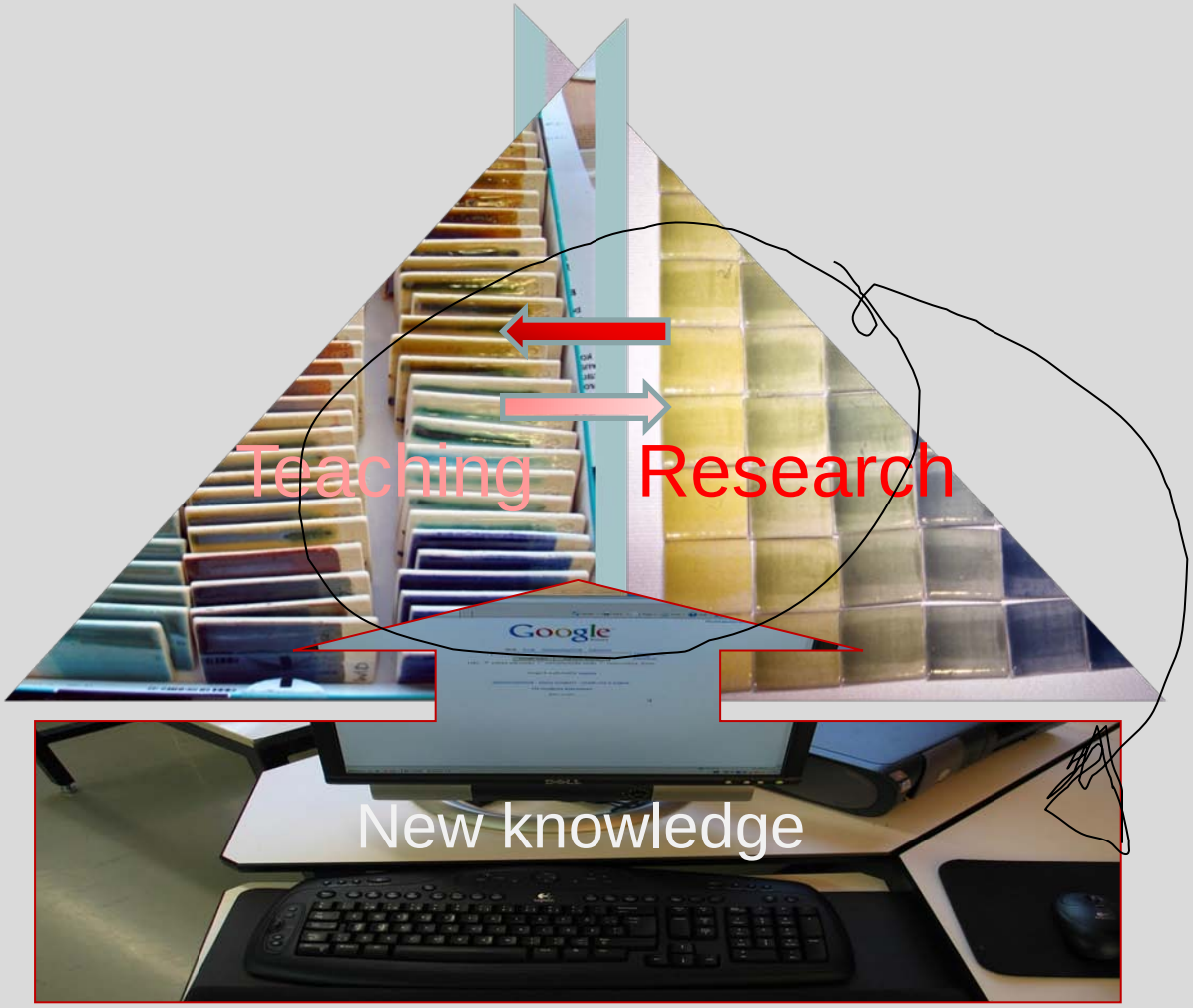
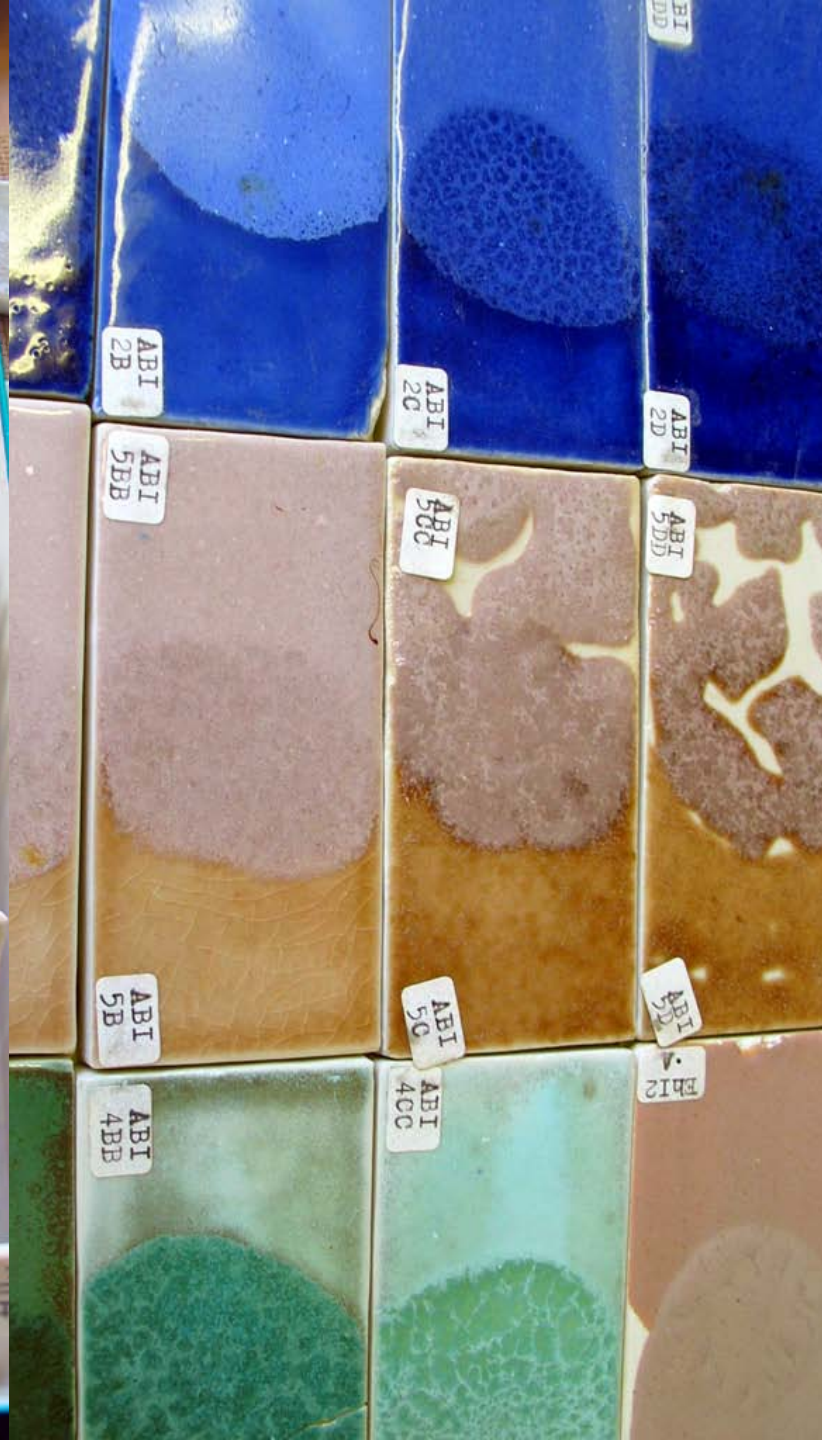
Ceramic material research

Airi Hortling
Licentiate of Arts, ceramist

Research as a teaching method




ABI 2B
ABI 2C
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ABI 4CC

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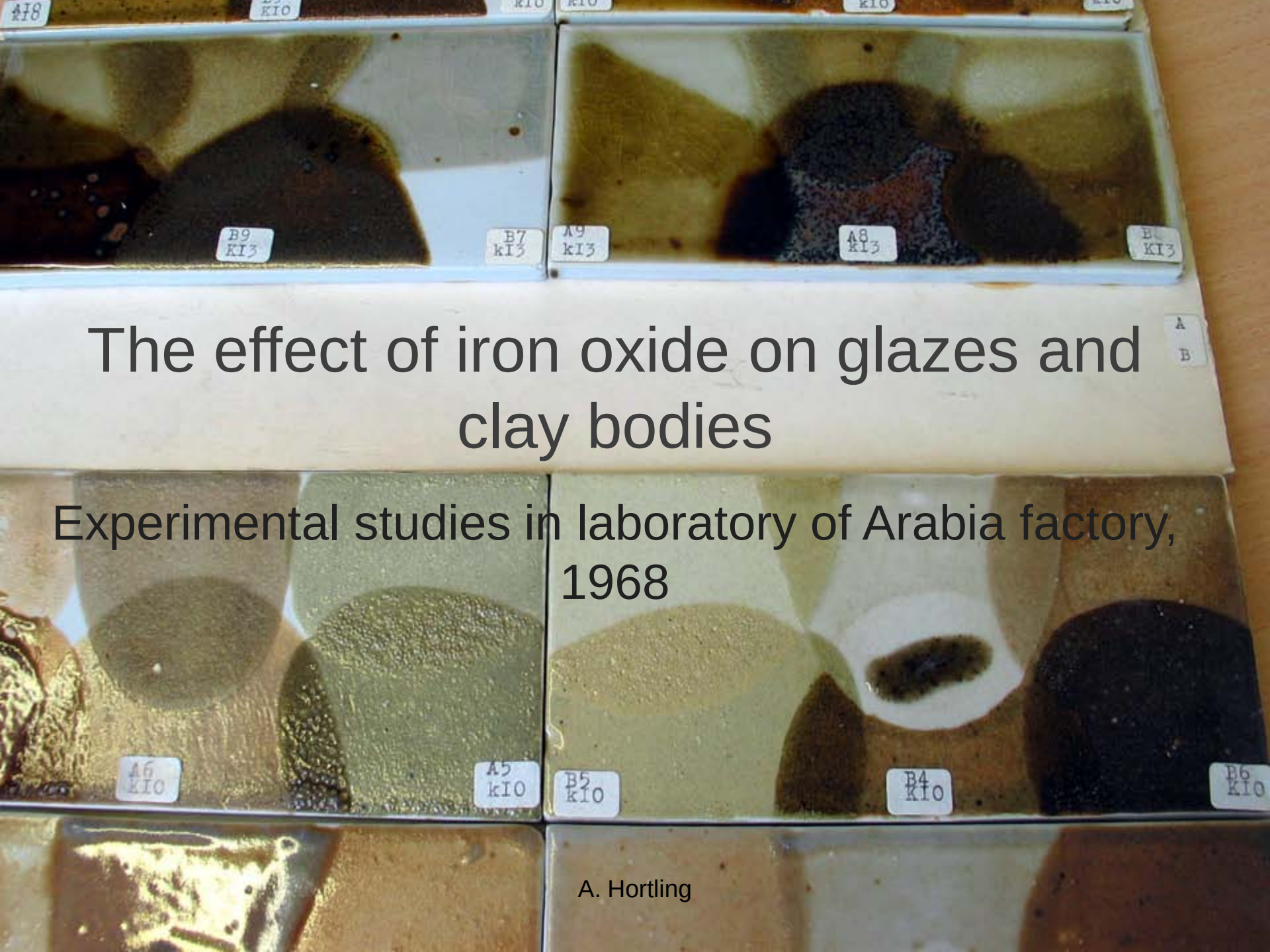

The effect of iron oxide on glazes and clay bodies

Experimental studies in laboratory of Arabia factory, 1968

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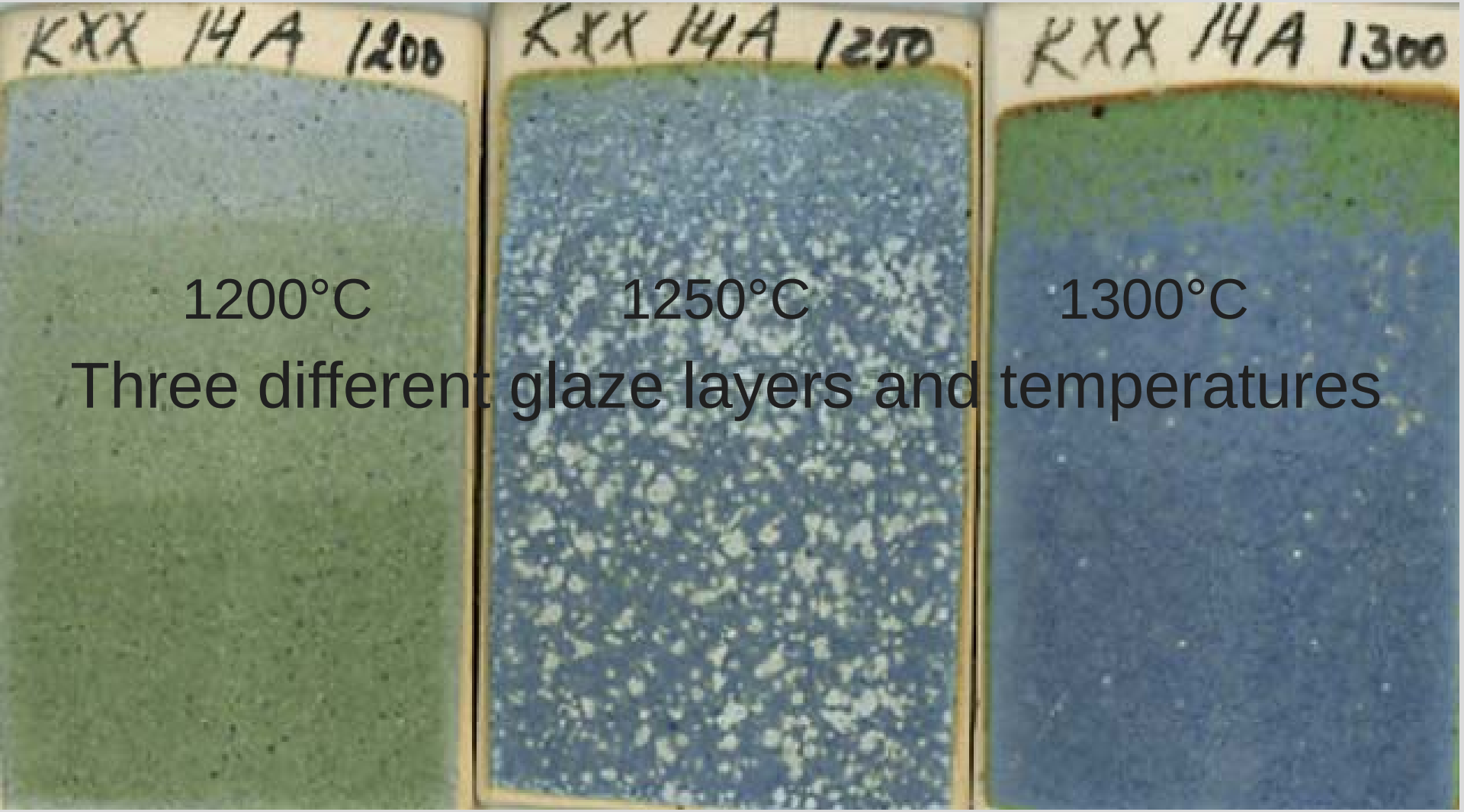
Material research, the quality and the depth, has increased during period of 1988-2010

