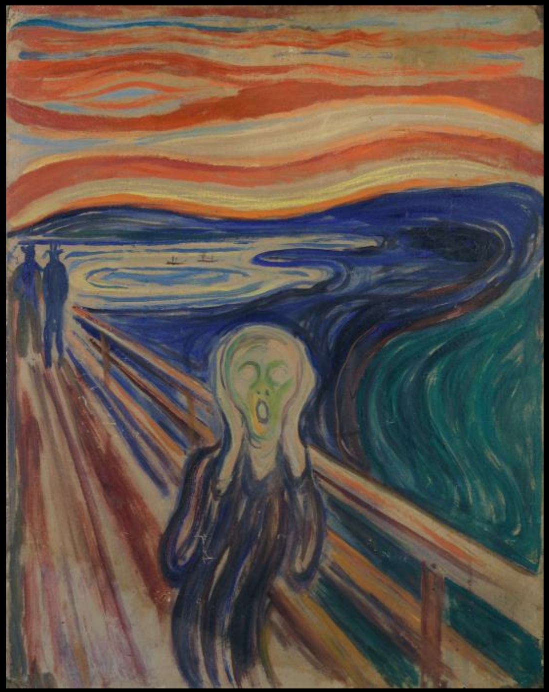
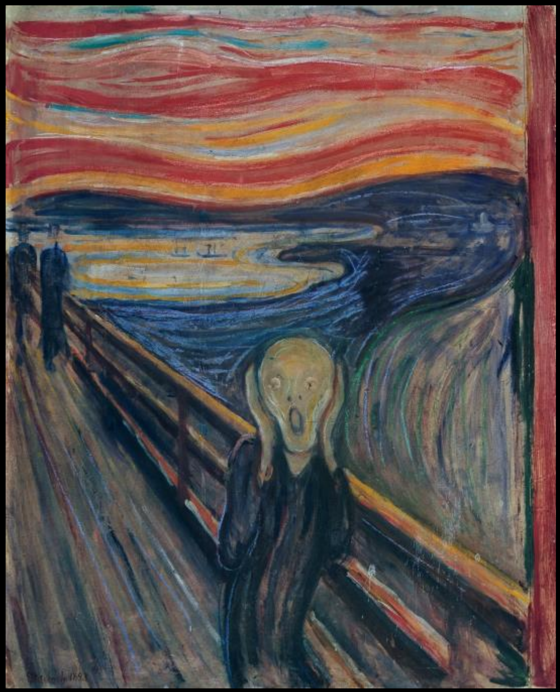
The "Scream" by Edvard Munch - same motif, different colours, different techniques and approaches – a novel non-invasive comparative study of two of its versions

Irina Crina Anca Sandu*, Thierry Ford, Costanza Miliani, Koen Janssens, Geert van der Snickt, Jana Striova, Marco Raffaelli, Raffaella Fontana, Laura Cartechini, Francesca Rosi, Aldo Romani, Letizia Monico, Chiara Grazia, Renato Pereira de Freitas, Aurelie Tournie, Christine Andraud, Vincent Detalle, Elsa Bourguignon, Kilian Laclavetine, François Mirambet, Sony George, Jon Yngve Hardeberg, Hilda Deborah, Magdalena Ufnalewska-Godzimirska, Gry Landro, Eva Storevik Tveit, Petra Pettersen



MM Scream - 1910 ?
Tempera and oil on cardboard
(83.5 x 66 cm)



NM Scream - 1893
Tempera and crayon on cardboard
(91 x 73.5 cm)

*Conservation Scientist –
Conservation Department, Munch Museum
irina.sandu@munchmuseet.no

The "Scream" version in the Munch Museum collection (MM, 1910?) was extensively investigated on several occasions (from 1974, up to now) [*Plahter, Singer, Topalova-Casadiego*].
These analytical approaches used mainly micro-destructive techniques (XRF, XRD, SEM-EDS, FTIR, GC-MS, and staining tests on cross-sections observed under optical microscope), but also multispectral and other screening techniques (Vis, UV, IR and false colour photography, X-ray radiography).

Recent analyses were performed [*Jennifer Mass, Letizia Monico & al*] with the aim of examining the **colour change** in the areas painted with cadmium yellow. **36 cadmium yellow** paint tubes of different brands were also sampled and analyzed on this occasion for understanding the fading mechanism.

The National Museum version of the Scream (NM, 1893) was also investigated by different specialists/institutions in 1974, 1992, 2006, 2015 & 2011 [*Plahter, Aslaksby & Singer; Casadiego; Hardeberg et al; Janssens & van der Snickt*] using micro-destructive and imaging tools (macro-XRF, hyperspectral etc.)

In **2008** a first comparison of two of the painted versions of the "Scream" (NM, 1893 and MM, 1910?) was published.

- Munch appears to have painted directly onto unprimed supports; cardboard similar to both paintings (light grey-brown color, mat, rough texture), made of mechanical pulp;
- Sketch phase on MM version; doubt about the creation year to be further clarified;
- NM version was signed (twice) & dated 1893 and presents also a sketch on reverse ;
- Cd yellow/orange colour in the sky presenting fading phenomena in the MM version; XRD analyses showed a different composition for the yellow pigment: Cd carbonate as synthesis reagent In MM version, Cd sulfate in NM version;
- Presence of different binding media: oil and water based paint media for MM version; water based tempera (casein, egg)& oil/wax crayon for the NM version;
- MM version - few layers of paint, vibrant tones – more compact in the landscape and the body of the main figure is more thinly applied;
- Both paintings are unvarnished;
- Both versions were stolen: NM in 1994 while the MM version in 2004.

Advantages of MOLAB non-invasive approach

- ✓ Does not require sampling of small amounts of materials (non-destructive approach);
- ✓ It can map on the same surface all the elements/materials present there;
- ✓ Allows direct correlation between an image and the spectroscopic/compositional data from a certain area or spot on the surface of the object;
- ✓ The images can describe and re-construct the whole sequence of layers and technique of the artist;
- ✓ Layers which are not visible to naked eye become visible under NIR or UV radiation;
- ✓ It is also possible to chemically and visually map the presence of degradation or deteriorİation patterns (e.g. the cadmium yellow presence and fading; oxalate formation and distribution on the surface).

TECH_SCREAM_TECH – TECHnical Study of CoRE Art Materials & TECHniques of SCREAM versions -

The MOLAB research and access project was proposed with the aim to add more data on the materials and techniques on **7 versions** of the “Scream” (MM + NM).

Among the different analytical techniques, only **3** of them were applied on both versions:

- **macro-XRF (MOLAB + Antwerp Univ.);**
- **hyperspectral VIS (MOLAB + NTNU) and NIR imaging (MOLAB)**
- **XRD (MOLAB).**

8 MOLAB researchers
9 instruments at work
4 full days of measurements

MOLAB-Italy 2nd-6th October 2017

MUNCH MUSEUM
2 weeks of Access

4 MOLAB researchers
2 instruments at work
3 full days of measurements

MOLAB-France 12-15th December 2017

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Multi/Hyper spectral imaging

VIS hyper spectral imaging
NIR hyper spectral imaging
SWIR hyper spectral imaging
X-ray fluorescence mapping

↓

Painting technique

Underdrawing

Underpaints

Point chemical analysis

X-ray fluorescence
Mid-FTIR
Near-FTIR
Raman
X-ray diffraction
UV-Vis absorption
UV-Vis fluorescence

