ROCEM and ROCARE projects: re-establishing Roman cements to the conservation practice

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Roman cement – what is it?

Roman cements were produced by:

firing marls – limestones containing clay,

below their sintering temperature,

grinding burnt stones to a required fineness.

Roman cement – history

1796, England, first patent by James Parker, trade name „Roman cement”

1850 – 1914, key material to cover facades during the 19th and early 20th centuries

after 1918, decline in the production and use

now, attempts to bring back Roman cement to conservation practice

England

Whitby

Harwich

Sheppey

Septaria – nodules of clay-containing limestone

Septaria and cements

Sheppey Whitby Harwich

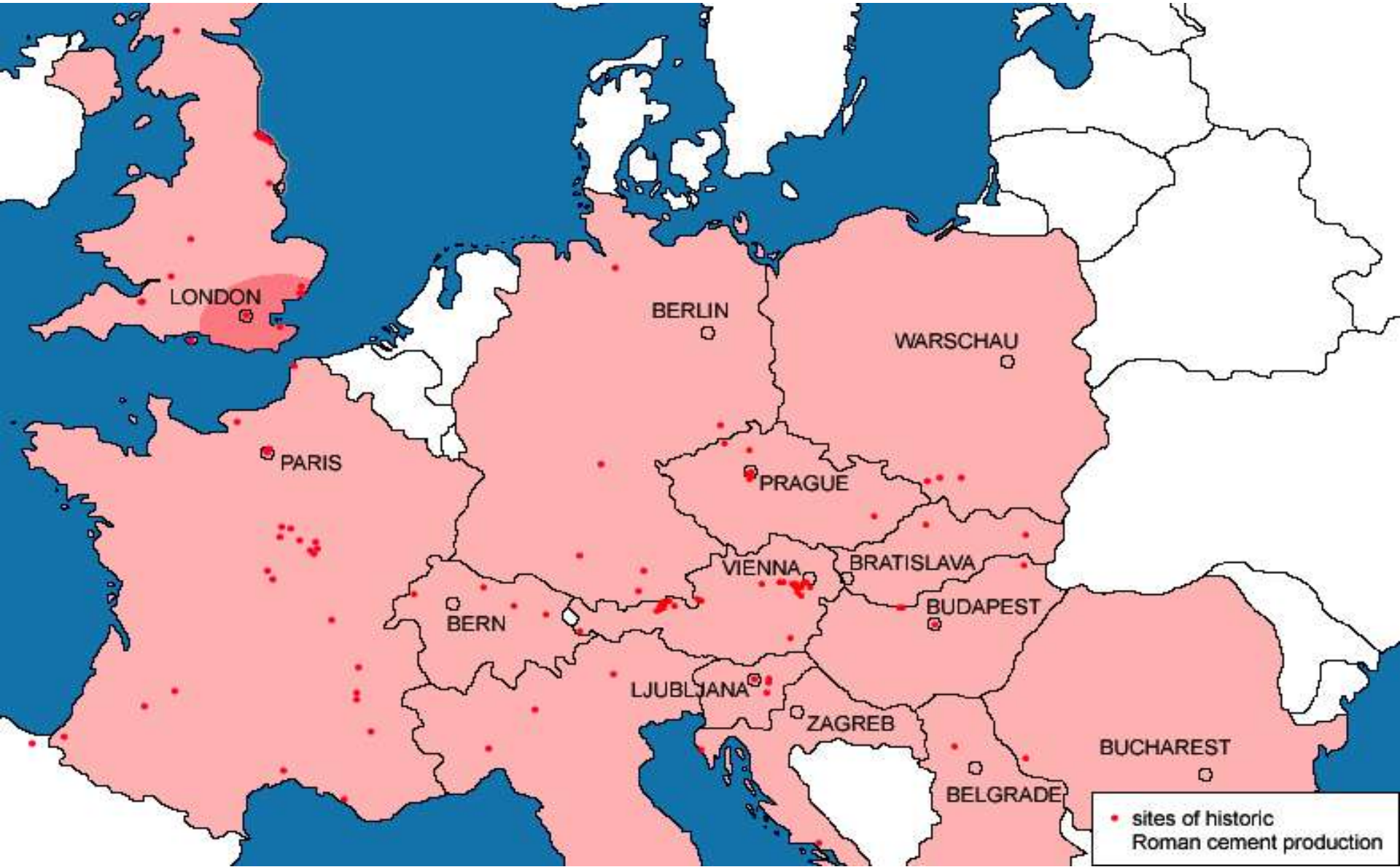
Shaft kiln in Whitby once…

…and today

Early developments in Central Europe - import

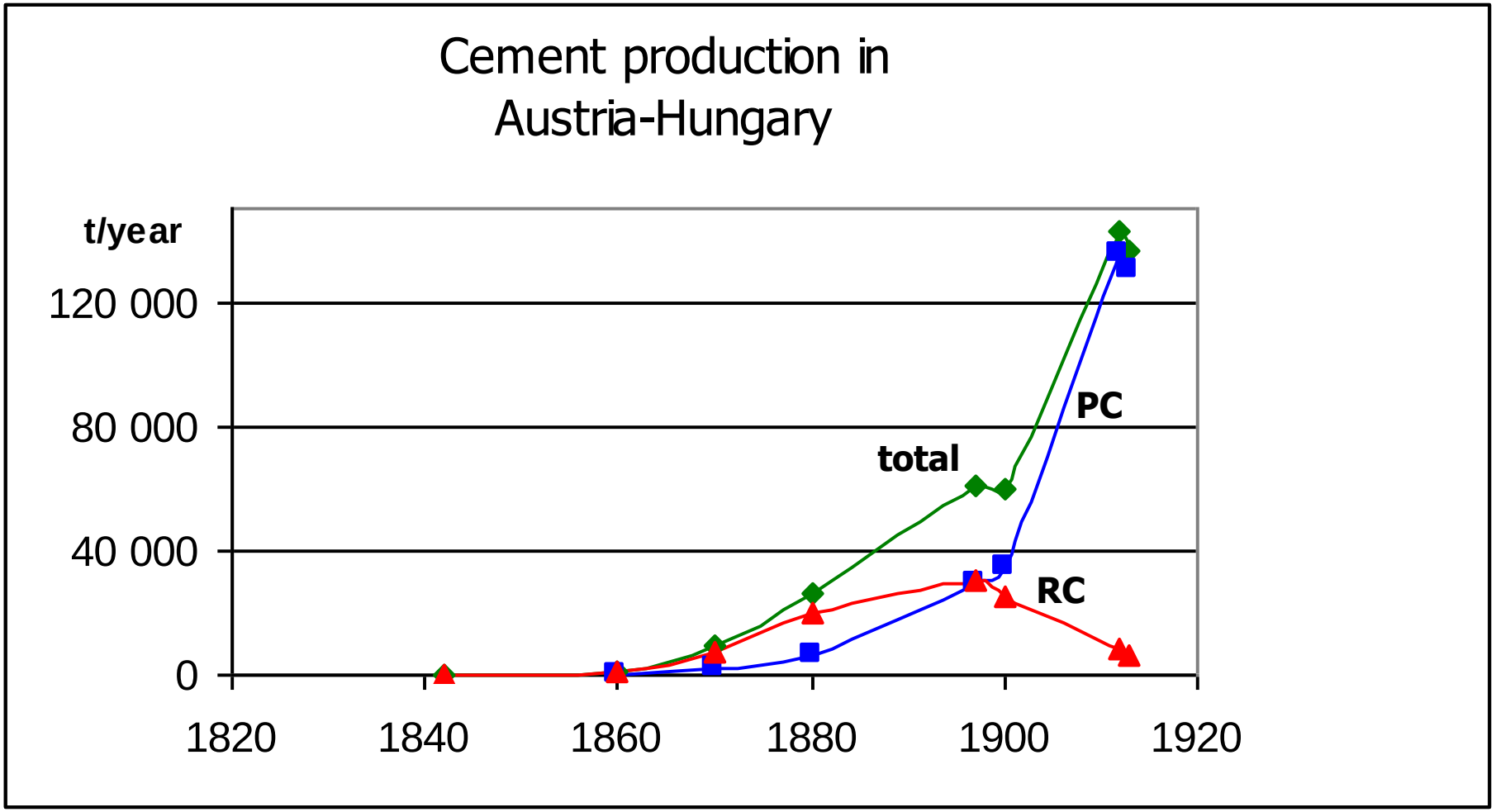
Old Nazareth Church, 1832-35, Karl Friedrich Schinkel, Berlin

Roman cement – material of the European dimension



Marl deposits were sources of raw materials in Central Europe

Historic quarry in Lielienfeld, Austria


Cement production in
Austria-Hungary
t/year
120 000
80 000
40 000
0
1820
1840
1860
1880
1900
1920
PC
total
RC

Packing and transport

Roman cement - features

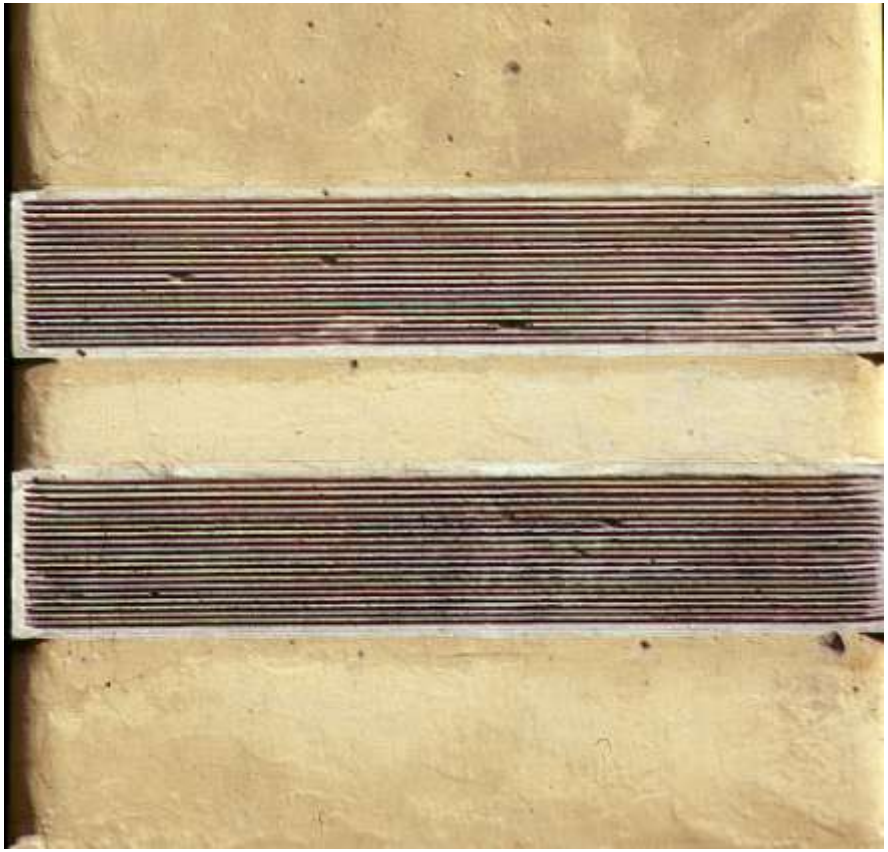
short time of setting, typically 7 - 20 minutes

