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CV NEWS LETTER 29

comite technique du corpus vitrearum

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THIS ISSUE CONTAINS ARTICLES ON:
DIESE NUMMER ENTHÄLT FOLGENDE BEITRÄGE:
CE NUMERO CONTIENT DES ARTICLES SUR:

1. generalities

1.1 CORPUS VOLUMES

Publications: In December 1978 came out Vol. I <u>Recensement</u>, <u>Les vitraux de Paris, de la région parisienne, de la Picardie et du Nord-Pas-de-Calais</u>. A presentation by M.L. Grodecki of this volume follows right below (1.3)
In the press: Corpus Volume Austria III, Steiermark 1, is expected to appear in 1979; -
German Federal Republic, Vol. II, Baden - Pfalz, is expected in Spring 1979; -
Great Britain, Country of Oxfordshire, is expected to appear in 1979; -
German Democratic Republic, Vol I/2, In the second quarter of 1979, the second volume of the Corpus Vitrearum Medii Aevi will be published by the publishing house of the Academy of Sciences of the DGR: Erhard Drachenberg. CVMA DDR, Vol. 1,2. Text: Medieval stained-glass windows of the Erfurt cathedral. In addition to the comments on glass staining, the volume offers a survey on the history of art. In this context, the windows published in CVMA DDR Vol. 1, 1 are also taken into consideration. Besides numerous line drawings on the state of preservation of the panels, the publication is vested with 20 colour plates and 24 black-and-white illustrations. The book of plates for the stained-glass cycle in the Erfurt cathedral with 1070 black-and-white pictures and also 20 colour plates (CVMA DDR Vol. 1,2 plates) will follow within a year.

1.2 Corpus Volumes at reduced prices

This is an imprtant notice to all Members of the Corpus Vitrearum. The publishing house in Vienna, Verlag Hermann Böhlaus Nachfg., Ges.m.b.H., A-1061, Wien Postfach 167, has kindly offered a special discount to all Members of the Corpus Vitrearum, on the retail price of CVMA Volumes published by them.

(1) A reduction in price of 20% is offered for the following volumes:

> <u>E. Frodl-Kraft</u> "Die mittelalterlichen Glasgemälde in Wien (1962). The retail price is 1 278 Austrian Schillings, or DM188. (It should be noted that the Volume on Vienna, of which only a very few copies remain, can be offered only at the full retail price.)

E. Frodl-Kraft "Die mittelalterlichen Glasgemälde Niederösterreichs. 1. Teil, Albrechtsberg bis Klosterneuburg", Wien (1973). The retail price is S.1678, or DM248.

E. Bacher "Die mittelalterlichen Glasgemälde der Steiermark, 1. Teil, Graz und Strassengel" Wien (1978). The retail price will be about S.1650, or DM. about 240.

(2) In a similar manner, a price reduction of 30% is offered on the following two CVMA Volumes if they are obtained through Verlag Böhlaus:

Frantisek Matous "Mittelalterliche Glasmalerei in der Tschechoslowakei", Prag (1975)

Erhard Drachenberg, K.J. Maerker, and Christa Schmidt "Die mittelalterlichen Glasgemälde in der Ordenskirchen und im Angermuseum zu Erfurt", Berlin (1976).

The retail price of these two volumes is, for the time being, S1420, or about DM205.

In all cases, where appropriate, the costs of packing and postage must be added.

The entire Membership of the Corpus Vitrearum, throughout the world, is entitled to benefit from these reductions, and orders must therefore be placed through the Austrian Institute for Care of Monuments, their address being:

Institut für Oesterreichische Kunstforschung des Bundesdenkmalamtes,
A-1010 Wien, Hofburg, Austria.

1.3 Les vitraux de Paris, de la région parisienne, de la Picardie et du Nord-Pas-de-Calais, Recensement des vitraux anciens de la France, volume 1, dirigé par Lous Grodecki, Jean Taralon et Françoise Perrot, Paris, Centre National de la Recherche Scientifique, 1978

Ce volume, préparé sous la direction du Comité français du Corpus Vitrearum Medii Aevi, est un recensement complet, quoique sommaire, de tous les vitraux anciens conservés dans les treize départements de la région parisienne et du Nord de la France. Il est exhaustif en ce qui cencerne les vitraux du Moyen Age et de la Renaissance jusqu'à la fin du XVIe siècle, et sélectif pour les périodes postérieures, choix fait en fonction de la valeur artistique ou de l'intérêt historique des oeuvres.

La lenteur de l'élaboration des volume du Corpus Vitrearum, dont l'objet est l'étude des verrières panneau par panneau suivant des méthodes d'étude historique, iconographique et matérielle très rigoureuses, a incité le Comité international de rédaction du Corpus à proposer en 1972 aux pays conservant de très nombreux vitraux anciens, de procéder à des inventaires plus sommaires afin de fair connaître rapidement les oeuvres et de faciliter ainsi leur protection et leur conservation. Le premier volume du Recensement entepris par la France est paru en décembre 1978 aux Editions du Centre National de la Recherche Scientifique. Il a été établi à partir des archives des Monuments Historiques, qui concernent essentiellement les oeuvres classées, et de la bibliographie générale et régionale, suivies de nombreuses vérifications sur place qui permirent de révéler un certain nombre de vitraux non classés et inédits.

Ce volume est divisé en quatre régions présentées par de courtes introductions mettant en valeur les oeuvres majeures et les resituant dans un courant stylistique. Les notices qui les suivent sont classées suivant l'ordre alphabétique des département, puis les communes et enfin des monuments; les vitraux conservés dans les musées n'appartenant pas à l'Etat sont également recensés. Ces notices ne prétendent pas constituer un état abrégé de la connaissance historique et technique; elles comportent les notifications du classement parmi les Monuments Historiques, une bibliographie sommaire pour l'édifice et complète en ce qui concerne les vitraux, et, baie par baie, des éléments de l'identification matérielle, historique et iconographique des verrières.

Des cartes permettent de localiser les oeuvres dans les départements, et des plans de les situer dans les édifices complexes. Les photographies illustrent un choix des vitraux, mais chaque notice donne les numéros des clichés conservés dans les archives publiques ou privées, permettant à tout chercheur de compléter la documentation qui lui est nécessaire.

Ce volume fait connaître un certain nombre de vitraux inconnus du Moyen Age; par contre, le nombre considérable et la haute qualité artistique des vitraux du XVIe siècle révèlent que la Renaissance fut une des grandes époque de l'art du vitrail. Il en est de même pour les régions de Centre et des Pays de la Loire, qui feront l'objet de second volume de la série dont la publication est prévue pour l'automne 1980.

1.4 The stained-glass windown of the region and the city of Paris, of Picardie and the Nord-Pas-de-Calais, New Census of the old stained-glass windows of France, volume 1, edited by Louis Grodecki, Jean Taralon and Françoise Perrot, Paris, Centre National de la Recherche Scientifique, 1978.

THE STAINED-GLASS WINDOWS OF THE REGION AND THE CITY OF PARIS, OF PICARDIE AND THE NORD-PAS-DE-CALAIS, NEW CENSUS OF THE OLD STAINED-GLASS WINDOWS OF FRANCE, volume I, edited by Louis Grodecki, Jean Taralon, and Françoise Perrot, Paris, Centre National de la Recherche Scientifique, 1978

This volume has been edited under the supervision of the French Committee of the Corpus Vitrearum Medii Aevi to take a complete, though summary, new census of the old stained-glass windows preserved in the thirteen "Départements" of the Paris area and of the North of France. It is exhaustive concerning the stained-glass windows of the Middle Ages and of the Renaissance up to the end of the XVIth century and selective for the ensuing periods; the latter examples were chosen according to the artistic value or the historic interest of those works.

The slow pace of elaboration of the Corpus Vitrearum volumes - with the avowed purpose of studying the stained-glass windows, panel by panel, according to the most rigorous historical, iconographical and material methods of research - led the international editing committee of the Corpus in 1972 to propose to the countries preserving a large number of old stained-glass windows that they draw up more summary inventories in order to make those works of art known rapidly and thus to make it easier to protect and preserve them. The first volume of the new census taken by France was published in December 1978 at the Editions du Centre National de la Recherche Scientifique. It was elaborated on the basis of the archives of the Monuments Historiques which concern primarily the classified works, as well as from the general and regional bibliography, followed up by many verifications on site which revealed a number of stained-glass windows that had not been classified nor published before.

This volume is divided into four areas, each of them presented by a brief introduction, giving prominence to the major works and placing them anew into a style context. The following notes are classified by alphabetical order of the "Départements", the communities and finally the monuments themselves; stained-glass windows in museums that do not belong to the State have also been covered by the new census. These notes are not meant to be an abbreviated inventory of the technical and historical knowledge; they contain the notifications regarding classification among Historical Monuments, a summary bibliography for the building and a complete one concerning the stained-glass windows and, window by window, the elements of identification from the material, historical, and iconographical points of view.

Maps help to localize the works of art in the different "Départements" and plans show their placements in the complex buildings. Photographs show a selection of windows, but each note gives the numbers of the negatives preserved in public or private archives so that anyone wishing to complete required data can easily do it.

This volume shows some unknown stained-glass windows of the Middle Ages. However, the substantial number and the high artistic quality of stained-glass windows from the XVIth century reveal that the Renaissance was one of the great periods oi the art of glass staining. The same applies to the region of Central France and the Loire countries which will be the subject of a second volume of this series. Publication is foreseen for the fall of 1980.

1.5 M E E T I N G S

Prof. G. Marchini has informed the president of the International Committee of the Corpus Vitrearum that both the idea of the exhibition and the Colloquium to be held at Florence in 1979 been abandoned. The only possibility of a meeting remaining therefore the International Congress of History of Art at Bologna / Italy allthough none of the sections there will be concerned with stained glass windows.

It is noticed that Miss Dane Hayword is still planning to see the exhibition an the colloquium at New York sometimes at the end of 1980 til the beginning of 1981.