↓

pigments and dyes

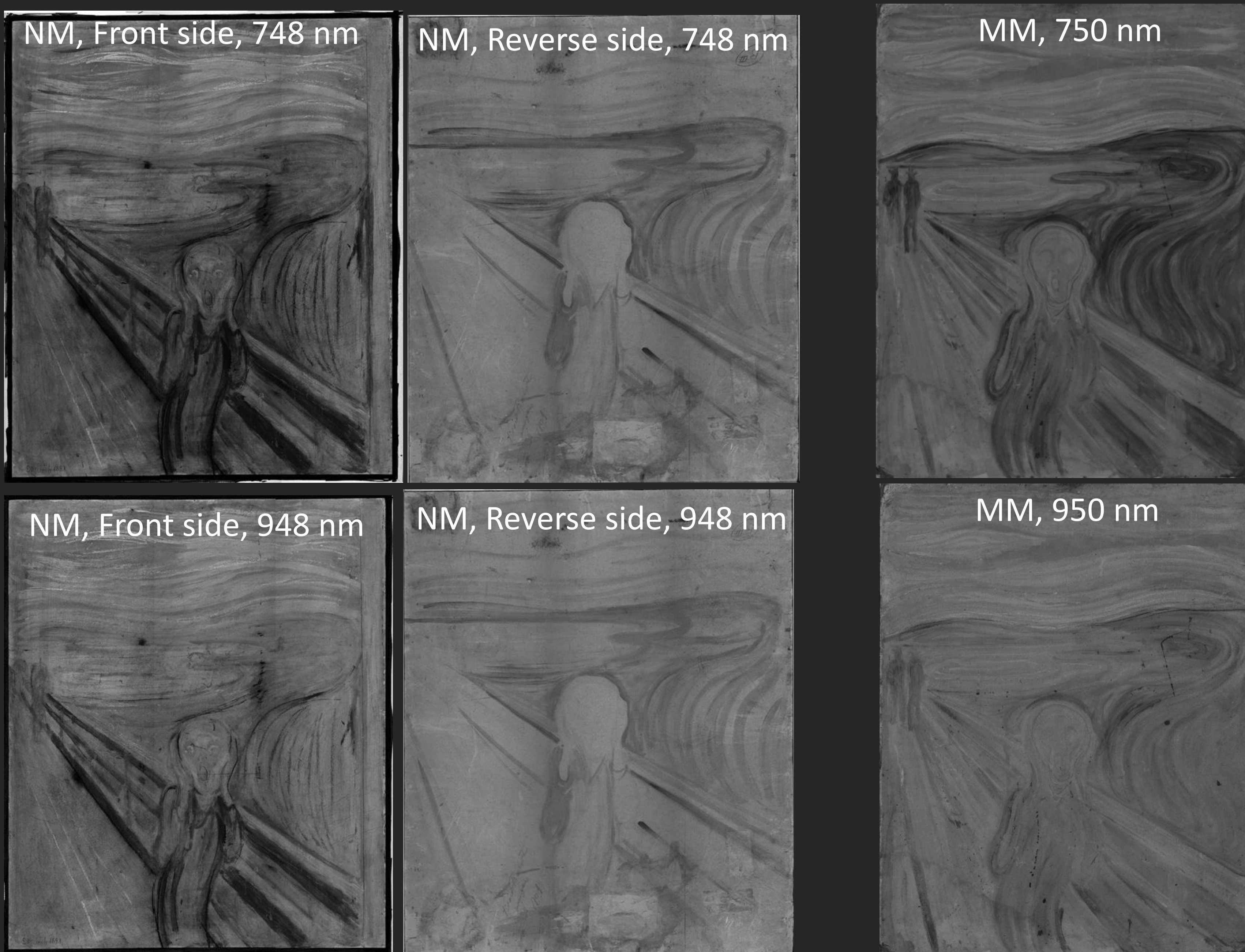
organic components

alteration products

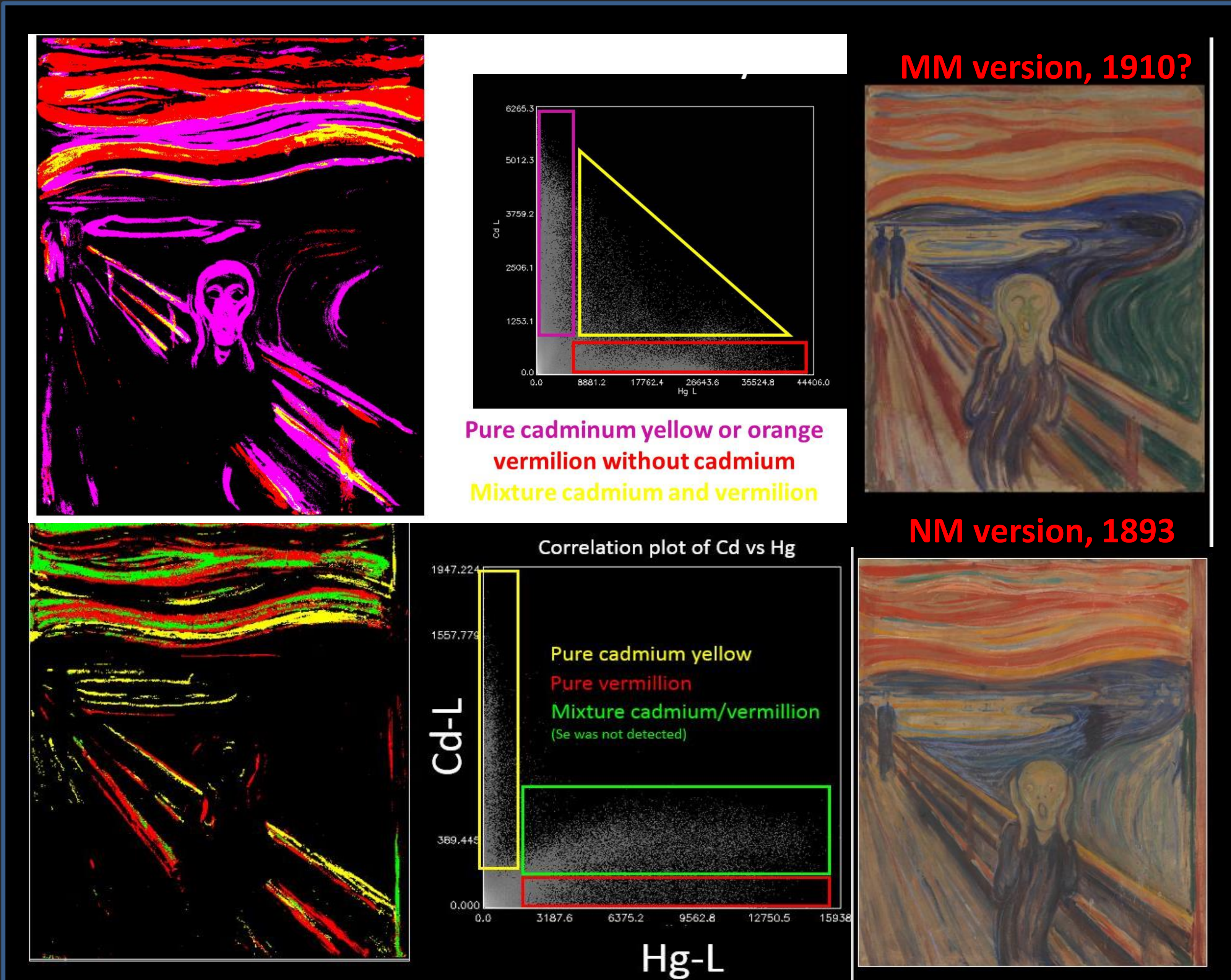
conservation treatments

MOLAB @ Munch Museum

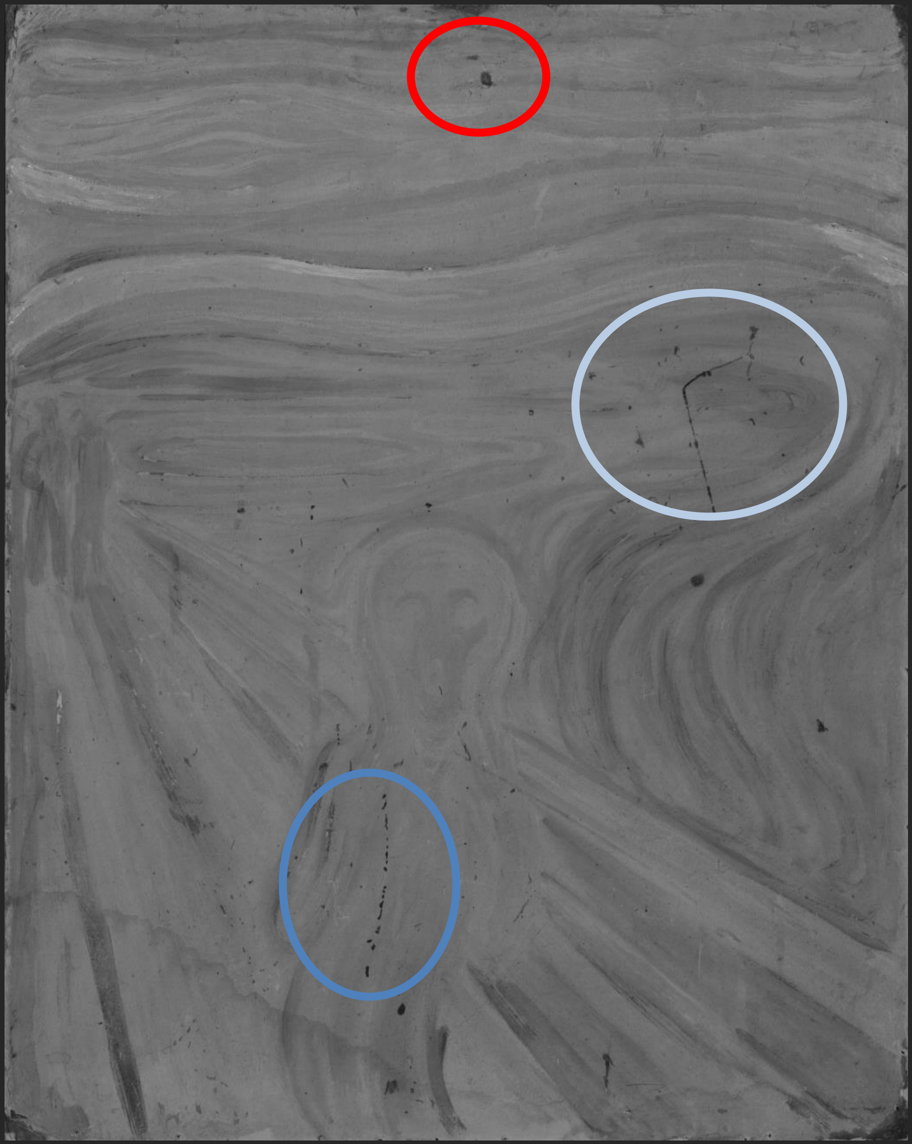
Comparative multi/hyper spectral imaging