warm yellow-to-brown colour

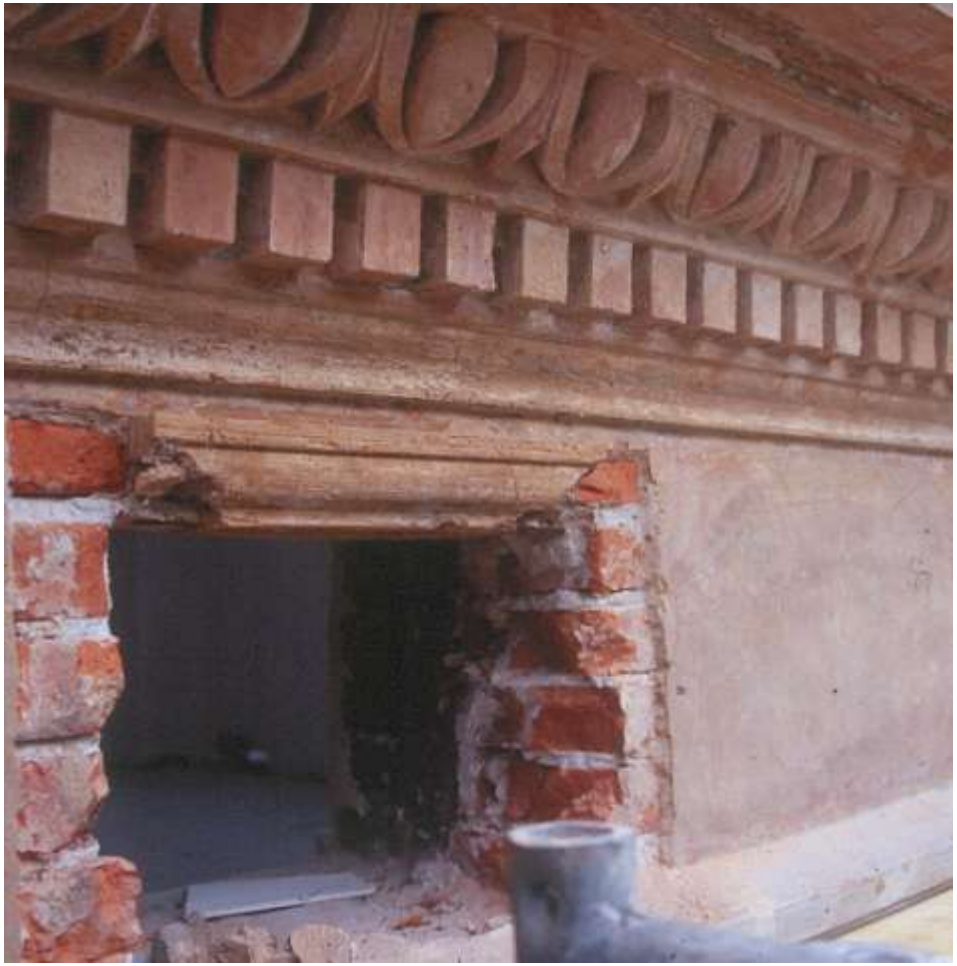
good durability to atmospheric influences