Session of the "Glass Project Group"

This session will probably take place within the business meeting of the study group "Archäometrie der Deutschen Mineralogischen Gesellschaft a.V." (Archeometry of the German Mineralogical Society) on June 7 in Berlin. The members of the "Glass Project Group" will particiapte with the following papers:

H.-J. Weigel Univ. of Erlangen	The corrosion by SO_2 and CO_2 in the presence of air humidity on simulatec glasses for medieval glass compositions
G. Hierel, H. Scholze, Silikatinstitut Würzburg	Research on the effect of surface treatments on the durability of glasses.
E. Bacher, Inst f. österr. Kunstforsch. d. Bundesdenkmalamtes Wien	Variations in corrosion of medieval glass stainings due to differing microclimatic situations
Ms. M. Spitzer-Aronson, Collège de France Paris	Problems of pollutants diffusion on the surface and in depth of medieval stained-glass cathedral windows. In particular lead.
G. Schulze, Techn. Uni. Berlin	The significance of phosphorus content in historic stained glasses.
G. Nauer Uni. Vienna	Analytical studies of a Syro-Franconian "enamelled glass" from Bingen FGR
J.C. Ferrazzini FIT, Zurich	Was gold leaf baked onto Roman glasses?
Please address all enquiries regarding the meeting to:	Dr. J.C. Ferrazzini, Institut für Kristallographie der ETH Federal Institute of Technology CH-8092 Zurich

1.6 PRELIMINARY NOTICE OF THE VIITH CONGRESS OF THE ASSOCIATION INTERNATIONALE POUR L'HISTOIRE DU VERRE

This Congress will be held in England in September 1979, and the preliminary programme envisages working sessions as follows: -

Roman glass, Wednesday 19th September 1979 Medieval, Byzantine and Islamic glass, Tuesday 20th September (morning)
Renaissance glass, Tuesday 20th Sept. (afternoon) 17th to 18th centuries, Friday 21st September (morning)
18th to mid-19th centuries, Saturday 22nd Sept. (morning)
Mid 19th to 20th centuries, Saturday 22nd Sept. (afternoon)
Scientific analysis and conservation in Liverpool on Monday 24th Sept. (afternoon)

During the first week, when meetings will be held in London, visits will be paid to the British Museum, the Museum of London, the Ashmolean Museum (Oxford), the Science Museum, and the Victoia and Albert Museum.

The Meetings in London will be followed by Post Congress Tour (Sunday 23rd to Tuesday 25th September) to Dudley (the new Glass Museum), St Helens (the Pilkington Glass Museum) and Liverpool (the City Museum), and to Scotland.
(second announcement)
For details of the Congress, please apply to:
G.H. Tait, Esq.
Department of Medieval and Later Antiquities, British Museum,
London WC1B 3DG.
(third announcement)

2. colloque international sur la conservation des vitraux de la cathedrale de Bourges

Bourges, 13. juin -
Champs sur Marne, 14 juin 1978

organisé par le L.R.M.H.
avec le concours des:
Comité Français de l'ICOM
Comité Français du Corpus Vitrearum
Comité Français de l'Histoire de l'Art

Introduction

Les verrières du Choeur de la cathédrale de Bourges sont dans un état de conservation alarmant. La corrosion du verre par les agents atmosphériques a atteint sur certaines verrières un stade critique menaçant leur existence. L'altération par cratères a rendu les verres très fragiles. Les produits d'altération opacifient les verres et rendent les scènes illisibles. Considérant l'importance et la complexité du problème posé par la conservation de ces vitraux , le L.R.M.H. a organisé une réunion d'experts internationaux invités à examiner les solutions qui permettraient de sauvegarder ces oeuvres.

Les vitraux du Choeur de la cathédrale de Bourges

Le 13 juin, les participants ont été accueillis dans la cathédrale par Monseigneur VIGNANCOUR, Archevêque de Bourges, Monseigneur GIRARD, Archiprêtre, et Monsieur l'Abbé MARTINEAU, Curé de la cathédrale et M. RIMBAULT, Maire de Borges.

En l'absence de M. TARALON, Inspecteur Général des Monuments historiques, Directeur du L.R.M.H., M. L. GRODECKI, Président du Comité International et du Comité Français du Corpus Vitrearum, a exposé l'historique des vitraux de la cathédrade (cf. Annexe 1). Mme BRISSAC a présenté les résultats de ses recherches sur les restaurations entreprises au 19e siècle, interventions qui sont en rapport avec la conservation inégale de ces oeuvres (cf. Annexe 2.)

L'examen des vitraux du déambulatoire et des chapelles rayonnantes montre un obscurcissement très accentué des verrières situées vers le Sud du Choeur (celles du Patriarche Joseph, de Saint Thomas et de l'Apocalypse); les vitraux de la Passion et de l'Enfant Prodigue, situés dans la partie centrale du Choeur, paraissent moins atteints; ceux de Lazare et du Mauvais Riche, du Bon Samaritain, des Reliques de Saint Etienne, au Nord, présentent une cohérence formelle et colorée supérieure. Dans les chapelles rayonnantes où les compléments et les restaurations du 19e siècle étaient particulièrement graves, l'état de conservation ne peut pas être décrit sans de nouvelles études. Les deux verrières encadrant la chapelle d'axe, celles de la Nouvelle Alliance et du Jugement Dernier, déposées en 1975, seront examinées par les participants dans l'atelier de M. MAURET, successeur de M. CHAUFOUR.

M. J.M. BETTEMBOURG explique les problèmes posés par la conservation de ces verrières: déformation des panneaux due à mauvais système de fixation; les armatures -dont une analyse a prouvé l'ancienneté- ne sont pas toujours dans un plan vertical. Les vergettes de section insuffisante et de formes différentes sont mal fixées.

Il est à noter, et ceci est important, que les barlotières ne comportent pas de feuillards. Les panneaux ne sont maintenus en place que par des clavettes et par un mastic grossier très dur. Ce mauvais système de fixation favorise, outre la déformation des panneaux -donc une altération des réseaux de plombs-, des défauts d'étancheité des joints fers-panneaux. La première mesure de conservation devra donc comporter la révision des armatures et des vergettes.

L'adjonction d'un feuillard nécessite une révision des pannetons trop courts. M. LEBOUTEUX, Architecte en Chef des Monuments historiques, étudiera les possibilités de leur remplacement ou de leur modification.

L'examen de l'extérieur de l'édifice a permis de confirmer la corrosion inégale de toutes ces verrières. On a constaté que la profondeur des voussures des fenêtre principales du déambulatoire permettrait l'installation d'un vitrage extérieur de protection, mais ce procédé se révèle inapplicable aux vitraux des chapelles rayonnantes, car ceux-ci se trouvent placés presque au ras de la surface du mur extérieur. Son application nécessiterait l'avancement des vitraux vers l'intérieur, le vitrage extérieur prenant la place du vitrail ancien.

Examen du vitrail du Jugement Dernier

La restauration des vitraux du Choeur a débuté par la dépose du vitrail du Jugement Dernier que les participants purent examiner dans l'atelier de M. MAURET.

La face interne des verres était recouverte d'un dépôt grisâtre uniforme dont l'analyse faite par le L.R.M.H. a montré qu'il était constitué de sulfates et de carbonates. Sous ce dépôt, le verre n'est pas altéré. Il est donc dû à un apport extérieur (poussières, mastics). Le nettoyage a l'eau n'a pas permis son élimination complète. Mme PEREZ Y JORBA précise que, si ce dépôt n'est pas nocif pour la conservation des verres, il en diminue la transparence et il serait préférable de l'éliminer.

La face externe des verres est plus ou moins corrodée (altération uniforme ou par cratères). Les produits de corrosion, sulfates et carbonates, ont pu être éliminés au moyen d'une solution d'E.D.T.A. préconisée par le L.R.M.H.

Là le résultat du nettoyage réalisé par M. CHAUFOUR a été excellent pour la majeure partie des panneaux, à l'exception de quelques scènes de la Résurrection des Morts, il faudrait, selon la majorité des participants, pousser plus loin le nettoyage de ces derniers panneaux. Le vitrail du Jugement Dernier pourrait alors être rapidement remis en place si une protection appropriée était réalisée. Les participants estiment qu'il est indispensable d'appliquer une méthode de conservation réversible et permettant d'intervenir en toute sécurité dans le futur.

On peut envisager la protection par un vitrage extérieur, solution coûteuse et qui demande une étude particulière de la parte de l'Architecte de la cathédrale (si l'on adoptait cette solution, il faudrait veiller à ce que les partages du vitrage de protection reproduisent le dessin des barlottières). On peut aussi opter pour la protection par un film, ce que souhaite une partie importante des experts. Dans ce cas, il faudrait choisier entre deux solutions techniques.

La première, préconisée par M. BACHER (Autriche) a été appliquée à l'église Sancta Maria am Gestade à Vienne et consiste en l'application du film par dessus les plombs, sans démontage du panneau et sans sa remise en plombs. La deuxième solution, protection de chacun des verres corrodés (système appliqué à Chartres) demanderait une totale remise en plombs. La discussion qui s'engage sur ce point n'aboutit pas à une conclusion unanime; il est souhaitable qu'une expérience soit tentée de l'application de la méthode de M. BACHER (voir note technique, annexe 3).

On procède également à l'examen de trois panneaux de la verrière de la Nouvelle Alliance, la signature et les deux panneaux de Moise accomagnant la Crucifixion (Moise frappant le rocher d'Horeb et Moise élevant le serpent d'airain). On constate l'état beaucoup plus avancé de la dégradation. C'est la question des méthodes de conservation de ce vitrail qui sera reprise lors des séances au Laboratoire de Champs.

Visite de l'expostion "Le vitrail: Art et Technique"

Le 14 juin, les participants ont été accueillis au Palais de la Découverte par M. ROSE, Directeur, pour la visite de l'exposition "Le vitrail: Art et Technique", celle-ci réalisée par le L.R.M.H.

Visite du Laboratoire de Recherche des Monuments Historiques à Champs sur Marne

Les participants ont pu examiner un panneau du vitrail de la Nouvelle Alliance (Elie rencontrant la veuve de Sarepta) en cours d'étude au L.R.M.H. Ce panneau a été soumis à de nombreux examens et tests physicochimiques de nettoyage. Les experts sont surpris par l'état de dégradation exceptionnel des verres (corrosion par cratères). Ils sont intéressés par l'essai de nettoyage par abrasion au moyen de la poudre d'alumine, opération faite à Norwich dans les ateliers de M.D. KING. Ils constatent, é peu près unanimes, les inconvénients de ce procédé, parfaitement efficace pour supprimer la corrosion, mais désastreux pour l'aspect du verre ancien, décoloré par l'amincissement du verre au niveau des cratères vidés des produits de corrosion.

En présence de M. DUSSAULE, Sous-Directeur des Monuments historiques, de M. CHARPILLON, Administrateur Civil chargé du Bureau de la Documentation et des Oeuvres d'Art classées et de MM. BAZAINE et MANESSIER, représentants de l'A.D.V.F., M. BURCK, chimiste au L.R.M.H., procède à l'expérience de réversibilité du film protecteur de viacryl posé en 1974 sur le vitrail de l'Arbre de Jessé de la cathédrale de Chartres. Après 3 ans et demi d'exposition in situ, le film de résine n'a subi aucune altération, il est facilement éliminé de la surface du verre au moyen de Cital 12-12 appliqué pendant 5 minutes au moyen d'une compresse de coton. L'opération ne nécessite aucune action méchanique comme cela a également été démontré par le Dr. BACHER sur un panneau de l'église Sancta Maria am Gestade après 6 années de vieillissement naturel.