Testing of glazes



Effect of adding iron oxide into glazes

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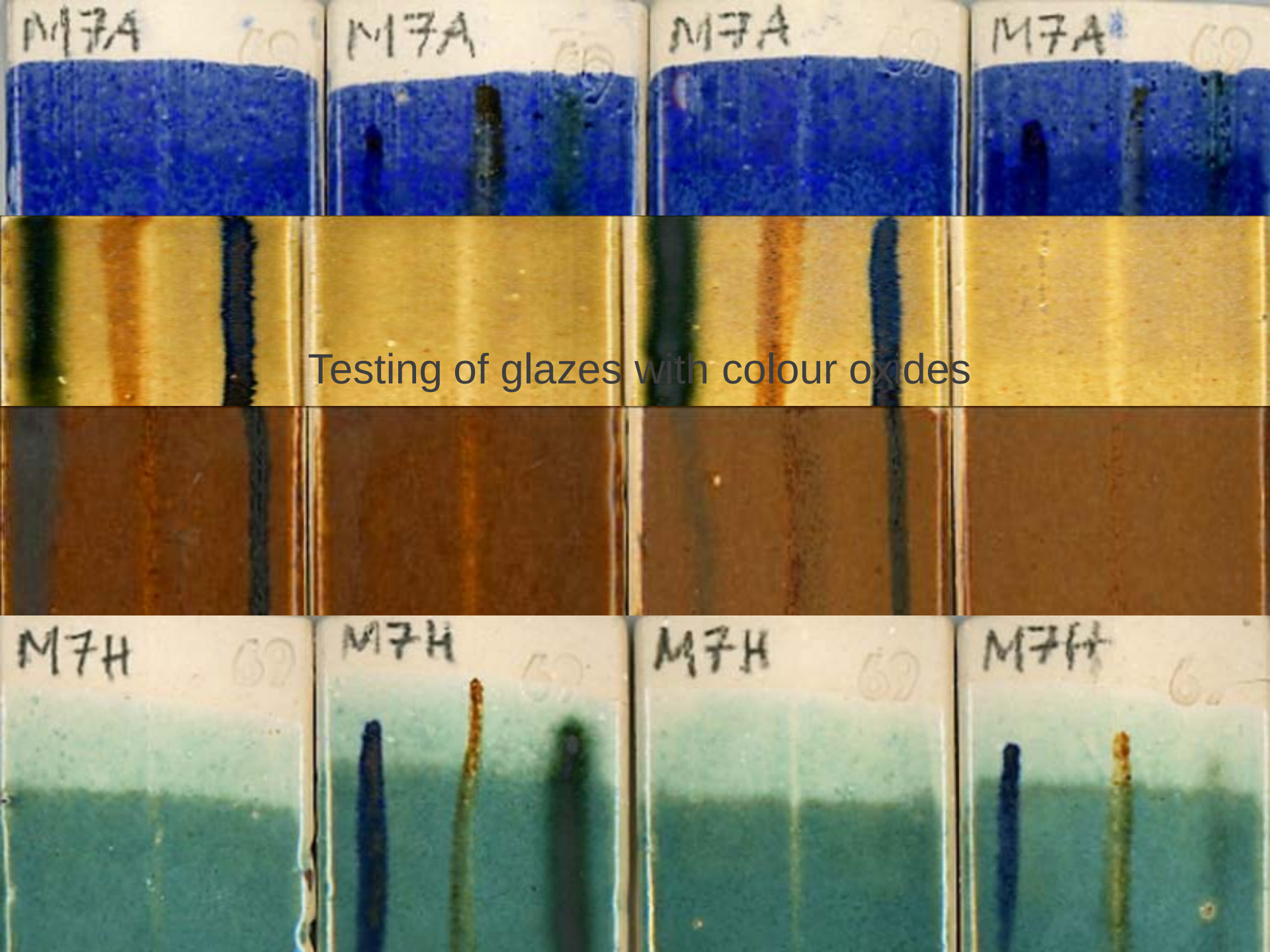
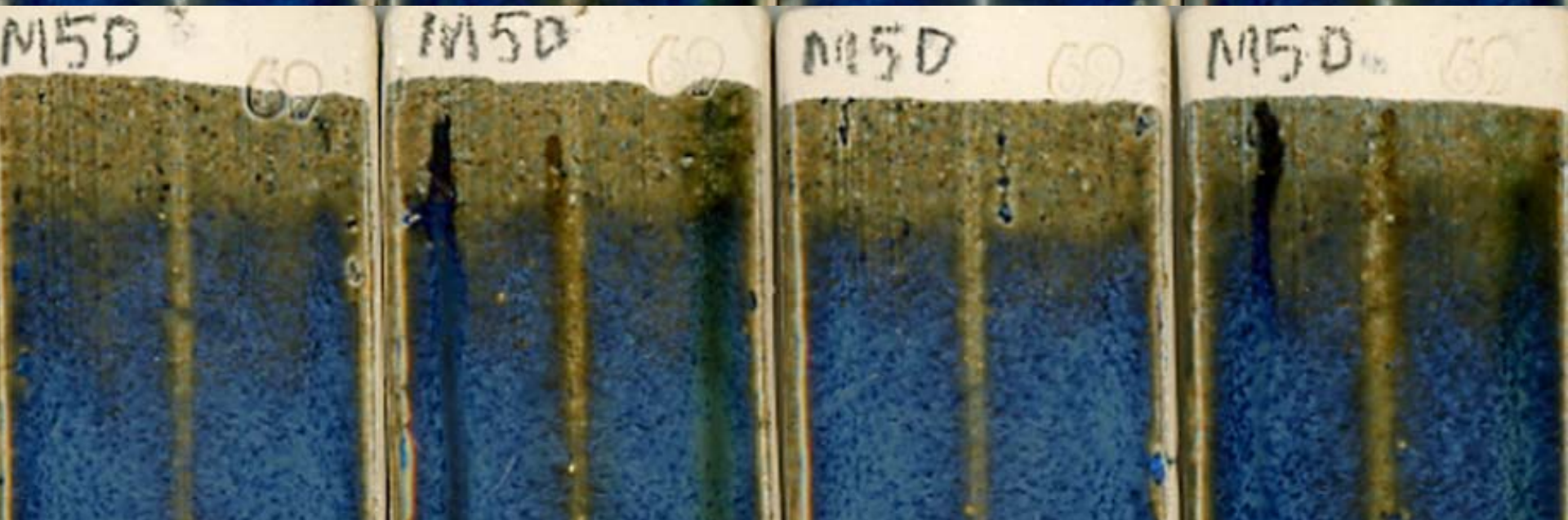
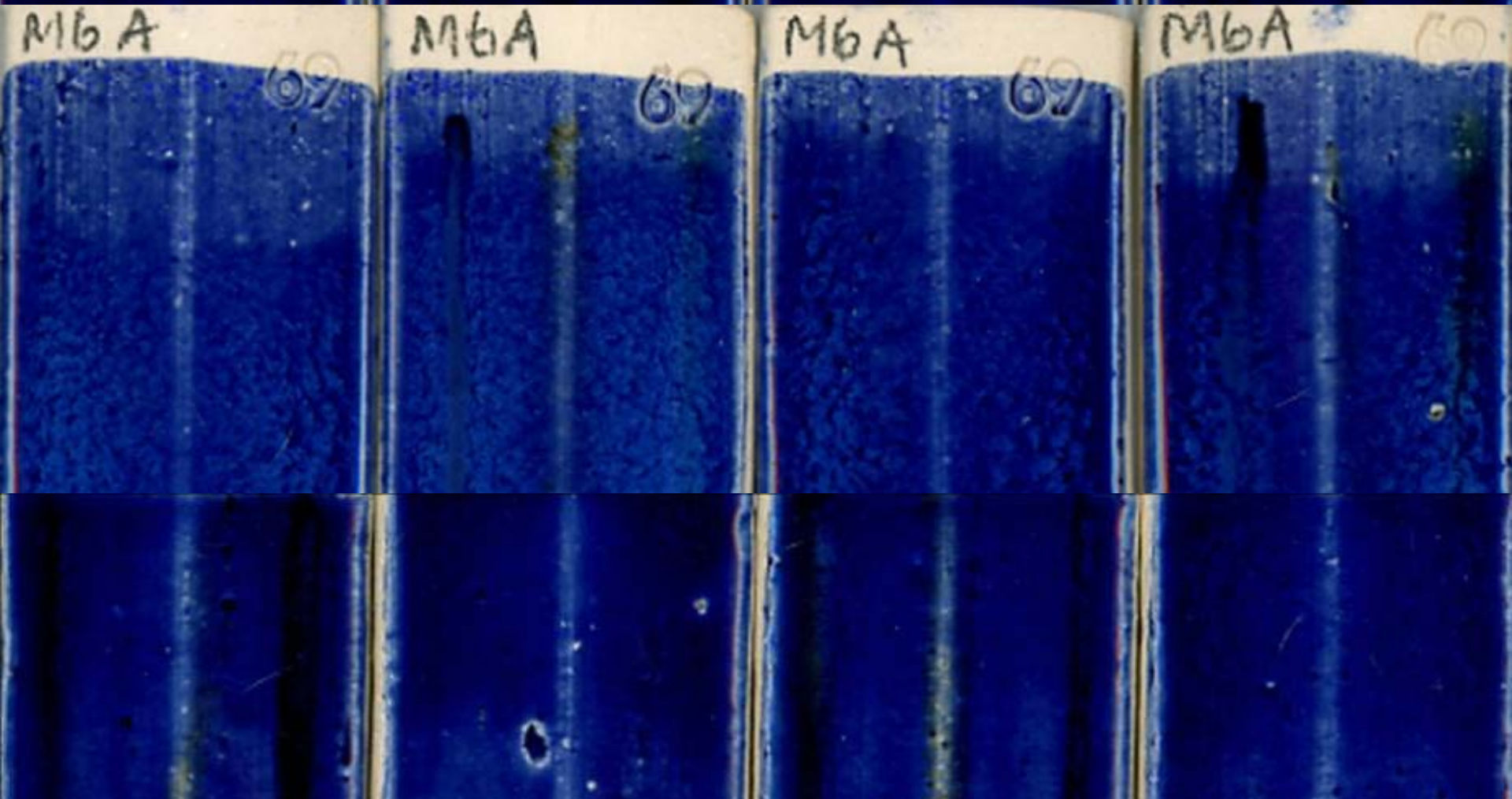

M7A
M7A
M7A
M7A
Testing of glazes with colour oxides
M7H
M7H
M7H
M7H

The effect of using the same colour oxides with different glazes

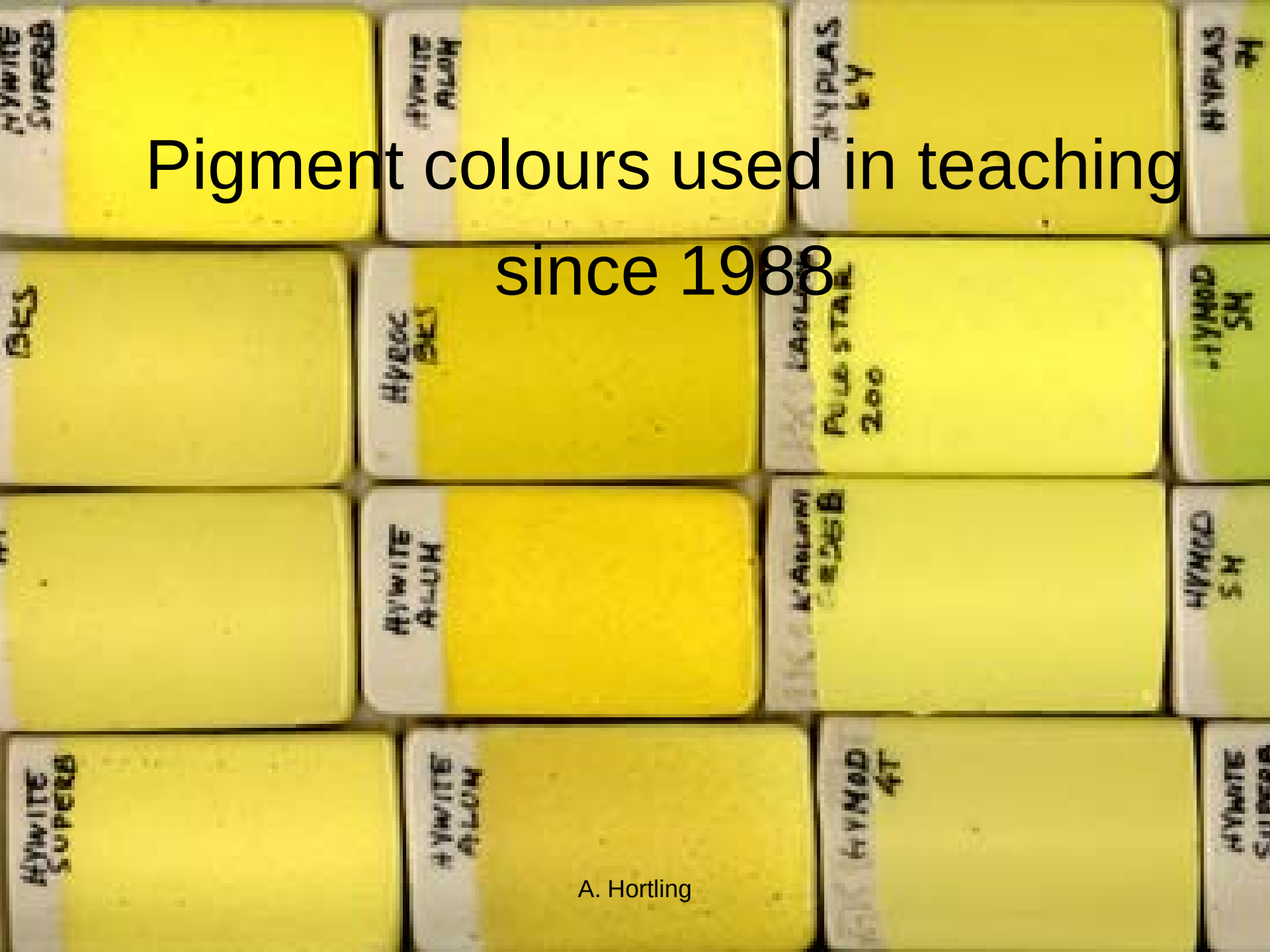
Iron oxide 3%
Titan dioxide 2%
Cobolt oxide 1%