Grand stuccoes

Architectural surfaces



Run elements



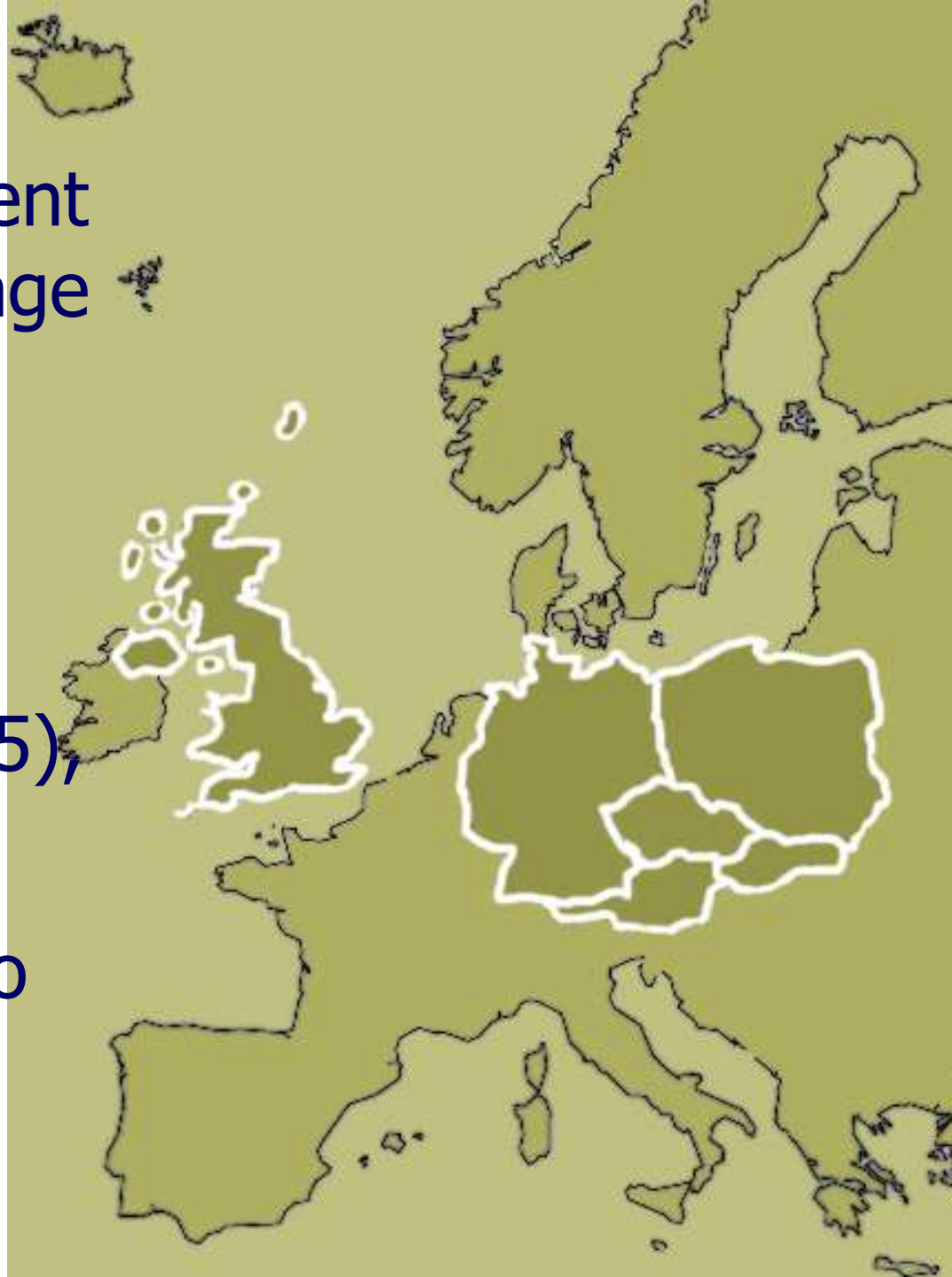
Castings

ROCEM 'Roman cement to restore built heritage effectively'

duration 2003-2006

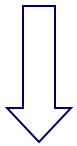
10 partners – research/education (5), companies (5)

budget 1.37 mln Euro

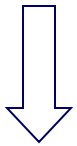


Overall approach in the project

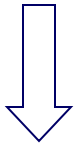
Analysis of historic mortars collected across Europe, survey of archival sources



Production of optimum Roman cements on laboratory and pilot scale



Formulation and tests of mortars matching the historic materials



Practical application in workshop and conservation practice

Marls

- mineral composition of the Lilienfeld marl - 63% calcite - $CaCO_3$, 23% clay -$(K,Mg,Fe)_x(Al,Si)_yO_z$, 9% quartz - SiO_2
- very fine grained
- natural, intimate mixture of calcite and clay

Chemical reactions during the burning process

- decomposition of calcite to lime - $CaCO_3 \rightarrow CaO$
- reaction between lime and aluminosilicates leads to the formation of the cement phases: belite – dicalcium silicate and calcium aluminates

Roman cement among hydraulic binders

Ancient Rome

T_c < 900°C

Natural /artificial pozzolans slaked lime

Ca/Si < 2?

Roman cement

T_c : 850 – 950°C

High clay content (30-40%)

Free lime < 1%

Fast binding

Ca/Si < 2

Hydraulic limes

T_c : 1000 – 1200°C

clay content < 25%

High free lime content (slaked)