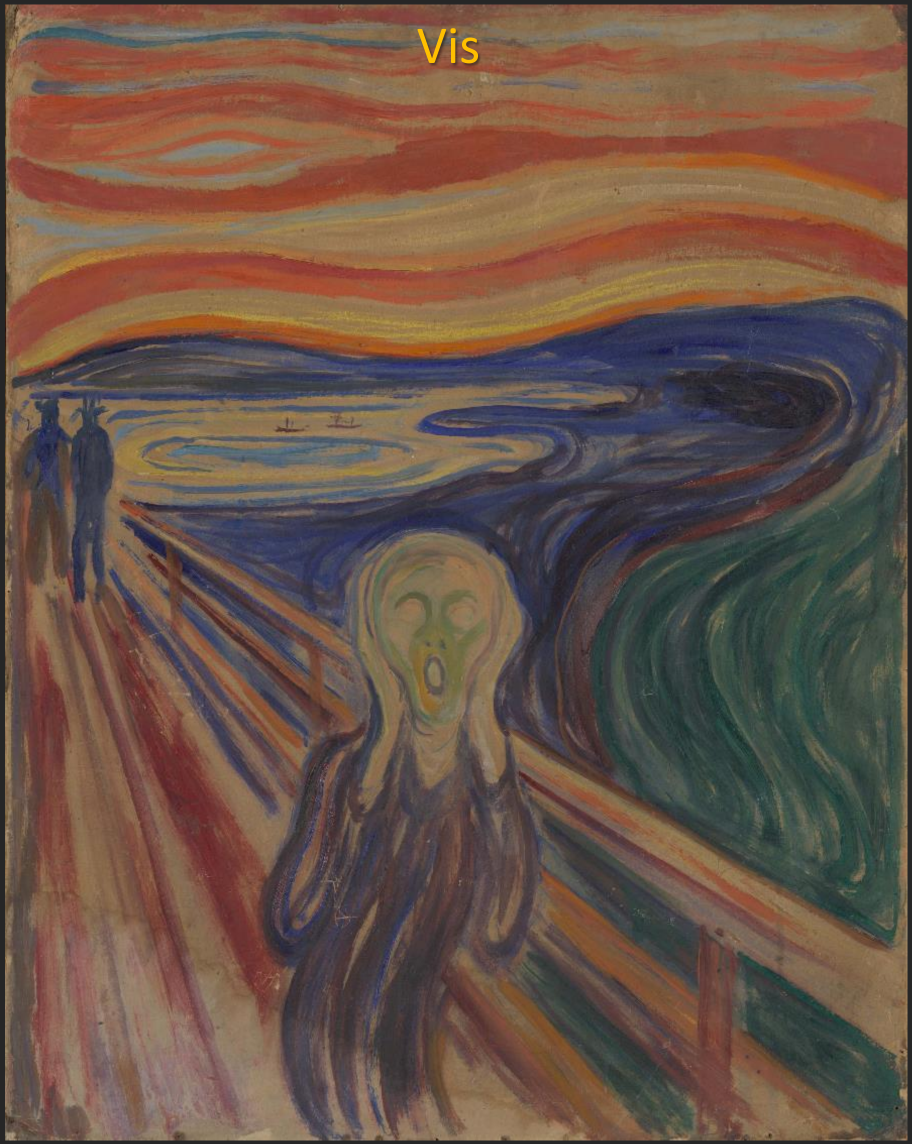
Comparative macro-XRF mapping/imaging



MM version



1940 nm



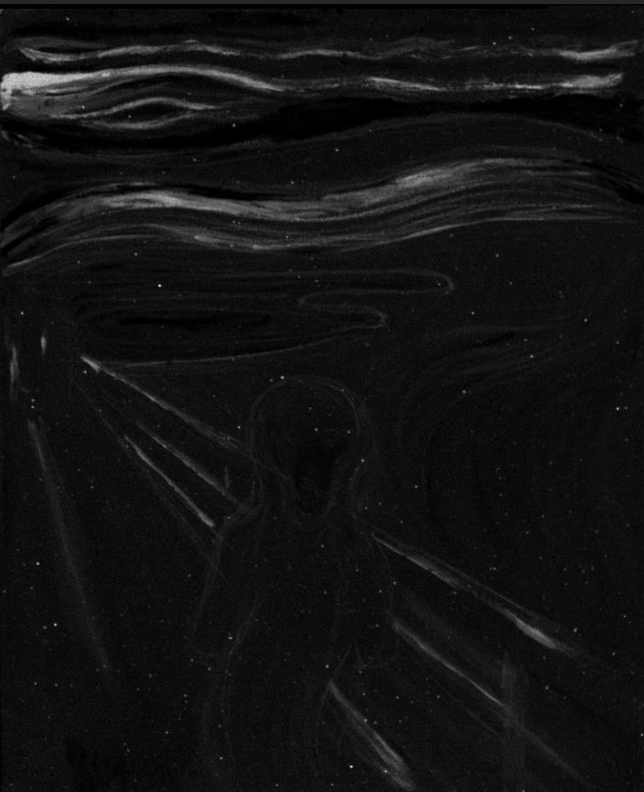
2345 nm

Vis-NIR hyperspectral

MA-XRF

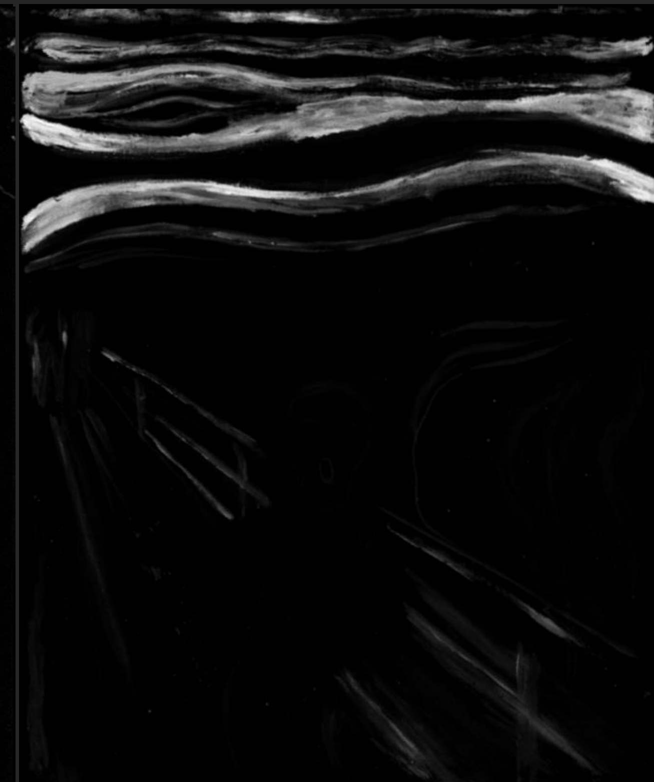
Red, orange and yellow hues of the sky

Pb-L



Se-K

Hg-L



Pb also present

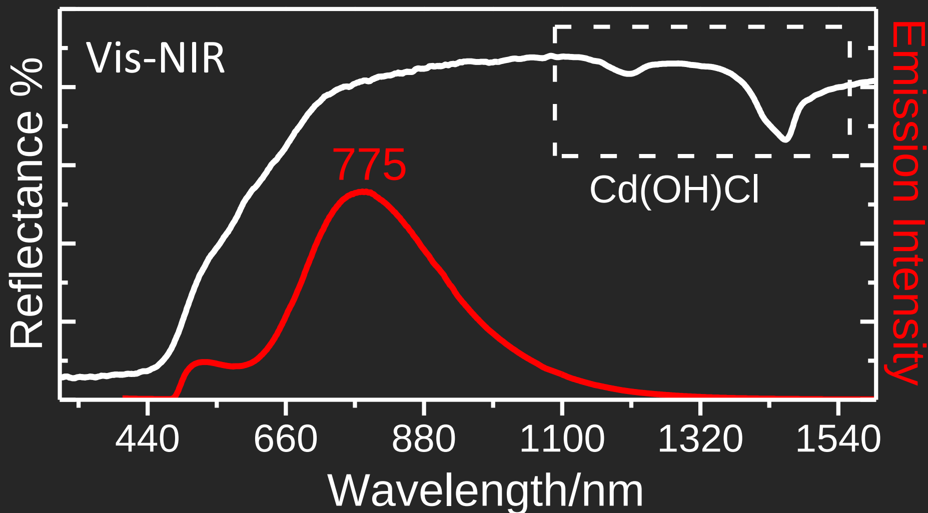
Se-K detected only in specific regions

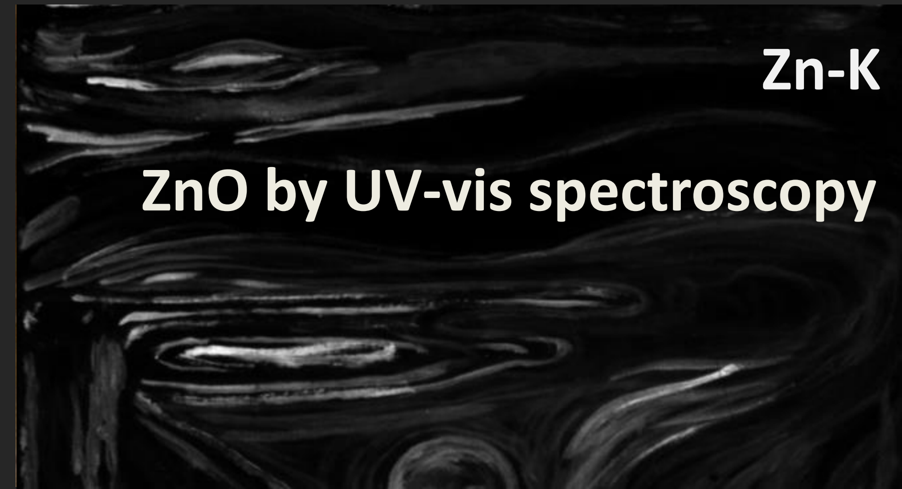
Retouchings?

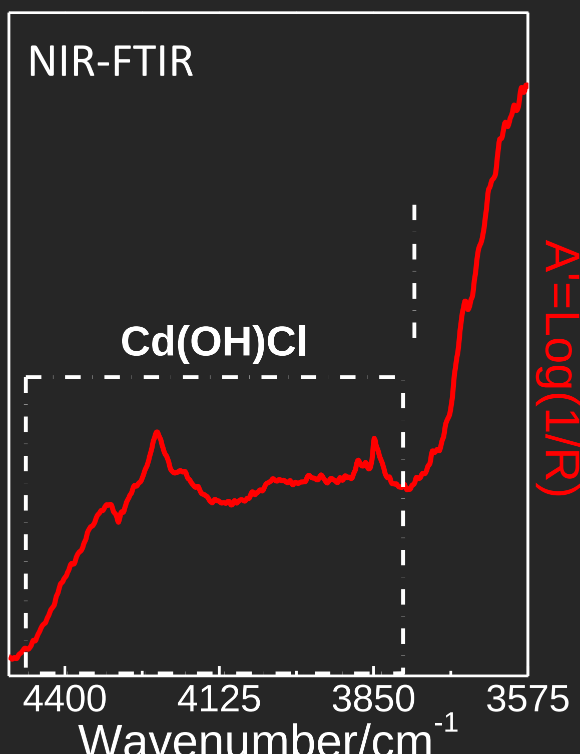
cadmium sulfide (CdS, by UV-vis fluo)

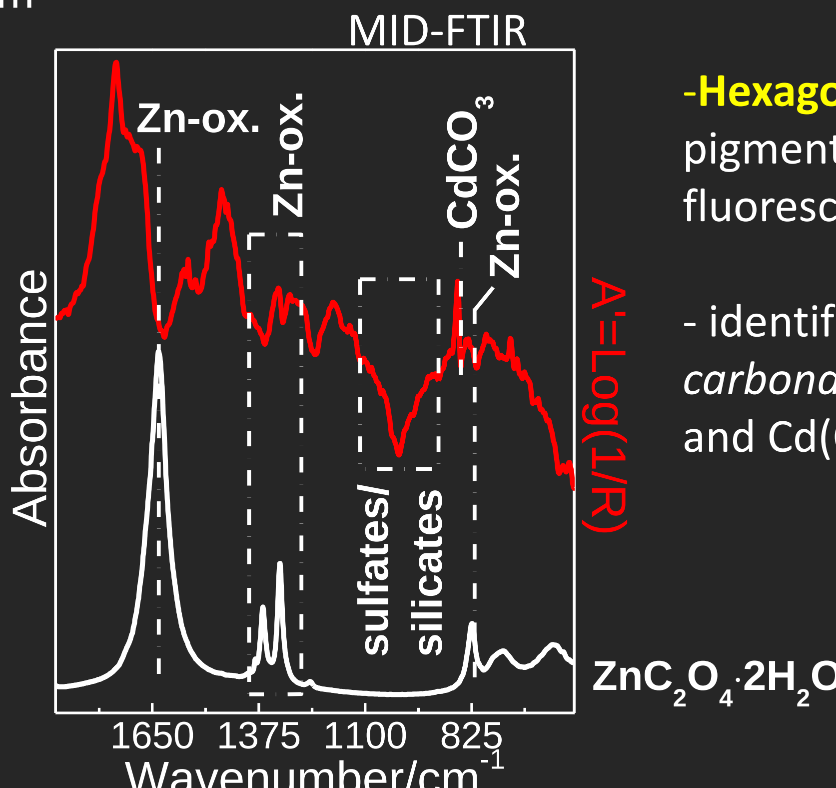
Vermilion (HgS)

Yellow shades of the sky and lake









-**Hexagonal CdS**-based yellow pigment characterized by a fluorescence band at 775nm

- identification of *cadmium carbonate* and *zinc oxalates* and Cd(OH)Cl by MIR

Fluorescence hyper spectral imaging @ 775nm

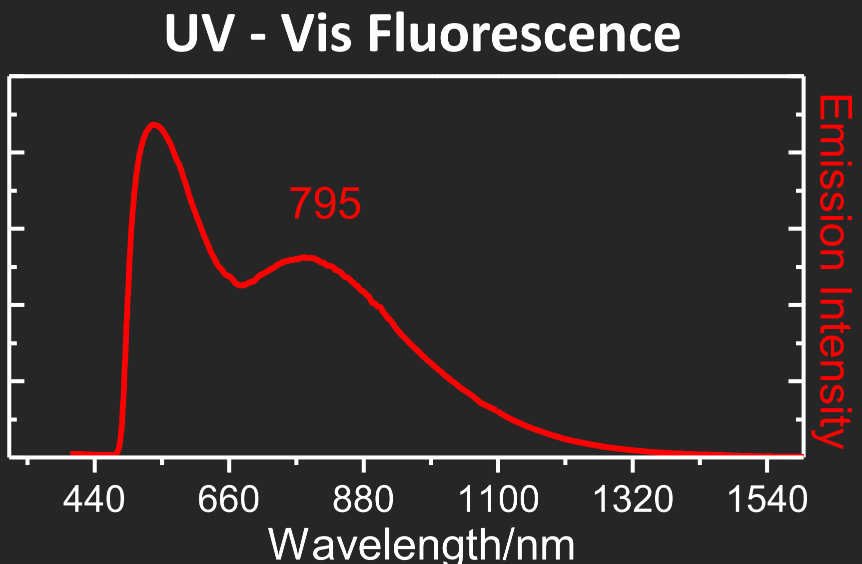
Cd-L

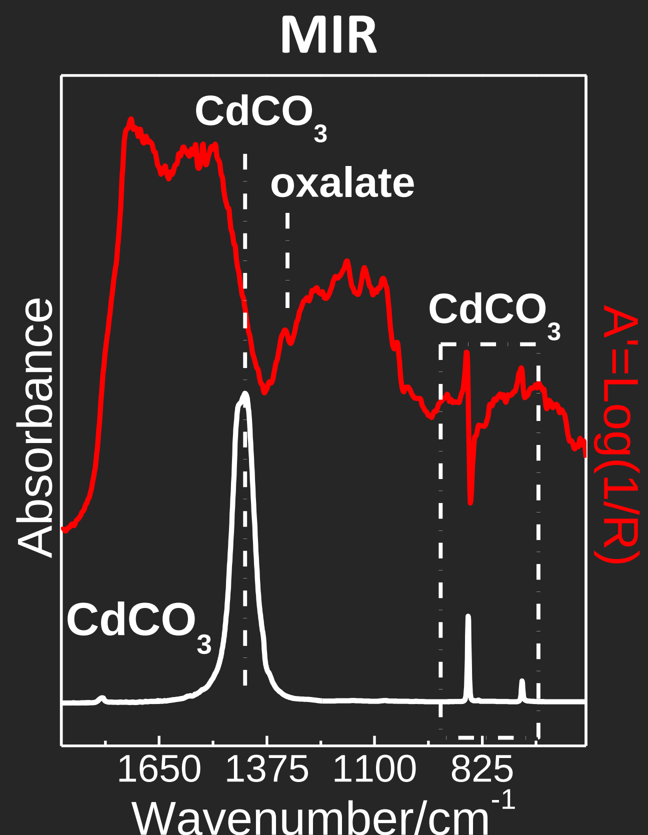
CdS emission

Yellow areas: sky and neck of the man

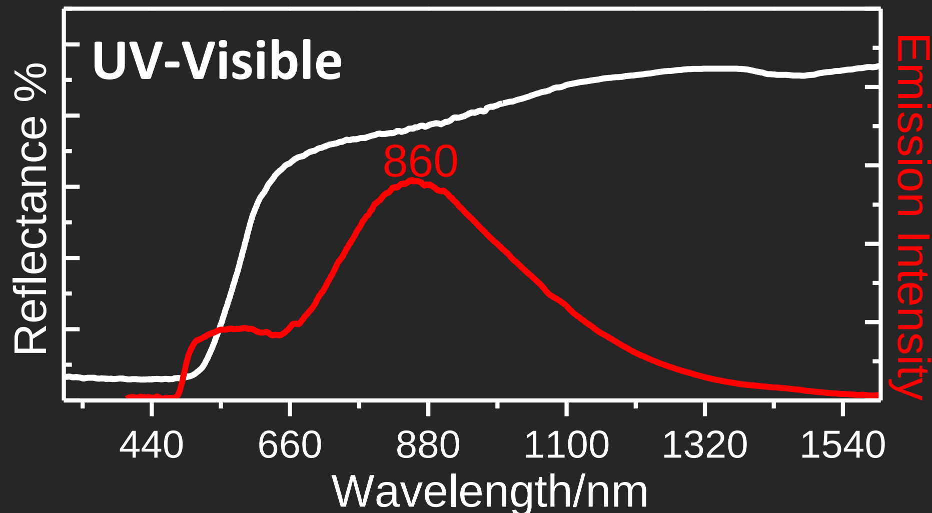
- **Hexagonal CdS**-based yellow pigment characterized by a weak fluorescence band at 795 nm