Etude de la conservation de vitrail de la Nouvelle Alliance

En séance de travail à laquelle assistent M. DUSSAULE et M. CHARPILLON, M.L. GRODECKI, expose le problème des deux vitraux concernes par la présente restauration. Pour la verrière du Jugement Dernier, il semble qu'après un nettoyage plus poussé de certains panneaux, une rapide remise en place est possible à condition que l'on choisisse les moyens appropriés d'une protection extérieure: film ou vitrage.

Quant à la verrière de la Nouvelle Alliance, les expériences du Laboratoire de Recherche des Monuments Historiques et du Laboratoire de Chimie Appliquée à l'Etat Solide de l'E.N.S.C.P. vont être exposés pas M. J.M. BETTEMBOURG et Mme PEREZ Y JORBA. M. BETTEMBOURG montre l'état très grave de la corrosion du vitrail de la Nouvelle Alliance, et plus particulièrement de son tiers inférieur. La corrosion en plusieurs couches superposées a provoqué des cratères très larges et profonds, affectant jusqu'aux 2/3 de l'épaisseur du verre. Les essais de nettoyage chimique (E.D.T.A.) n'ont pas donné de résultats satisfaisants, la couche de corrosion résistant à ce procédé. Plusieurs verres ont été soumis, sans résultat, à l'expérience de nettoyage par ultrasons. On a été amené à procéder, à titre d'expérience, dans les ateliers de M.D. KING à Norwich, au nettoyage par abrasion au moyen de poudre d'alumine. La méthode est efficace pour supprimer la corrosion, mais elle altère profondément l'effet et la nature du verre ancien.

L'observation au microscope de la morphologie des produits d'altération met en évidence un type de corrosion jamais rencontré sur d'autres vitraux. Les recherches du L.R.M.H. et de Mme PERREZ Y JORBA (cf. Annexe 4) amènent l'hypothèse d'une restauration ancienne défectueuse (application d'une couche de silicate?, couche résistant aux traitements chimiques et rendant impossible l'assainissement des verres). Les analyses à la microsonde réalisées par Mme PEREZ Y JORBA semblent confirmer cette hypothèse. (interventions de MM. J.J. GRUBER et L. GRODECKI que l'hypothèse d'une restauration ancienne celle de THEVENOT entre 1845 et 1848 concorde avec les observations en laboratoire. En effet, on spéculait beaucoup à cette époque sur l'introduction d'une "couverte" pour protéger la surface du verre).

La discussion s'engage sur les conclusions pratiques à tirer de ces expériences et examens. Il ne semble pas que dans l'état actuel de la technologie, on puisse trouver un moyen efficace pour assainir ce vitrail de Bourges et lui rendre un aspect acceptable.

Trois solutions peuvent être envisagées:

1. Remettre ce vitrail en place en le protégeant extérieurement par un vitrage, ce qui ne garantirait pas sa conservation d'une façon définitive et n'améliorerait pas son aspect actuel.
2. Procéder à un nettoyage mécanique (abrasion), mais en limitant son action; la présentation de ce vitrail dans la fenêtre de la cathédrale devrait s'accompagner d'une très rigoureuse protection par film ou par vitrage.
3. Remplacer les panneaux trop corrodés de la Nouvelle Alliance par des copies modernes en conservant les panneaux authentiques dans des conditions hygrométriques suffisantes pour qu'elles ne se dégradent pas davantage (dépôt au Musée). Cette solution pourrait n'être que provisoire, il se pourrait que dans les années à vernir une nouvelle solution soit trouvée.

Discussion générale: Les avis sont très partagés. Le remplacement du vitrail authentique par une copie est un dangereux précédent. Il ne correspond pas à la doctrine généralement suivie par le Service des Monuments Historiques. Certains experts estiment que c'est la solution la plus prudente et qui n'engage pas l'avenir. Plusieurs s'élèvent contre la solution du vitrage extérieur qui serait une atteinte à la beauté de l'architecture du chevet de la cathédrale de Bourges. Son efficacité totale n'est d'ailleurs pas prouvée, mais on peut répondre que cette solution pourrait être, elle aussi, provisoire, et pourrait être supprimée si d'autres moyens de protection étaient découverts.

La questions de nettoyage, du procédé à employer et de l'effet recherché sont inséparables pour Mme FRODL-KRAFT. Elle est partisan d'un nettoyage n'allant pas jusqu'à la suppression totale de la corrosion. La protection des vitraux moyennement nettoyés peut aussi être assurée par l'application d'un film, comme le prouve les essais réalisés en Autriche.

Il se dégage, en tout cas, de l'avis des experts que le nettoyage total par abrasion est à déconseiller. Il est encore moins possible de "resurfacer" des verres de la Nouvelle Alliance par un polissage.

La séance de travail se termine par l'appel de M. l'Inspecteur Général AUZAS, de M. MARTINEAU, Curé de la cathédrale de Bourges, et de M. LEBOUTEUX, Architecte en Chef de la cathédrale pour qu'une des solutions proposées soit définitivement décidée par la Direction de l'Architecture, afin que la cathédrale puisse retrouver la cohérence de son décor de vitraux.

<u>Liste des participants</u>

M. AUZAS, Inspecteur Général des Monuments historiques

M. BACHER, Directeur du Comité Technique Autrichien du C.V.M.A., Institut für Oestrreichische Kunstforschung à Vienne

M. BAILLY, Conservateur A.O.A. du Cher

Mlle BAUER, Institut für Werkstoffwissenschaften III, Erlangen

M. BAZAINE, Président de l'A.D.V.F.

M. BETTEMBOURG, Chef de la section vitrail au L.R.M.H., Comité Technique Français du C.V.M.A.

Mme BRISAC, Comité Français du C.V.M.A., U.E.R. d'Art et d'Archéologie

M. BURCK, chimiste au L.R.M.H., Comité Technique Français du C.V.M.A.

M. CHARPILLON, Administrateur Civil chargé de la Documentation et des Oeuvres d'Art classées

M. CHAUFOUR, Maître-verrier à Bourges

M. DALLAS, Laboratoire de Chimie Appliquée de l'Etat Solide à l'E.N.S.C.P.

Mme DI MATTEO, Inspecteur des Monuments historiques

M. DUSSAULE, Sous-Directeur des Monuments historiques

Mme FRODL-KRAFT, Institut für Oesterreichische Kunstforschung, Vienne

Monseigneur GIRARD, Président de la Commission d'Art Sacré, Archevêché de Bourges

M. GRODECKI, Président du Comité International du C.V.M.A., Président du Comité Français du C.V.M.A., U.E.R. d'Art et d'Archéologie

M. GRUBER, Maître-verrier à Paris, Comité Technique Français du C.V.M.A.

M. KING D., Maître-verrier, Comité Technique Anglais du C.V.M.A.

M. KING M., Maître-verrier à Norwich

M. LAMY, Architecte des Bâtiments de France du Cher

Mlle LEBOUCHER, Documentaliste au L.R.M.H.

M. LEBOUTEUX, Architecte en Chef des Monuments historiques

M. MANESSIER, Membre de l'A.D.V.F.

Mme MARIOTTO, Secrétaire au L.R.M.H.

M. l'Abbé MARTINEAU, Curé de la catédrale de Bourges

M. MAURET, Maître-verrier à Bourges

M. MUEHLETHALER, Président du Comité Technique de C.V.M.A., Comité International de Conservation de l'ICOM, Laboratorium des Schweizerisches Landesmuseum à Zurich

Mme PEREZ Y JORBA, Comité Technique Français du C.V.M.A., Laboratoire de Chimie Appliquée de l'Etat Solide à l'E.N.S.C.P.

Mme PERROT, Secrétaire du Comité Français du C.V.M.A.

M. RIMBAULT, Maire de Bourges

M. STEFANAGGI, Chef du Laboratoire de Recherche des Monuments Historiques

M. VAN ASPEREN DE BOER, Comité International de Conservation de l'ICOM

Monseigneur VIGNANCOUR, Archevêque de Bourges

M. VINCENT, Conservateur des Bâtiments de France à Tours

Excusés

M. COLLONGUES, Professeur, Laboratoire de Chimie Appliquée de l'Etat Solide à l'E.N.S.C.P.

Mme DELBOURGO, Chef des services techniques et scientifiques du Laboratoire de Recherche des Musées de France

M. FAVIERE, Conservateur en Chef des Musées de Strasbourg, Président du Comité National Français de l'ICOM

M. FROIDEVAUX, Architecte en Chef des Monuments Historiques, Inspecteur Général

Mme HOURS, Conservateur des Musées Nationaux, Chef du Laboratoire de Recherche des Musées de France, Comité International de Conservation de l'ICOM

M. PAGANELLI, Directeur des Affaires Culturelles à Tours

M. TARALON, Inspecteur Général des Monuments Historiques, Directeur du L.R.M.H., Président du Comité Technique Français du C.V.M.A.

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c.p. 3263
CH - 8031 Zürich / Suisse

International Colloquium on the preservation of the stained-glass windows of the cathedral of BOURGES

Bourges, June 13 - Champs sur Marne, June 14, 1978

Organized by the L.R.M.H. with the cooperation of the:
Comité Français de l'ICOM
Comité Français du Corpus Vitrearum
Comité Français de l'Histoire de l'Art

Introduction

The stained-glass windows of the Choir of the cathedral of Bourges are in an alarming state of preservation. On some of the windows, the corrosion of the glass by atmospheric agents has reached a critical stage and their very existence is endangered. The pitting has rendered the glass quite fragile. The corrosion products obscure the glass and make the scenes illegible. In view of the importance and of the complexity of the problem posed by the conservation of these windows, the L.R.M.H. has organized a meeting of international experts who were invited to look into the solutions that might permit to preserve these works of art.

The stained-glass windows of the Choir of the cathedral of Bourges

Mr. L. GRODECKI has outlined the history of the staines-glass cathedral windows (see Annex 1). Ms. BRISSAC has presented the results of her research on the restoration work carried out in the 19th century, interventions that are in keeping with the unequal preservation of those works of art (annex 2).

An inspection of the stained-glass windows of the aisle and of the side chapels shows avery marked obscuring of the windows towards the south of the Choir; the windows in the center part of the Choir seem less affected; those in the north show a formal coherence and superior colouring. In the side chapels where the completions and restorations of the 19th century were particularly serious, the state of preservation cannot be described without new studies. The two windows framing the apsis chapel, those of the New Alliance and of the Last Judgement, taken into custody in 1976, will be inspected by participants in Mr. MAURET's workshop.

Mr. J.M. BETTEMBOURG explains the problems posed by the preservation of these stained-glass windows: Deformation of the panels due to a poor fastening system. The mountings - proven to be ancient by an analysis - are not placed in a vertical line, the saddle bars are void of hoop irons. The panels are only held in place by cotters and a coarse, very hard mastic. This poor mounting system thus is conducive to an alteration of the lead networks and to sealing gaps between irons and panels.

