CONSTGLASS

Table of results

1- Pilot Object

Pilot object:	The *Last Judgement*, BOURGES **Bay 4, panel 13**
Picture	 © LRMH  © LRMH

Identification of the panel :

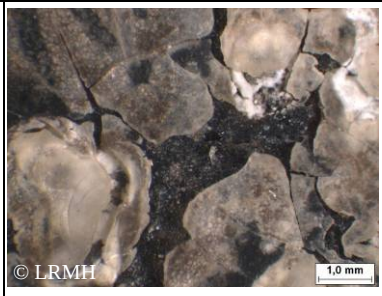
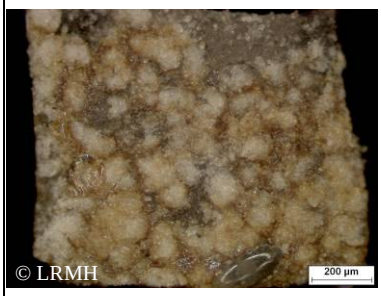
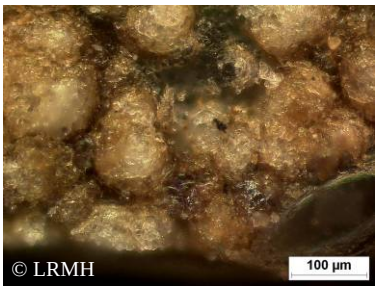
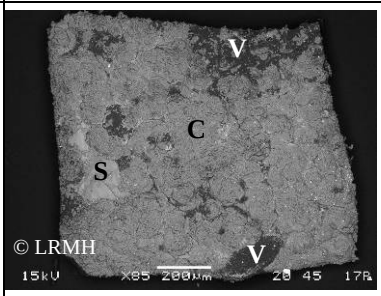
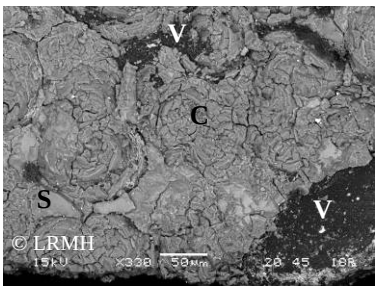
Bay : 4
Panel : 13
Internal face, transmitted light
External face, reflected light

Treatment :

- **1981**, by **Mauret** studio.
- Product: polyurethane resin (80% Viacryl® VC363 + 20% Desmodur® N75).
- Application: with a soft brush after cleaning by a solution of EDTA + ammonium bicarbonate on glass and lead.

2-Results

Sample reference:	***BOU_b4p13_E_v2** : flake with white and brown corrosion products (on dark red glass)*

Questions	**Techniques**	**Answers**
Morphology - *What is the morphology of the weathered coating?* - *How is the bonding between coating and glass?*	**Optical Microscope**	 Important deterioration of the film: flakes, macro-cracks, detachment of the flakes, discoloration (slight yellowing), loss of transparency (milky aspect).   Internal views of the flake show an adherence of corrosion products on the Viacryl®.
	SEM	  Presence of a part of the silica gel layer (**S,** light grey) and corrosion products (**C,** grey) on the flake of Viacryl® (**V,** dark grey). The bonding with corrosion products is strong and widespread, whereas it is sporadic (limited) with gel layer.
Chemical Composition - *What is the chemical composition of the alteration products?*	**SEM/EDX**	Calcium sulphate neo-crystallisations (gypsum)