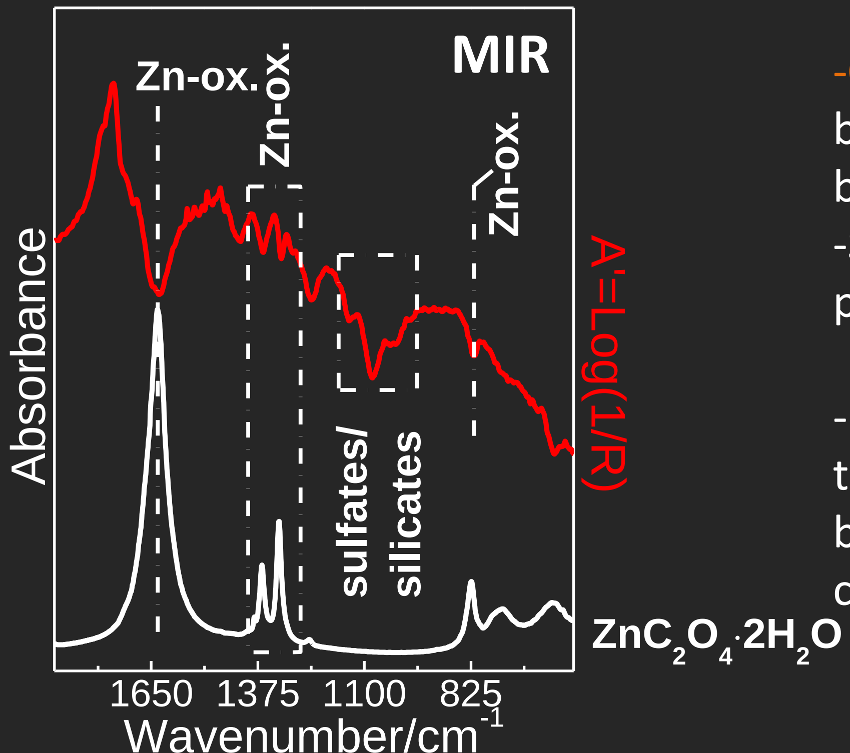
- identification of *Cd carbonate* and *oxalates* by MIR spectroscopy





Orange hues of the sky



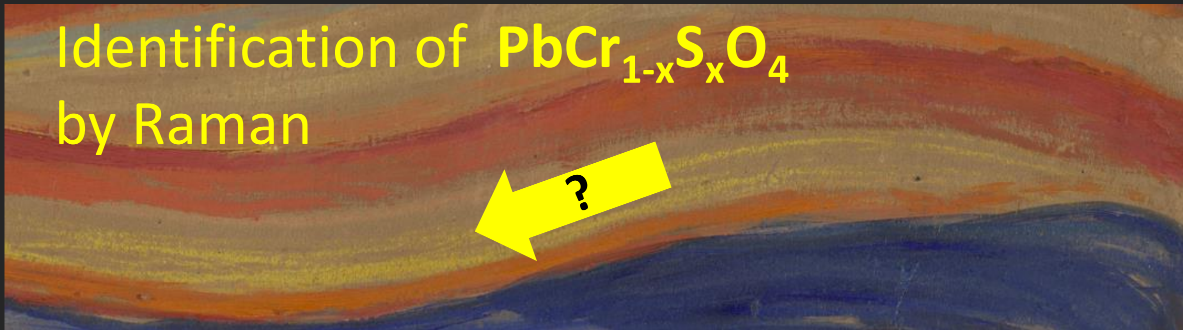


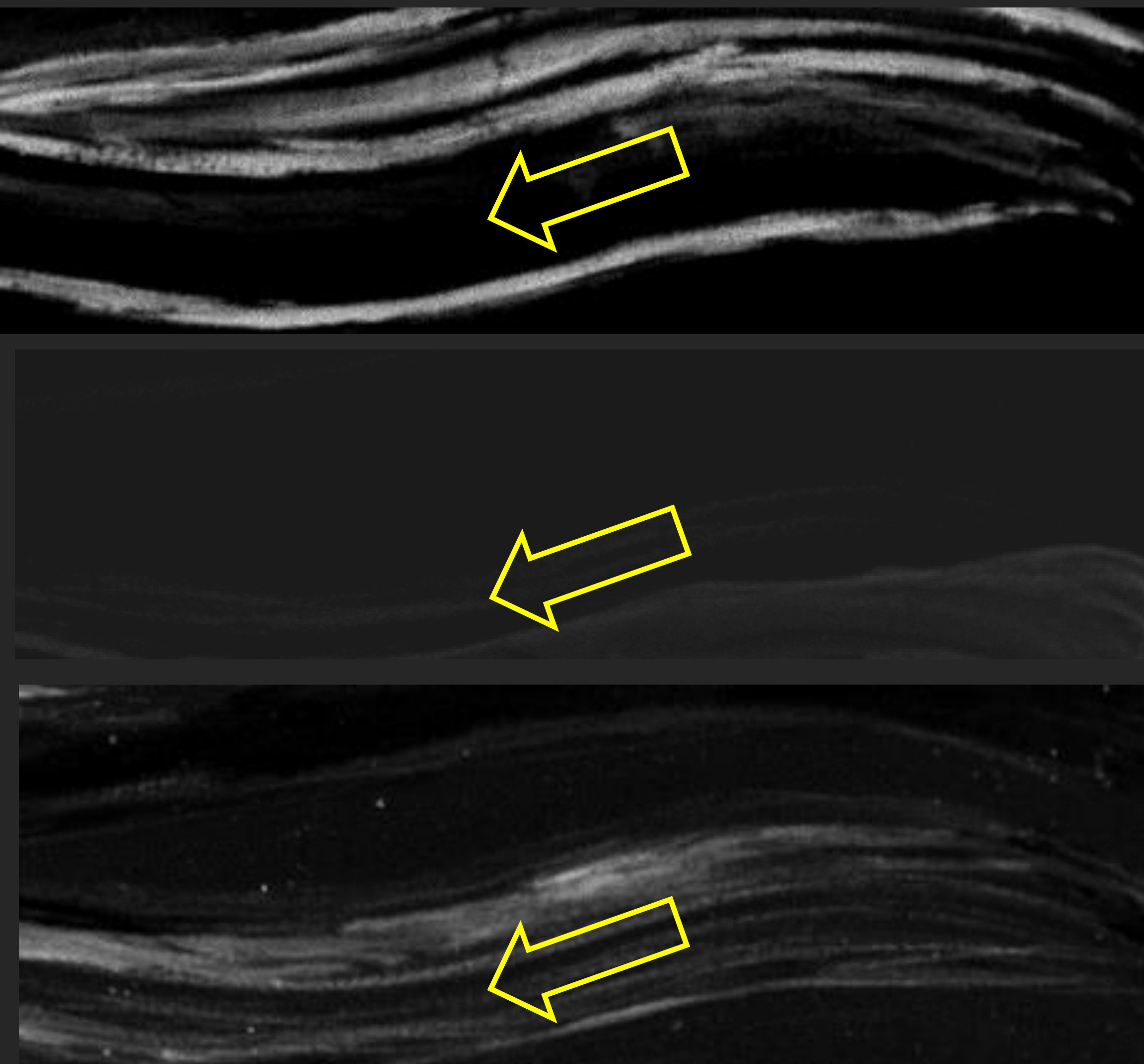
-**Cubic + Hexagonal CdS**-based pigment characterized by a fluorescence band at 860 nm and reflectance band with inflection point at about **530** nm.

-Second inflection point at **590** nm indicating a red pigment (HgS)

- identification of *zinc oxalates* (signals more intense than in the yellow tones) and *sulfates* and/or *silicates* by MIR spectroscopy. No presence of cadmium carbonate and Cd(OH)Cl in this area.

