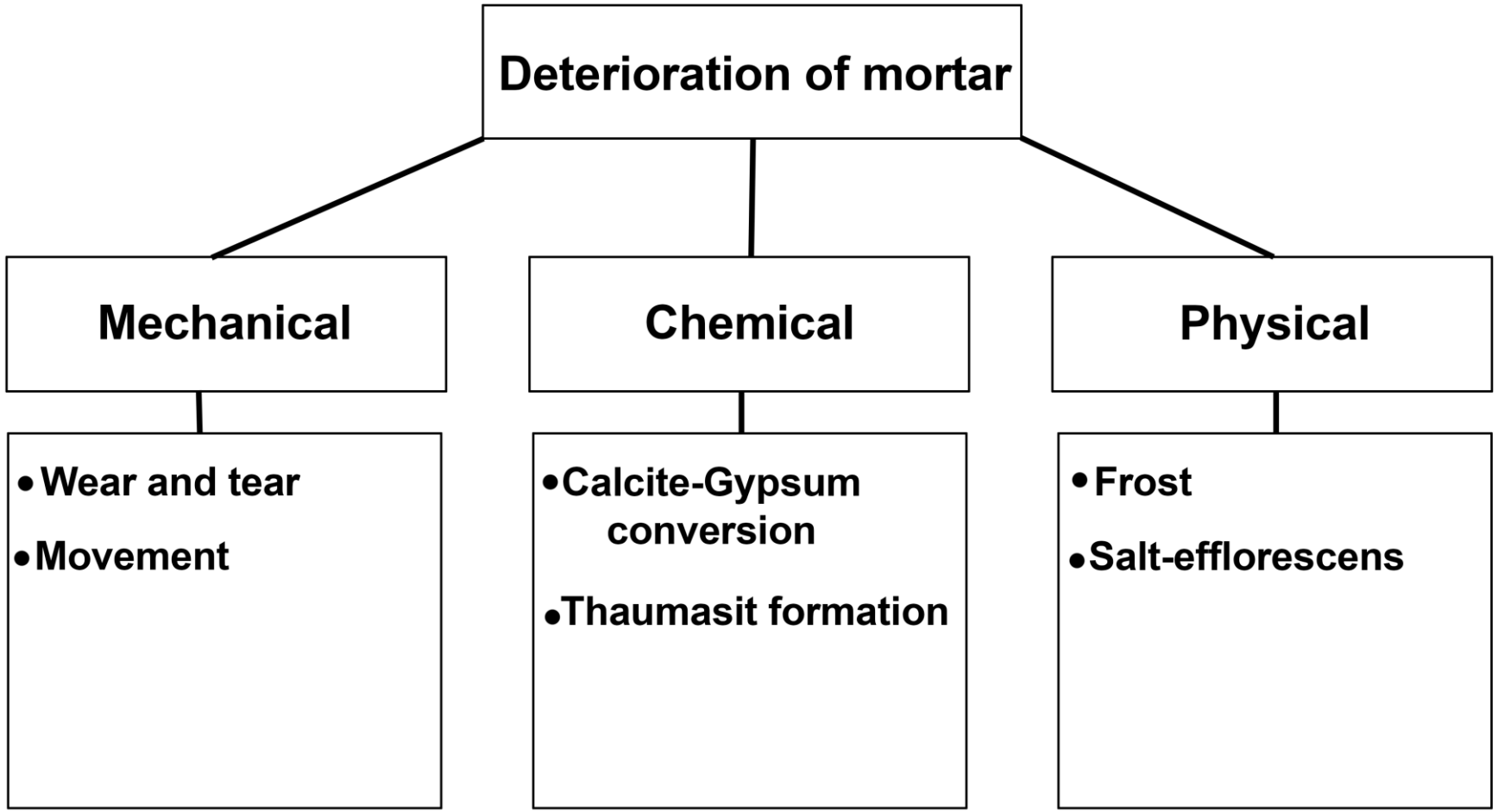
Different types of lime mortar (from the middle-ages to the beginning of 1900