The first conservation measure will therefore involve the revision of the mounting system. An inspection of the building's exterior permitted to confirm the unequal corrosion of all those windows. It was found that the depth of the inner face of the main window openings on the aisle would permit the installation of an external protective glazing, but such a proceeding is not applicable to the stained-glass windows of the side chapels since they are almost on an even level with the surface of the outer wall. Its application would make it necessary to move the old stained-glass windows towards the interior.

Inspection of the Last Judgement window

The inner surface of the glass panels was covered with a uniform, greyish deposit, and the analysis performed by the L.R.M.H. showed that it consisted of sulphates and carbonates. Underneath this deposit, the glass is unchanged. Consequently, it is due to an external addition (dust, mastics). Cleaning with water did not permit its complete elimination. Ms. PEREZ Y JORBA states that this deposit, although not detrimental to the preservation of the windows, does, however, diminish their transparency and it would be better to eliminate it.

The outside of the stained-glass panes is more or less corroded (uniform alteration or pitting). The corrosion products, sulphates and carbonates, could be eliminated with an E.D.T.A. solution recommended by the L.R.M.H.

Although the cleaning was excellent for the major part of the panels - with the exception of some scenes of the Resurrection of the Dead - the majority of the participants feel that the cleaning of those last panels ought to be pushed further.

The stained-glass window of the Last Judgement could then be quickly put back into its place if it were appropriately protected. The participants consider it indispensable that a reversible method of conservation be applied so as to permit in all safety to intervene in the future.

Protection by external glazing could be envisaged, a costly solution which would require a special study by the architect of the cathedral. There is also the option of protection by applying a film which is preferred by a considerable number of experts. In such a case there would be a choice of two technical solutions. The first, recommended by Mr. BACHER (Austria) has been applied at the Sancta Maria am Gestade church in Vienna and it consists in an application of the film over the lead, without dismounting the panel and without reframing it in lead.

The second solution, namely a protective film on each of the corroded glasses (this system was used at Chartres), would require a complete reframing in lead. The discussions on this point do not lead to a unanimous conclusion; it is to be wished that an attempt be made to apply Mr. BACHER's method (see technical note, annex 3).

Visit to the Laboratoire de Recherche des Monuments Historiques at Champs sur Marne

The participants had the opportunity to examine a panel of the stained-glass window of the New Alliance in the course of the study at the L.R.M.H. This panel has been submitted to numerous physico-chemical cleaning studies and tests. The experts are amazed by the exceptional state of wear of the glasses (pitting). They are interested in the trial cleaning by abrasion by means of alumina powder as performed in Mr. D. KING's workshop at Norwich. They agreee almost unanimously on the inconvenients of this procedure which is perfectly efficient to suppress corrosion but desastrous for the aspect of the old glass: due to the thinning of the glass at the level of the pitting emptied of the corrosion matter, the glass is discoloured.

In presence of Mr. DUSSAULE, Deputy Director of Historical Monuments, of Mr. Charpillon, Manager in charge of the Bureau de la Documentation et des Oeuvres d'Art classés and of Messrs. BAZAINE and MANESSIER, representatives of the A.D.V.F., M. BURCK, chemist at the L.R.M.H. proceeds to test the reversibility of the protective film of viacrylic resin applied to the stained-glass window of the Jesse Tree of the cathedral of Chartres in 1974. After 31/2 years of exposure in situ the resin film has not suffered any alteration and it is easily removed from the glass surface by means of a cotton pad soaked in Cital 12-12 and applied during 5 minutes. This operation does not require any mechanical action, as has also been proven by Dr. BACHER on a panel of the Sancta Maria am Gestade church after 6 years of natural ageing.

Study on the conservation of the stained-glass window of the New Alliance

In a study session, Mr. L. GRODECKI outlines the problem of the two stained-glass windows involved in the present restoration. Concerning the Last Judgement window it seems that after a more pronounced cleaning of certain panels, it is possible to put it back into place quickly, provided an appropriate means of external protection is chosen: either film or glazing.

Regarding the stained-glass window of the New Alliance, the experiments of the Laboratoire de Recherche des Monuments Historiques and of the Laboratoire de Chimie Appliquée à l'Etat Solide de l'E.N.S.C.P. will be explained by Mr. J.M. BETTEMBOURG and Ms. PEREZ Y JORBA (see Annex 4). The corrosion in several covering layers has caused pitting affecting up to 2/3 of the glass thickness. Trials with chemical cleaning methods (E.D.T.A.) did not produce satisfactory results as the corrosion layer resisted this process. Several glasses were submitted to cleaning by ultrasonic frequency, unsuccessfully. Then, on a trial basis, an attempt was made to clean the glasses by abrasion with alumina powder. This method is an efficient means of eliminating the corrosion but it also causes profound changes in the appearance and the nature of ancient glass. A microscopic scrutiny of the morphology of the decomposition products shows a type of corrosion never found on any other stained-glass windows. Based on the research that has gone into this matter it may be assumed that there was possibly a defective, previous restoration (application of a silicate layer? a chemically resistant layer making it impossible to restore the glasses). Microprobe analyses seem to confirm this hypothesis of an earlier restoration (may-be the one by THEVENOT between 1845 and 1848?).

Practical conclusions to be derived from these experiments and tests

At the present stage of technology it does not seem possible that an efficient means be found to restore this stained-glass window from Bourges and to make it look acceptable.

Three solutions may be envisaged:

1. To put this stained-glass window back in its place, protecting it with an external protective glazing. This would not definitely guarantee its preservation and would not improve its present aspect.
2. To carry out a mechanical cleaning (abrasion) but of limited action; the presentation of this stained glass in the cathedral window would have to go hand in hand with a most rigorous protection by film or glazing.
3. To replace the panels in the New Alliance that are too badly corroded by modern copies and to keep the authentic panels in sufficient hygrometric conditions to assure that they will not deteriorate further (deposit at the museum). Such a solution might only be provisional since it is possible that a new solution be found in the future.

General discussion: Replacing the authentic stained glass by a copy would set a dangerous precedent and it does not agree with the doctrine generally followed by the Service des Monuments Historiques. Some experts feel that this is the most prudent solution which would not jeopardize the future. Several experts rise against the external glazing which would be detrimental to the beauty of the architecture of the apse of the cathedral of Bourges. Besides, its overall efficiency has not been proven, but this could be a provisional solution to be replaced by a better one at a later date if such protective means were discovered.

Matters of cleaning, the procedure to be applied and of the desired effect are inseparable for Ms. FRODL-KRAFT. She is in favour of a cleaning that does not completely eliminate corrosion. Protection of the half-way cleaned stained glass could also be assured by a protective film, as proven by the trials made in Austria. In any case, the expert's opinion seems to be that a total cleaning by abrasion cannot be recommended. It is even less possible to provide a "new surface" to the glasses of the New Alliance by polishing them.

Annexe 1

HISTORIQUE DES VITRAUX DU CHOEUR DE LA CATHEDRALE DE BOURGES

par L. Grodecki

Les baies du déambulatoire et des chapelles rayonnantes à la cathédrale de Bourges furent vitrées juste après l'achèvement de cette partie de l'édifice, c'est-à-dire entre 1210 et vraisemblablement avant 1214.Voir p. 16

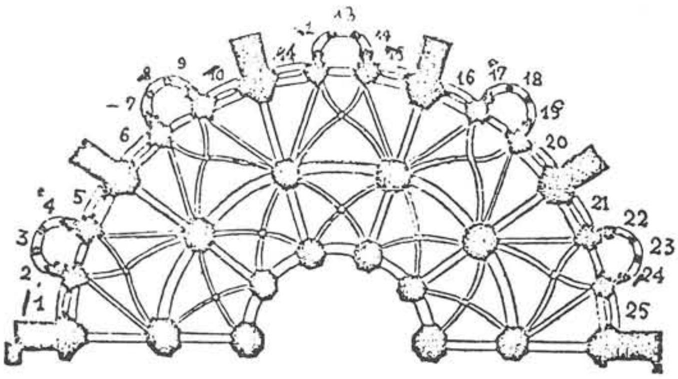
Cet ensemble, bien qu'amputé des trois verrières de la chapelle axiale, remplacées au 16e siècle, présente une incomparable cohérence iconographique où des correspondances thématiques s'établissent entre les verrières hagiographiques des chapelles rayonnantes et celles allégoriques, symboliques ou encore néo-testamentaires du déambulatoire. Ce programme est l'oeuvre d'une pensée théologique unique et imposé aux "donateurs", pour la plupart des corporations; mais la réalisation en a été confiée à trois "alteliers" différents qui ont oeuvré en même temps, peut-être en commençant leurs travaux avant 1205.

La personnalité de chacun reflète celle de leur chef ou "maître"; celui du "Maître du Bon Samaritain", responsable aussi des verrières de la Passion, de l'Apocalypse, de Sainte Marie-Madeleine, de Saint Nicolas et du Martyre de Saint Etienne, a probablement été formé dans l'Ouest de la France, à Angers peut-être: son écriture graphique reproduit les schémas en usage dans cette zone à la fin du 12e siècle ou au début du 13e siècle.

Au second maître, celui da la Nouvelle Alliance, on peut attribuer le Jugement Dernier et les vitraux hagiographiques de Saint Denis, Saints Pierre et Paul et Saint Martin. Son origine doit être cherchée dans le Nord de la France: des rapports stylistiques sont évidents avec les traditions de certains ateliers de la région Laon-Soissons dont plusieurs essaimèrent au début de 13e siècle vers d'autres chantiers, tel celui de Chartres.

Le style du troisième, celui du "Maître des Reliques de Saint Etienne", reste difficile à circonscrire. Les conventions qu'il utilise sont, pour le décor, celles habituelles à cette époque, mais, pour la figuration et l'espace, inattendues et personnelles, au point qu'on pourrait admettre qu'il puise probablement aux sources locales.

Les vitraux du déambulatoire de Bourges sont rigoureusement contemporains de ceux de la nef de Chartres; contrairement à ce qui a été quelquefois affirmé, ils n'ont pas été faits par les mêmes artistes ou les mêmes ateliers, même si des rapports formels ou techniques unissent les deux ensembles.



