

# Investigation of glass plate negatives deterioration

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**INSTITUTE OF  
CHEMICAL TECHNOLOGY  
PRAGUE**

# Chemical point of view

## Problem 1 :

Composition of photographic materials

## Problem 2:

Process failure during image developing

## Problem 3:

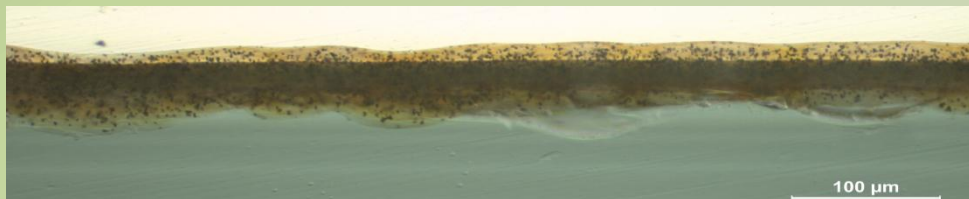
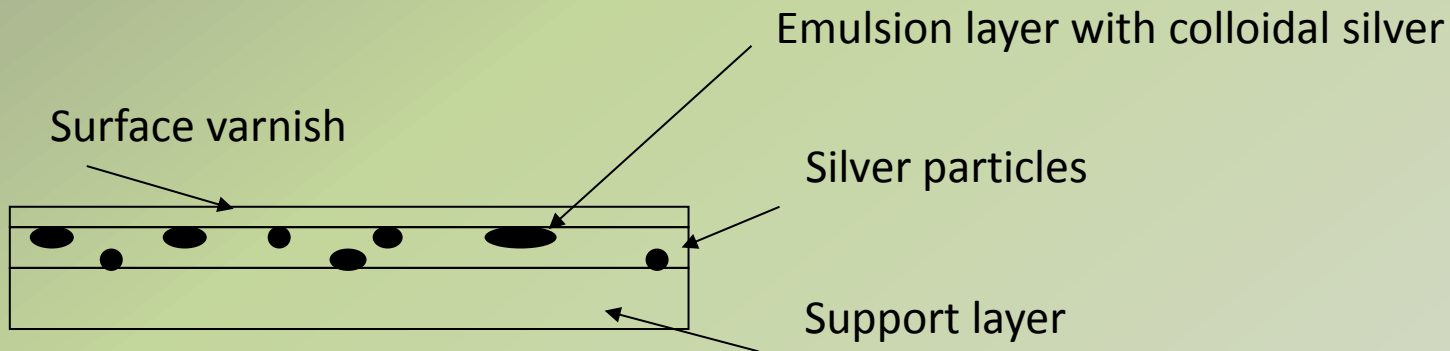
Wrong and inconvenient storage conditions

# Chemical point of view

## Problem 1 :

photographic negatives are composed objects

- Support layer – glass (followed by polymer materials)
- Emulsion layer - gelatin with silver