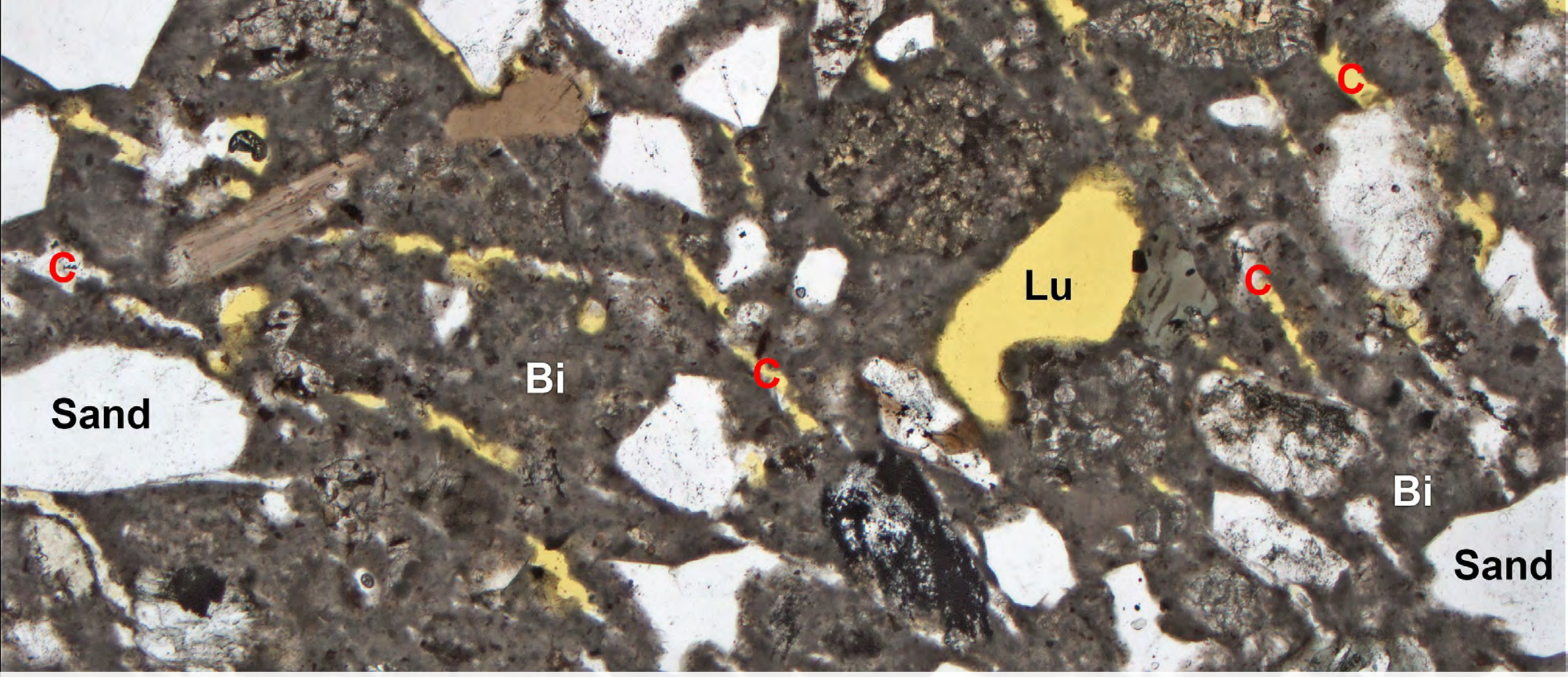




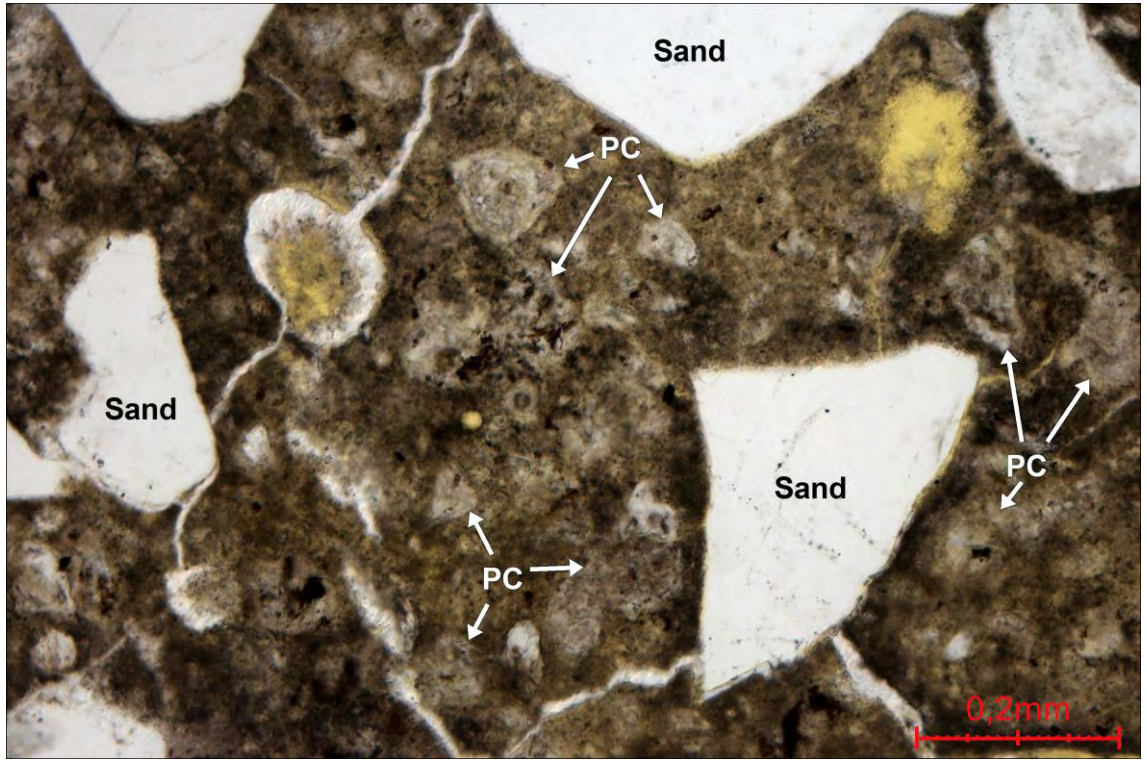


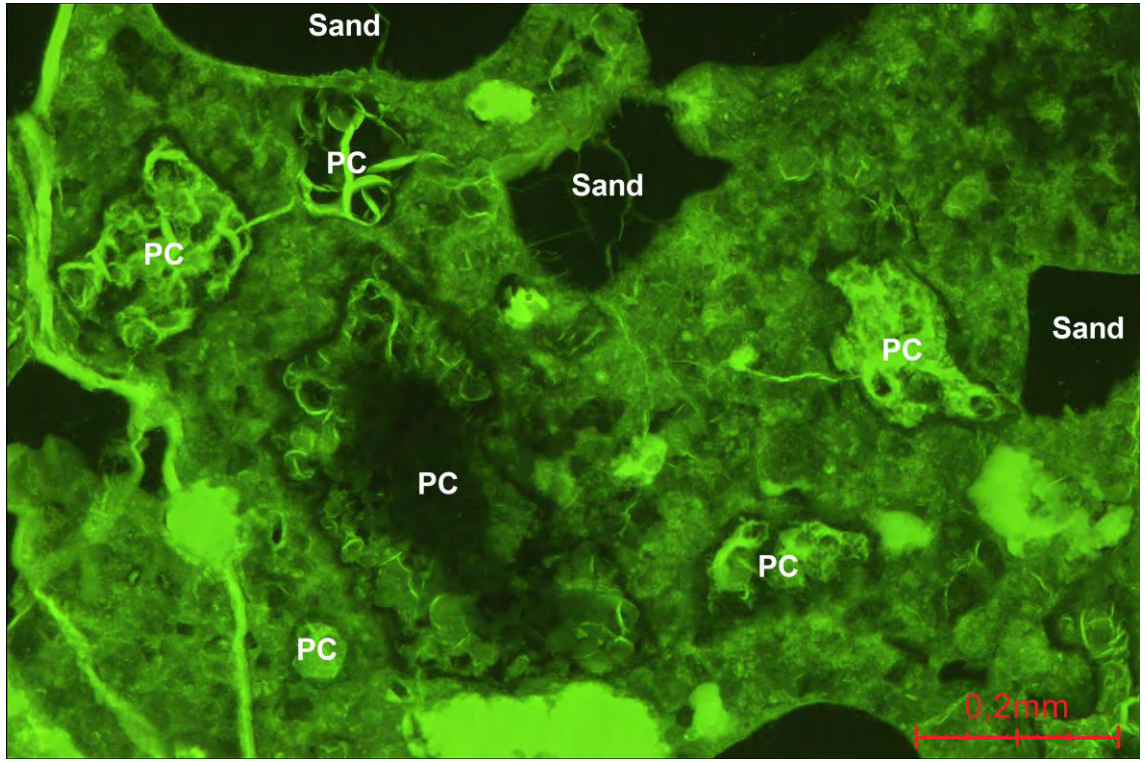
Paint layers


Deterioration of mortar
Mechanical
Chemical
Physical
• Wear and tear
• Movement
• Calcite-Gypsum conversion
• Thaumasit formation
• Frost
• Salt-efflorescens