Plan de situation des vitraux du déambulatoire de la cathédrale de Bourges

1. Parabole de Lazare et du Mauvais Riche
2. Vie de St. Marie Egyptienne
3. Vie de St. Nicolas
4. Vie de Ste. Marie-Madeleine
5. Histoire des Reliques de St. Etienne
6. Parabole du Bon Samaritain
7. Vie de St. Denis
8. Vies des SS. Pierre et Paul
9. Vie de St. Martin
10. Parabole de l'Enfant Prodigue
11. Nouvelle Alliance
12. (Disparu: Vie de la Vierge?)
13. (Disparu: Enfance de Christ?)
14. (Disparu: Arbre de Jessé?)
15. Jugement Dernier
16. Passion
17. Vie de St. Laurent
18. Martyre de St. Etienne
19. Vie de St. Vincent
20. Apocalypse
21. Vie de St. Thomas
22. Vie de St. Jacques Majeur
23. Vie de St. Jean-Baptiste
24. Vie de St. Jean-l'Evangeliste
25. Histoire du patriarche Joseph

<u>Annexe 2</u>

LES RESTAURATIONS DES VERRIERES DU DEAMBULATOIRE ET DES CHAPELLES RAYONNANTES A LA CATHEDRALE DE BOURGES AU 19e SIECLE ET AU DEBUT DU 20e.

par C. Brisac

On ne sait rien de précis sur les restaurations de ces vitraux avant le 19e siècle. Dès le début de ce siècle, leur état préoccupe les autorités diocésaines. Un rapport en 1824 insistait sur l'usure des plombs et sur l'étendue de la rouille des chassis et des barlottières. Quelques travaux d'entretien furent réalisés en 1830, mais la situation ne fit qu'empirer au point qu'on dut en 1839 ouvrir un dépôt destiné à recevoir les débris authentiques de verres peints. Pour les opérations d'entretien, on choisissait de préférence ces pièces sans se soucier de leur provenance.

La monumentale publication de Cahier et Martin sur les vitraux du 13e siècle de cet édifice (1841 - 1844) focalise l'attention de l'Administration des Cultes sur le mauvais état de ces verrières. En 1843, THEVENOT, maître-verrier clermontois et restaurateur en vogue, fur chargé d'établir un devis portant sur l'ensemble de la vitrerie de la cathédrale.

Malgré certains appuis, l'Administration prescrivit seulement une restauration "d'essai", c'est-à-dire à ritre d'exemple, sur trois verrières du chevet choisies pour leur degré de "dégradation" variée, les autres vitraux devant être seulement consolidés.

L'opération débute en janvier 1845 et dura trois ans. Comme verrière très dégradée, on prit celle de Saint Thomas, celle de la Nouvelle Alliance comme moyennement altérée. Comme exemple de dégradation faible, on n'en restaura pa une, mais trois, celles de la chapelle de Saint Etienne (2e chapelle rayonnante sud), consacrée aux vies des Sainsts Vincent, Etienne et Laurent. Par "dégradation", on doit comprendre non mutilation de l'ensemble d'une verrière, mais bien corrosion et altération des verres. En effet, ce sont les verrières considérées comme moins "dégradées" où THEVENOT refit le plus de panneaux modernes, par exemple douze à celle de Saint Etienne.

Pour échapper aux attaques dont il avait été l'objet lors de restaurations précédentes, THEVENOT prit de sérieuses précautions dont la plus spectaculaire fut le relevé grandeur nature et aquarellé de chaque panneau comportant l'ensemble du chevet: certaines de ces planches sont aujourd'hui conservées à la Bibliothèque de l'Union Centrale des Arts Décoratifs à Paris ou à l'Agence des Bâtiments de France à Bourges.

Néanmoins, beaucoup de verres peints furent éliminés et volés par la suite, mais leur disparition effective ne fut constatée qu'en 1922: un grand nombre de ces pièces, les plus belles, se trouvent aujourd'hui dans des collections ou musées américains. La remise en plombs fut totale. En ce qui concerne le nettoyage des verres que les rapports décrivent comme fort encrassés, THEVENOT choisit le lavage et le séjour prolongé dans l'eau, puis le frottement avec un linge, selon un procédé voisin de celui préconisé par CHEVREUL. S'en tint-il à cette méthode ou bien utilisa-t-il des moyens plus énergiques? On sait qu'à Saint-Jean de Lyon, son ami et parfois associé Emile THIBAUD employa des lames d'acier pour gratter les verres et de l'acide fluorhydrique pour le nettoyage.

L'intervention de THEVENOT fut mise en accusation: elle fut jugée trop onéreuse. On reproche au maître-verrier d'avoir emmené beaucoup de pièces et panneaux à Clermont-Ferrand et d'avoir peu travaillé sur place, mais l'examen de ses comptes tendrait à prouver le contraire. Une commission d'experts comprenant DIDRON, VIOLET-LE-DUC et Ferdinand de LASTEYRIE fut nomée pour contrôler les travaux: le compte-rendu de DIDRON fut accablant alors que ceux de VIOLLET-LE-DUC et de LASTEYRIE furent relativement mesurés.

Ce n'est qu'en 1853 que les travaux reprirent à la suite d'un ouragan. THEVENOT fut évincé et remplacé par COFFETIER de Paris. Les méthodes suivies par cet artiste restent assez mystérieuses en raison du laconisme des documents d'archives. Il semble que la verrière de Lazare et du Mauvais Riche ne fut pas touchée par cette intervention: elle ne le sera qu'en 1917, lors d'un nettoyage qui affecta aussi une autre verrière, celle de la Nouvelle Alliance.

Lors de la dépose des vitraux en 1939 et leur repose en 1946 - 47, les interventions du peintre-verrier CHAUFOUR, travaillant sous la direction de CHIGOT (de Limoges) et de LORIN (de Chartres) furent très restreintes: quelques consolidations de panneaux, quelques plombs de casses, un dépoussiérage à l'eau et au chiffon. Ces vitraux du déambulatoire furent alors photographiés par MAS au cinquième de leur grandeur (Archives des Monuments Historiques).

Annexe 3

PROTECTION DES VITRAUX DU JUGEMENT DERNIER ET DE LA NOUVELLE ALLIANCE PAR UN FILM DE VIACRYL

par J.M. Bettembourg

Les solutions proposées pour la protection du vitrail du Jugement Dernier par un film de Viacryl sont les suivantes:

a/ Application du film par panneau sur l'ensemble verre-plombs

b/ Application du film sur chaque pièce de verre dessertie.

L'application sur l'ensemble verr-plombs a été expérimentée en Autriche. Le film n'a subi aucune perturbation après 6 ans de vieillissement in situ. Cependant, il faut souligner que les panneaux de Bourges n'ont pas la même configuration que les panneaux de Vienne: les ailes de plomb ne recouvent pas toujours parfaitement les pièces de verre; des amas de mastic sont visibles dans les interstices verre-plombs.

Le revêtement des verres et des plombs par un film protecteur entraînerait une épaisseur trop importante de résine dans les joints: durcissement incomplet, adhérence non assurée sur le mastic, imperméabilité douteuse.

Ce système de protection ne pourrait être tenté que sur des panneaux comportant des réseaux de plombs en parfait état de conservation et peu de pièces altérées. Son application devra être précédée d'un essai de vieillissement en laboratoire pour juger de son efficacité dans le cas précis de Bourges. Des contrôles réguliers in situ seront nécessaires pour permettre une intervention rapide au cas où cette méthode s'avèrerait défectueuse.

Les panneaux les plus altérés - même lorsque le réseau de plombs semble dans un bon état de conservation - ne pourront être protégés qu'après dessertissage des verres; une remise en plombs sera indispensable. C'est cette méthode qui a été adoptée pour la restauration des vitraux de Chartres.

Les protection du vitrail de la Nouvelle Alliance pose un problème plus difficile, le nettoyage des pièces de verre étant impossible. Le Viacryl a également été expérimenté avec succès sur des verres non nettoyés en Autriche. S'il était adopté, pour la protection des panneaux supérieurs de la Nouvelle Alliance, des essais en laboratoire seront nécessaires et de tout manière une remise en plombs s'imposera. L'exposition dans un musée des panneaux les plus altérés (panneaux inférieurs) remplacés in situ par des copies, devra se faire dans des conditions climatiques rigoureuses, l'attaque du verre se poursuivant lorsque l'humidité ambiante est supérieure à 60%.

Annexe 4

CORROSION DU VITRAIL DE LA NOUVELLE ALLIANCE DE BOURGES

par J.M. Bettembourg et M. Perez Y Jorda

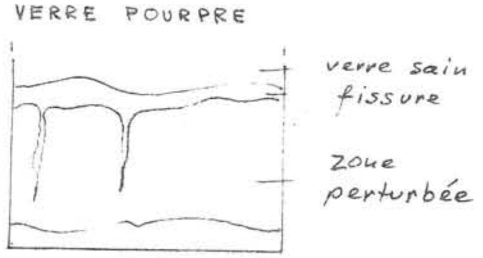
La face interne des verres est rexouverte d'un dépôt grisâtre uniforme composé de sulfates, -de carbonates (calcite) et de silicates. Sous ce dépôt, le verre est corrodé par endroits. Les méthodes de nettoyage chimiques sont insuffisantes; les procédés mécaniques sont d'un grand danger pour les dessins de grisaille et la surface du verre.

Bien que contribuant à l'opacité des verres, ce dépôt ne présente pas un grand danger pour la conservation du vitrail. Sa formation est due à un apport exérieur favorisé par les phénomènes de condensation (poussières, mastic...). Les analyses par infrarouge du L.R.M.H. et les analyses par diffraction de rayons X du Laboratoire de Chimie Appliquée de l'Etat Solide ont mis en évidence la présence d'oxalate de calcium. Ce composé n'est pas réparti d'une façon homogène, on le retrouve également sur la face externe. Il est difficile de donner une explication de sa formation.

L'observation au microscope de la morphologie de l'altération par cratères de la face externe révèle différents produits de corrosion répartis en 3 couches successives: une couche blanche sur le verre, puis une couche brunâtre et de nouveau une xouche blanche. Ces produits sont composés de gypse et de silicates. Ce type d'altération n'a jamais été rencontré au cours de nos études: est-il le résultat d'un processus de corrosion du verre ou résultate-t-il d'une restauration antérieure (application d'un silicate à la surface du verre ?).

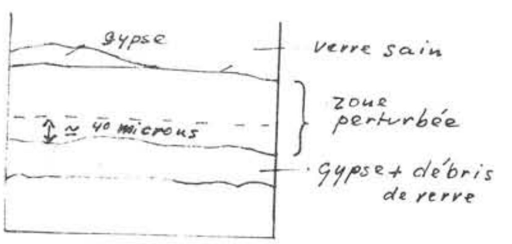
Les analyses à la microsonde faites par le Laboratoire de Chimie Appliquée de l'Etat Solide ont permis une étude plus approfondie.

VERRE POURPRE



Dans la zone perturbée, l'élimination du calcium, du potassium et du phosphore est traditionnelle. Le départ de l'élément colorant (manganèze) du verre pourpre est à noter, car le même phénomène ne se reproduit pas avec le verre bleu coloré par le cuivre et le cobalt. Ce départ affecte une zone de quelques microns d'épaisseur. L'état actueldes recherches ne permet pas d'affirmer si ce départ provoque l'extraction du colorant du verre sous-jacent. Dans la fissure située entre le verre sain et la zone perturbée, on trouve une association inexpliquée du soufre avec du titane et du fer. Ces éléments proviennent-ils d'un apport extérieur, les teneurs en ces éléments du verre étant très faibles.