Changes in blue glazes



Pigment colours used in teaching since 1988



Pigments and frits

The use of pigment colours between clay and glaze

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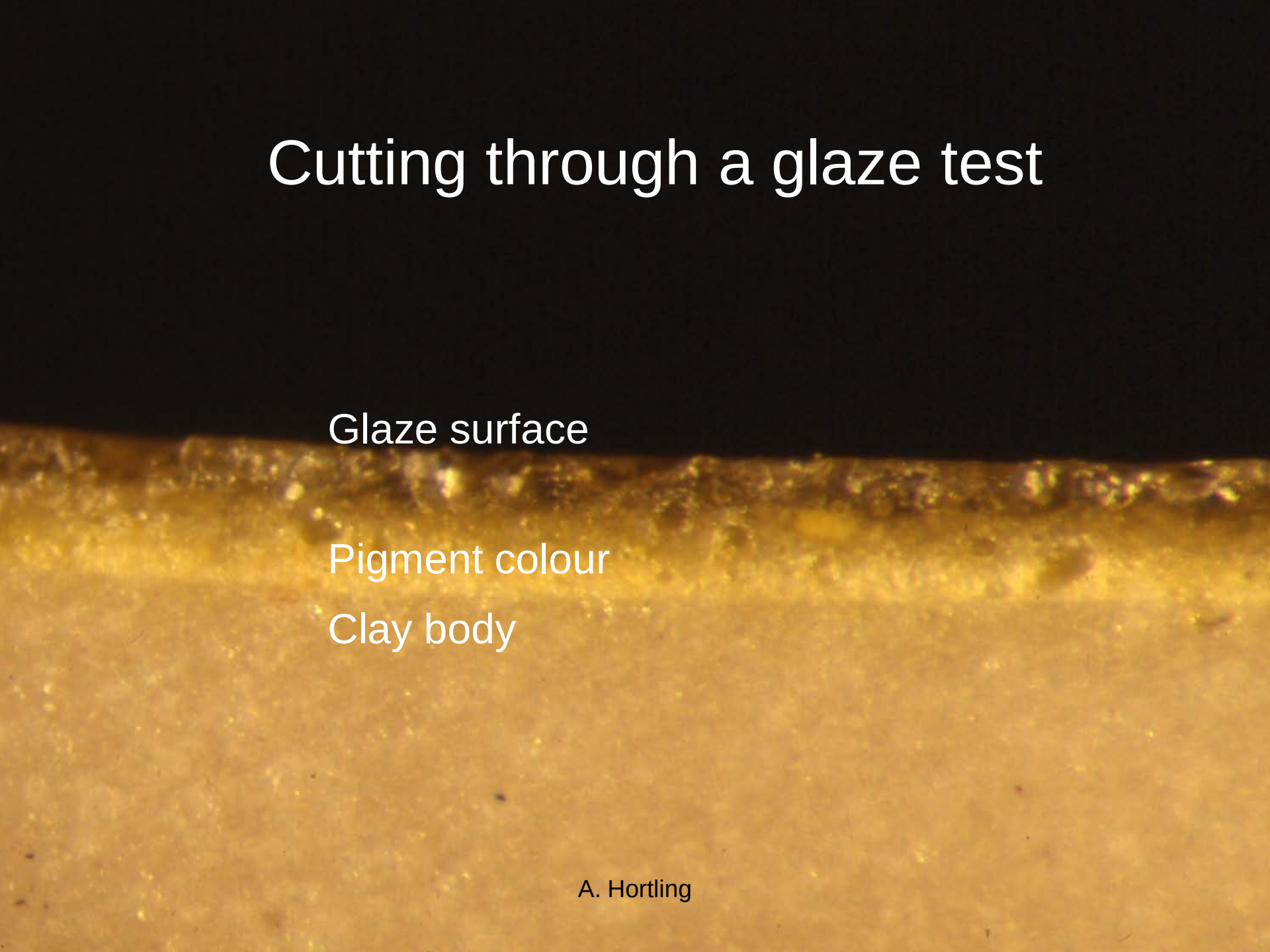
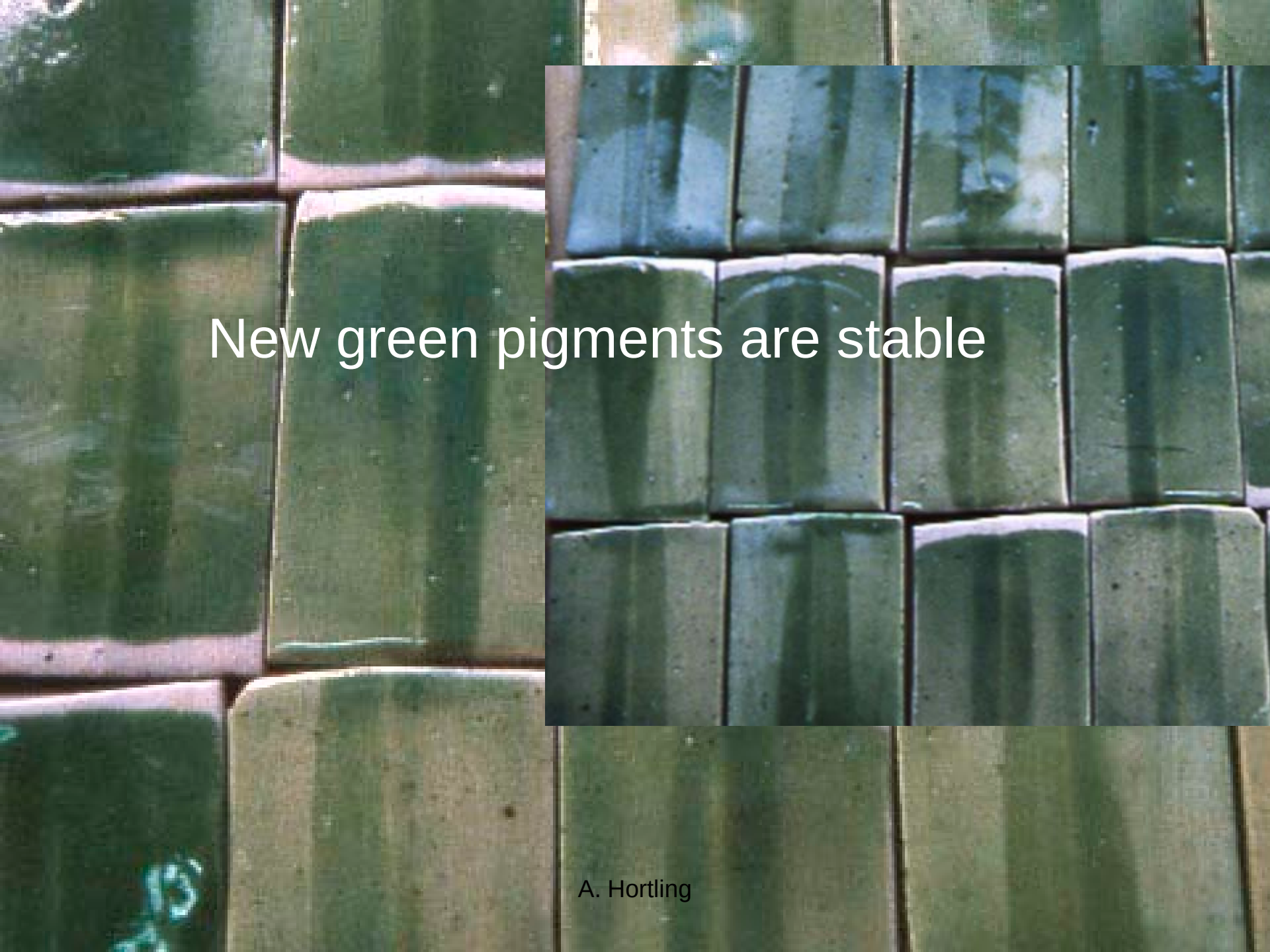
Cutting through a glaze test