Identification of $PbCr_{1-x}S_xO_4$ by Raman





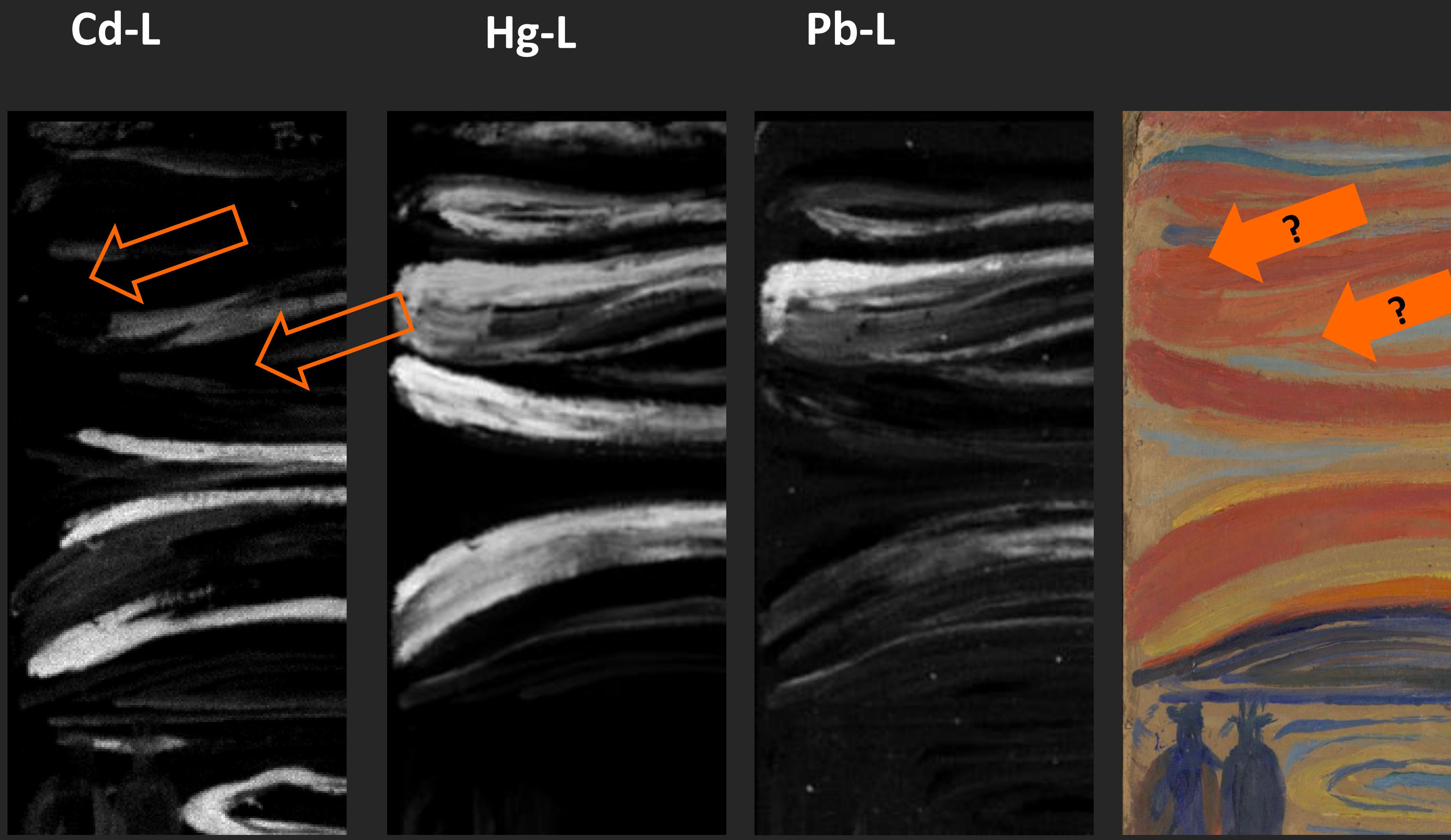
Cd-L

yellow strokes that do not show up in the Cd-L map…

Cr-K

…but in the maps of Cr-K and Pb-L

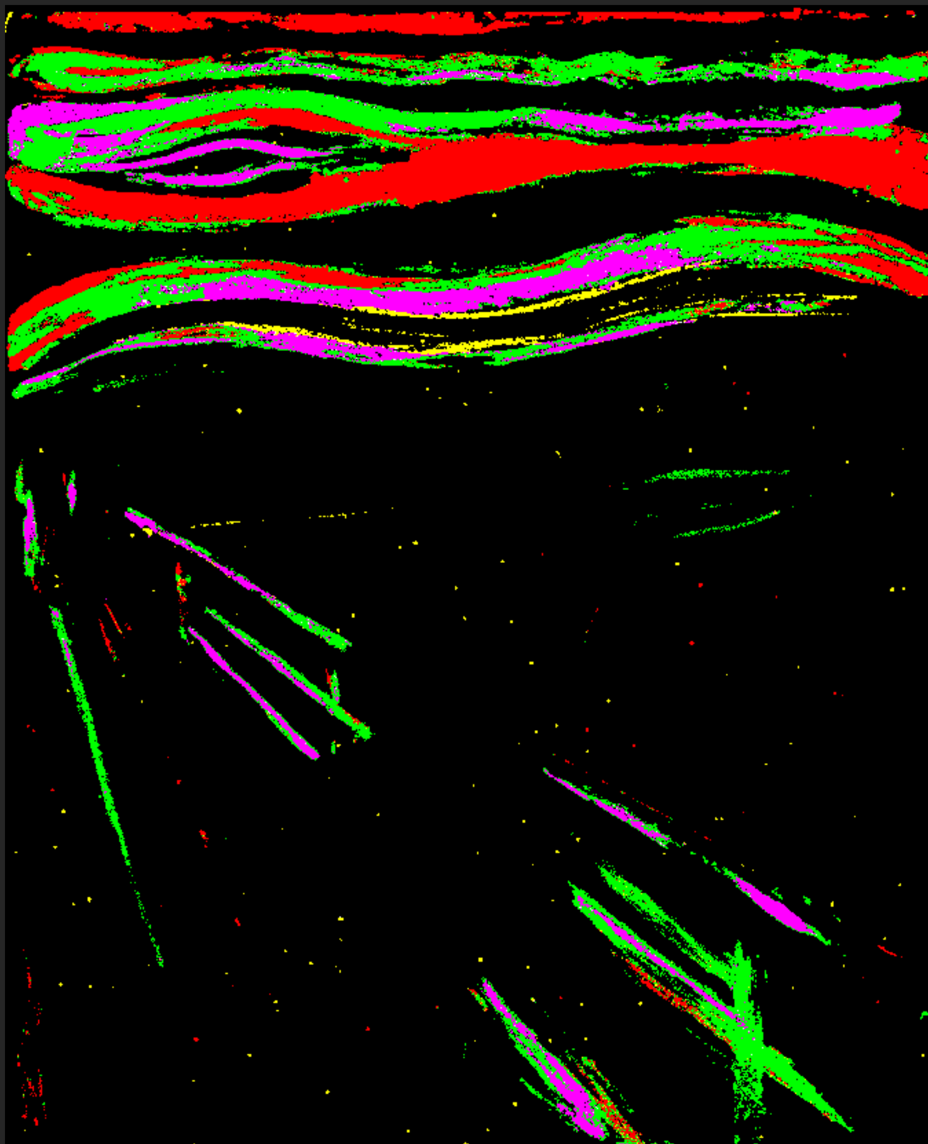
Pb-L

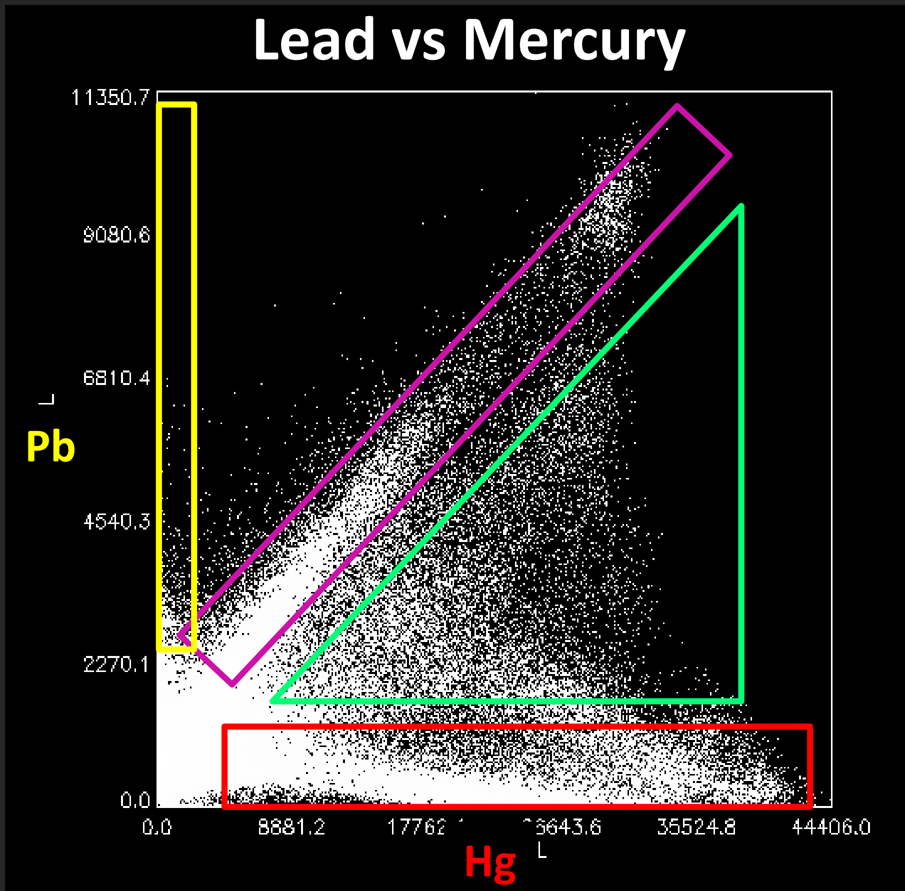


Orange strokes that do not show up in the Cd-L map but in the maps of Pb-L and Hg-L.