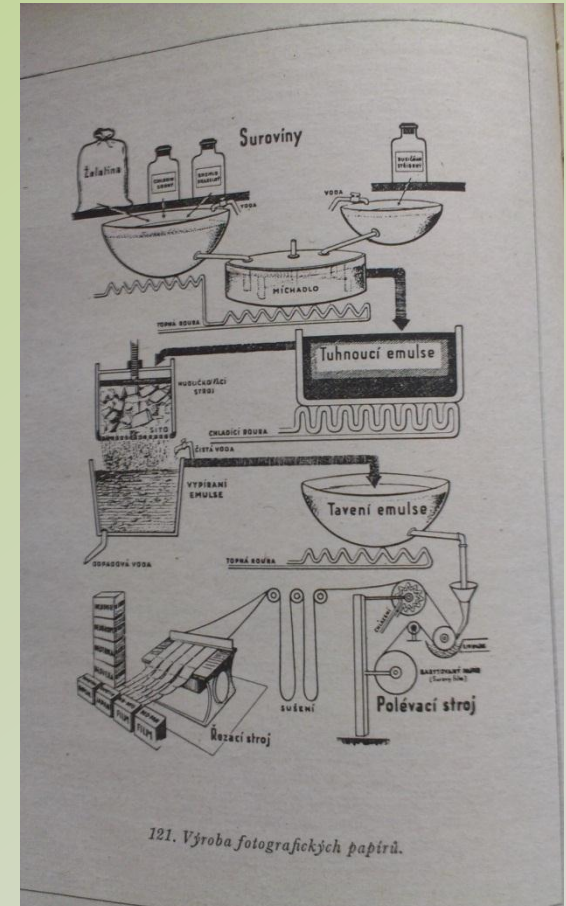


# Chemical point of view

## Problem 2:

Bad process during image developing

- Residual chemicals from photochemical process
- The main problem is short time of final bath

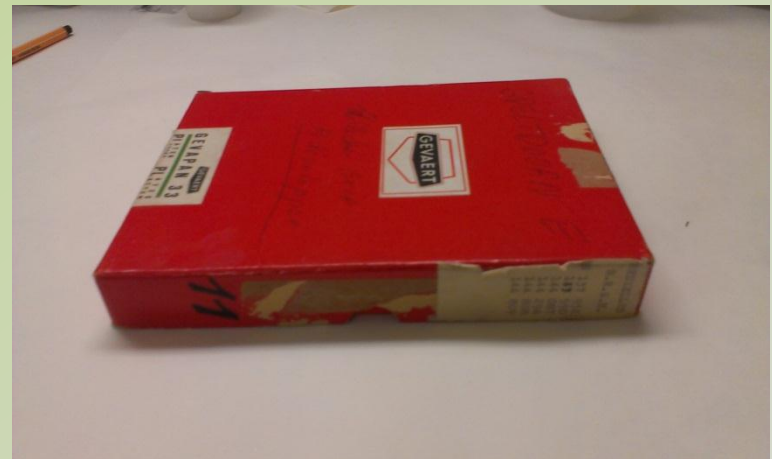
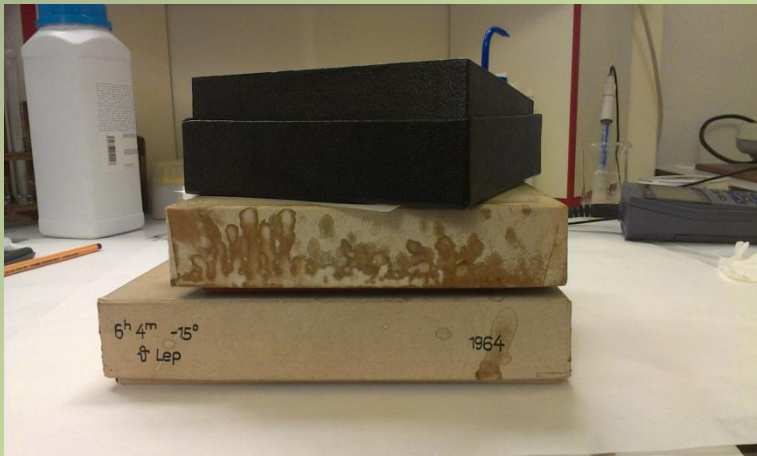