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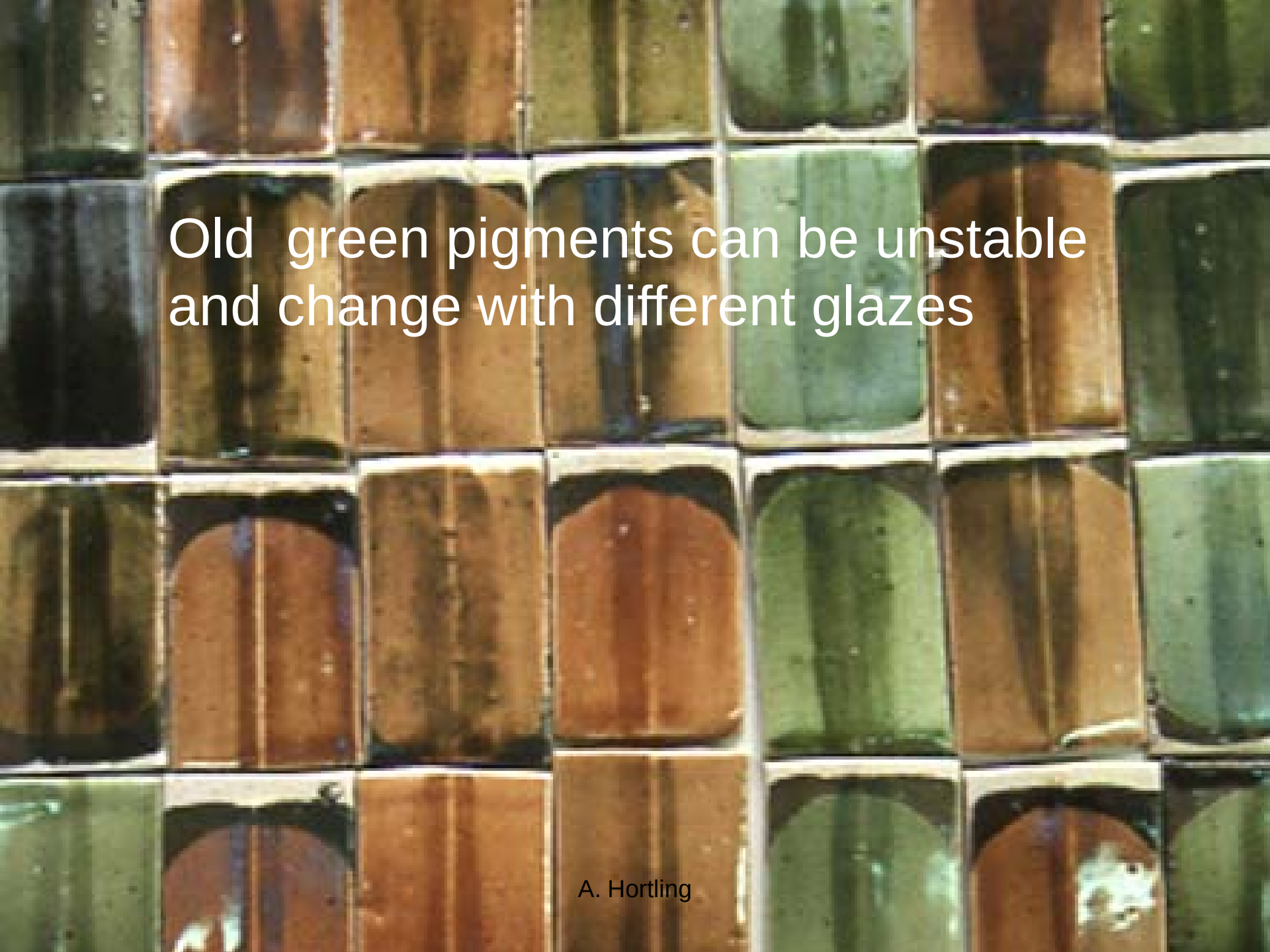
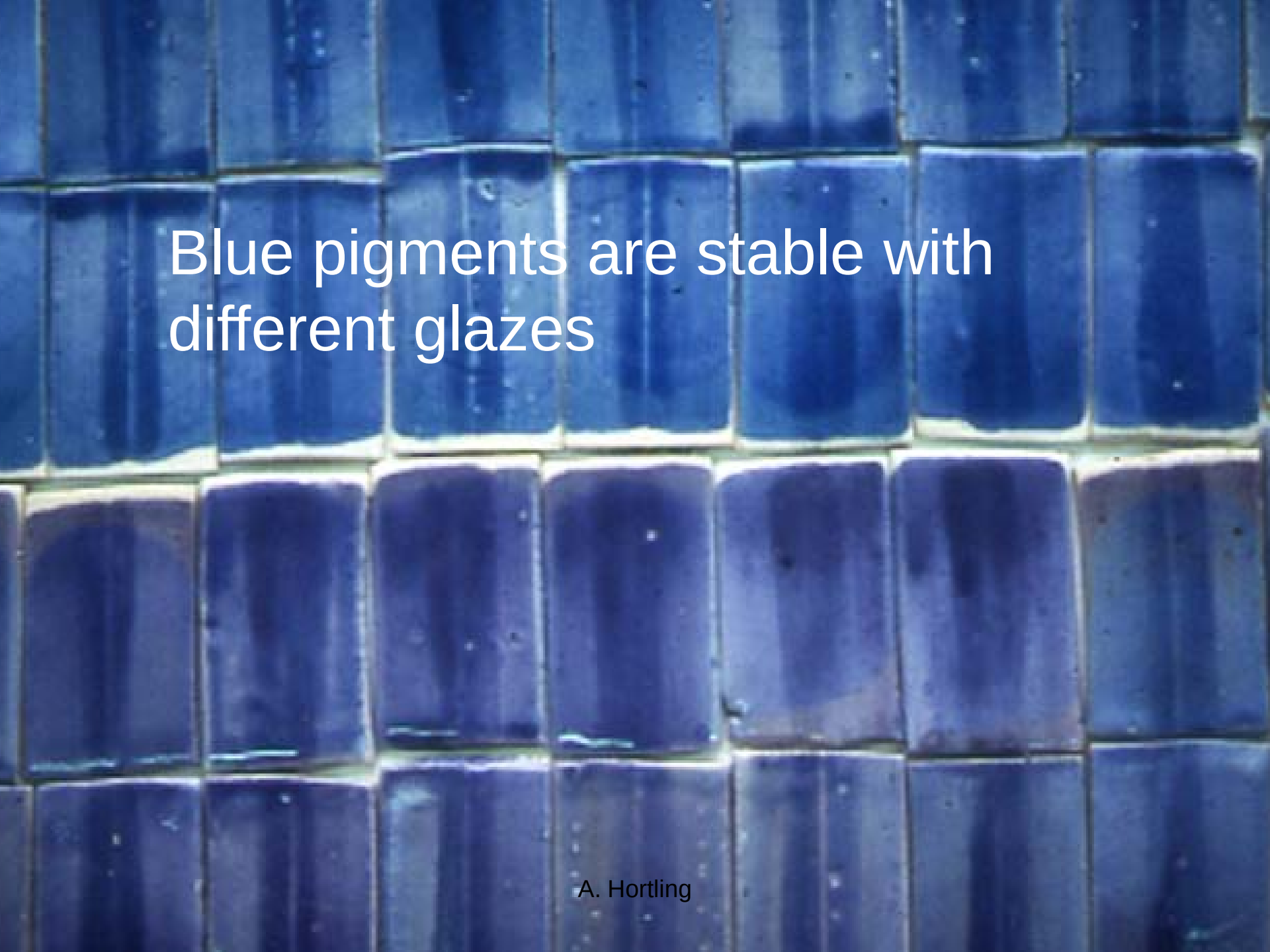
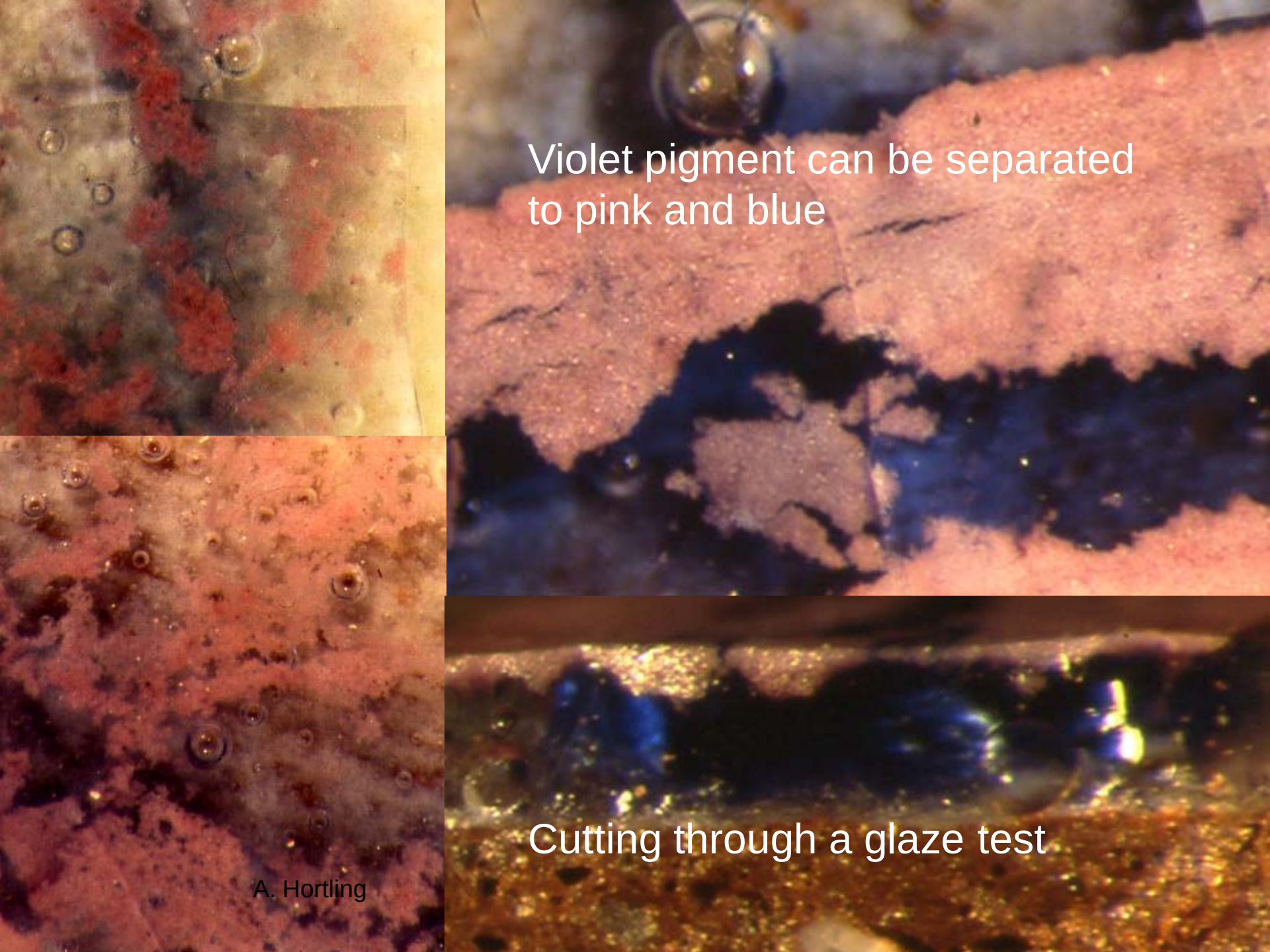

Old green pigments can be unstable
and change with different glazes


Blue pigments are stable with different glazes


Violet pigment can be separated to pink and blue
Cutting through a glaze test
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Use red iron pigments to blend colours

Cadmium pigment fired1400°C

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Iron red pigments effect blends

Colour blends with three pigments, citrus, red and turquoise.

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Colour blends with two pigments,
citrus and blue
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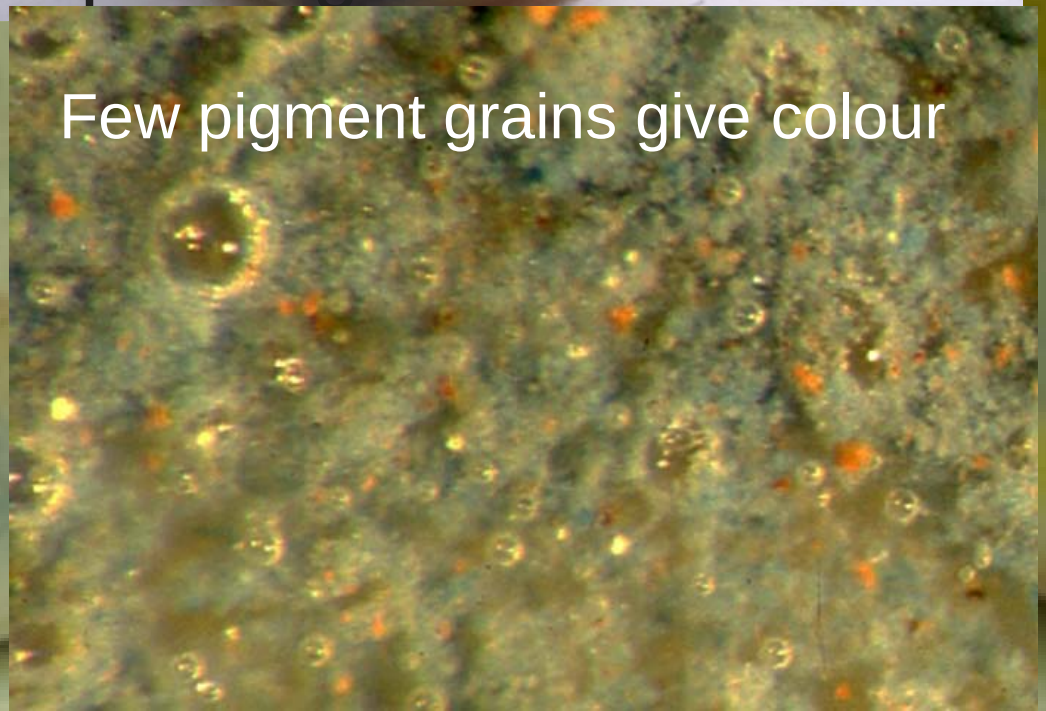
Screen printing and air brush decoration



Pigments 1000-1300°C

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Taking Care – COSHHing the Ceramist
Heavy metals from ceramic materials should not be released into the nature
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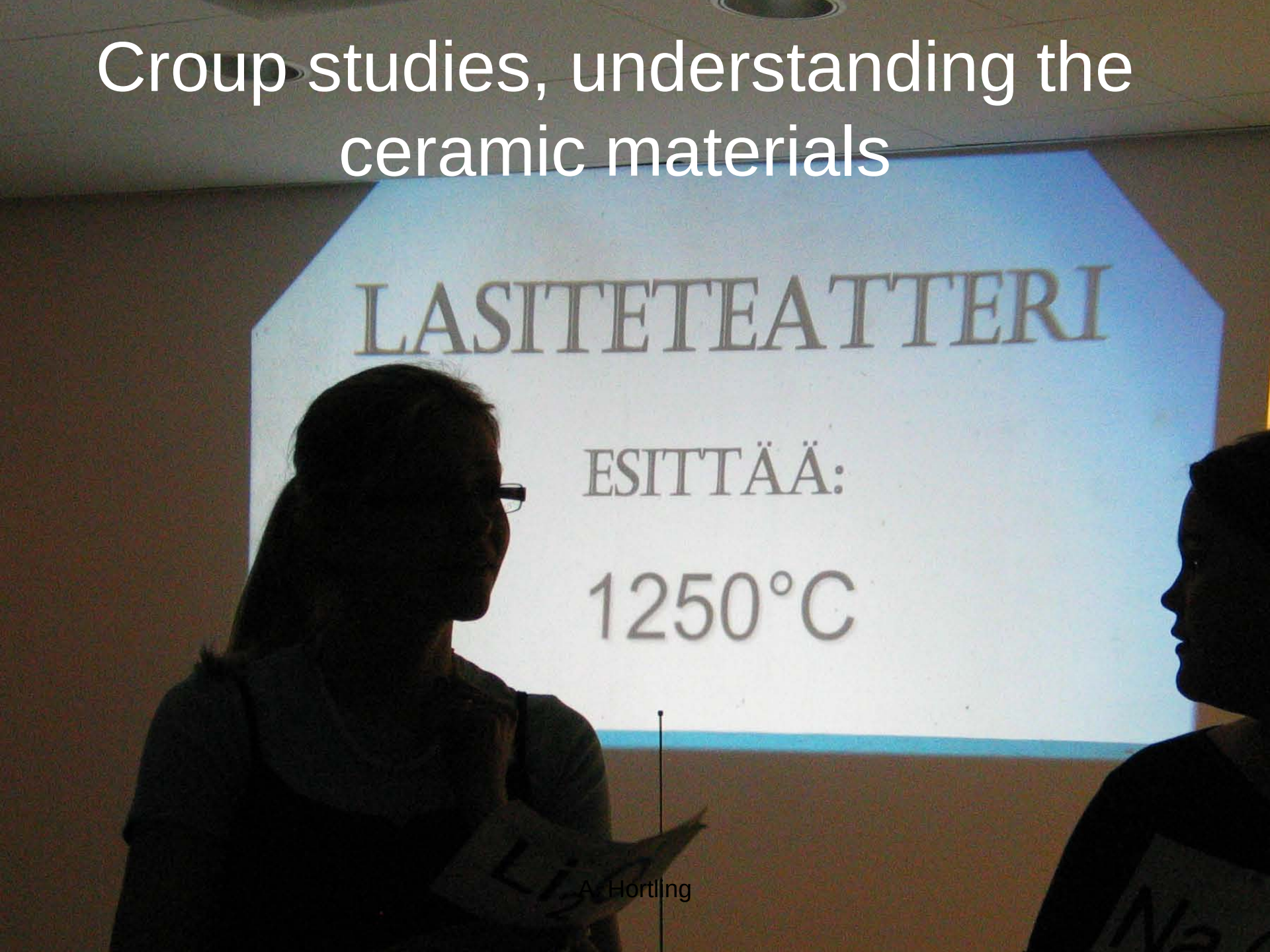
Croup studies, understanding the ceramic materials



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Storage of ceramic raw materials

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Recycling of clay

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International marks for ceramic raw materials

Control of raw materials

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Melting control of different raw materials
(Different feldspars and others)


960°C
8
9
10
12
13
14
960°C
1
2
3
5
6
7
Lead frits
Borax frits
Li_2CO_3 VARNIA
Li_2CO_3 P3330
3069 F VARNIA
PZ960
1200°C
PETALIITTI VARNIA
STOBUMOVE P3357
LEPIDOLIITTI VARNIA
STRONTIUM F7146
KALIMS. LOHJA
KALIMAAS. NG.
NATRON. MAAS.
NEFELIINI-SYENIITTI
PETALIITTI
K-M S-
1300

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Safety of colour oxides

Painting with pigments

Painting with oxides

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Laboratory in Ateneum in Helsinki 1968-1981

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Laboratory in University of Industrial Arts in Helsinki 1988-