Slow binding

Ca/Si > 2

Portland cement

T_c : 1460°C

Highly hydraulic klinkerphases Free lime < 1%

Controlled rate of binding

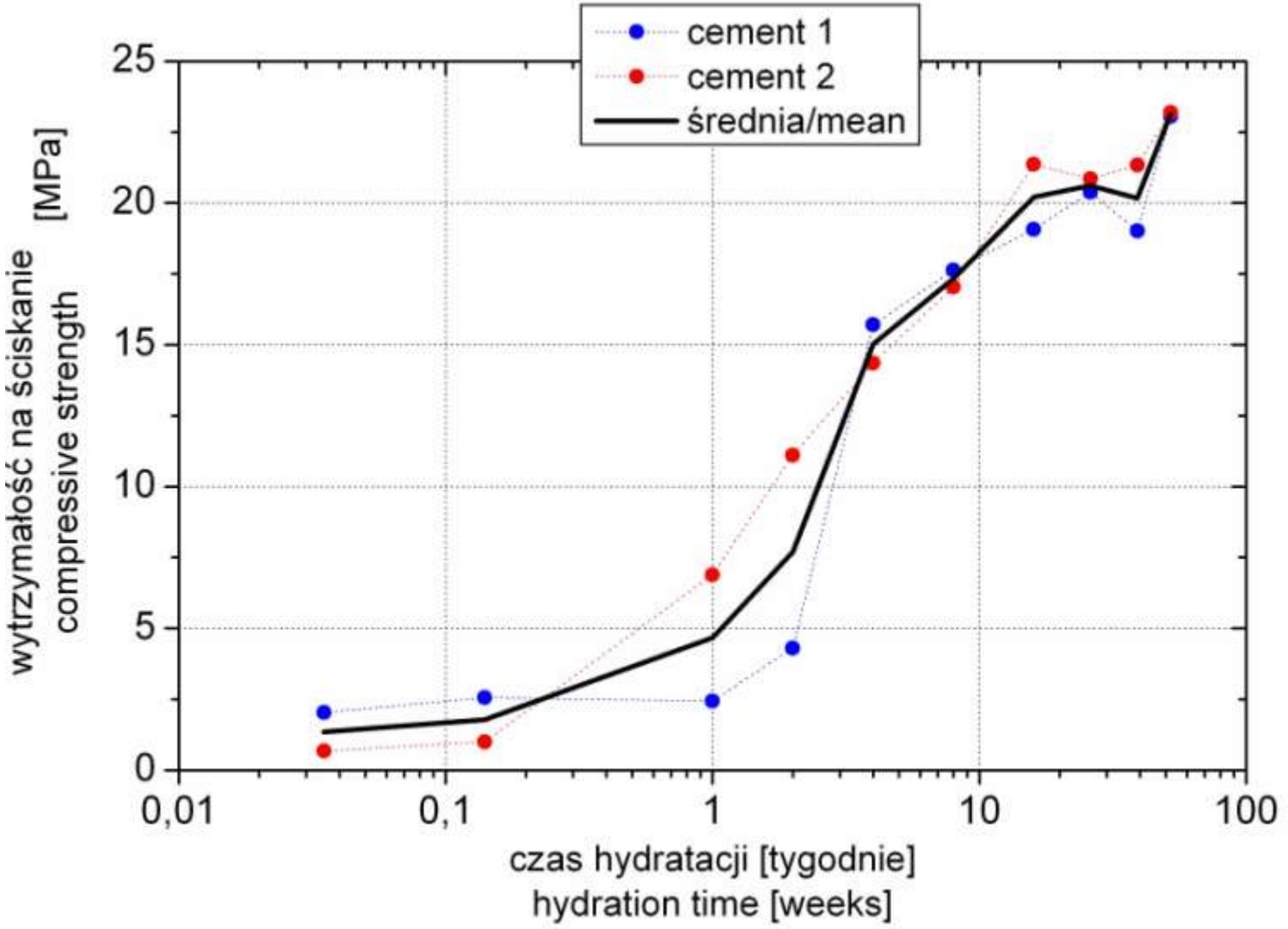
Ca/Si > 3

Roman cement - hydration

belite Ca_2SiO_4 → slow reaction → **C-S-H**

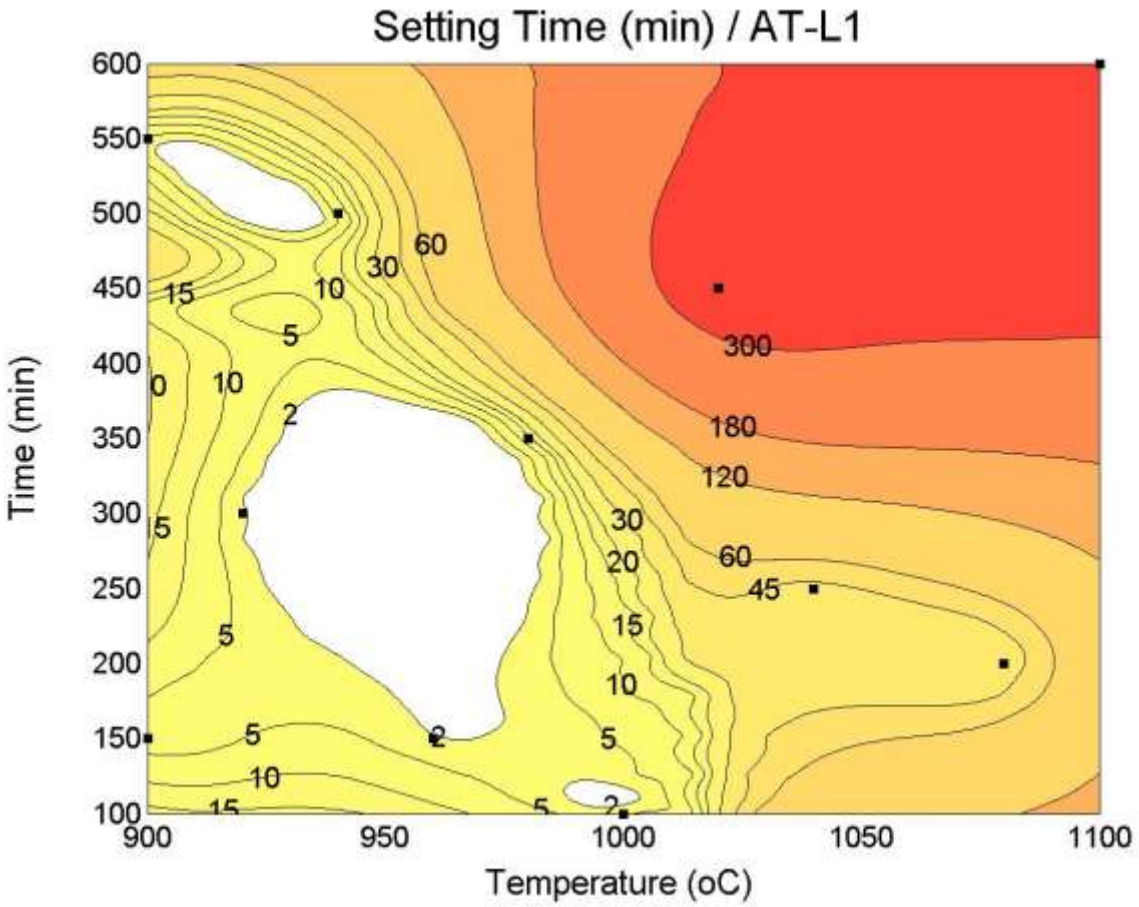
calcium aluminates → fast reaction → **C-A-H**