Presence of vermilion confirmed by Raman

Correlation plot



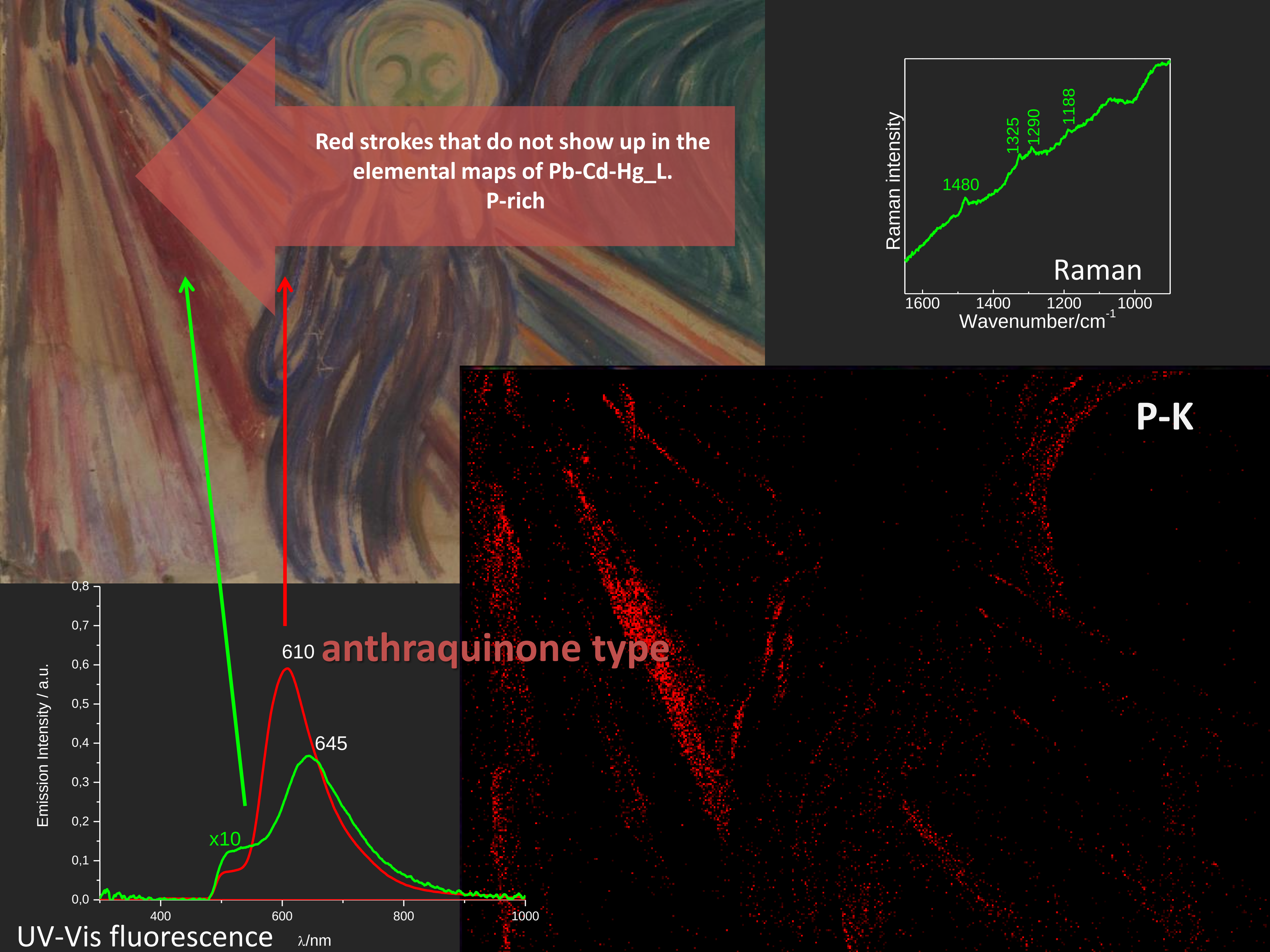


Hg without Pb: HgS

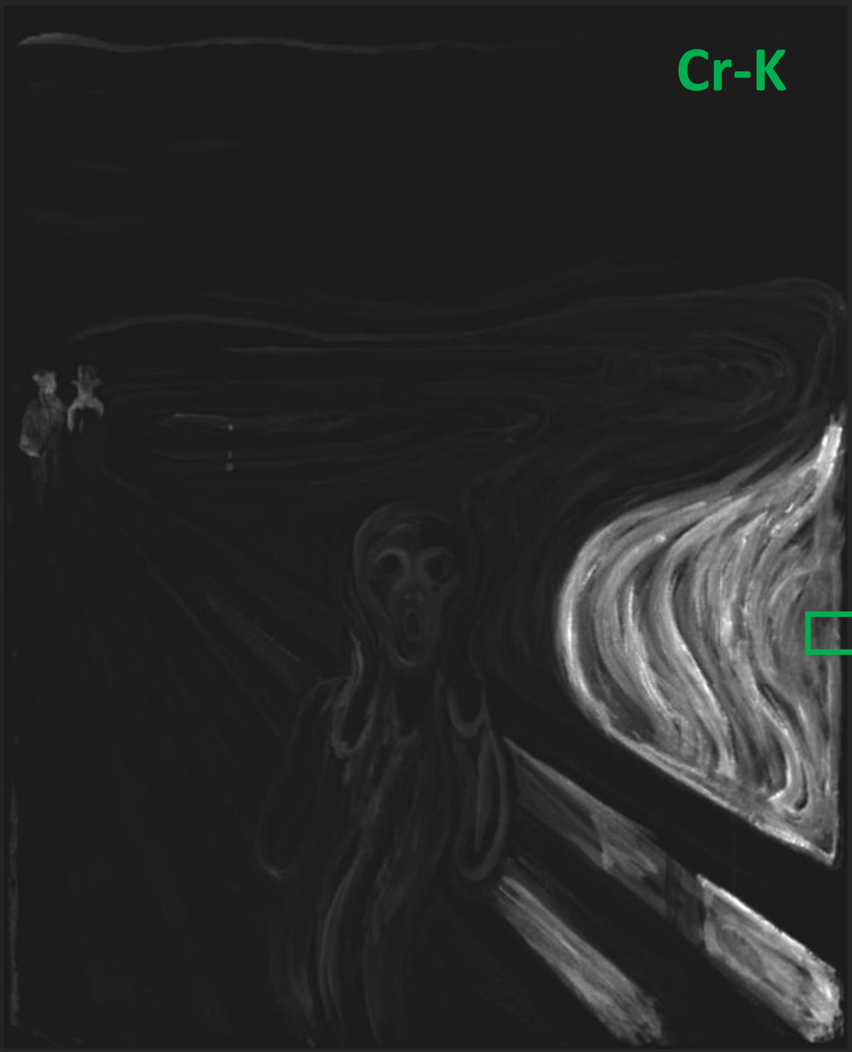
Pb without Hg: lead chromate

Correlated Pb/Hg =intentional pigment mixture or tube formulation

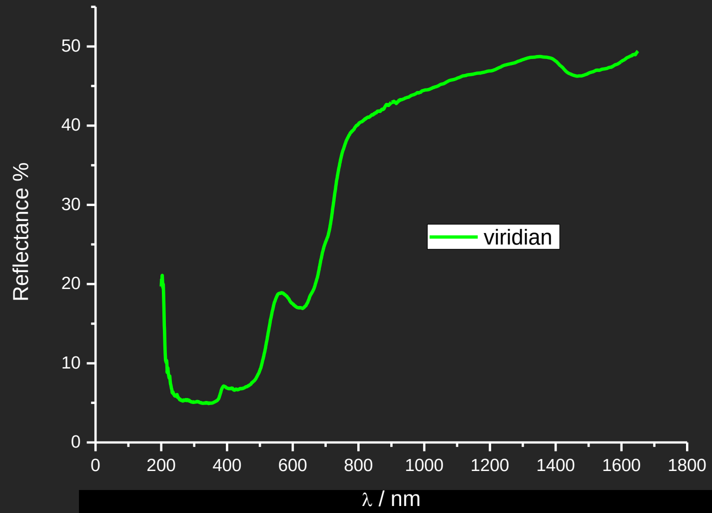
Uncorrelated Hg/Pb

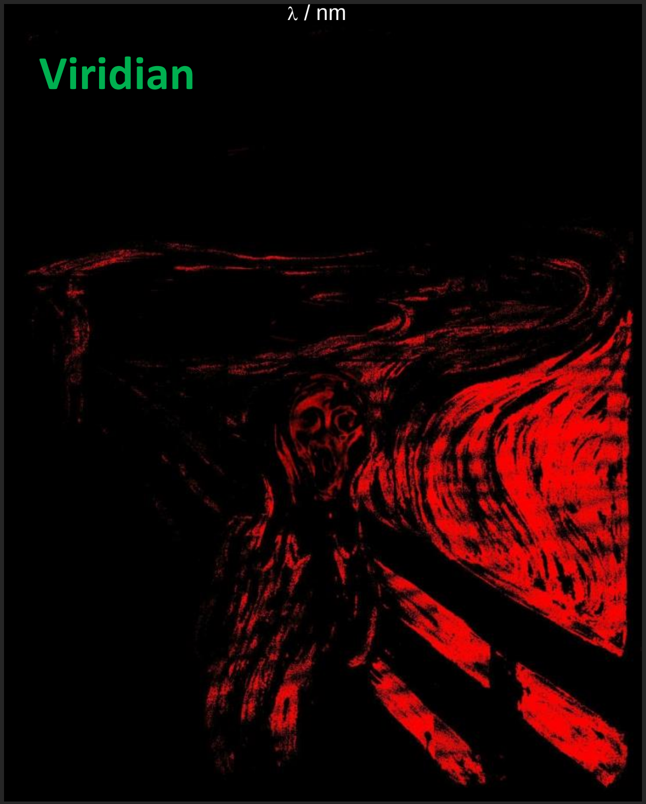

Red strokes that do not show up in the elemental maps of Pb-Cd-Hg_L.
P-rich
Raman intensity
1480
1325
1290
1188
Raman
1600
1400
1200
1000
Wavenumber/cm-1
P-K
610
anthraquinone type
645
x10
Emission Intensity / a.u.
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
400
600
800
1000
UV-Vis fluorescence
λ/nm

Cr-based green



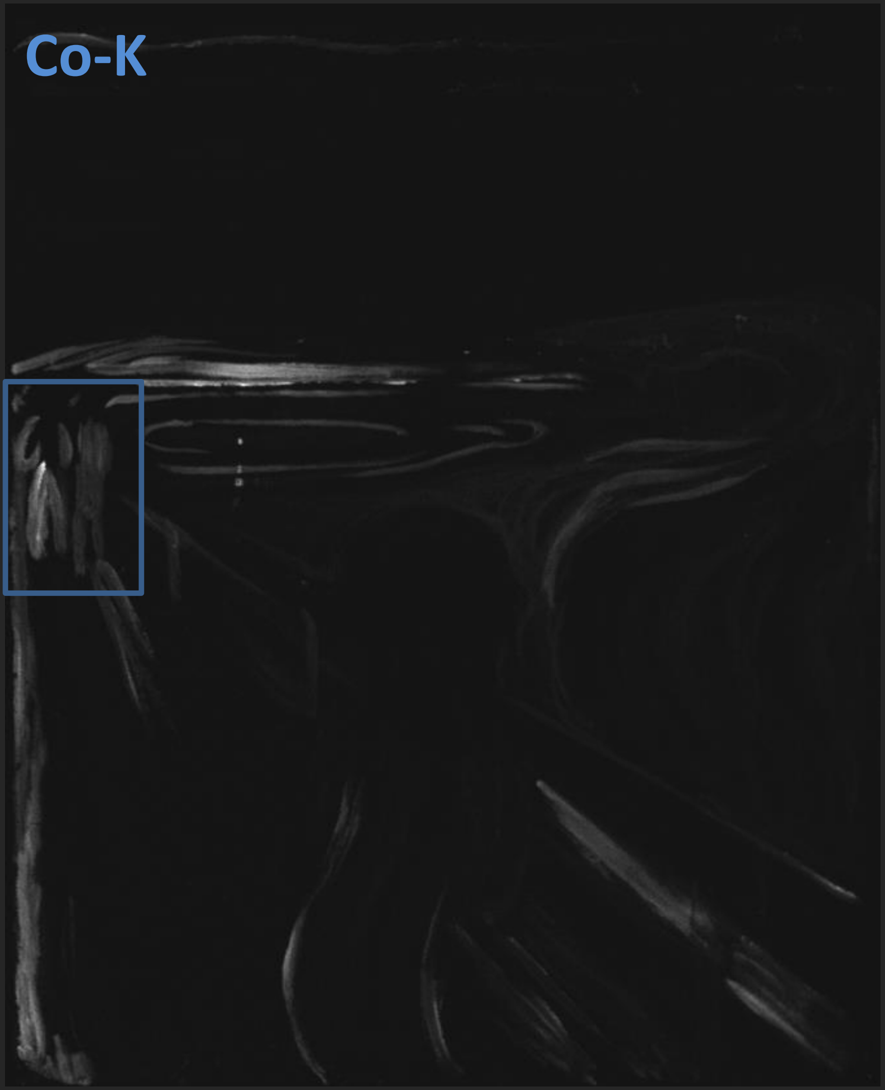
UV-VIS reflectance



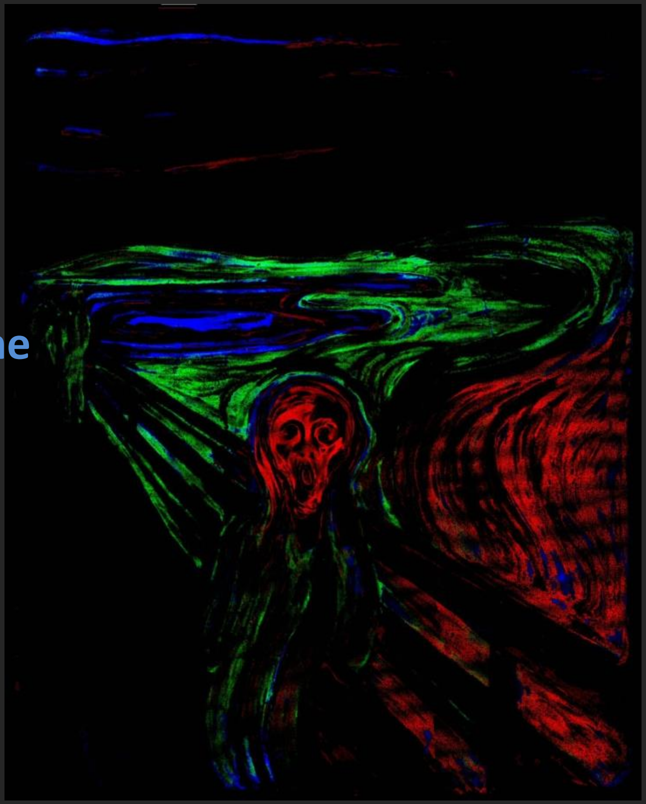


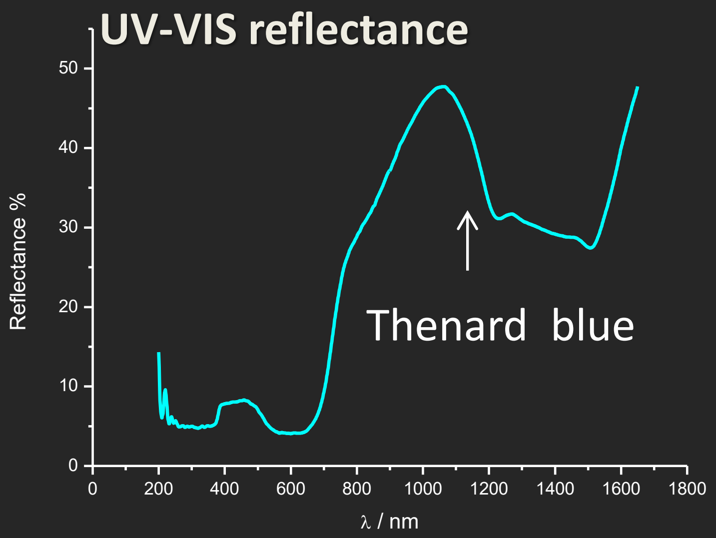
VIS hyper spectral imaging

Blue areas

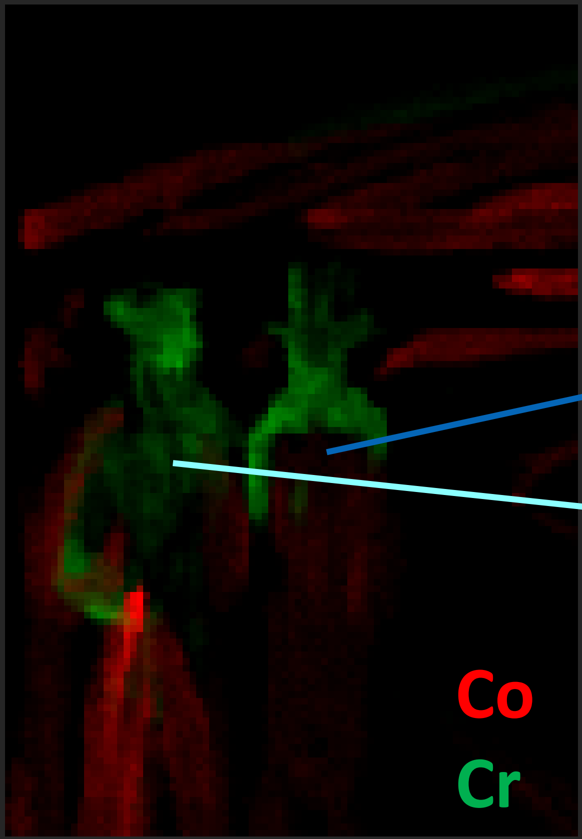


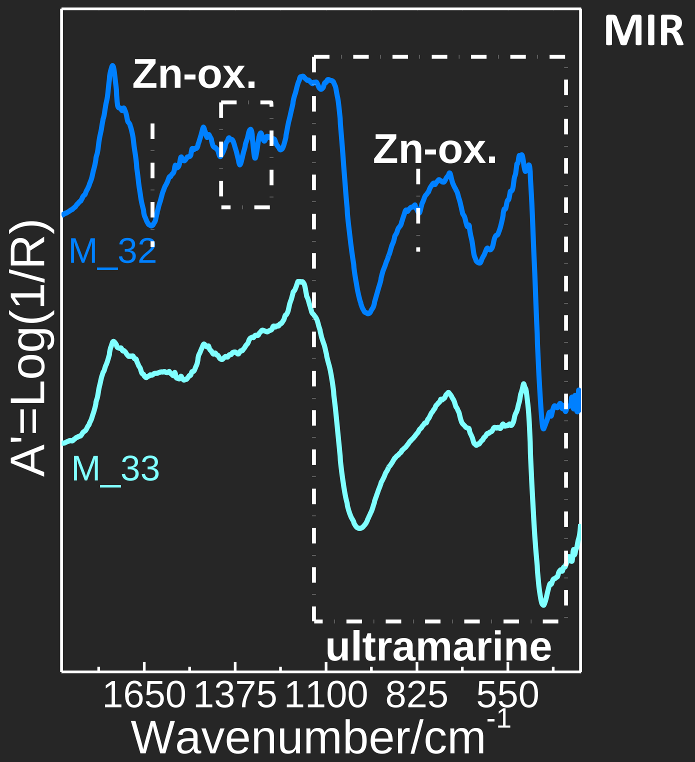
Hyperspectral
VIS:
red: Viridian,
green: Thenard
blue
blue: Ultramarine