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Clay testing

Finnish red fired eathenware gradients 925-1075

Finnish china clay gradients 1050-1250

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Colour-tradition

Iron-, cobolt-, and copper oxides in lead glazes

Research of the colour oxides in lead frit glazes

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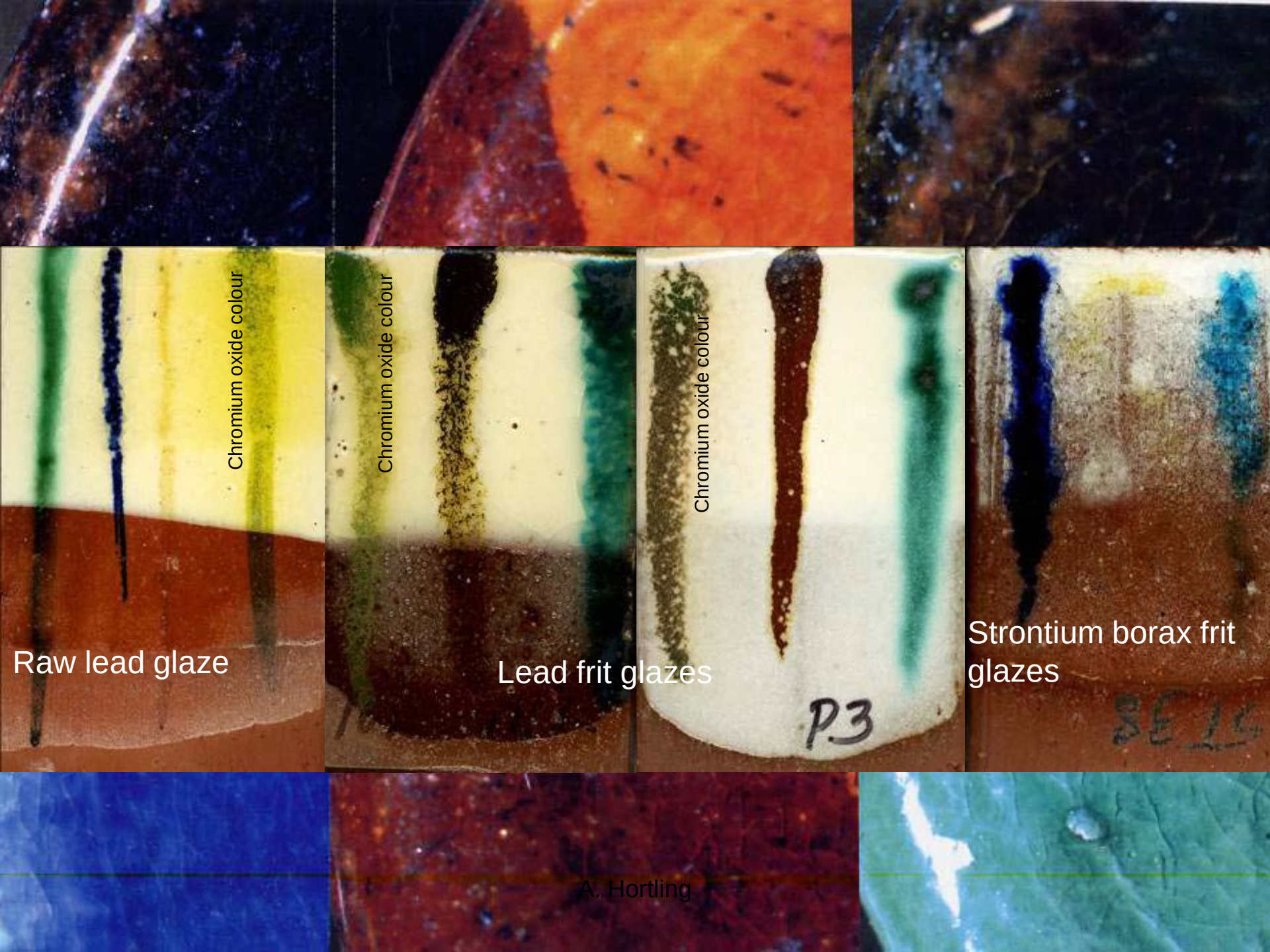
Chromium oxide colour
Chromium oxide colour
Chromium oxide colour
Raw lead glaze
Lead frit glazes
Strontium borax frit glazes
P3
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Lead release in clossy and matt raw lead glazes

Research of lead release in lead frit glazes and borax-lead frit glazes (more toxic)

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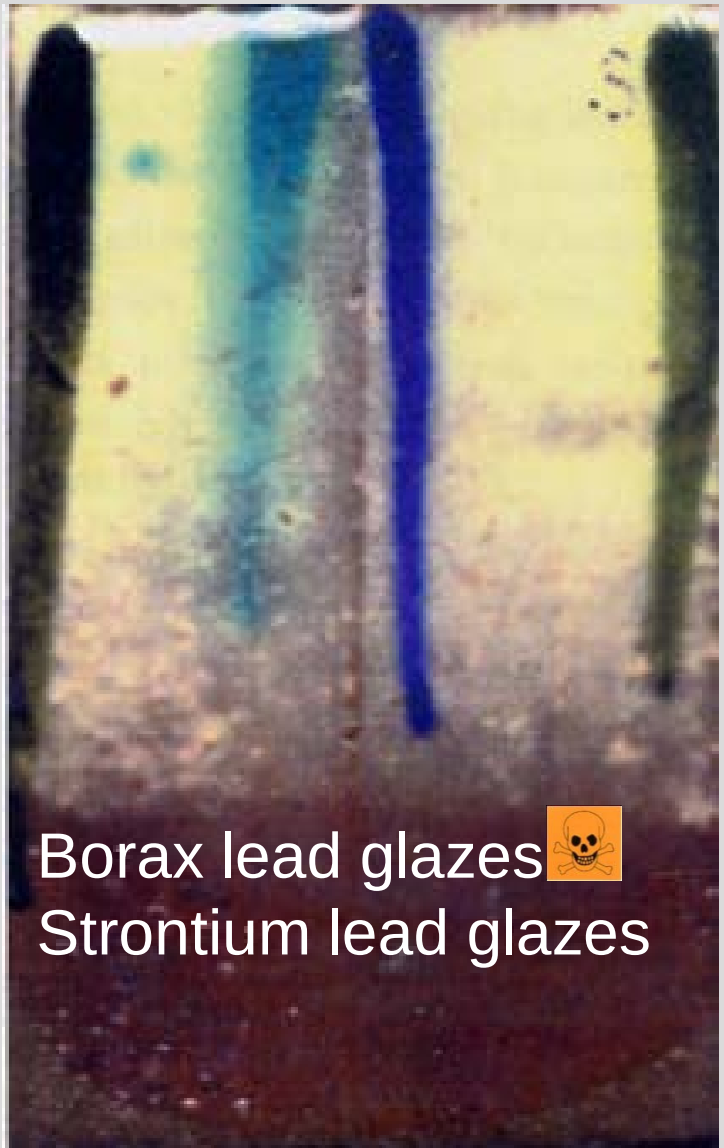
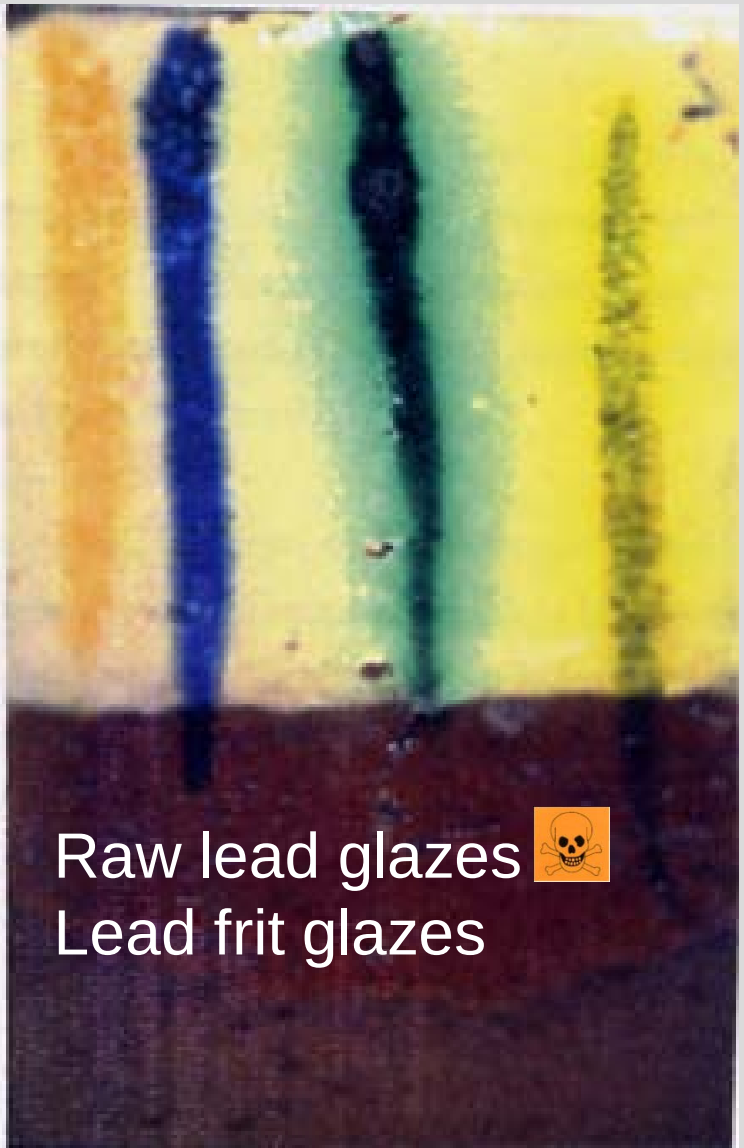
Lead frit research in England 1890-1910

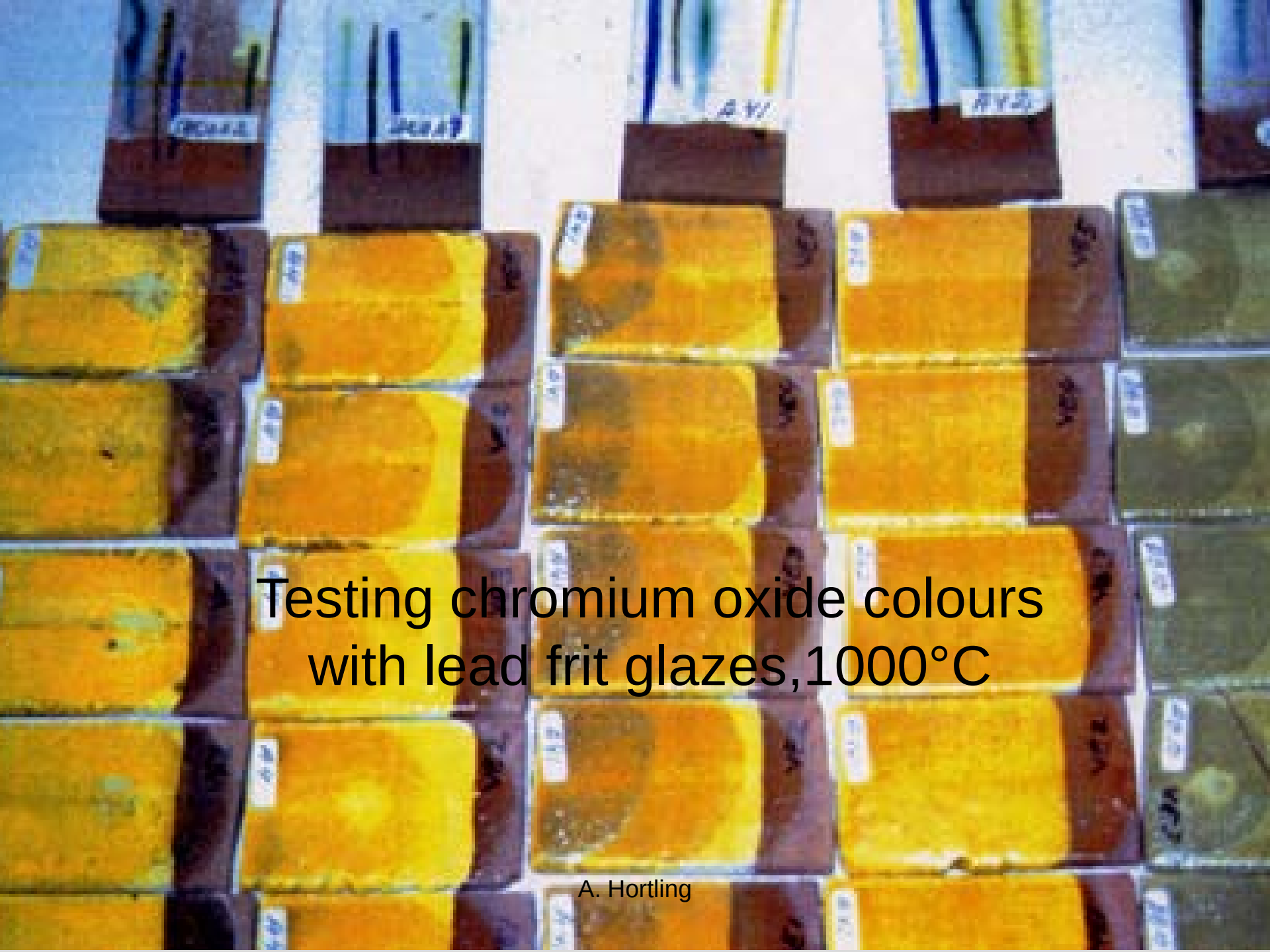
Making lead frits
(monosilicate and bisilicate)

”Fresh” air from the Potteries

Testing colour oxides in low fired lead glazes






Testing chromium oxide colours
with lead frit glazes,1000°C

Testing colour changes of chromium oxide with lead frit and raw lead glazes in gradient fire, 880-1030°C

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Strontium lead glaze with pigment colours fired in wood kiln

Viscosity changes by adding manganese dioxide

Colours of leadless glazes differ from colours of raw lead glazes

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Lead in ceramics is dangerous for people and environment

- The using of lead bearing raw materials changes slowly

  - ✓ 12 years research work (1988-2000)
  - ✓ 300 pages research publications

T = POISONOUS

Helsingin sanomat
August 2007

”hidden lead” in toys

Sami Sillanpää

3.8.07 HS

Mattel veti markkinoilta 1,5 miljoonaa vaarallista lelua

AP–REUTERS–HS

▶ Yhdysvaltalainen leluJätti Mattel vetää markkinoilta 1,5 miljoonaa vaaralliseksi epäiltyä lelua. Alle kouluikäisille tarkoitetut Fisher-Price-lelut voivat sisältää terveydelle vaarallista lyijymaalia. Mattelin mukaan lelut ovat peräisin yhdeltä kiinalaiselta alihankkijalta, jonka käyttämät maalit eivät täyttäneet turvallisuusmääräyksiä.