VERRE BLEU



Dans la zone perturbée du verre bleu, on remarque, sous la couche superficielle du gypse, une frange de 40 microns d'épaisseur dans laquelle certains éléments sont présents en plus grande quantité (potassium, calcium, phosphore, fer, pbomb....). Il est à noter que cette zone ne contient pas de soufre. L'examen par diffraction de rayons X du produit opaque marron clair sous le gypse révèle son caractère vitreux. Ce fait tendrait à confirmer l'hypothèse de l'application d'un silicate lors d'une restauration. Une recherche sur les verres des autres vitraux restaurés par le même atelier pourrait apporter une réponse et expliquerait les difficultés rencontrées lors des essais de nettoyage chimique.

Le nettoyage par abrasion au moyen de poudre d'alumine et de microbilles de verre en éliminant les produits d'altération des cratères éclaircit le verre d'une façon trop importante. L'effet esthétique obtenu est inacceptable, l'aspect obtenu étant celui d'un "verre cathédrale". L'observation au microscope électronique montre que le nettoyage par abrasion provoque des perturbation à la surface du verre qui peuvent favoriser une altération future.

Il est nécessaire d'appliquer un procédé de protection réversible qui permettrait de stopper, ou du moins de ralentir, le processus de corrosion en attendant de découvrir une méthode de nettoyage acceptable.

3. recent work

3.1 Cooperation within the German Democratic Republic regarding matters of restoration and preservation of medieval stained-glass windows

By an agreement between the Institute for the Preservation of Monuments and the Central Institute for Anorganic Chemistry of the Academy of Sciences of the German Democratic Republic, a group of people - small in numbers but with great experience in glass research - is working on the problems of preservation and restoration of medieval stained-glass windows. Three domains are envisaged for the long-range study:

1. Research on the causes and mechanisms of corrosion. They will provide conclusions, e.g. on cleaning methods, etc.
2. Research on possible preservation methods. In particular, matters of refixing paint will have to be taken into consideration.
3. Work in direct support of restoration workshops. This is often a matter of solving partial problems resulting from the differentation of individual stocks of stained-glass windows.

In the work performed so far, good use was made of findings derived from the work carried out primarily in England, France, Austria, and Switzerland and which had already been published.

The investigation of some medieval glasses from the German Democratic Republic showed - for instance in X-ray diffraction analysis of random samples of weathering crusts of the most diverse outer appearances - matching results, the main elements being gypsum, syngenite and an amorphous component which was identified by emission spectrography as SiO_2. Analyses of glasses from different sites (Naumburg, Schulpforta, Erfurt, Stendal, Salzwedel, and others) almost exclusively showed chemical compositions which may be within the triangular diagram proposed by Newton and Iliffe (Verres Refract. -F-30 (1976), 1, 30-34) in a range which is limited by the simulated glasses 1.....7 of British origin mentioned in NL No. 5; the compositions of glasses 1,2,4,5,6, and 7 were therefore adopted for our own tests. Samples of simulated glasses which were melted and processed into calibrated standards in the laboratory, upon prolonged storage under water produced results that could already be well utilized. They permit tentative conclusions regarding the corrosion mechanisms. Furthermore, these samples of simulated glass can be used for comparative preservation tests. The publication of results is envisaged.

E.Drachenberg / W. Müller

Zusammenarbeit in der DDR zu Fragen der Restaurierung und Konservierung mittelalterlicher Glasmalerei

Auf der Basis einer Vereinbarung zwischen dem Institut für Denkmalpflege und dem Zentralinstitut für Anorganische Chemie der Akademie der Wissenschaften der DDR arbeitet eine zahlenmäßig kleine, in der Glasforschung erfahrene Gruppe an Problemen der Konservierung und Restaurierung mittelalterlicher Glasmalerei. Drei Aufgabenkomplexe sind für die langfristige Bearbeitung vorgesehen:

1. Untersuchungen zu den Korrosionsursachen und -mechanismen. Daraus ergeben sich z. B. Schlußfolgerungen für Reinigungsverfahren.
2. Untersuchungen zu möglichen Konservierungsmethoden. Hierbei sollen besonders auch die Fragen der Schwarzlotsicherung berücksichtigt werden.
3. Arbeiten zur direkten Unterstützung der Restaurierungswerkstätten. Hier geht es oft um die Lösung von Teilproblemen, die sich aus der Differenziertheit der einzelnen Bestände ergeben.

Bei der bisherigen Bearbeitung wurden Erkenntnisse aus den hauptsächlich in England, Frankreich, Österreich und der Schweiz durchgeführten und bereits veröffentlichten Arbeiten weitgehend genutzt.

Die Untersuchungen einiger mittelalterlicher Gläser aus der DDR ergaben z. B. bei röntgenographischen Stichprobenanalysen an Wettersteinschichten sehr unterschiedlichen äußeren Aussehens übereinstimmend als Hauptbestandteile Gips, Syngenit und eine röntgenamorphe Komponente, die spektralanalytisch als SiO_2 identifiziert wurde. Analysen von Gläsern aus verschiedenen Orten (Naumburg, Schulpforta, Erfurt, Stendal, Salzwedel u. a.) zeigten fast ausnahmslos chemische Zusammensetzungen, die sich in dem von Newton und Iliffe (Verres Refract. - F - 30 (1976), 1, 30-34) vorgeschlagenen Dreiecksdiagramm in einem Bereich anordnen lassen, der durch die im NL Nr. 5 angeführten synthetisierten Gläser 1....7 der englischen Serie abgesteckt wird; die Zusammensetzungen der Gläser 1, 2, 4, 5, 6 und 7 wurden deshalb für eigene Versuche übernommen. An entsprechenden Testgläsern, die im Laboratorium erschmolzen und zu definierten Proben verarbeitet wurden, lieferten Wasserlagerungsversuche unter variierten Bedingungen bereits gut auswertbare Ergebnisse, die sowohl erste Schlußfolgerungen auf die Korrosionsmechanismen zulassen als auch die Grundlage für Vergleiche darstellen, bei denen die Glasproben Konservierungsmaßnahmen unterzogen werden sollen. Die Veröffentlichung der Ergebnisse ist beabsichtigt.

E.Drachenberg/W.Müller

Chemische Zusammensetzungen ausgewählter mittelalterlicher Gläser aus Glasmalereibeständen in der DDR

W. Müller, E. Drachenberg

English Summary

Already some years ago, simulated medieval glasses were used by the British Technological Committee of CVMA. Iliffe and Newton /1/ suggested a triangle diagram for the classification of original glasses. According to this method the present work was to clarify, if medieval glasses, existent in the GDR, would possess chemical compositions similar to the proposed simulated ones. All selected glasses of the 13th-15th century proved arrangable within or immediately nearby the region of the diagram, limited by the simulated glasses No. 1...7. The compositions No. 2 and 4 are the most suitable of them. They are nearly identical with the glasses No. 2 and 4, presented in NL No. 25. These two glasses and a third one with 5 wt% MgO in its composition will be used for chemical investigations according to corrosion mechanism and possibility of protection.

Für Untersuchungen sowohl der Korrosionsursachen und -mechanismen als auch der möglichen Schutzmaßnahmen werden größere Mengen von Glas als Probematerial benötigt. Da original mittelalterliche Gläser nicht oder nur in ganz geringem Umfang zur Verfügung stehen, ist es erforderlich, entsprechend simulierte Gläser nachzuschmelzen.

Die von Iliffe und Newton /1/ gewählte Darstellung der sehr variantenreichen Zusammensetzungen in einem einfachen Dreieckdiagramm ermöglicht die Auswahl brauchbarer simulierter Gläser, die in Bezug auf ihr Korrosionsverhalten als repräsentativ für den größten Teil der mittelalterlichen Originalgläser gelten können. So lassen sich die etwa 150 bisher analysierten mittelalterlichen Gläser überwiegend englischer, französischer und österreichischer Herkunft (NL 21 und 24) in einem Bereich des Diagramms anordnen, der durch die Gläser 1 bis 7 der "englischen Serie" von simulierten Gläsern abgesteckt wird /2/. Insbesondere die alkalireichen Gläser 2 und 4, die ebenso wie die Gläser 6 und 7 sehr ähnlich zusammengesetzt sind wie die in NL 25 angeführten und bei Pilkington Brothers Ltd. hergestellten mit der gleichen Probenbezeichnung. Es war nun zunächst zu klären, ob die in der DDR vorhandenen mittelalterlichen Scheiben ähnliche chemische Zusammensetzungen aufweisen.

Dabei konnte zum Teil auf bereits vorliegende Analysenwerte anderer Autoren zurückgegriffen werden. Im einzelnen handelt es sich um die von Kühne /3/ durchgeführten Analysen an Scheiben des Stendaler und des Erfurter Domes (Tabelle I, Punkte K 1 bis K 4, Bild 1) sowie um Angaben in einem Bericht des Corning-Glasmuseums /4/ über chemische Zusammensetzungen von Fenstern des Erfurter Domes (Tabelle II, Bild 1, Punkte C 1 bis C 6).

Tabelle I: Zusammensetzung von Gläsern des Erfurter (K 1, K 2) und des Stendaler Domes (K 3, K 4), ermittelt von Kühne /3/, Gehalte in Masse-%

Oxid	Glas K 1	K 2	K 3	K 4
SiO_2	48,7	45,2	58,0	45,2
Na_2O	0,8	0,6	4,9	1,1
CaO	17,6	21,4	19,0	20,1
K_2O	22,0	23,3	4,5	23,4
Al_2O_3	4,1	7,4	8,0	2,8
Fe_2O_3	0,3	-	0,6	0,4
MgO	2,8	5,0	3,6	5,0
BaO	1,0	-	0,5	0,9
MnO	0,7	-	0,6	0,4
CuO	-	-	-	0,2

Neben den in Tabelle I angeführten Gläsern wurden von Kühne einige weitere untersucht, für die ein hoher PbO-Gehalt charakteristisch war. Gläser dieses Typs lassen sich in das Schema von Iliffe und

Newton nicht einordnen. Es hat sich gezeigt, daß solche Gläser mit Bleioxidgehalten von mehr als 10 % sehr wenig korrosiv angegriffen werden, so daß sie hinsichtlich ihrer hydrolitischen Beständigkeit im Vergleich mit den bleifreien Gläsern unkritisch sein dürften.