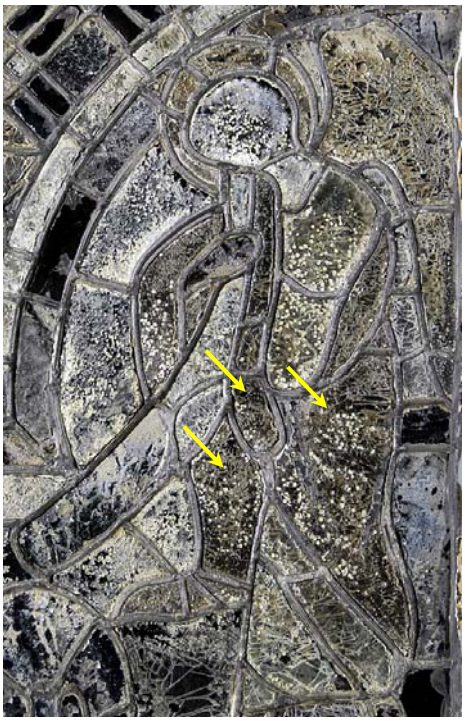
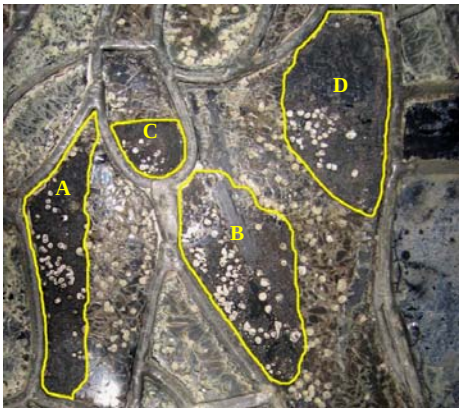
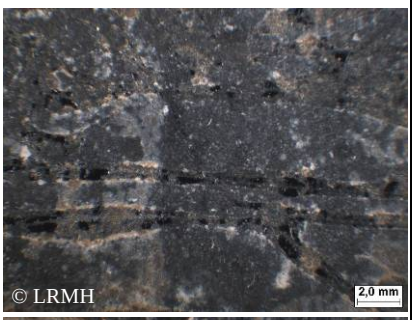
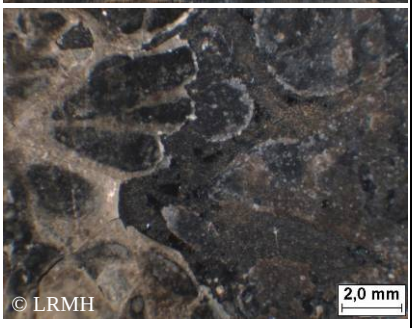
Reversibility - *How can I remove the film without damage?* - *Which kind of method and of solvent, can I use?* 	**Test studies elimination**	4 solutions were tested on similar pieces: - A : dichloromethane + ethanol - B : acetone - C : acetone + toluene + ethanol - D : ethanol  The best results were obtained with **Ethanol gel** (ethanol 30mL + Klucel G <1g): - Duration: 2h - Results: no visible remains.    Under the action of ethanol gel, Viacryl® film blew up considerably and came off from the glass as flexible large flakes. Then we can easily wipe away the residue of polymer with a humid stick, then brush (with a soft brush) the surface of the glass and rinse with a solution of demineralized water and ethanol. After cleaning, we can see the baring of healthy glass following the cracks of Viacryl®: it seems to have been made before the cleaning. Brown and white corrosion products are also following the cracks. These phenomena are due to the flaking of Viacryl®.
Retreatability - *Should we retreat the panel?*	**Test studies for re-treatability**	**No need for retreatment** Recommendation of **protective glazing installation**

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Table of results

Sample reference	***BOU_b4p13_E_v6** : corrosion products between Viacry®l and glass (on red glass).*