# Chemical point of view

## Problem 3:

Wrong storage conditions and materials – degradation by external factors

- Non stabile temperature and relative humidity
- Non-suitable packaging system



# Degradation of glass plate negatives

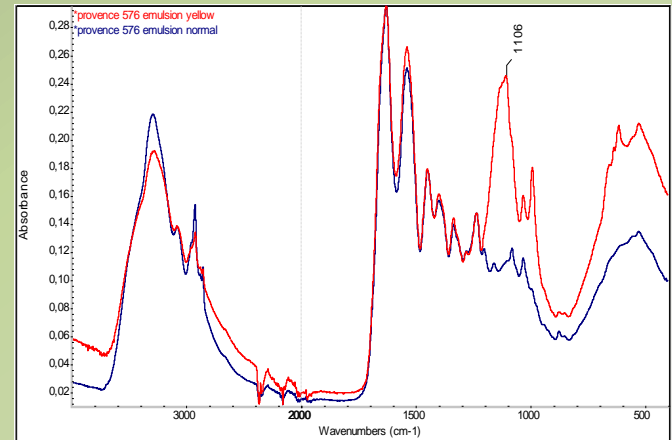
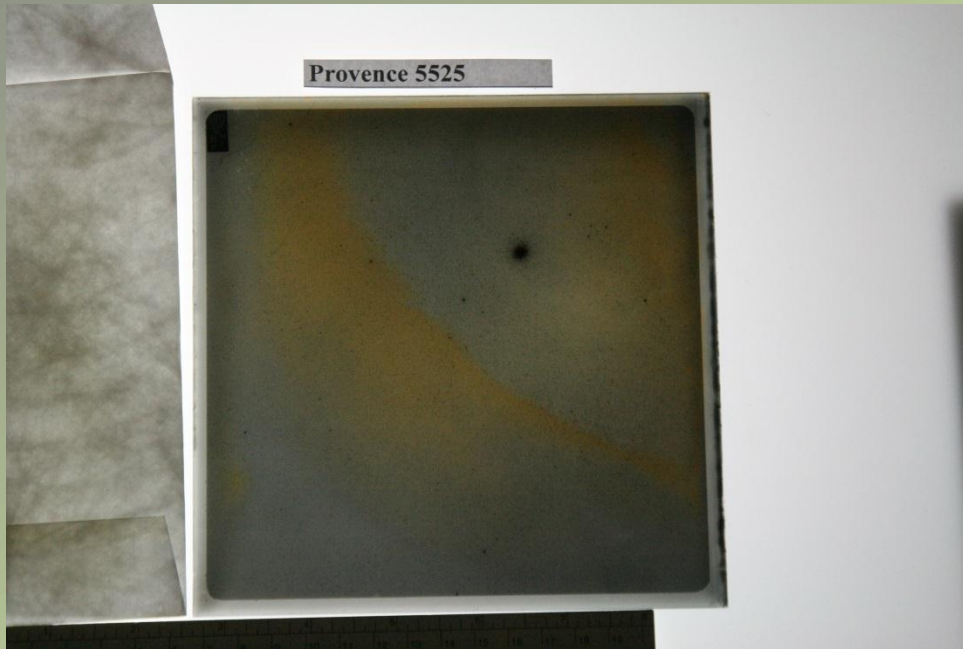
- Degradation of emulsion layer
  - Silver mirrors
  - Yellowing
  - Golden and silver surface spots
  - Lost of the adhesion of emulsion layer
- Degradation of glass
  - Glass corrosion in the environment with higher relative humidity

# “Golden (spot) disease”

- Investigation of astronomical plates from different observatories (Provance, Sonneber, Ondrejov, Bamberg, etc.)
- Yellowing inside the emulsion layer
- Surface golden spot