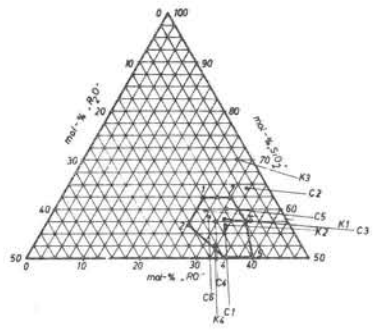


Bild 1: Darstellung der vom CVMA vorgeschlagenen /2/ (Punkte 1, 2, 4, 5, 6 und 7) und der von Kühne /3/ (Punkte K 1 bis K 4) bzw. dem Corning-Glasmuseum /4/ (Punkte C 1 bis C 6) ermittelten Glaszusammensetzungen im Dreiecksdiagramm nach Iliffe und Newton

Weitere Informationen über die chemischen Zusammensetzungen von mittelalterlichen Glasfenstern, die als potentielle Objekte denkmalpflegerischer Arbeiten in der DDR in Frage kommen, wurden durch Röntgenfluoreszenzanalysen erhalten. Die Ergebnisse sind in Tabelle III angegeben. In Bild 2 sind diese Gläser wiederum im Dreiecksdiagramm angeordnet, wobei die Punkte M 1 bis M 7 den Zusammensetzungen von Bruchstücken folgender Herkunft entsprechen:

M 1: farbloses Glas, Klosterkirche Schulpforta, um 1260, Außenseite stark verwittert

M 2: dunkelviolettes Glas, Naumburger Dom, Westchor, 1250-1260, sehr stark verwittert

M 3: dunkelblaues Glas, Barfüßerkirche Erfurt, 1230-1235, stark verwittert

M 4: farbloses Glas, Katharinenkirche Salzwedel, um 1420, korrosiv nur wenig angegriffen

M 5: hellblaues Glas, Barfüßerkirche Erfurt, 1230-1235, Außenseite stark verwittert

M 6: farbloses Glas, Klosterkirche Schulpforta, um 1260, Außenseite stark verwittert

M 7: grünes Glas, Naumburger Dom, Ostchor, 1420-1430, stark verwittert

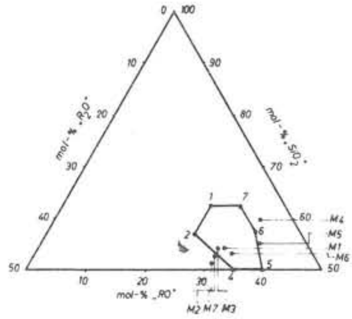


Bild 2: Darstellung der durch Röntgenfluoreszenzanalysen erhaltenen chemischen Zusammensetzungen einiger mittelalterlicher Gläser (Punkte M 1 bis M 7) im Dreiecksdiagramm nach Iliffe und Newton

Aus den Bildern 1 und 2 geht hervor, daß nahezu alle Gläser der Serien K, C und M innerhalb bzw. in unmittelbarer Nähe des Bereichs liegen, der durch die vom CVMA vorgeschlagenen Synthesegläser begrenzt wird. Eine Ausnahme liegt lediglich beim Glas K 3 vor. Da Ausnahmen dieser Art relativ "SiO_2"-reich und "R_2O"-arm sind, werden sie mit Sicherheit chemisch beständiger als die simulierten Synthesegläser sein.

Aus den Ergebnissen kann geschlossen werden, daß die vorgeschlagenen simulierten Gläser 1, 2, 4, 5, 6 und 7 auch für die Mehrheit der original mittelalterlichen Gläser der Glasfenster aus Kirchen der DDR als in ihren chemischen Eigenschaften repräsentativ angesehen und für entsprechende Forschungsarbeiten eingesetzt werden können. Es erscheint zweckmäßig, die Auswahl durch ein weiteres Glas zu ergänzen, das etwa in der Mitte des Bereichs liegt. Für diesen Zweck bietet sich das Glas K 2 an. Die Erweiterung ist insbesondere auch deshalb sinnvoll, weil dieses Glas 5 Masse-% MgO enthält. (Aus den Tabellen I bis III geht hervor, daß alle untersuchten mittelalterlichen Gläser zwischen 3 und 5 Masse-% MgO enthalten.)

Mit den nun insgesamt sieben simulierten Synthesegläsern sollen Untersuchungen durchgeführt werden, die das Ziel haben, zur Klärung der Ursachen für die Korrosion beizutragen sowie Möglichkeiten für wirksame Schutzmaßnahmen zu testen.

Literatur

/1/ Iliffe, C.J., Newton, R.G.: Verres Refract., F, 30 (1976), 1, 30-34

/2/ Unveröffentlichtes Material des Technischen Komitees des CVMA

/3/ Kühne, K.: Silikattechnik 11 (1960) 6, 260-262

/4/ Forschungsprogramm für mittelalterliches Farbglas des Corning-Glasmuseums; unveröffentl.Mat. Mai 1970

Tabelle II: Zusammensetzung von Gläsern des Erfurter Domes, ermittelt vom Corning-Glasmuseum /4/, Gehalte in Masse-%

Oxid	Glas					
	C 1	C 2	C 3	C 4	C 5	C 6
SiO_2	51,7	60,1	53,4	53,3	55,9	54,3
Na_2O	0,67	2,60	0,45	0,56	0,36	0,25
CaO	21,9	22,7	21,5	20,5	21,0	19,0
K_2O	17,9	5,30	17,2	19,2	15,5	20,7
MgO	3,96	3,98	3,72	3,70	3,88	3,50
Al_2O_3	1,28	2,34	1,29	1,13	1,29	0,85
Fe_2O_3	0,38	1,50	0,45	0,40	0,40	0,10
MnO	1,10	1,20	1,00	0,45	0,50	0,50
PbO	0,50	-	0,55	0,25	0,75	0,50
SrO	0,18	0,15	0,20	0,20	0,20	0,18
Rb_2O	0,20	-	0,10	0,20	0,20	0,05
P_2O_5	< 1	< 1	< 1	< 1	< 1	< 1

Tabelle III: Röntgenfluoreszenzanalytisch ermittelte chemische Zusammensetzungen von Gläsern verschiedener Kirchen der DDR

Oxid	Glas						
	M 1	M 2	M 3	M 4	M 5	M 6	M 7
SiO_2	50,76	48,05	50,85	59,00	51,44	49,49	49,91
Na_2O	0,90	1,17	0,97	2,71	1,01	0,90	0,65
CaO	22,19	21,87	21,79	25,63	26,41	23,36	21,59
K_2O	20,87	24,89	21,81	5,94	12,77	20,25	21,79
MgO	4,20	3,69	3,67	5,06	5,12	4,60	3,71
Al_2O_3	0,71	0,18	0,32	1,07	1,42	1,00	0,52
Fe_2O_3	0,32	0,11	0,52	0,50	1,05	0,32	1,77

3.2 RECENT BRITISH WORK: CHEMICAL DURABILITY OF MEDIEVAL GLASS

MEDIEVAL GLASS

.1 Introduction

As was stated in N.L. No.26, Section 4.3.2, Mr Frederick J. Briggs has been studying the durability of simulated medieval glasses in the Department of Ceramics, Glasses and Polymers, of the University of Sheffield, under the supervision of Dr J.O. Isard and Professor H. Rawson.

His First Annual Report, entitled "The Chemical Durability of Medieval Glass - A Study of Chemical Durability and Weathering", has just been made available. This interesting report, consisting of 26 + iii pages of text and 20 figures, describes the careful work carried out to measure the "durability" of the ten simulated medieval glasses, prepared for the European Science Foundation by Pilkington Brothers Ltd with the aid of a grant from the Nuffield Foundation, as described in News Letter No.25, pp.3-5.

2 Experiments carried out

Briggs measured nine different aspects of the durability both with the standard grain test and with polished blocks (2.9), either singly or in combination, and obtained somewhat different answers according to the test carried out. These were:-

2.1 The final pH value of the water in which the glass was placed

2.2 The effect of the time of attack by the water

2.3 The effect of the temperature of the water

2.4 The amount of alkali extracted

2.5 The amount of silica extracted

2.6 The amount of lime extracted

2.7 The amount of magnesia extracted

2.8 The amount of alumina extracted

2.9 The loss of thickness of a polished block of glass. Here the most durable of the glasses (No.149) lost 0.17 µm in 24h at 60°C, and the least durable (No.158) lost 5.5 µm under the same conditions.

There is also a full discussion of the problems of carrying out satisfactory chemical analyses of the glasses, and of the extract solutions (produced by the inter-element interferences), together with procedures for overcoming or reducing the effects of the interferences.

3 Summary of the results obtained

3.1 Alkalinity of the water. The pH value of the water in contact with the glass could increase remarkably rapidly, rising to a value of 10 in less than 3h at 60°C in the case of glasses Nos 144 and 145!

.3.2 Effect of time of attack by the water. The more-durable glasses needed a longer time to reach such a high alkalinity, more than 24h at 60°C being required to reach pH=10 in the case of glass No.149. The all-soda glass (No.77/33) produced noticeably less alkalinity than the potash glasses having a similar alkali content (see also 3.9 below).

.3.3 Effect of temperature depended markedly on the composition of the glass. For example, a poorly-durable glass like No.144 gave potash extraction rates in the ratios 1.0:1.7:3.4 at temperatures of 25°, 40° and 60°C. In the case of a more-durable glass, such as No.149, these ratios were only 1.00:1.14:1.71. (See also items 3.4, 3.6, 3.7 below).

3.4 Potash extraction. The glasses which contained about 7.5 mol% K_2O showed extraction rates of less than 850 µg K_2O/g glass at all temperatures, but glass No.144 showed an extract of nearly 3000 µg/g at 60°C. There was a rapid increase in the rate of loss of potash when the K_2O/SiO_2 ratio was higher than about 0.2, glasses Nos 144, 145 and 158 showing extraction rates which were 2 to 4 times higher than in the former group.

3.5 Silica extraction showed the closest relationship with the composition of the glass. The glasses which contained only about 44 mol% of SiO_2 showed losses of silica as high as 2000 µg/g at 60°C, but there was a linear decrease, with an increase in SiO_2 content, until the extraction rate fell to only about 300 µg/g (at 60°C) at 57 mol% SiO_2. When the SiO_2 content was higher than about 57 mol%, the further decrease in silica extraction was proportionately much less. It is interesting that the all-soda glass (No.77/33) showed substantially less loss of silica (c.850 µg/g at 60°C) than the equivalent potash glass (No.144 = c.1500 µg/g), both having 50 mol% SiO_2.

3.6 Extraction of lime was markedly dependent on the lime content of the glass, but almost independent of the other constituents, except that the all-soda glass (No.77/33) showed only about half the extraction rate of the comparable potash glass (No.144) at 40°C, although the difference was much less at 60°C. For example, at a CaO/SiO_2 ratio of 0.8, the extraction rate was 3000 µg CaO/g at 60°C, but it was only 500 µg/g when the ratio was 0.35. It would seem likely that the loss of lime would be negligible when the ratio is less than about 0.30, but only about 10% of medieval glasses have such a low lime content (see Fig.1).