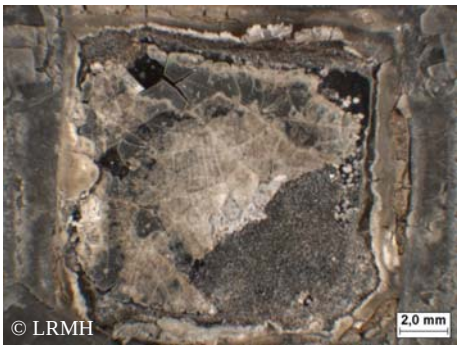
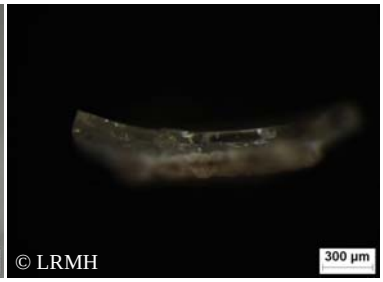
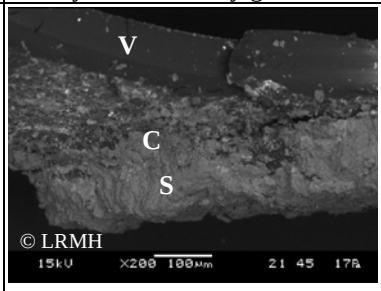
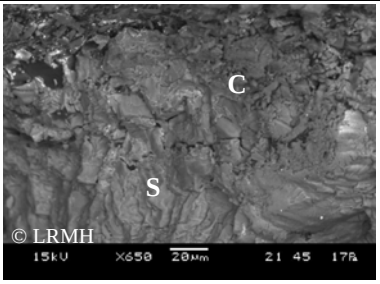
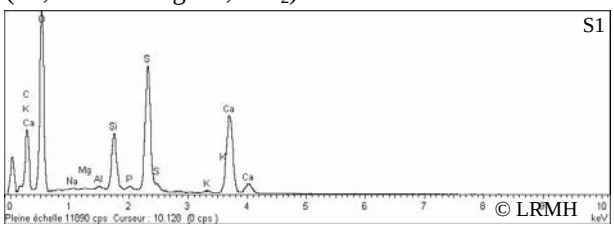
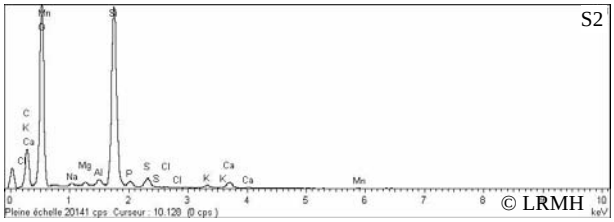
Questions	Techniques	Answers
Morphology - *What is the morphology of the weathered coating?* - *What is the process of the weathering? Different steps?* - *How is the bonding between coating and glass?* 	**Optical Microscope**	  Important deterioration of the film: flaking, yellowing and milky aspect. This sample is a stratigraphy of the products present between Viacryl® and healthy glass.
	SEM	  The different layers under Viacryl® (**V**) are distinguishable only by their morphology (**S**, the silica gel layer, and **C**, corrosion products).
Chemical Composition - *What is the chemical composition of the alteration products?*	**SEM/EDX**	Calcium sulphate neo-crystallizations (S1, gypsum) and silica gel layer (S2, weathered glass, SiO_2)  

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Table of results

Sample reference	***BOU_b4p13_E_v7, v10, v11, v15*** *: Viacry®l sampling on yellow, blue and white glasses.*