# Yellowing of the emulsion layer



IR spectra of yellow and not yellow part of the negative

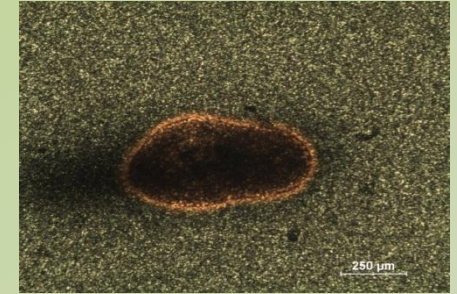
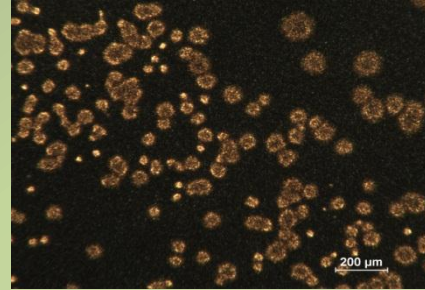
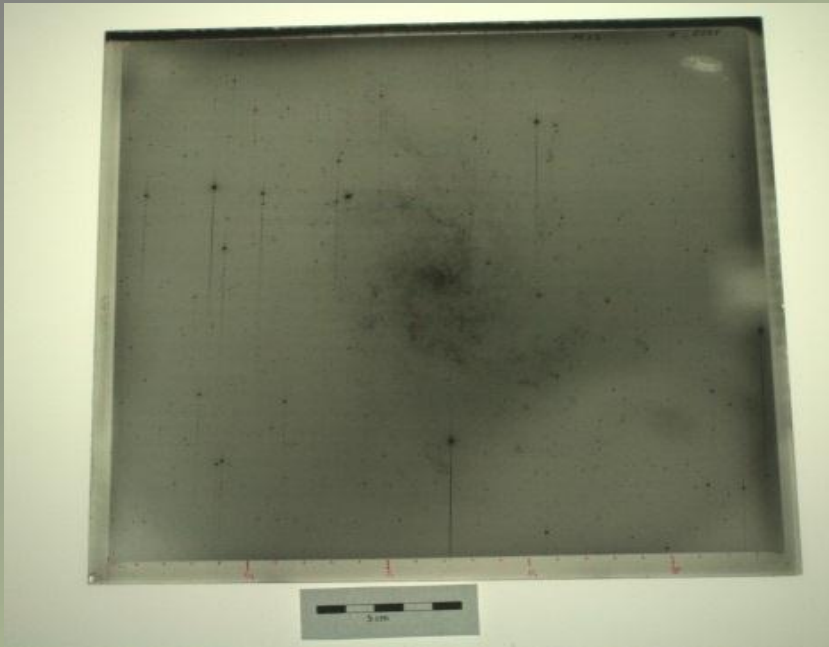
Analysis using FTIR-ATR

Results - sulfates ( $\text{SO}_4^{2-}$ ) – residual from the photographic process