Complex blue paints





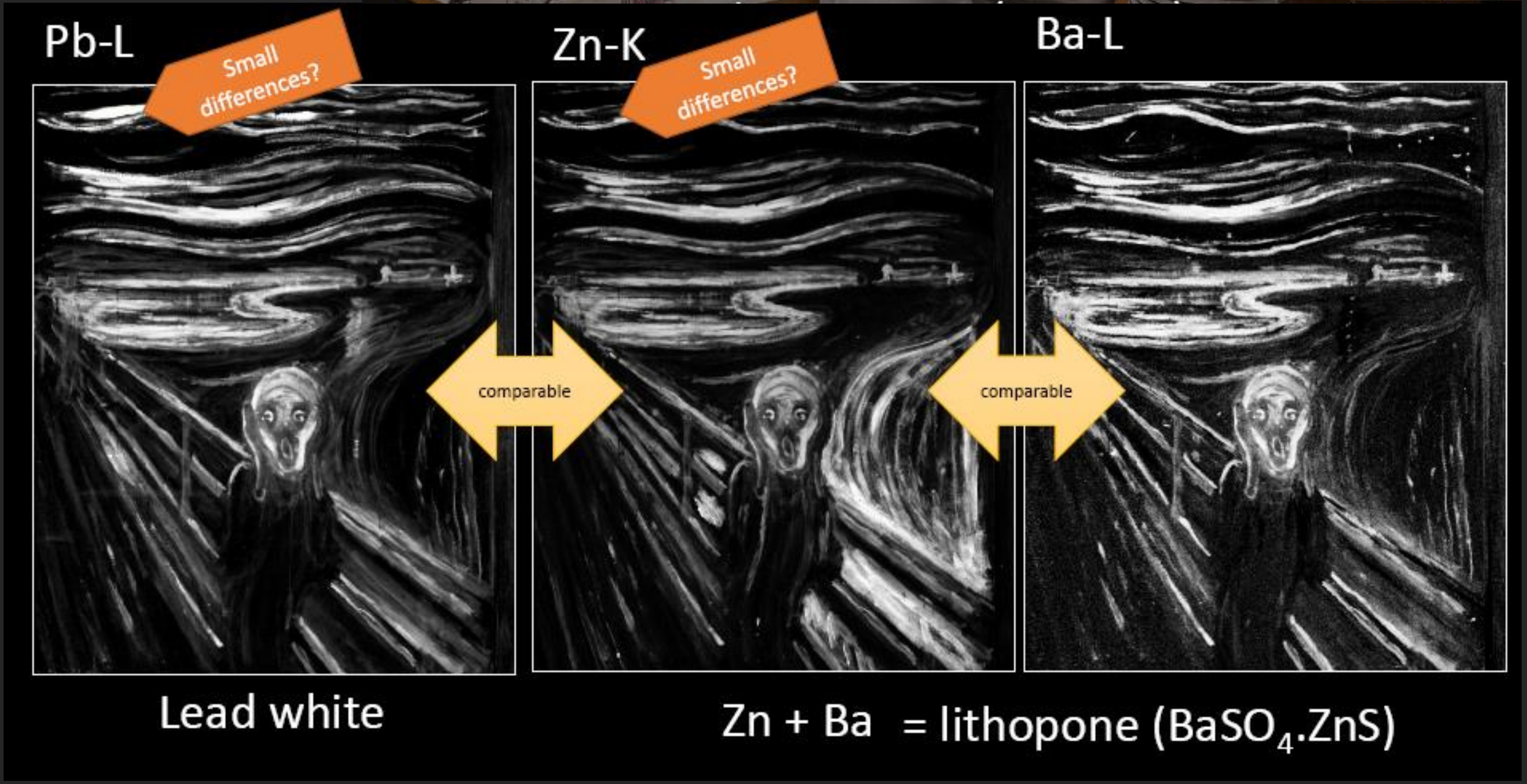
-identification of **ultramarine** in both areas;

-Only in point M32: additional presence of *zinc oxalates*

- Presence of **Thenard blue** confirmed by NIR/UV-Visible spectroscopy

NM version

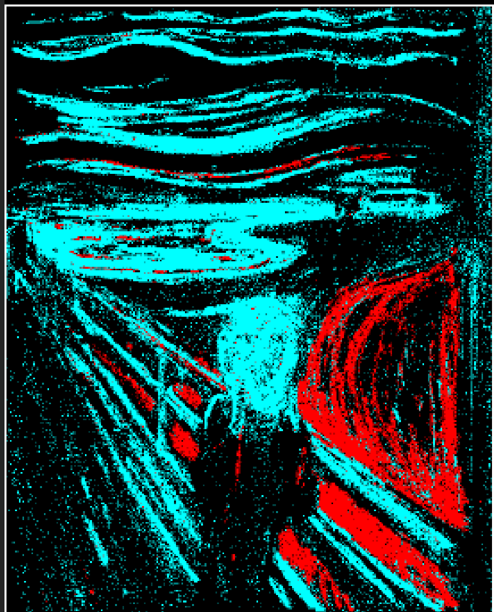
MA-XRF



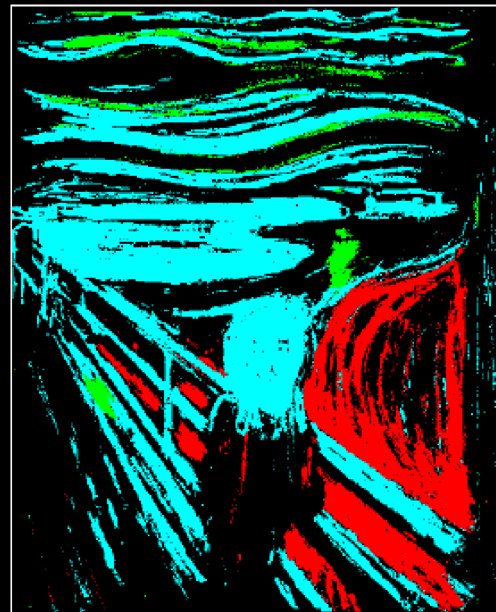
Lead white and lithopone distribution in cardboard and paint layers

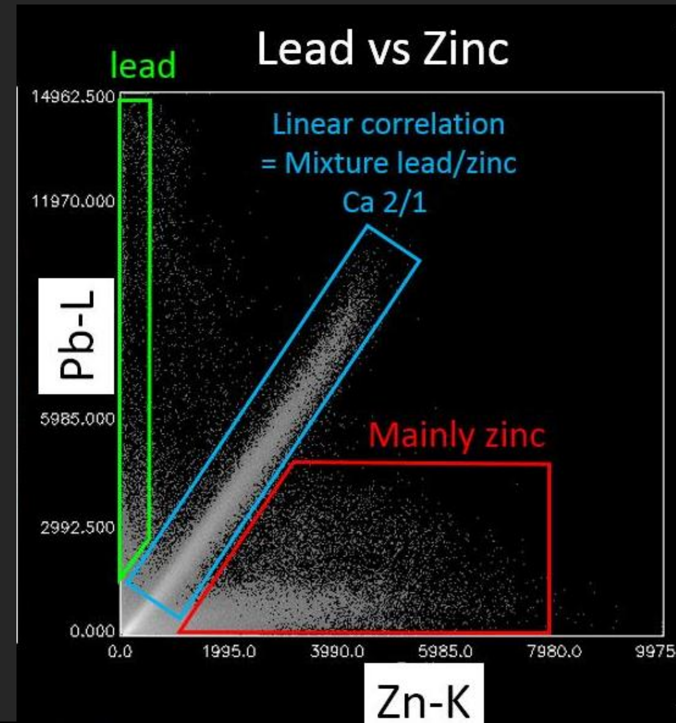
Correlation plot

Barium vs Zinc



Lead vs Zinc

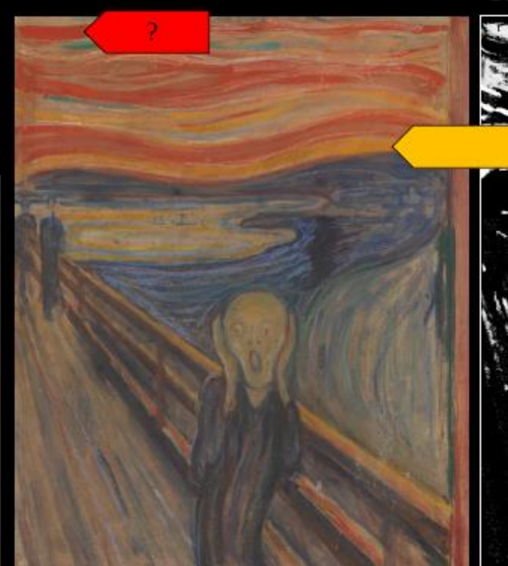




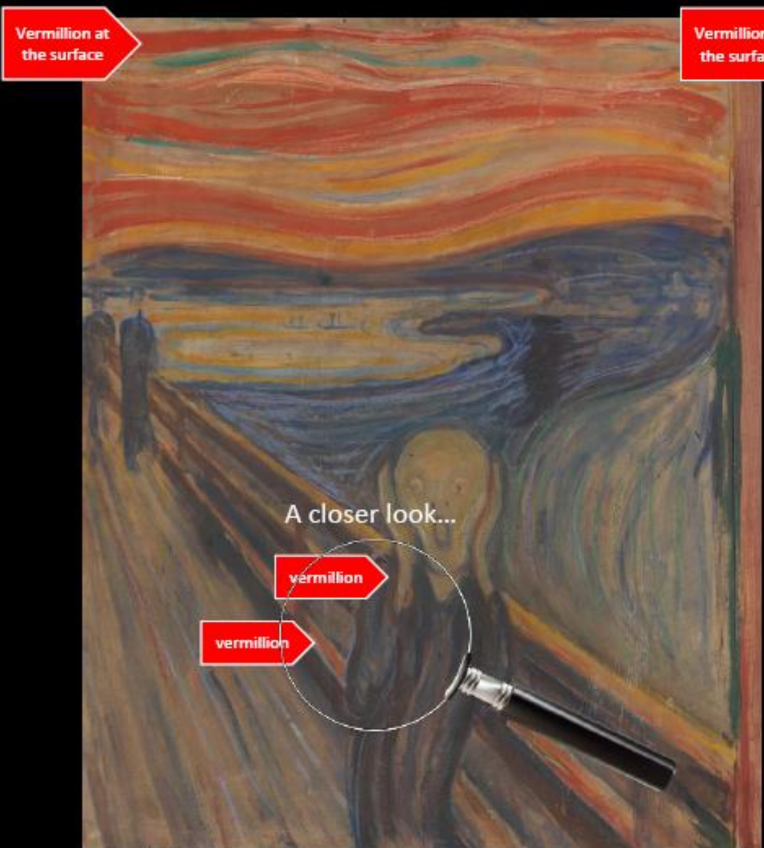
Lead + Zinc + barium = lead white + lithopone

Mainly zinc

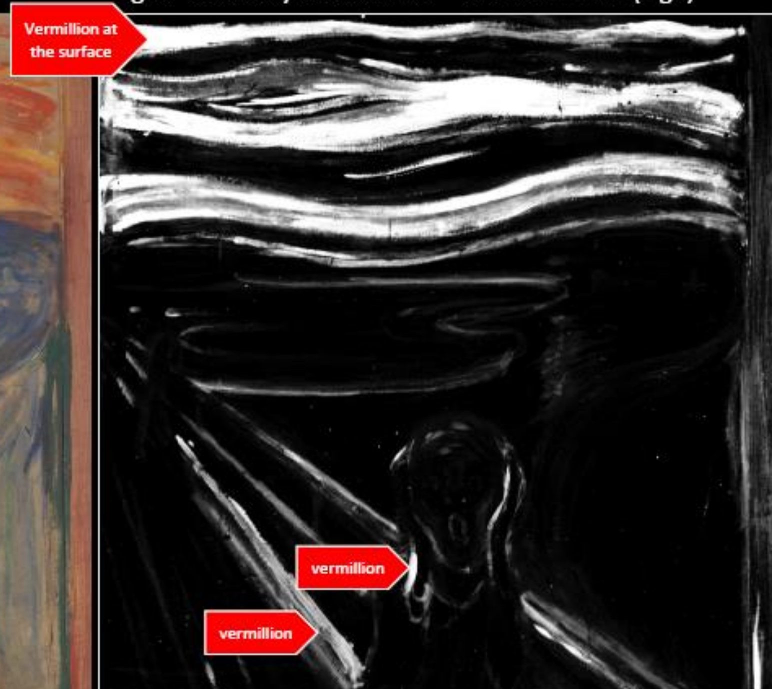
Mainly lead white: last/correction phase