Valtaosa leluis-

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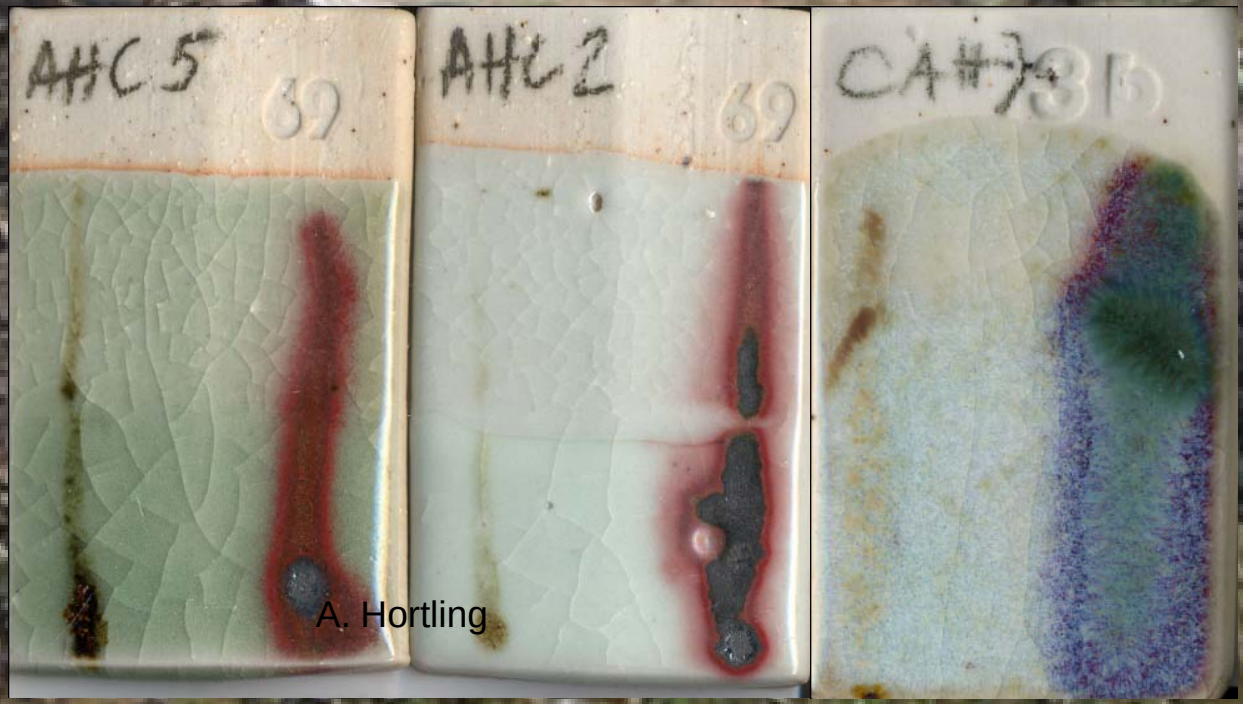
- The designer is responsible of the life cycle of the item
- The designer should choose materials, which effect on health and environment is known
- The effect of elimination of the item should be known

Local materials and the firing tradition



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Celadon glaze with natural (beach) sand

Celadon colour with Finnish red clay

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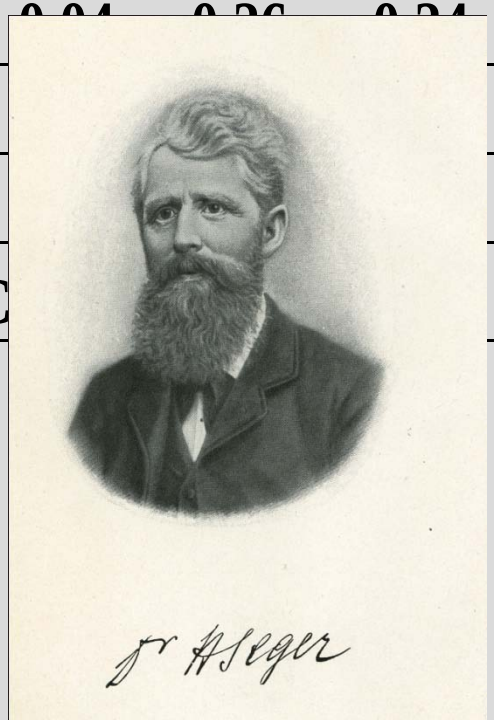
Celadon glaze
AHC 1-6, 1200-1240°C

Raw material	1	2	3	4	5	6
Feldspar FFF	50	50	65	65	60	60
Quartz FFQ	20	20	15	15	10	10
Red clay	5	5	10	10	15	15
Whiting	25	-	10	-	15	-
Wollastonite	-	25	-	10	-	15

Empiric formulas of celadon glazes

AHC 1-6

Lasite	CaO	MgO	K_2O	Na_2O	Fe_2O_3	Al_2O_3	SiO_2
AHC 1	0,74	0,07	0,13	0,11	0,01	0,28	2,71
AHC2	0,71	0,01	0,14	0,13	0,01	0,31	3,69
AHC3*	0,46	0,04	0,25	0,22	0,03	0,56	4,54
AHC4*	0,43				0,03	0,59	5,20
AHC5*	0,55				0,03	0,45	3,37
AHC6*	0,52				0,04	0,49	4,10
* Firing	1240 °C						



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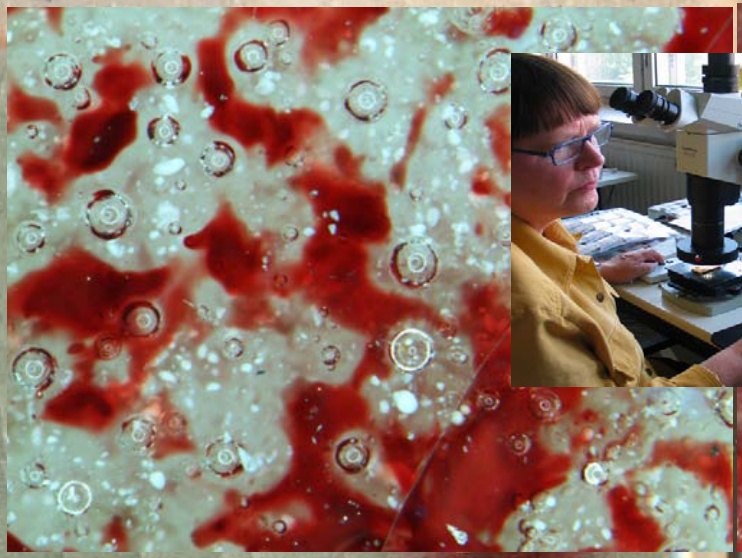
Firing in electric, gas and wood kiln



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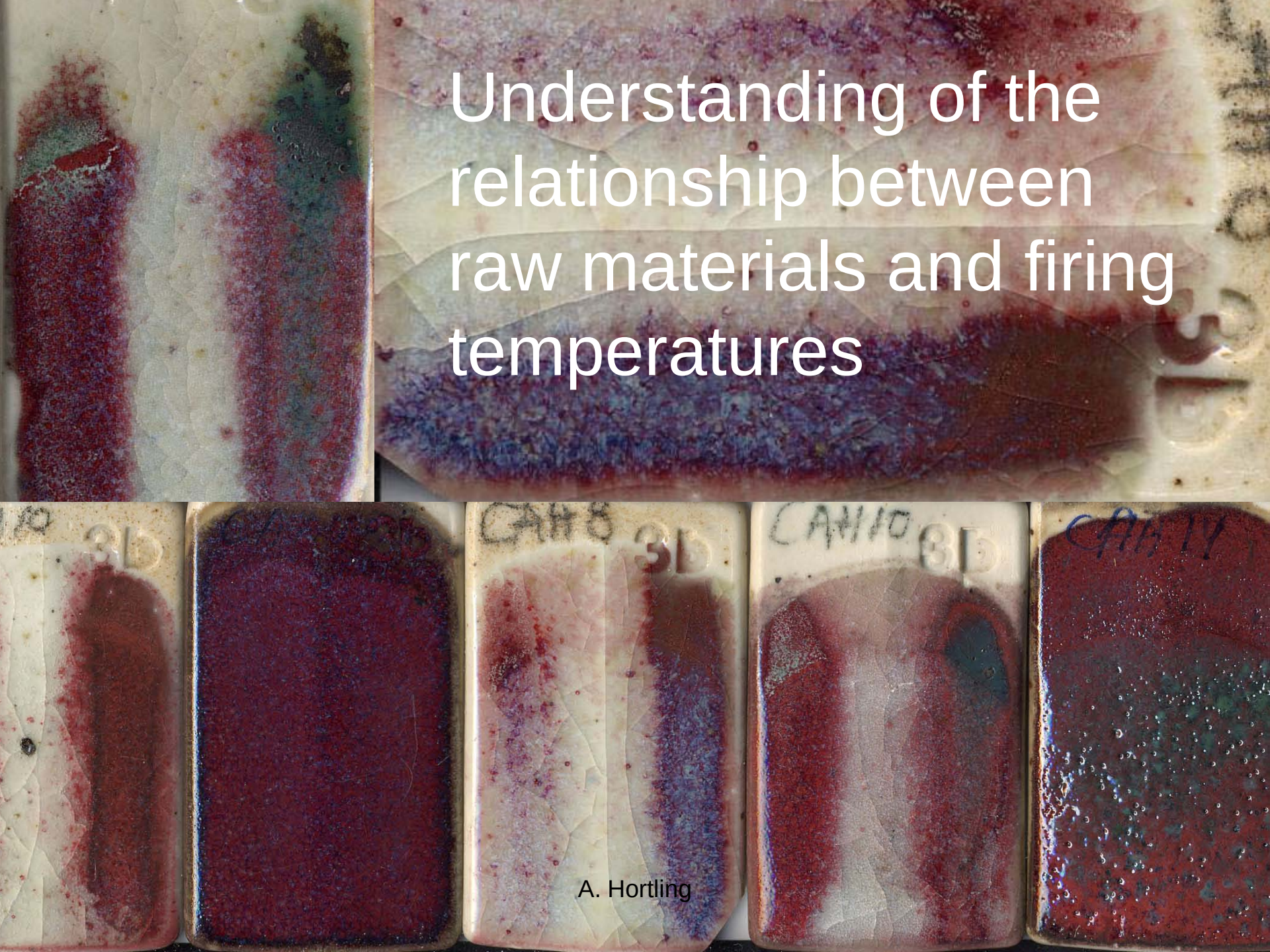
Understanding of the relationship between raw materials and firing temperatures
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A. Hortling 2007

Slip glazes – a combination of red clay and whiting

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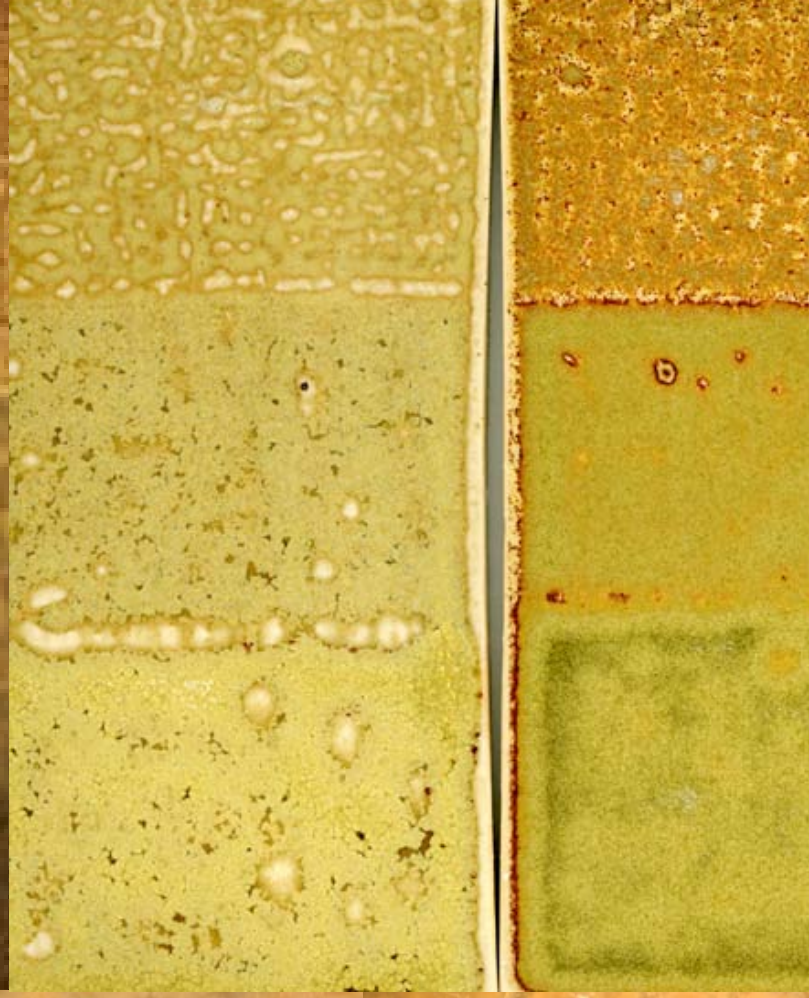
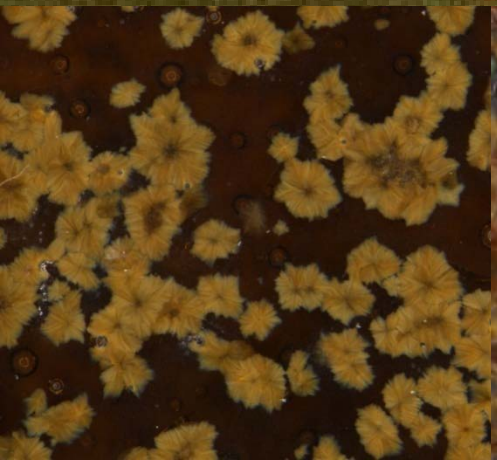
Yellow and red brown slip glazes 1200-1300°C

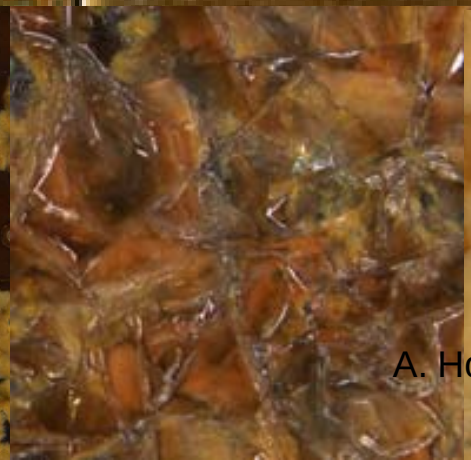
Raw material	1	2	3	4
Red clay	80%	60%	40%	20%
Whiting/Dolomite/Wollastonite	20%	40%	60%	80%

- Single mixtures
- Four combinations of two raw materials
- The thickness of glaze layers effect the colour