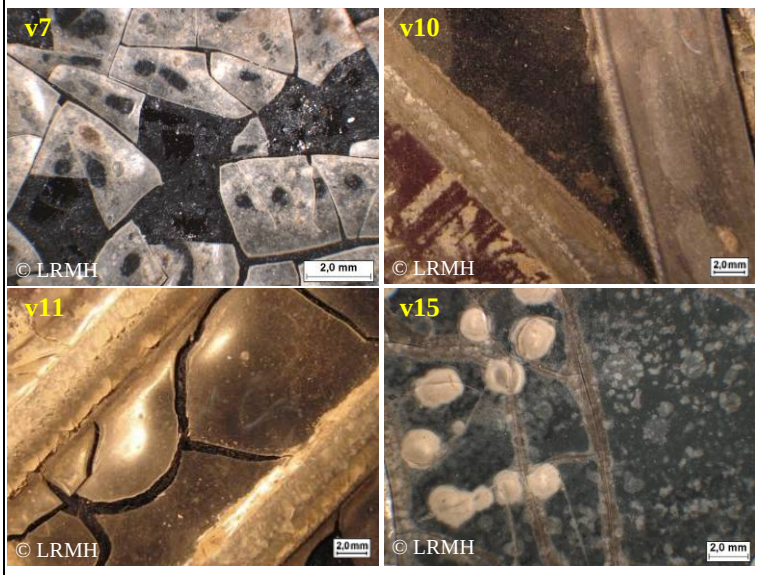
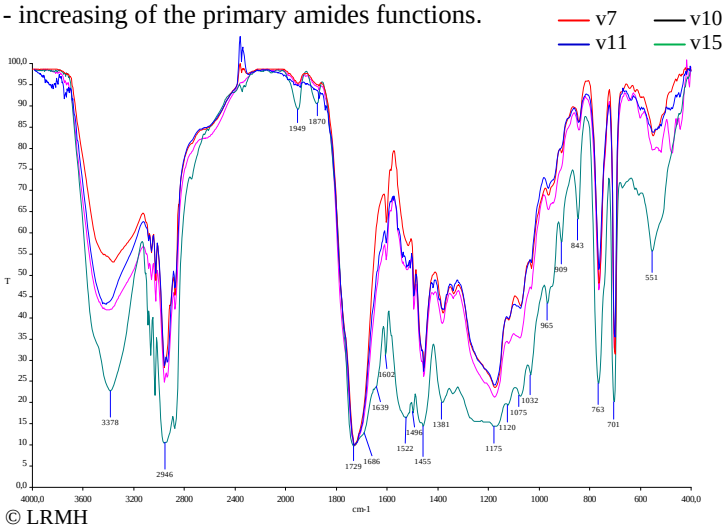
Questions	Techniques	Answers
Morphology *- What is the morphology of the weathered coating?* *- What is the process of the weathering? Different steps?*	**Optical Microscope**	1. **Loss of adhesion** (bubbles), *see v10 and v15* 2. formation of **macro cracks**, *see v10 and v15* 3. **flaking**, possibility of partial detachment of the glass surface (corrosion products and/or gel layer), *see v7 and v11* 
Organic component composition *- What is its chemical evolution?*	**FTIR**	Chemical degradation : - decreasing of the secondary amides functions - increasing of the primary amides functions.  © LRMH
	RAMAN	*Not necessary, FTIR gives the needed information*

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Table of results

Sample reference	*Microbiology tests*

Questions	Techniques	Answers
Microbiology *- Is there a biological contamination?* *- Is there an active infestation?*  	**Molecular biology ATP measurements** (Microscopical analysis, metabolic activity and taxonomical description of microorganism)	Treatment with VIACRYL (in storage, 5 samples): - **within cracks and fissures**: high accumulation of dust and dirt as well as punctual, medium fungal infestation - medium metabolic activity (ATP ∅ 459 RLU/25 cm² with a maximum at 1.324 RLU/25 cm² within cracks and fissures !) - isolated microorganisms: *Penicillium chrysogenum, P. expansum, Cladosporium herbarum, Cl. cladosporioides, Cl. sphaerospermum, Alternaria alternata, Epicoccum purpurascens, Aspergillus versicolor, **Chaetonium globosum**, Acremonium strictum, Stachybotris chatarum, Fusarium oxysporum, Mucor hiemalis* and *Phoma glomerata,* (fungi; medium infestation) and *Roseomonas sp.* respectively *Bacillus flexus* (bacteria; low infestation). The confined areas under cracks are preferential zones for the moisture keeping. The Cladosporium herbarum (high presence) and other present fungi (*Cladosporium cladosporioides, Cladosporium sphaerospermum, Alternaria alternate*) can produce pigments (melanin which is responsible of a brown to black coloration) and can explain the brown coloration observed under Viacryl® flakes. But, on the glass, SEM/EDS analyses show the presence of manganese in the brown coloured gel layer. Then, this coloration can be due (or not) to both phenomena. On the lead, one case of black coloration was observed (figure 34): it is due only to melanin production.

Conclusion: Viacryl® is still present on most of the pieces. Its degradation state is different regarding the environment and the support (weathered glass or not, color of the glass). In most of the cases, the film could tear off the gel layer, or even healthy glass.

The removal of the coating is recommended with ethanol gel because e of the risk of microorganisms. No re-treatment, but a protective glazing is recommended to be installed.