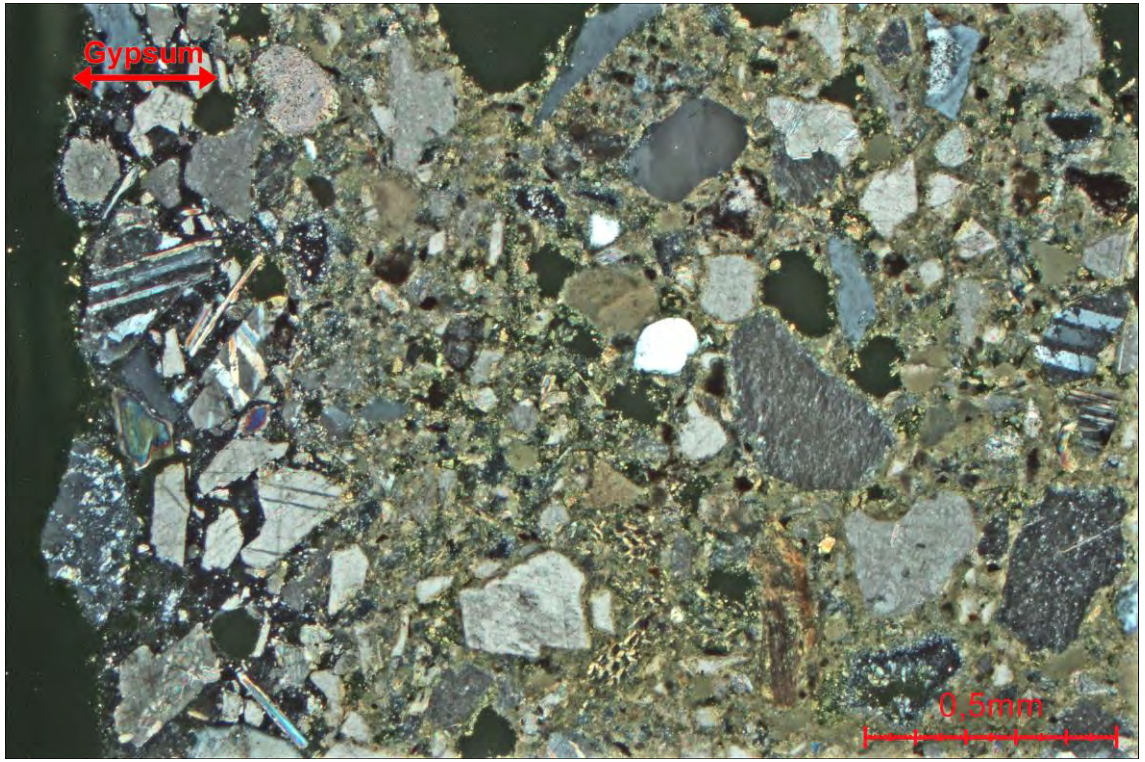
Influence of moisture and frost

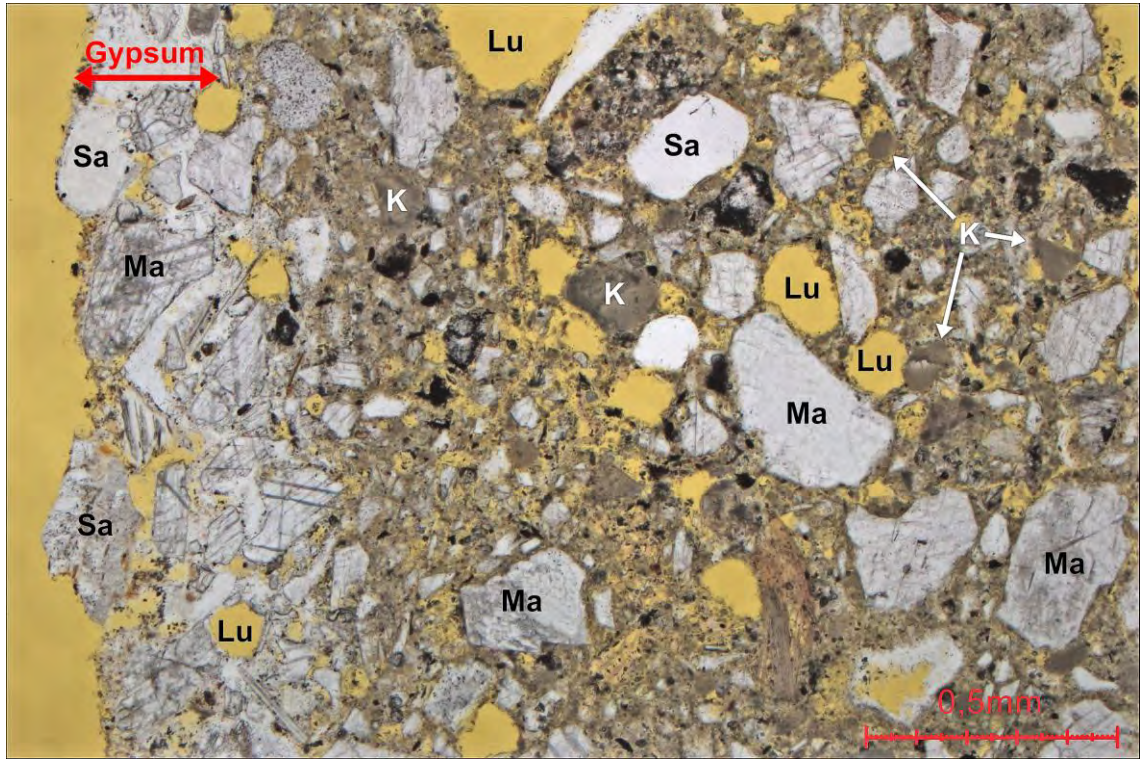




Hydration of cement: $2Ca_3SiO_5 + 7H_2O \rightarrow 3CaO{*}2SiO_2{*}4H_2O + 3Ca(OH)_2$

Thaumasit formation: $3CaO{*}2SiO_2{*}4H_2O + 2CaSO_4{*}2H_2O + CaCO_3 + 24H_2O \rightarrow 2(CaSiO_3.CaCO_3.CaSO_4.15H_2O) + Ca(OH)_2$