Strength development

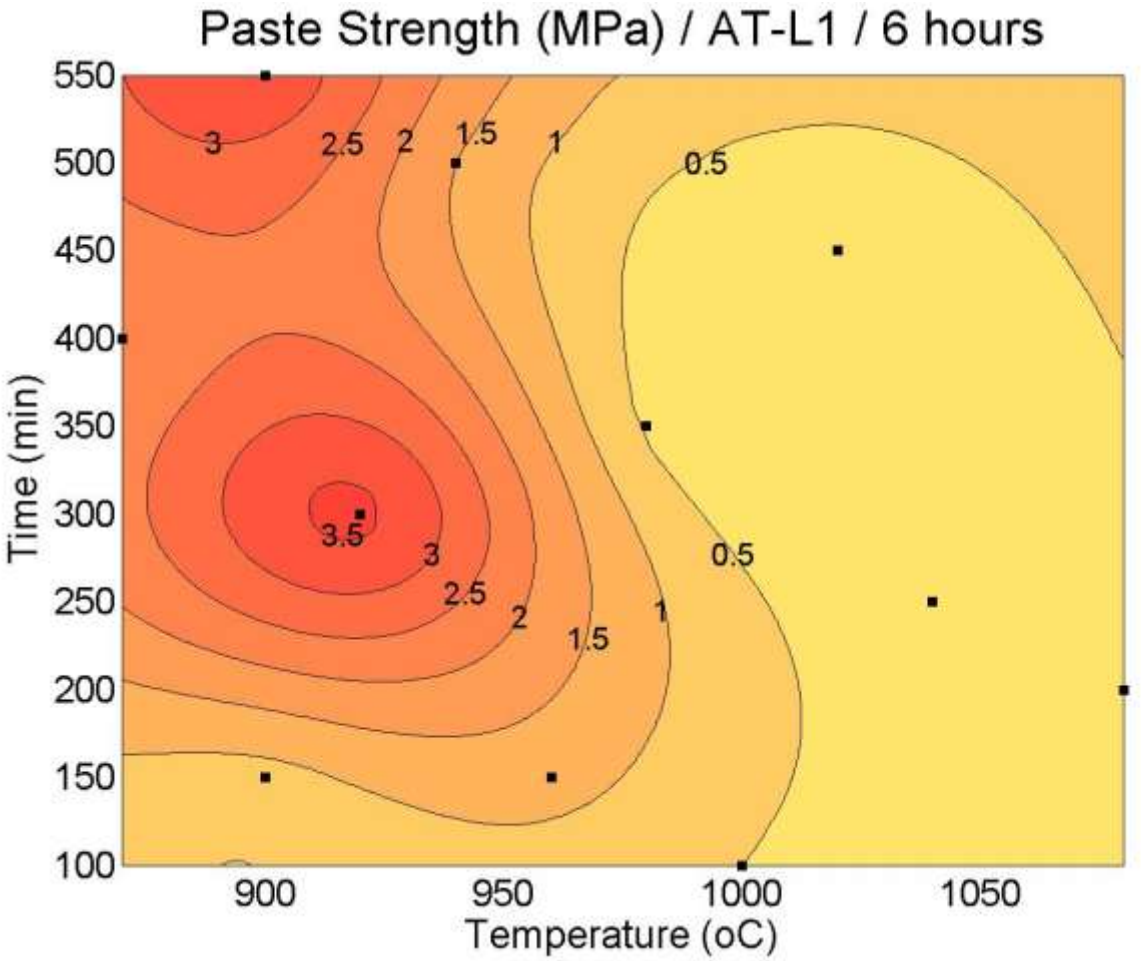


Optimising burning conditions

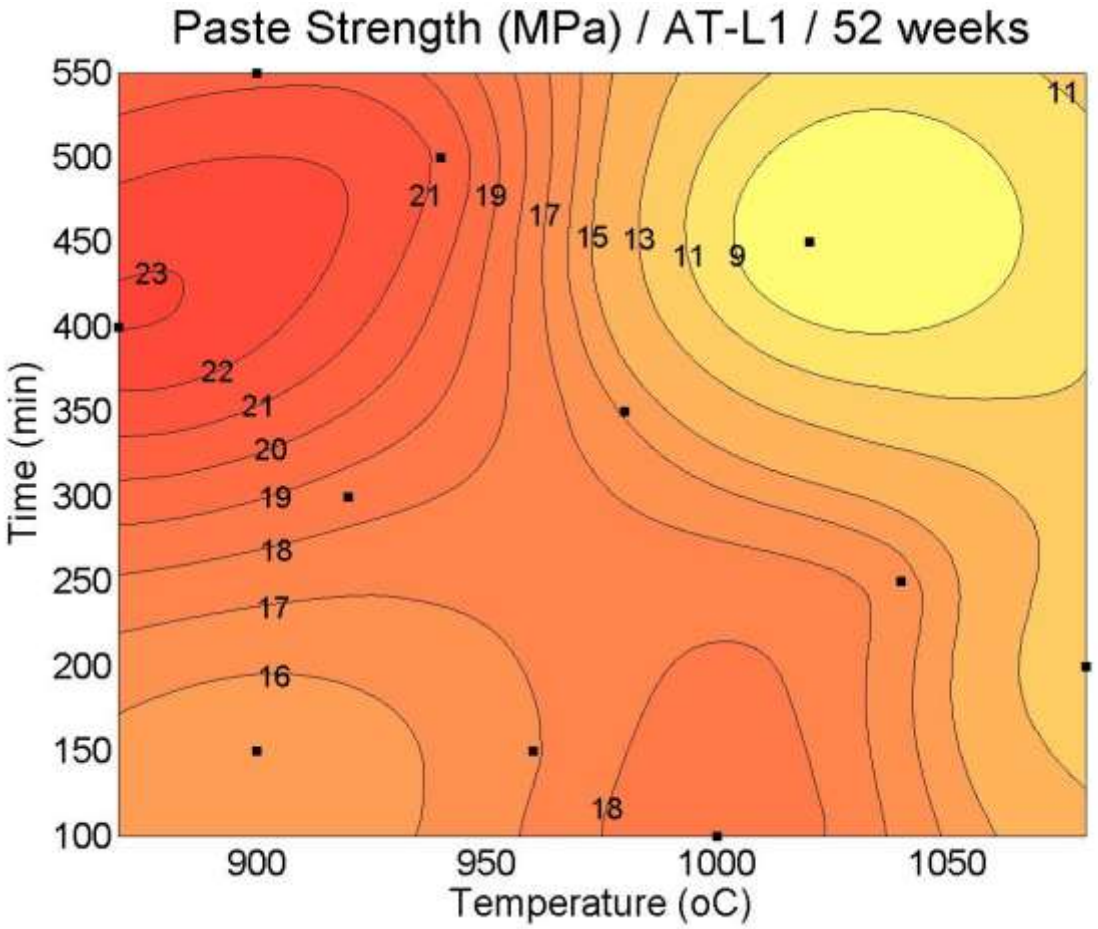
setting



early strength
(6 hours)



late strength