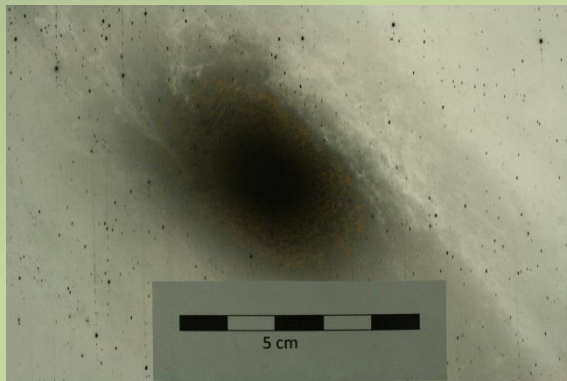
Material of the envelope – polyethylene



# PROVENCE – surface golden disease



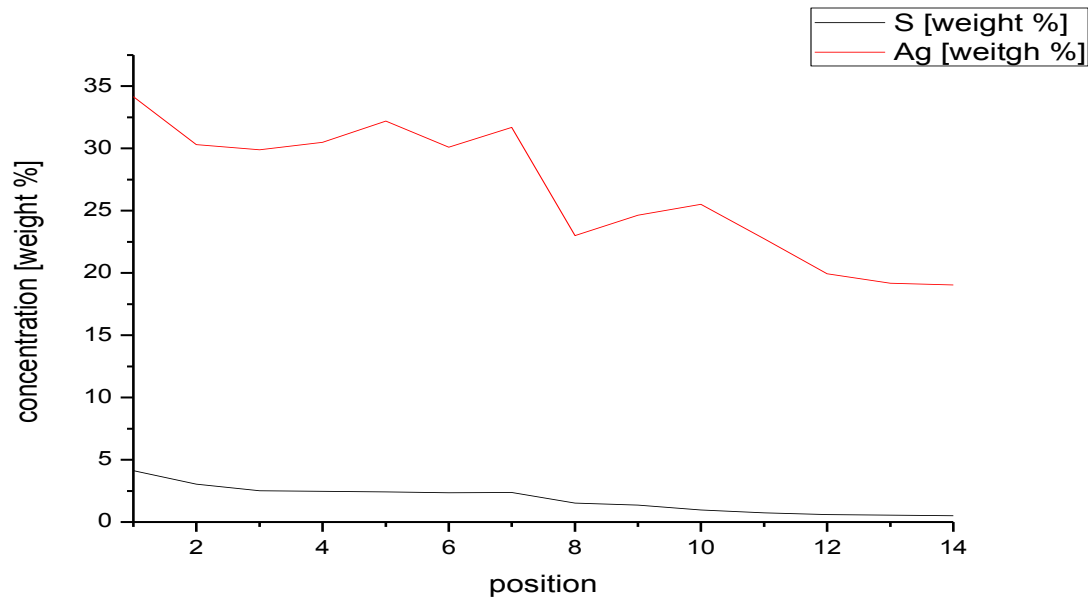
Microscope analysis



Cross section of the negative

# PROVENCE – surface golden disease

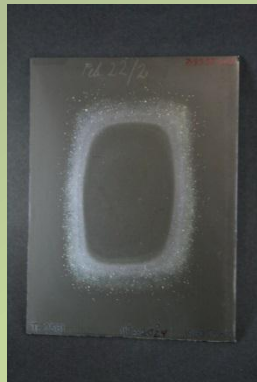
Element analysis of the golden spots using SEM/EDS  
Table and graph of element concentration [weight %]



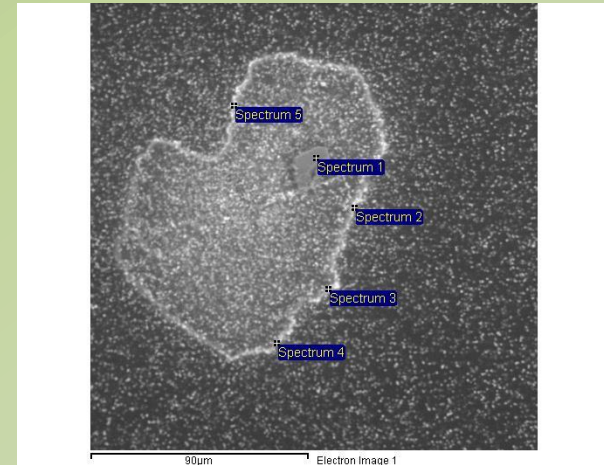
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ag	34,15	30,30	29,89	30,50	32,19	30,10	31,70	32,00	24,63	25,51	22,75	19,93	19,18	19,04
S	4,12	3,04	2,51	2,47	2,43	2,36	2,37	1,52	1,36	0,96	0,73	0,61	0,55	0,51

# Sonneberg

Photographic documentation in the  
Reflection and transmission light

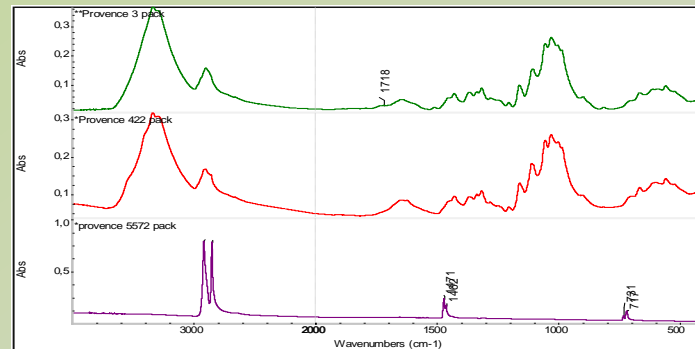
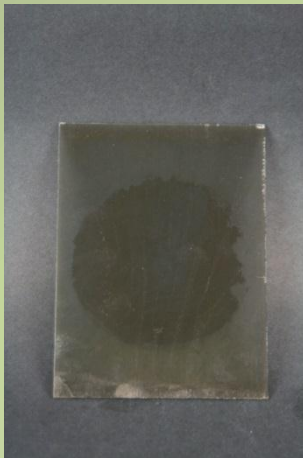