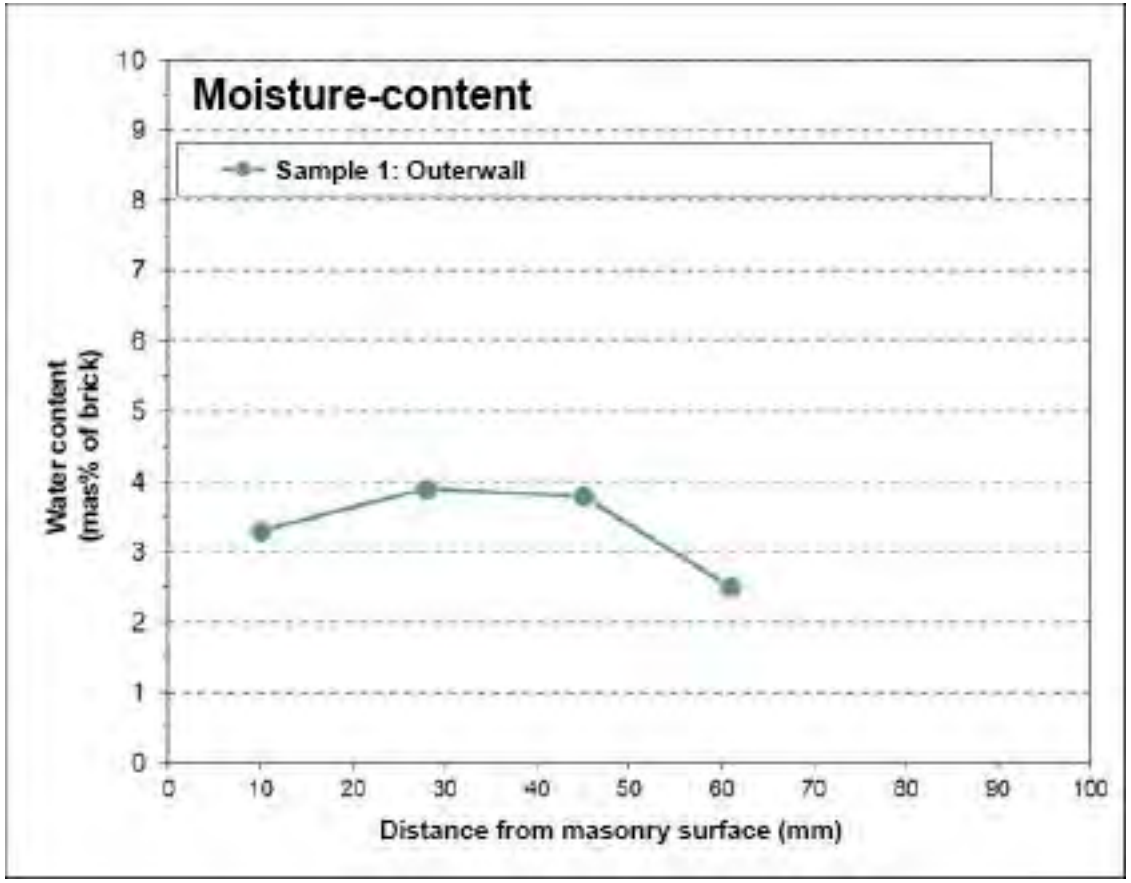


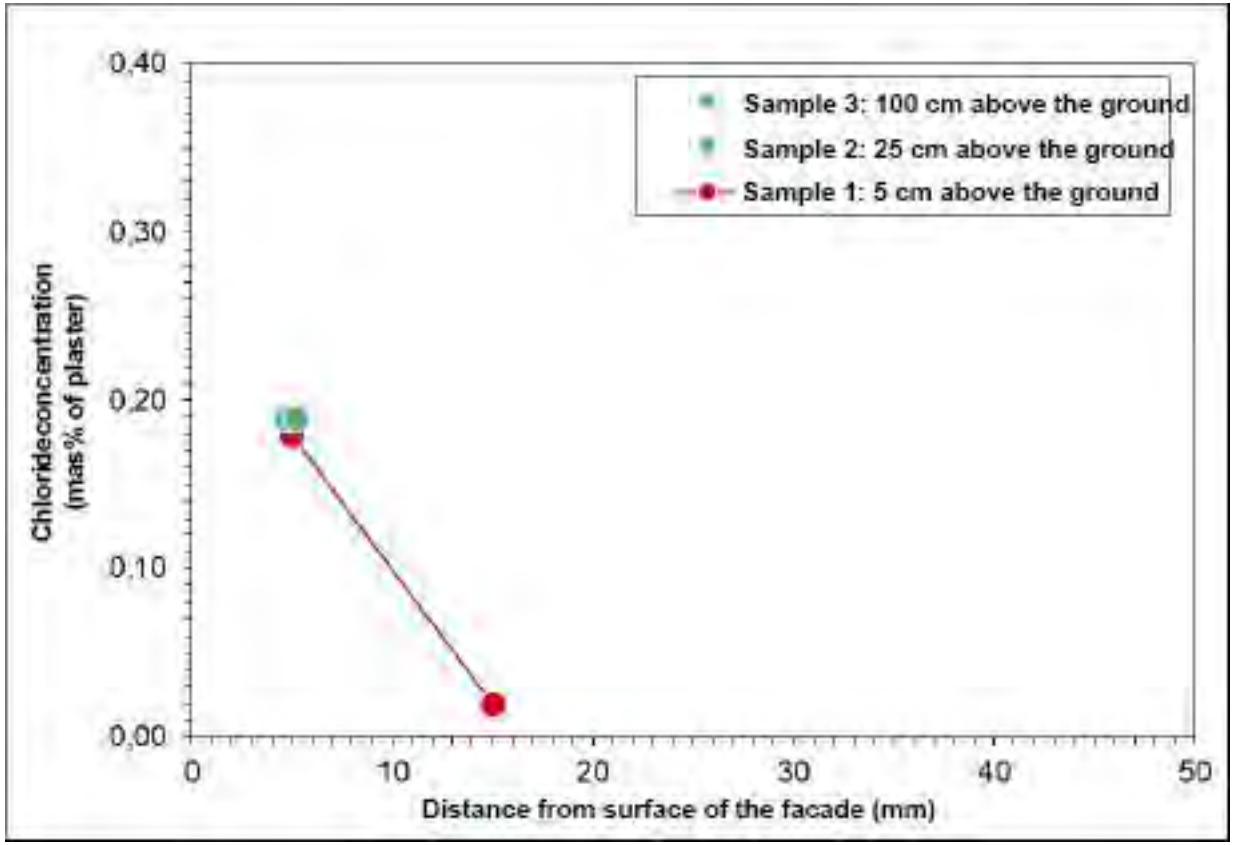


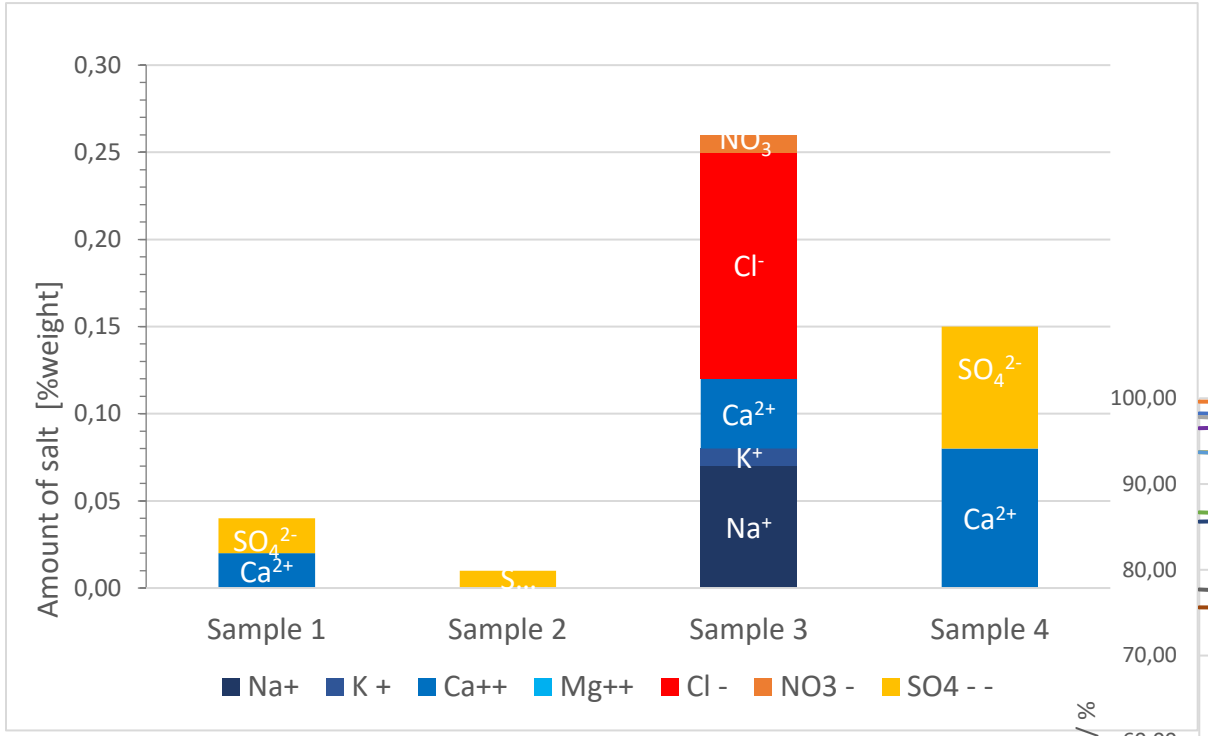
Acid rain: $SO_{2(g)} + O_{2(g)} \rightarrow 2SO_3 + H_2O_{(l)} \rightarrow H_2SO_{4(l)}$

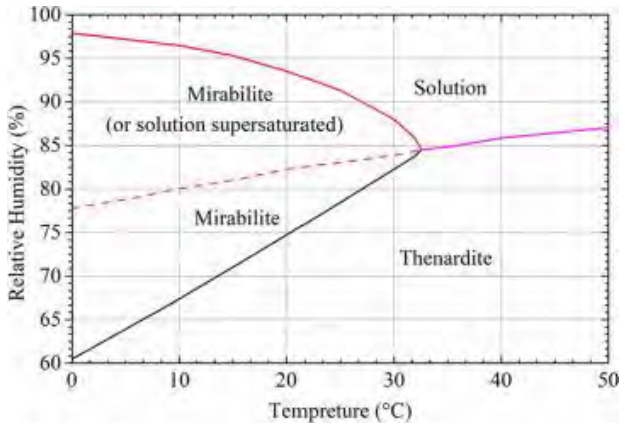
Gypsum formation: $CaCO_{3(s)} + H_2SO_{4(l)} \rightarrow CaSO_{4*}2H_2O_{(s)} + CO_{2(g)}$