one year



Pilot scale firing

electric kiln - 300 kg load of marls

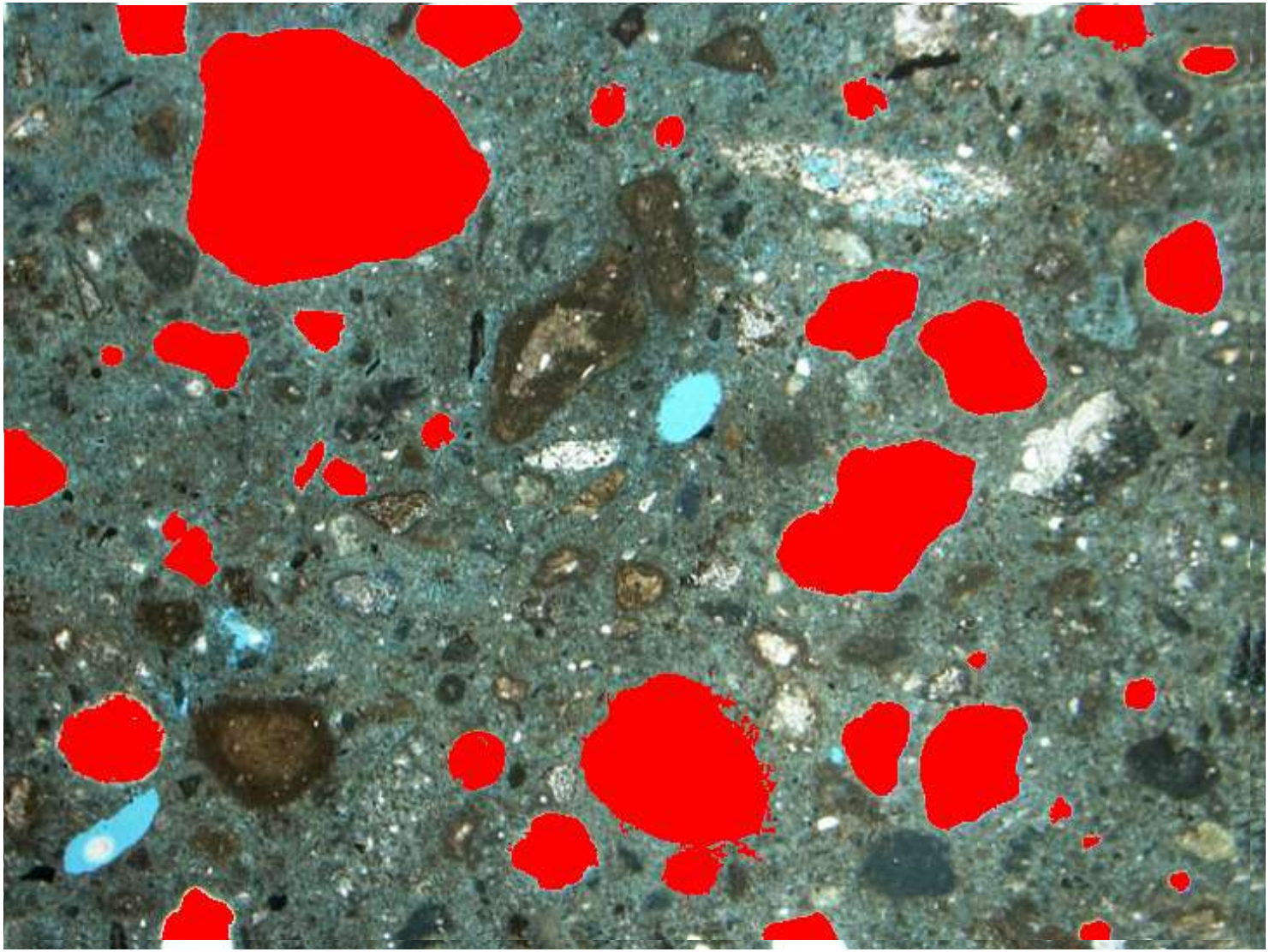
Hydration mechanism makes Roman cement a good binder for stuccowork