Yellow and red brown slip glazes 1200-1300°C

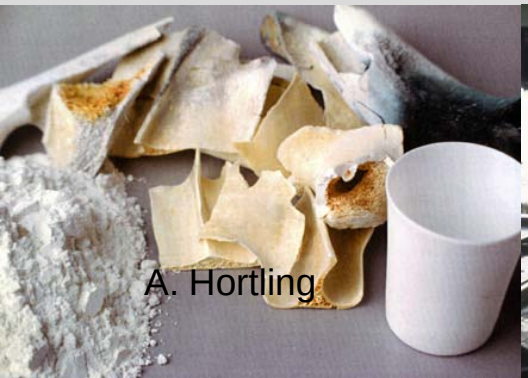




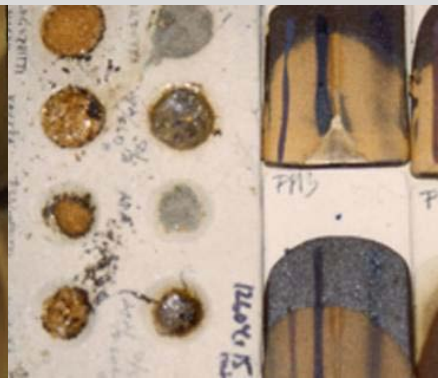


Businesses invest in innovative ceramic research

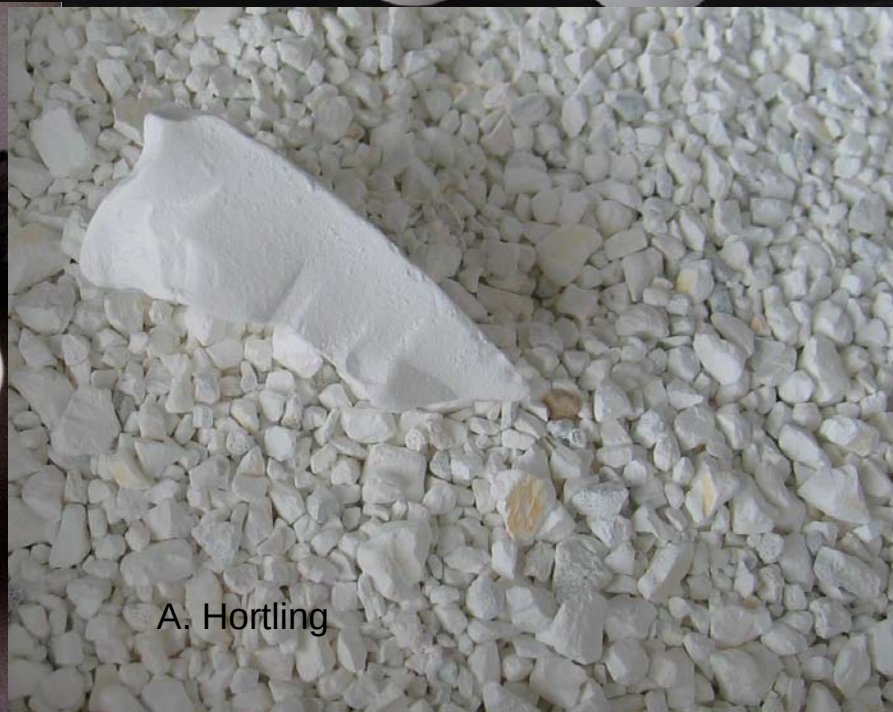
- Reindeer bone china research
-
-
-







Reindeer bone china material research 1997-98



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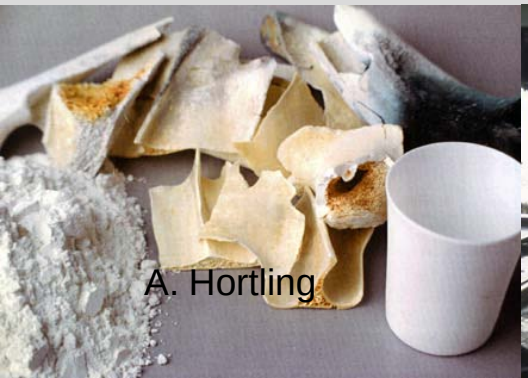
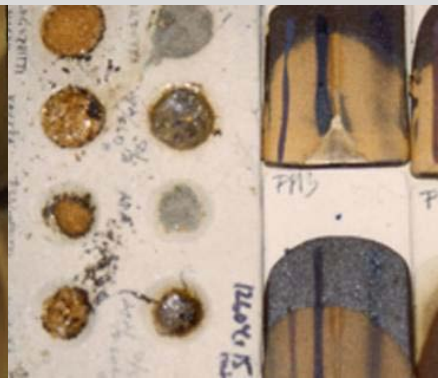
Businesses invest in innovative ceramic research

- Soapstone powder research





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Soapstone mining in Nunnalahti

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Soapstone mineral composition

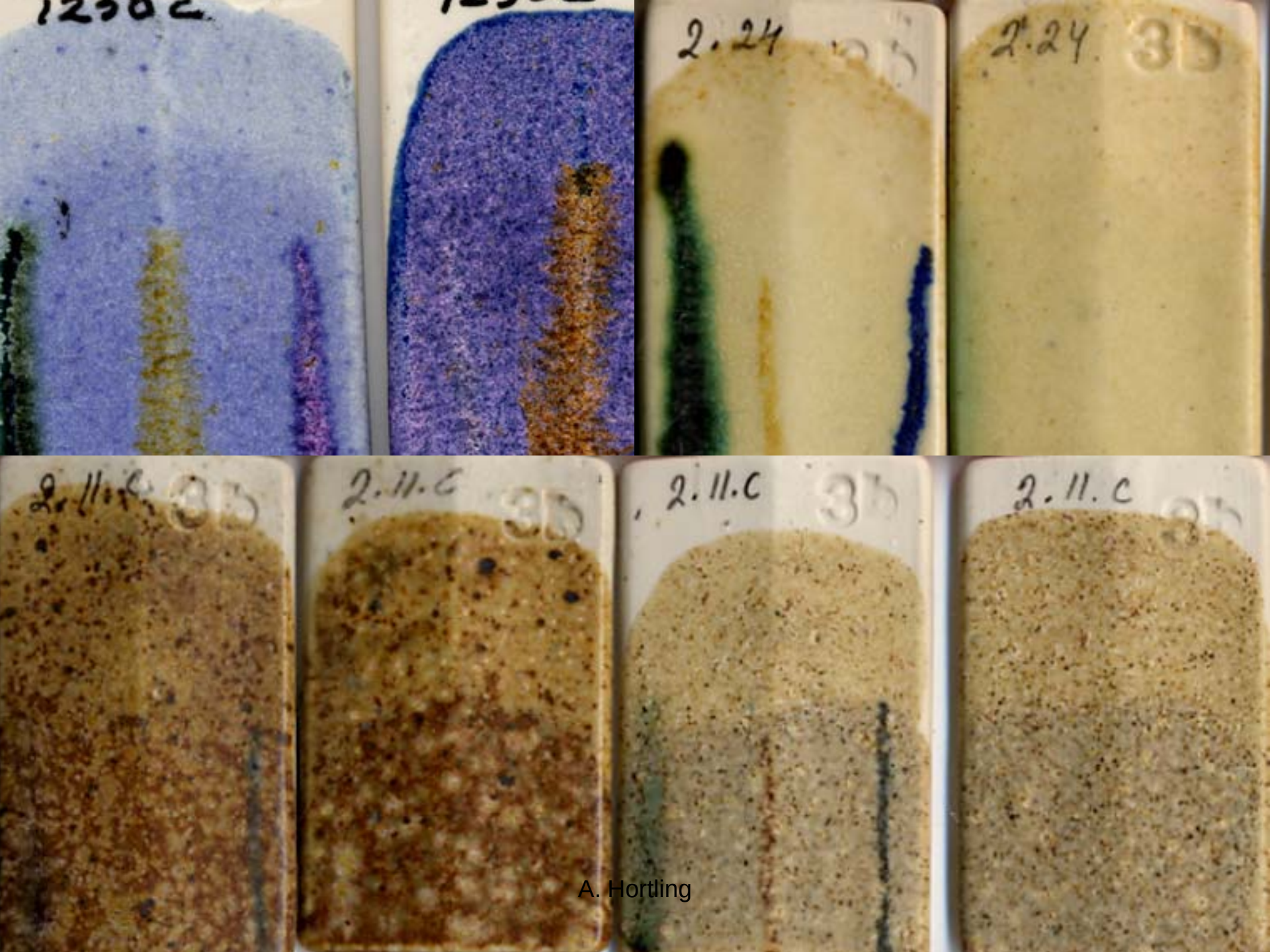
Nunnalahti

- Talc 40 - 50%
- Magnesit 40 - 50%
- Chlorite little

Soapstone glazes 1250-1280°C
Empirical formulas

Glazes	CaO*	MgO*	K_2O*	Na_2O*	$Fe_2O^*_3$	Al_2O_3	SiO_2
Glossy, translucent							
A11	**0,735**	**-**	**0,139**	**0,123**	**0,003**	**0,377**	**3,709**
Glossy, matt							
C8.1	**0,252**	**0,539**	**0,121**	**0,060**	**0,029**	**0,226**	**2,051**
C8.2	**0,233**	**0,570**	**0,116**	**0,048**	**0,034**	**0,203**	**1,866**
C8.3	**0,181**	**0,597**	**0,132**	**0,049**	**0,041**	**0,219**	**1,992**
Dim, slightly glossy							
C14	**0,374**	**0,354**	**0,143**	**0,126**	**0,003**	**0,403**	**5,018**
C14.1	**0,370**	**0,349**	**0,147**	**0,131**	**0,003**	**0,381**	**4,982**
C14.2	**0,319**	**0,290**	**0,205**	**0,183**	**0,004**	**0,521**	**6,499**

*RO-group= sum of oxides 1



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CaO-MgO-Glaze for cordierite clay body
Hortling. A. Jokinen . E. Engineering Materials, Euro Ceramics, Belgium, 2001

Soapstone glaze research, EU- project Ceramic Center in North Carelia

Research of clay bodies with soapstone and red clay

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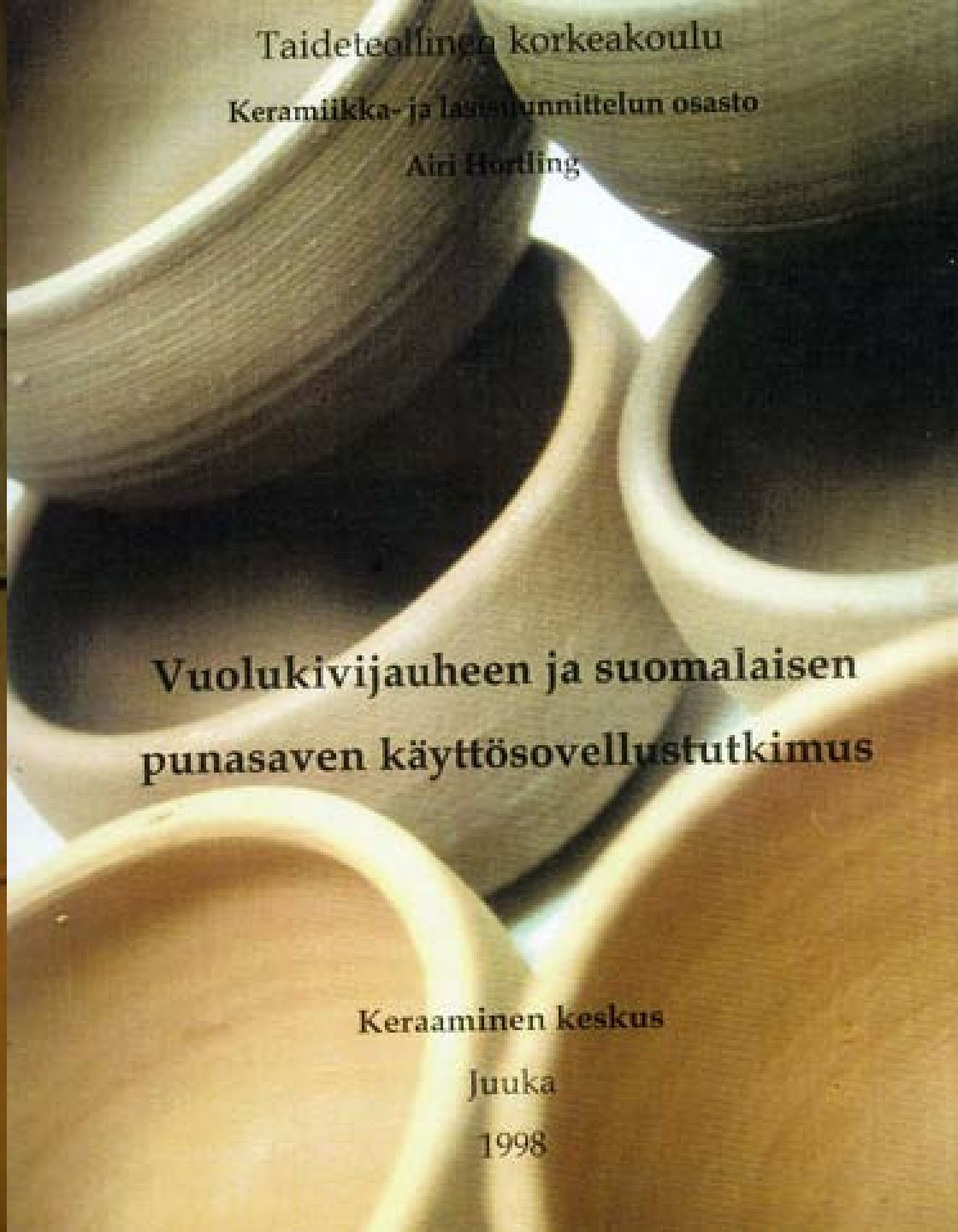
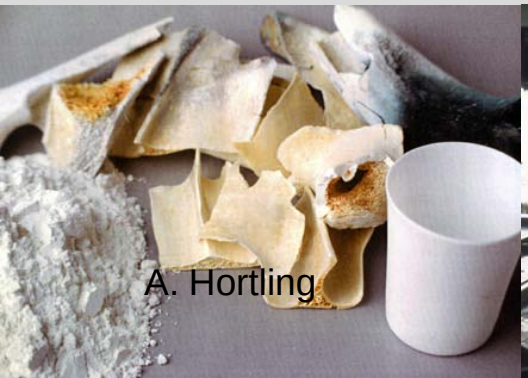
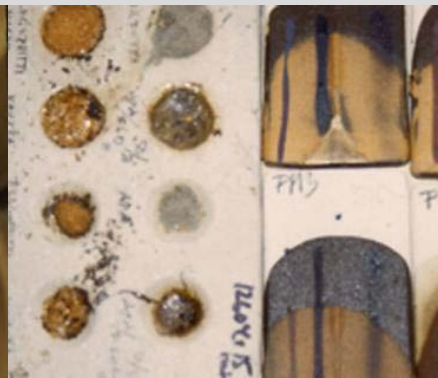


Businesses invest in innovative ceramic research

- Apatite and phlogopite mica research







Shell from Japan

Apatite from Siilinjärvi

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Apatite mineral composition

Siilinjärvi

- Apatite 10%
- **Phlogopite mica* 65%**
- Calsite,dolomite 19%
- Rihterite 4%
- Other minerals 2%

* Shell luster has same composition as phologopite mica

Applied research on phlogopite mica

Effect of phlogopite mica on the sintering point and colour of a clay body. Hortling A. Härmälä O. Kaarna K. Sotamaa T. Engineering Materials, Euro Ceramics, Versailles, France, 1997.