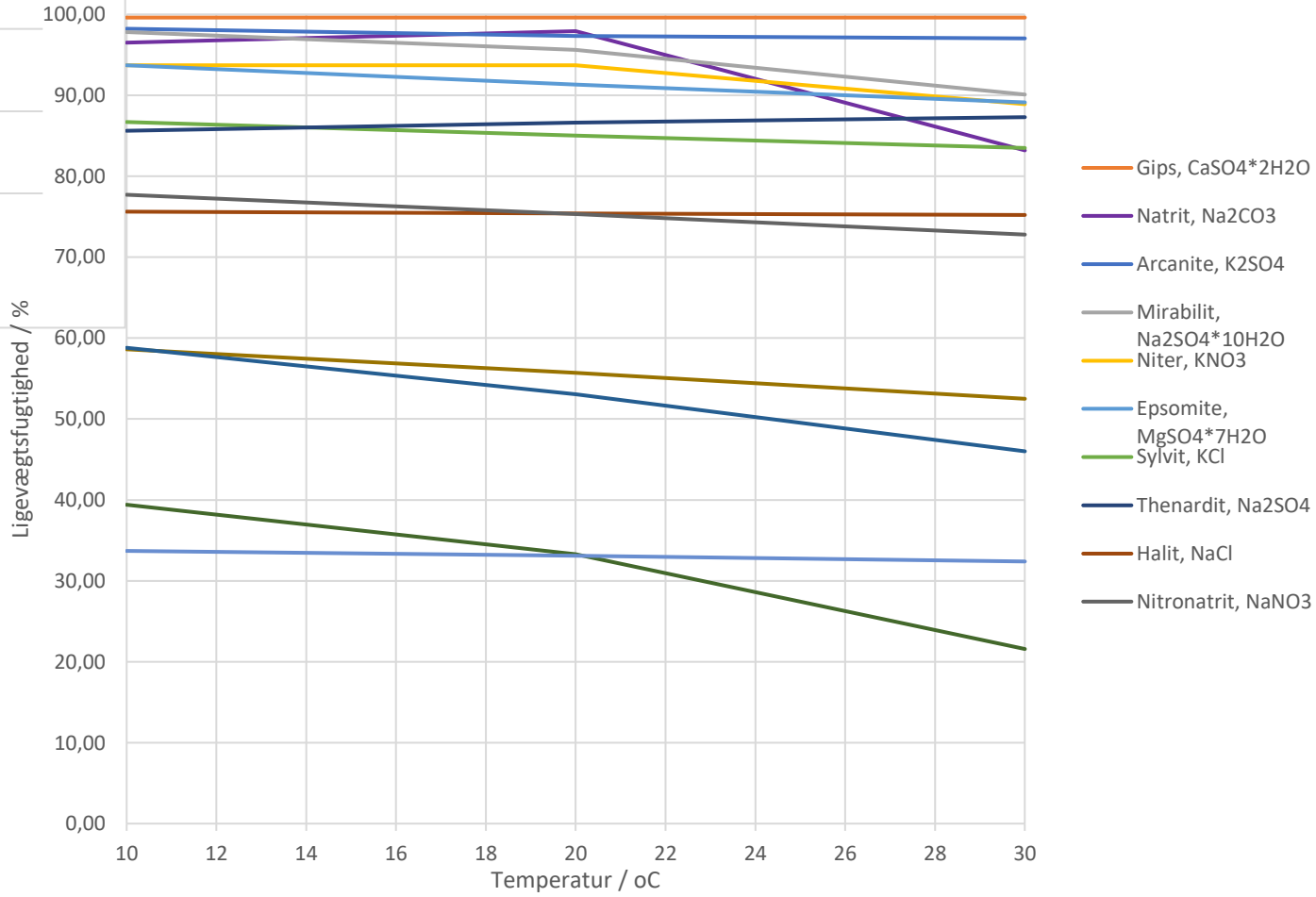
Other analysis






0,30
0,25
0,20
0,15
0,10
0,05
0,00
Amount of salt [%weight]
Sample 1
Sample 2
Sample 3
Sample 4
Na+
K +
Ca++
Mg++
Cl -
NO3 -
SO4 - -


Mirabilite
(or solution supersaturated)
Solution
Mirabilite
Thenardite
Relative Humidity (%)
Tempreture (°C)


100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
Ligevægtsfugtighed / %
10
12
14
16
18
20
22
24
26
28
30
Temperatur / oC
Gips, CaSO4*2H2O
Natrit, Na2CO3
Arcanite, K2SO4
Mirabilit, Na2SO4*10H2O
Niter, KNO3
Epsomite, MgSO4*7H2O
Sylvit, KCl
Thenardit, Na2SO4
Halit, NaCl
Nitronatrit, NaNO3

Thank you

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