- early strength of 1 – 5 MPa allows demoulding of a casting after 15 minutes

- high late strength makes the decoration durable

Coarse grinding and non-uniform firing

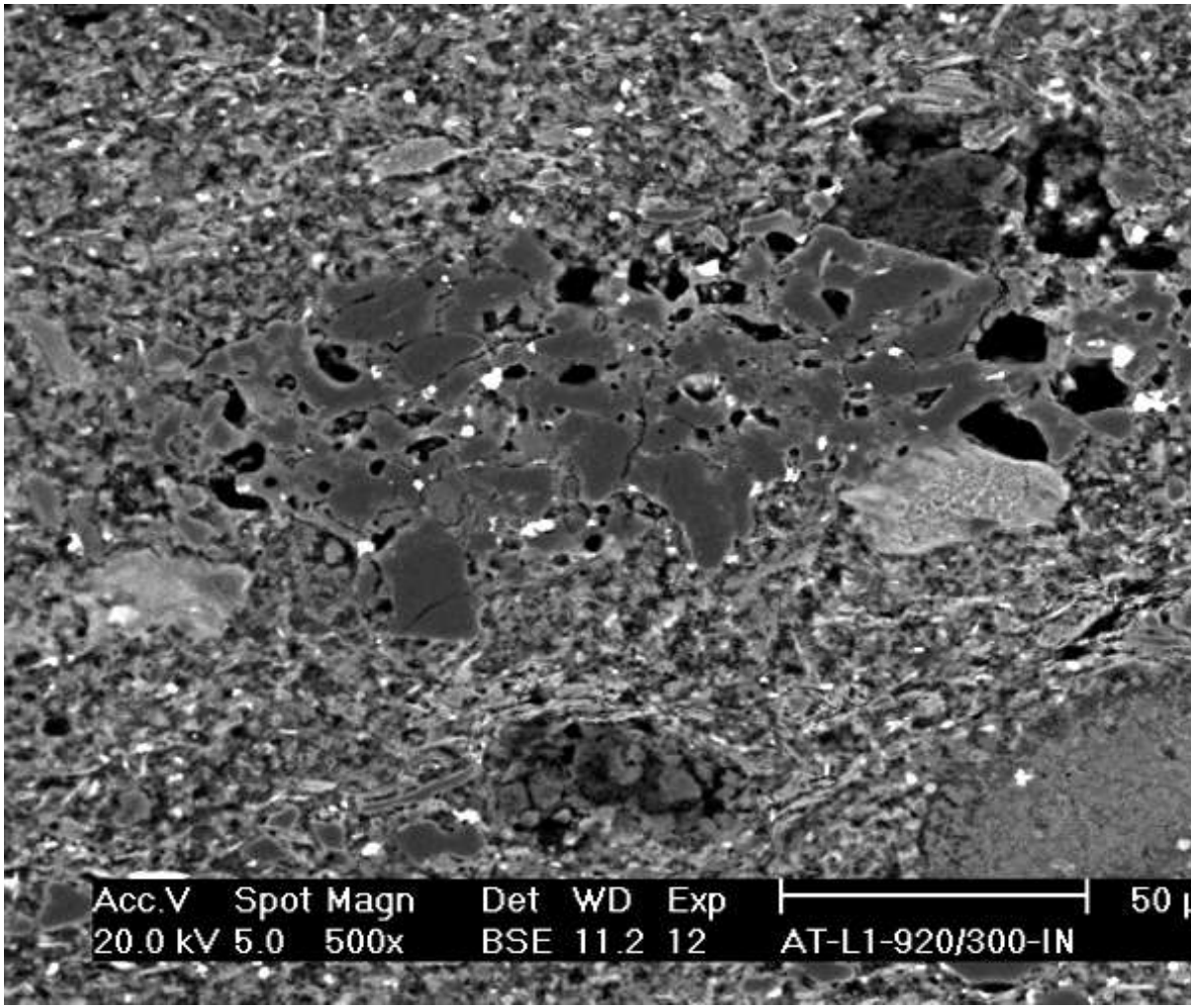
- historically, cement stones were burnt to various degrees – underburnt, well burnt, overburnt
- they were coarsely ground (grain size up to 1 mm)
- result – a characteristic structure of Roman cement mortars



Cement remnants encapsulated in the hydrated groundmass

Characteristic structure of Roman cement mortars

- the remnants of the cement grains are „active” aggregate well bound to the surrounding matrix



A cross-section through a historic casting

Roman cements re-established during the project were used in practical conservation

more information
Jacek Olesiak

ROCARE – a new EC project

ROman **C**ements for **A**rchitectural **RE**storation to new high standards

duration: 2009-2012

14 partners

coordinated by professor Johannes Weber from the University of Applied Art in Vienna

Objectives

- develop diversified production of Roman cements
- fully understand processes during the cement hydration
- involve the specific demands of end-users
- establish Roman cements as marketable building materials

Concept

Collaborative action of different group of partners:

- producers of Roman cements
- research units
- end users
- institutions regulating issues of application (the Advisory Panel)


MORE INFORMATION
www.heritage.xtd.pl
THANK YOU!