Colour changes on clay body (mixed phlogopite mica and red clay), in different temperatures.

Phlogopite mica…

- .. increases melting in firing range 1100-1200°C
- .. enhances the crystallization of the glaze
- .. increases the adherence of ceramic coatings in high temperatures
- .. is suitable as coating with soapastone clay

Research results of phlogopite mica and apatite

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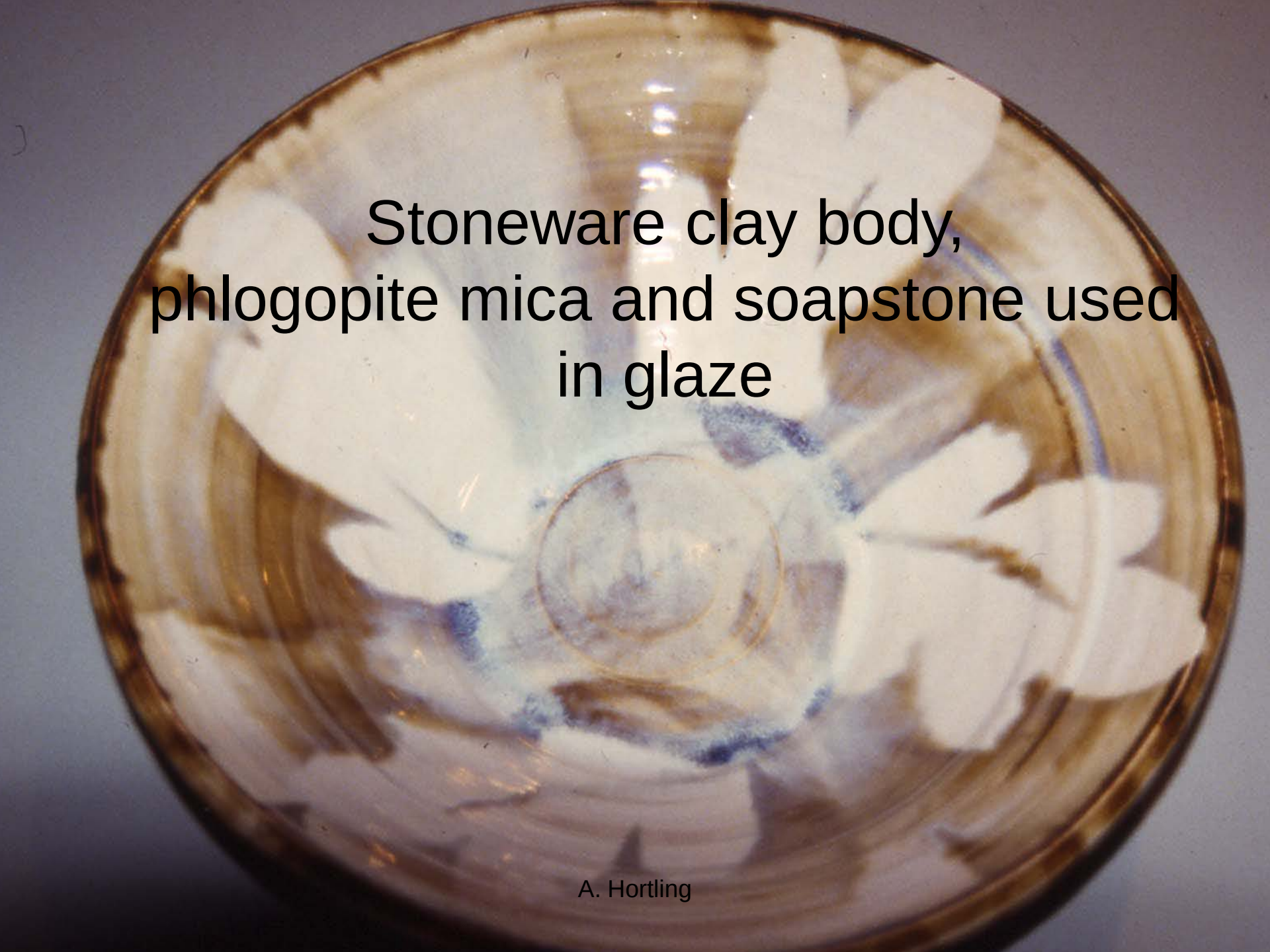
Stoneware clay body,
phlogopite mica and soapstone used
in glaze

Soapstone clay body, phlogopite mica used in glaze

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Mining byproducts from Finland have been investigated as ceramic raw materials

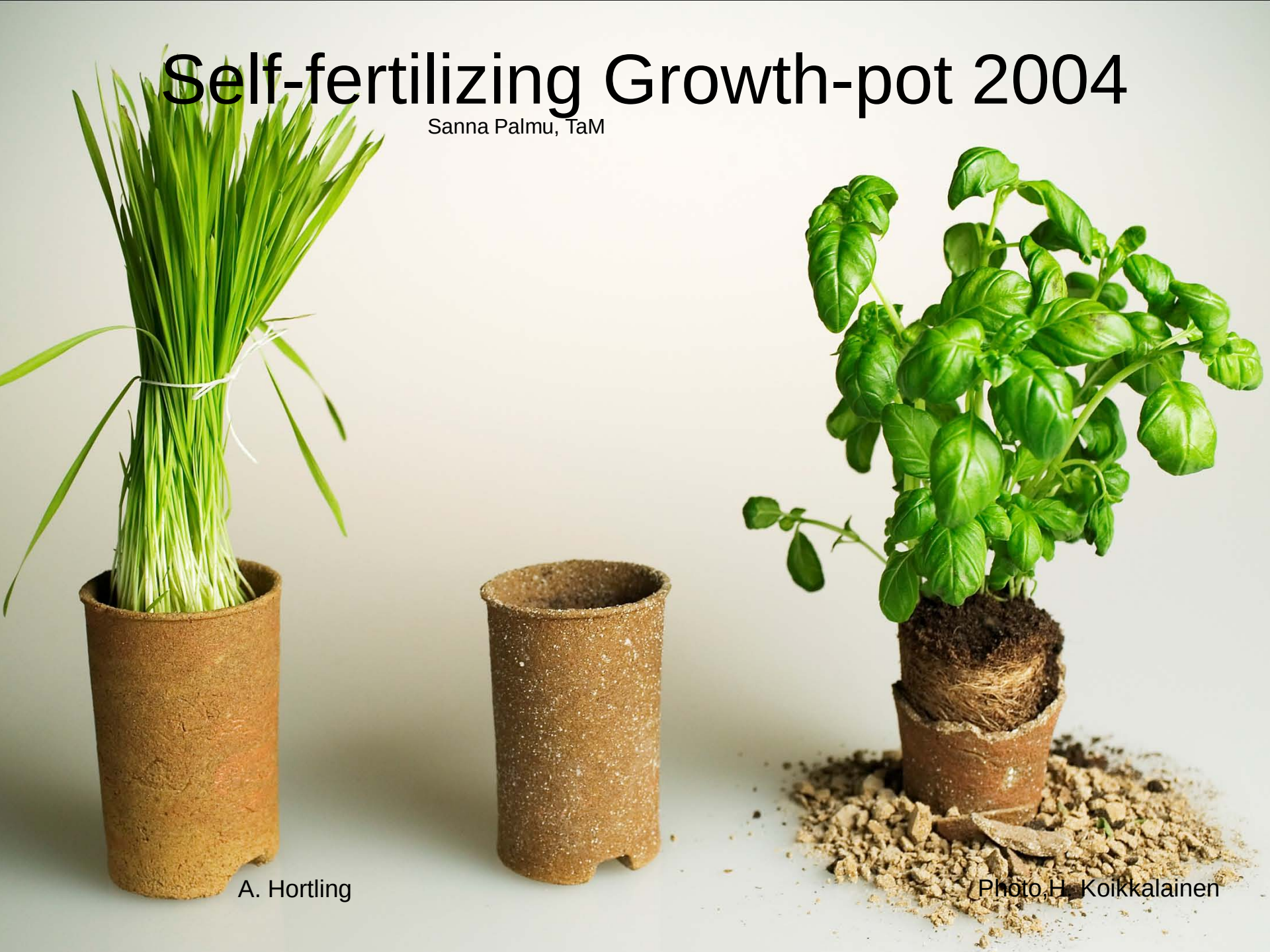
- Soapstone powder, Nunnalahti, North Carelia
- Granite powders, Mäntsälä, Taivassalo and Kuru
- Apatite and Phlogopite powders, Siilinjärvi
- Calsite powder, Sodankylä

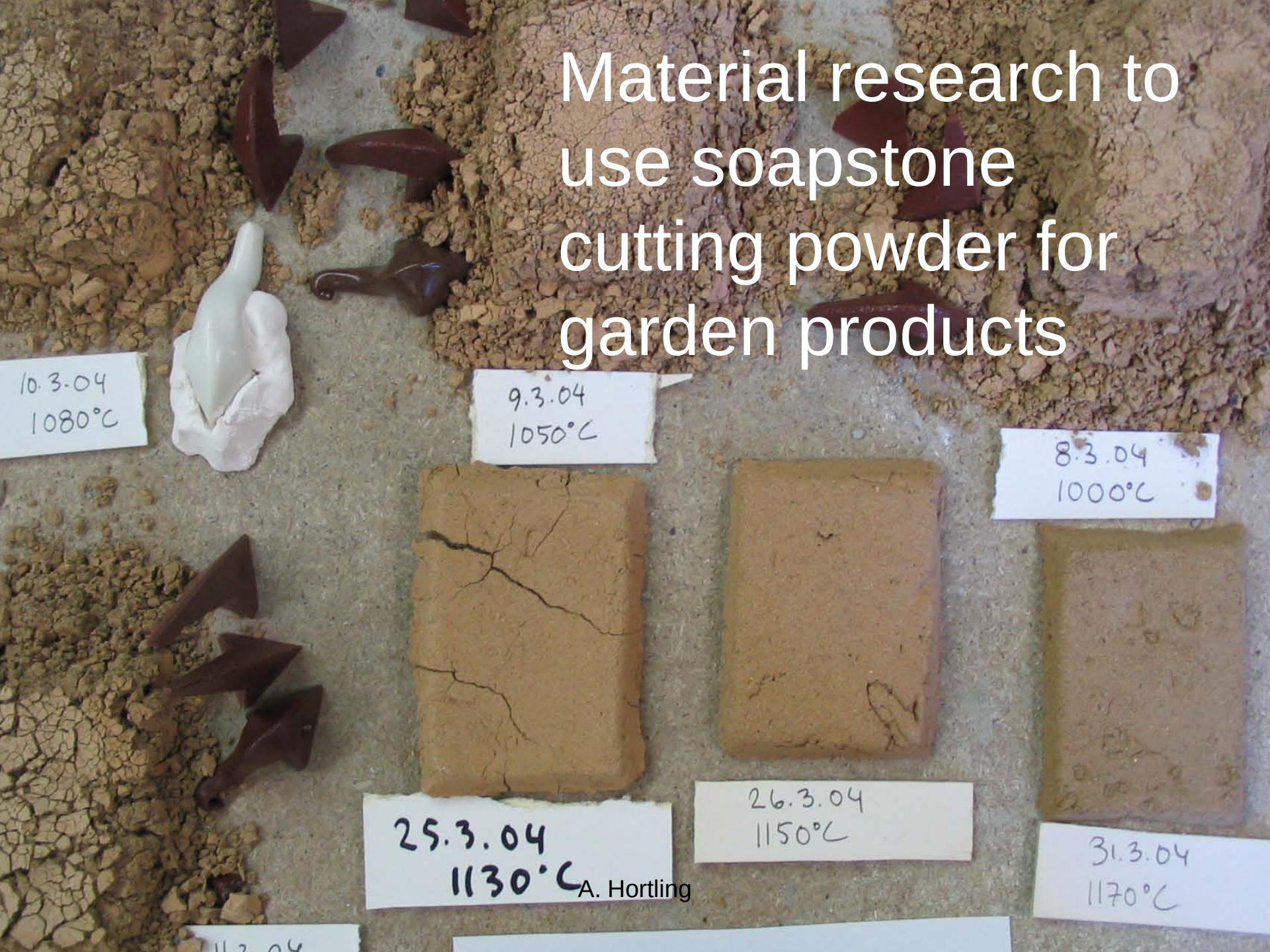
Businesses invest in innovative ceramic research

- Development of a self-fertilizing growth platform from natural resources

Self-fertilizing Growth-pot 2004

Sanna Palmu, TaM




Material research to use soapstone cutting powder for garden products
10.3.04
1080°C
9.3.04
1050°C
8.3.04
1000°C
25.3.04
1130°C
26.3.04
1150°C
31.3.04
1170°C
A. Hortling

Kuva: Photograph by Riitta Teeriaho

A. Hortling

Photograph by Riitta Teeriaho

A. Hortling

- An ecological product from stone industry waste
- A new business idea for the garden-field

Material innovations drive sustainability

- Ecology and sustainable development
  - For example, recycling of raw material
- Development of new materials
  - For example, mining industry waste and by-products, bio waste
- Life cycle responsibility of the environment
  - For example, heavy metals should not be used in ceramic products

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Publications

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My principles

Empirical research create education
(every item is also a research result)

Ecological environment
(every item has an effect on the environment)