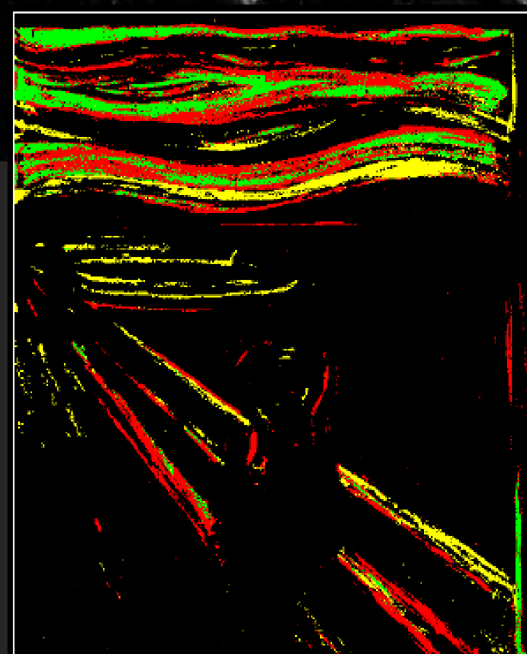


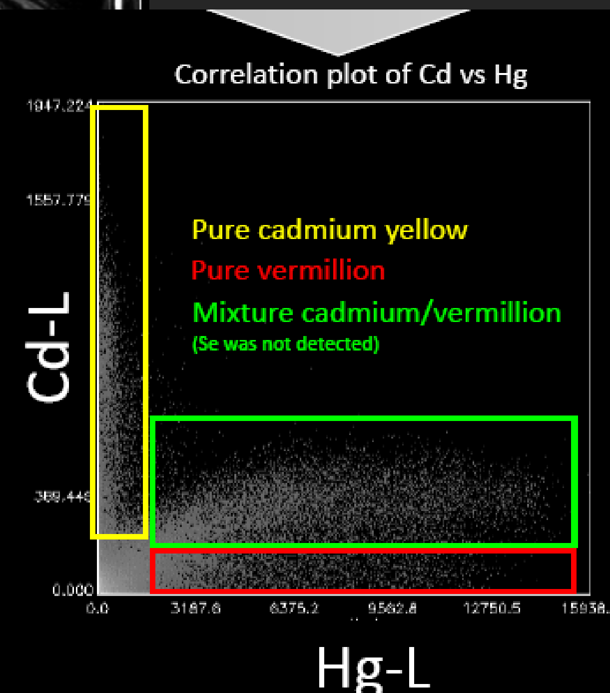
Cd-L = cadmium yellow - CdS (No zinc)



Hg-L = mercury distributon = red vermillion (HgS)

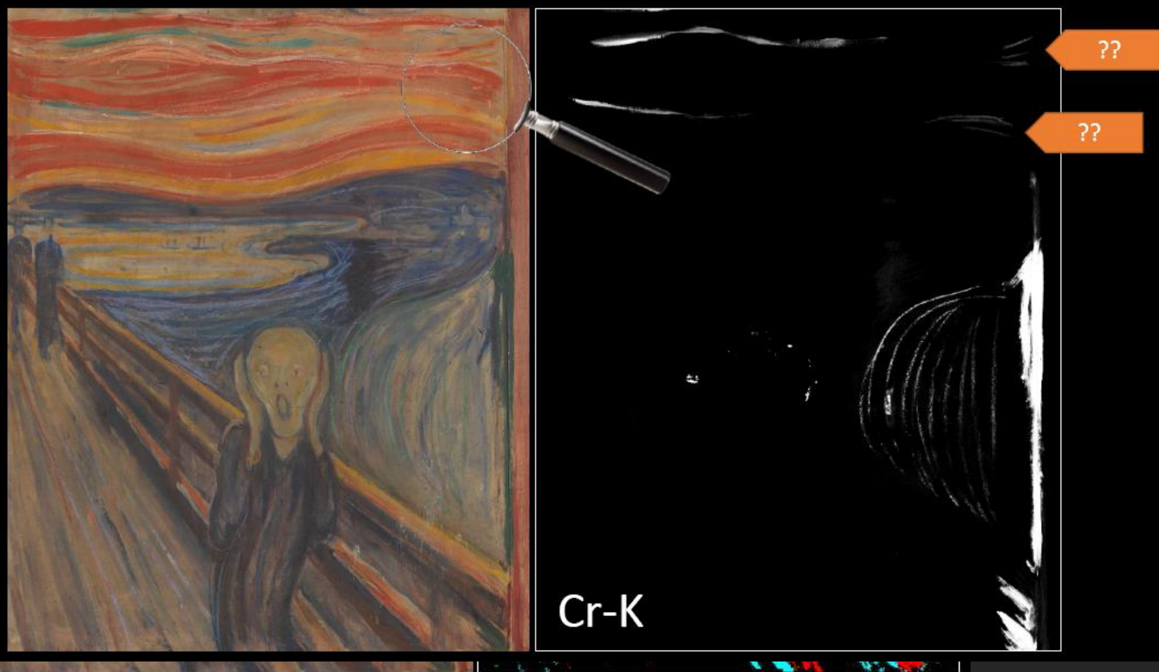






In MM version there is no correlation between Cd and Hg

Cr-K – chrome distribution = viridian



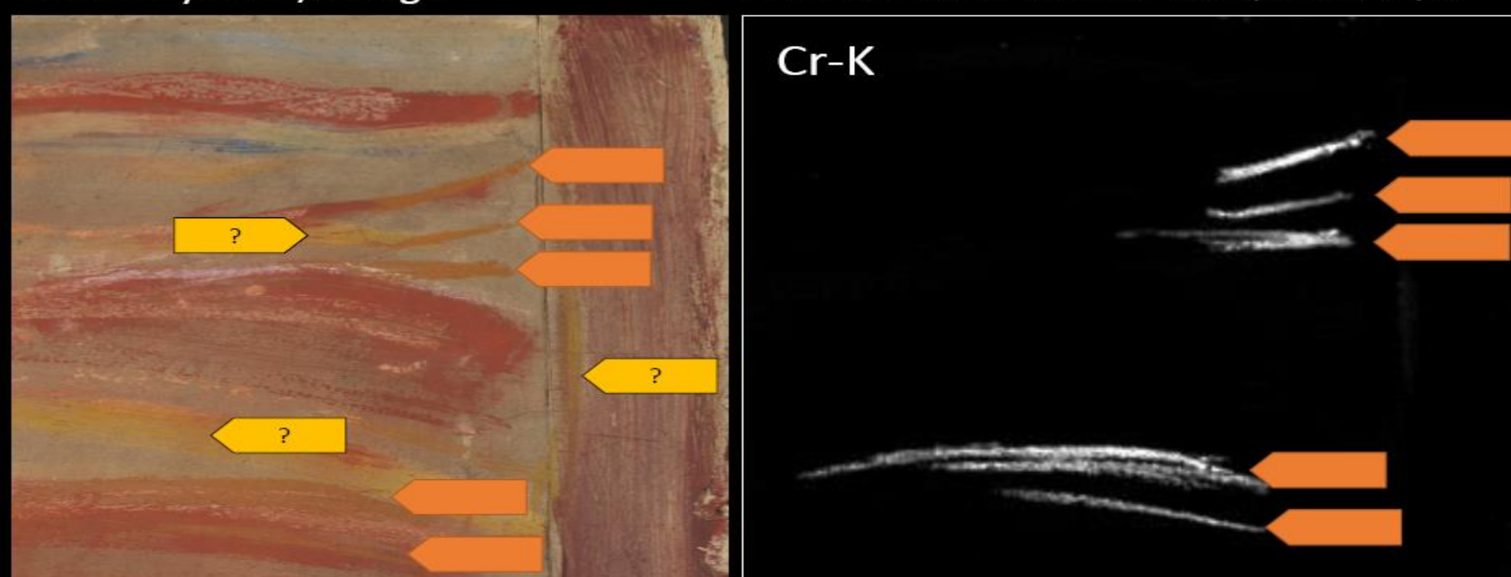
Cr-based pigments:
Green (Viridian) and yellow/orange

R = Zn
B = Pb/Zn

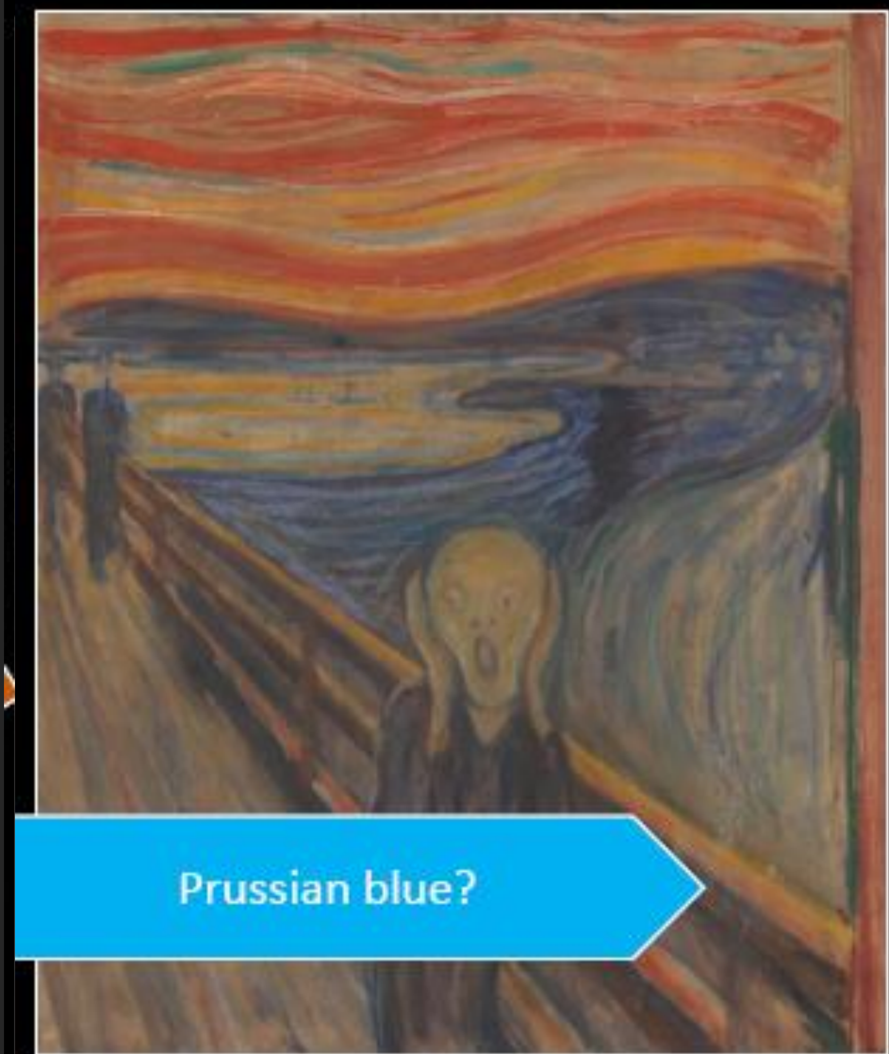
Green paint + two corrections = paint mixed with lead white exclusively = same phase?

Chrome yellow/orange

No zinc or barium detected in these strokes = not zinc yellow or barium yellow



Fe and Mn distribution in cardboard and paint layers (brown and blue)



Fine, dark blue Fe lines without Mn
Other blue lines not visible @ MA-XRF

Prussian blue and ultramarine and/or organic blue?

CONCLUSIONS

	Support	Yellow/ Orange	Red/ Brown	Blue	Green	White	Alteration products/ synthesis residuals
MM version	Ca, Ba, Zn (low counts) Kaolin	CdS : ▪Hexagonal type 1 ▪Hexagonal type2 ▪Cubic/hexagonal $PbCr_{1-x}S_xO_4$	HgS Organic lakes (antraquinone type) Minium?	Thenard Blue Ultramarine	Viridian	ZnO	Zn Oxalates $CdCO_3$ Cd(OH)Cl
NM version	Fe (Ca, Ba and Zn?)	CdS Cr yellow	HgS Fe + Mn	Prussian blue Synthetic ultramarine and/or organic blue? No Cobalt blue)	Cr based green (Viridan?)	Lithopone Hydrocerussite ZnO?	-

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THANK YOU!

IPERION CH