SEM/EDS image of spot particle



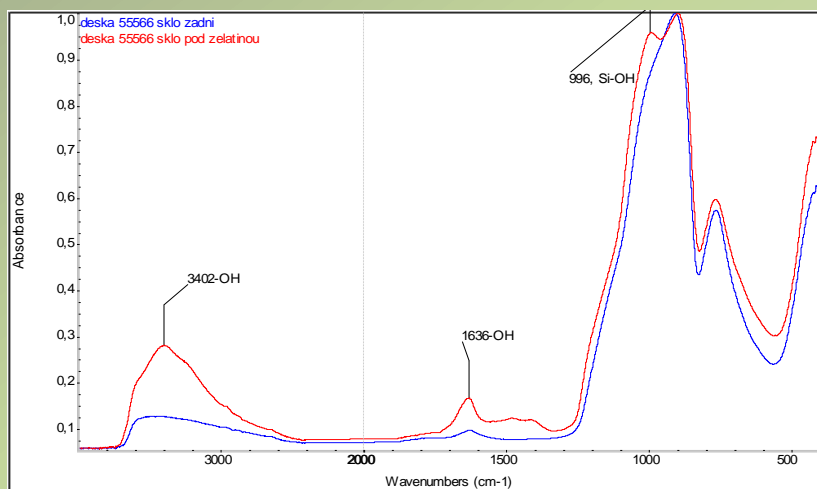
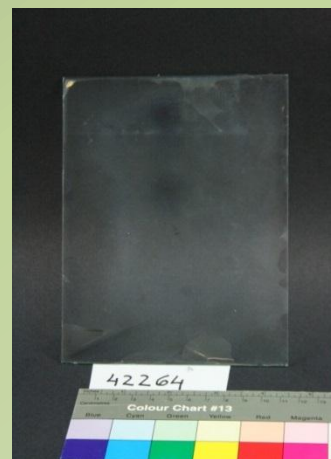
	1	2	3	4	5
Ag	7,16	28,64	25,76	25,45	27,51
S	0,3	0,81	0,76	0,75	1,01

# Ondrejov-problem with the envelopes and bad storage condition



Comparison of IR spectra cellulose and polyethylene

# Glass analysis

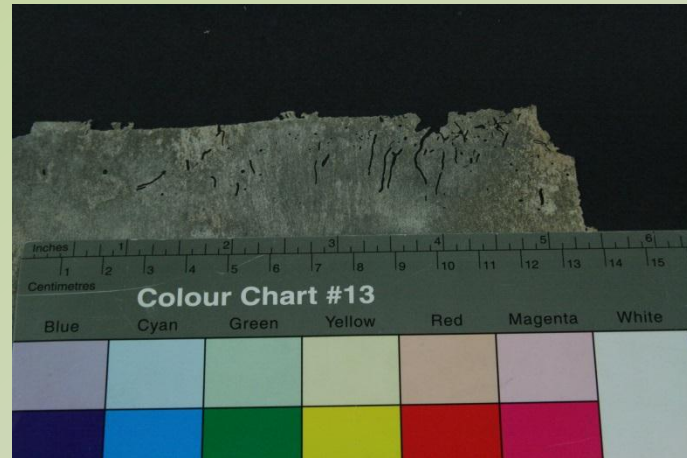


## Analysis of the glass using FTIR

- proof of glass hydration
- exposition of the water or high humid environment



# Long exposition to the water



# Common problems of glass negatives

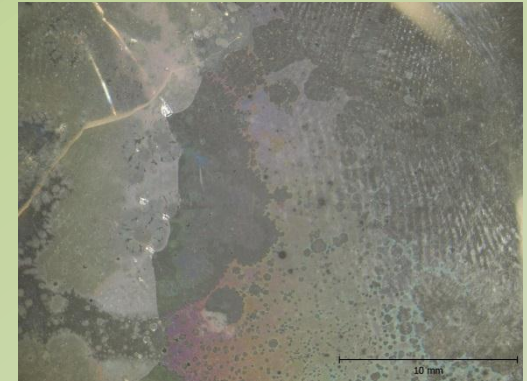
## Glass corrosion



Transmission light



Reflection light



Microscopic detail



Lost of emulsion layer adhesion



Microscopic documentation of gelatin which laid on the glass



# Conclusions

- Non-destructive analysis of degradation products of glass plates negative – secondary degradation products of sulfur
- Analysis of used packaging material

# Conclusions

- To prevent the formation of and/or to remove of the sulfur degradation products, it is necessary to monitor storage conditions also for the better understanding of chemical reactions in the photo-emulsion layer during long term storage under various conditions
- modeling using accelerated ageing – data for digital restoration of the images

# Thank you for your attention