3.7 Extraction of magnesia could be determined on only two glasses (Nos 150 and 151) and there was a linear relationship with temperature. For example, No.150 lost about 70 µg MgO/g at 60°C, 33 µg/g at 40°C, and only about 5 µg/g at 25°C. These interesting results would suggest that losses of magnesia would be negligible at temperatures below 20°C.

3.8 Extraction of alumina was rather small, being less than 200 µg Al_2O_3/g at all temperatures, and the loss from the more-durable glasses (Nos 148, 149, 150 and 151) was below the limit of detection with the present equipment.

3.9 Soda compared with potash. Earlier work on simple soda- and potash- glasses always showed that the potash glasses were much less durable than the equivalent soda glasses, but there was a school of thought which believed that the presence of large amounts of lime would have a "balancing" effect and thus reduce or even remove the adverse effect which potash has on the durability. However, the high lime potash glass (No.144) had only about half the durability of the corresponding soda glass (No.77/33). Also, more lime was extracted from the potash glass (Section 3.6) and the same applies to the alumina extraction. It must therefore be concluded that this all-soda glass is about twice as durable as the all-potash glass, despite the large amount of lime present.

3.10 The mixed alkali glasses (Nos 150 and 151) were more durable than had been expected, but the position is complicated by the presence of magnesia and phosphorus and it cannot yet be claimed that these glasses display an improved durability which is attributable to the classical "mixed-alkali" effect found in the electrical properties of glasses.

3.11 Glass No.159 proved to be more durable than would be expected from its position on the triangular diagram, and it seems likely that a protective layer forms on the surface, especially as actual medieval glasses, which have the same compositions, form dense crusts of gypsum. In fact it is concluded that crusts on glass may protect the glass from attack by the environment.

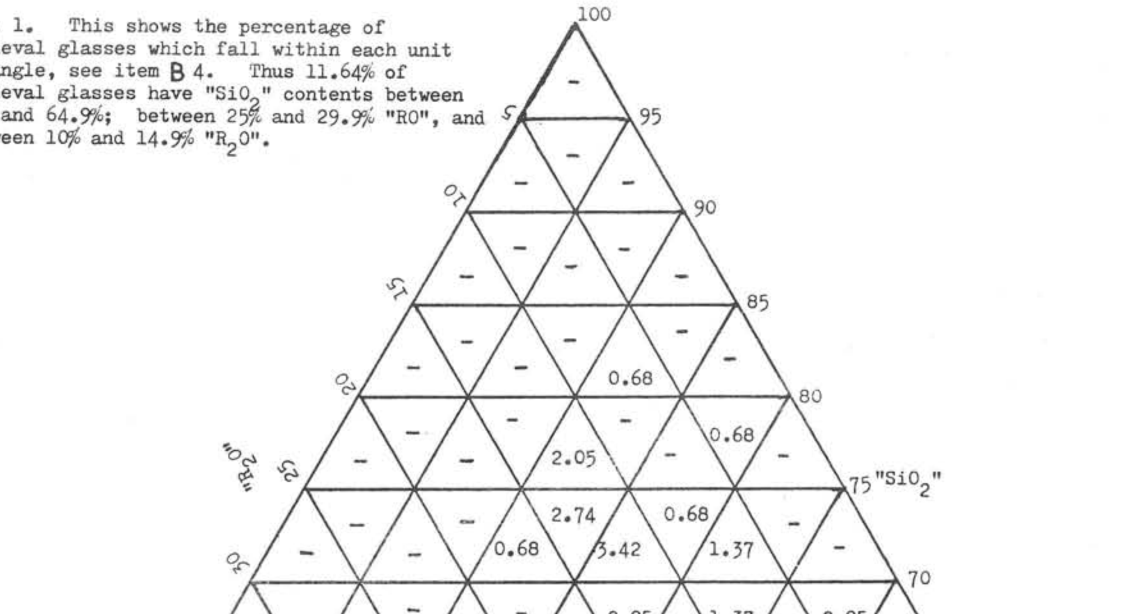
3.12 This work has confirmed the general validity of the triangular diagram for representing the durabilities of glasses, but it has drawn attention to three features which need reconsideration: these are the lack of equivalence (even on a molar basis) between sodium and potassium (K_2O glasses have only half the durability), between calcium and magnesium, and when protective surface layers form.

4 New simulated medieval glasses

Briggs also carried out a computer analysis of the compositions of medieval glasses and his results are shown in Fig.1, which will be of interest to all glass technologists. The number in each triangle shows the percentage of medieval glasses which fall within each unit triangle, defined by a 5% change in the molar percentage of "SiO_2", "RO" and "R_2O". These results convinced Briggs that the ten ESF glasses are not truly representative of medieval glasses* and he is proposing to melt two new series of glasses which, for example, will contain more Al_2O_3 and more P_2O_5 than in the ESF glasses. The results of his further work will be awaited with great interest.

*Note by the Editors: These glasses were not intended to be representative of all medieval glasses, but they served two purposes (i) to help in exploring the boundaries of the medieval compositions and (ii) to provide analytical standards for calibrating equipment for chemical analysis.

Fig. 1. This shows the percentage of medieval glasses which fall within each unit triangle, see item B 4. Thus 11.64% of medieval glasses have "SiO_2" contents between 60% and 64.9%; between 25% and 29.9% "RO", and between 10% and 14.9% "R_2O".



3.3 RECENT WORK IN ITALY: CHURCH OF SS. GIOVANI E PAOLO IN VENICE

1 General

The large painted window in the south transept of this church is quite remarkable and unique in the whole of Italy, and it is the work of at least three artists. However, the painted line-work (grisaille) is often in a loose state and the window suffers from unsatisfactory restorations in earlier years.

The restoration of this window is to be financed by the Venice in Peril Fund, under the aegis of Sir Ashley Clarke, who lives in Venice. At the beginning of February a meeting was held in Venice, attended by all the interested parties. Chief among these were Dr Renato Padoan, Superintendent of Monuments in Venice, Dr Francesco Valcanover, Superintendent of Works of Art in Venice, Professor Giuseppe Marchini from Florence, and representatives from the Stazione Sperimentale del Vetro (S.S.V.) in Murano. In addition, technical and administrative advice was available from Dr Bernard Feilden, CBE, Director of ICCROM, Mr Dennis King, MBE, of the Norwich glass restoration centre, and Professor Roy Newton, OBE, of the University of York and a Vice-President of the CVMA.

2 Analyses of the glass.

The 2½ days of discussions were very fruitful and cannot adequately be summarised in this short note. However, analyses carried out by the S.S.V. showed that the glass in the window came from at least three different sources; (a) high soda (16.5-19.5% Na_2O), low potash (2.0-3.0% K_2O) glass which originated in Murano; (b) high potash (15.5-19.7% K_2O) glass with very little soda (0.3% Na_2O) which had been made on a forest site, presumably in Germany, and (c) glass where the ratio of Na_2O: K_2O was 2:1 and which is certainly later than type (b). The only glass which had deteriorated badly was type (b) and this had a white crust which contained gypsum and syngenite.

3 Analyses of the paint (grisaille)

All of the original paint was of a low-melting type containing lead oxide, with potash as the alkali, and the pigmentation contained iron, copper, cobalt, nickel and zinc (the last three were not all present in every sample). An interesting feature was that three kinds of original paint were identified, but they were not related to the different glasses in a simple manner. For example, the paint which contained cobalt and nickel (in addition to copper and iron) was found on glass of types (a) and (c), whereas the paint which contained some zinc (and also phorphorus) was on one of the samples of type (b) and it protected this glass against the white powdery corrosion. The paint which contained only iron and copper was found on glass of types (a) and (c).

One of the problems is that the grisaille had been re-touched during one of the restorations, using a bitumenous "cold" paint which is partially soluble in acetone. In some cases it was this overpainting which was lifting from the glass, and in other cases the organic layer had caused badly-fired grisaille to become detached, but the complete situation has not yet been surveyed in detail.

4 Future action

It was agreed that a team of three local experts should supervise the future work to be carried out. The team leader is Dottoressa Serena Romana, from the Superintendency of Monuments, and she will be given specialised technical assistance by (i) Dr Lorenzo Lazzarini, of the Superintendency of Works of Art, who has facilities such as gas chromatography at the Laboratory in S. Gregorio, and (ii) Dr Marco Verita of the S.S.V., who will supply the specialised knowledge about glass technology, and has facilities such as X-ray fluorescence analysis.

The philosophy which will guide this team is:

(a) to preserve the artists' work in the position it was designed to occupy (i.e. in the south transept) and to carry out the restoration so that the restored glass will have the correct light values, even though the window will be lighter than at present;

(b) to retain the original material as far as possible; ascertain the technologies used; and record the history of the window and its previous restorations;

(c) to report the restoration in as full a manner as possible (fuller than is required by the CVMA), for example by recording the presence of dirt; cracks and holes; rust stains; corrosion, pitting and scratching; and the condition of the paint;

(d) to examine all possible methods of re-affixing the loose paint;

(e) to replace the present iron ferramenta by bronze T-bars and saddle bars.

4. problems of conservation and restoration at canterbury

PROBLEMS OF CONSERVATION AND RESTORATION AT CANTERBURY: A REVIEW OF FORMER AND CURRENT PRACTICES

Madeline H. Caviness

English Summary

Previous restorations of the glass of Canterbury Cathedral involved some falsification, especially in supplying new pieces which were made to look old, but there was little repainting of the original glass to strengthen the design, and cleaning was not so thorough that it removed paint from the outer surface.

Modern methods, in use since the new Restoration Centre was set up in Canterbury in 1973, have, however, involved experiments in which original glass has been repainted to improve the design, and cleaning which has severly damaged the paint on both surfaces. The use of painted backing glasses covers up any paint loss which may occur in cleaning, and renders the original

glass inaccessable to the viewer; but these, at least, can be removed again. Now under consideration by the Advisory Committee is a policy to allow the restorer to paint directly onto the original glass with reversible pigment, in order to supply missing parts of the design.

A question that has once more been raised at Canterbury deserves the serious attention of all art historians, conservators and scientists working on medieval glass: That is, should any attempt be made to paint in detail that has been lost on the original piece of medieval glass? The question will no doubt be hotly debated.

This notice is intended to supply information on the various methods and policies thus far employed in Canterbury. Having a year ago completed the text and plates for the Corpus volume on Canterbury Cathedral, I am in a position to present an overview of restoration practices from the nineteenth century to the present time.[1] As one would predict from the general situation elsewhere, it was the norm in the nineteenth century--up to about 1890--to replace damaged original pieces by modern copies; George Austin (active 1848-1862)

1. Detail of Abia from the clerestory, ca. 1200; head repleced by Austin, ca. 1860 (photo: Victoria & Albert Museum). Inset: Original head, now lost (after Rackham).

was expert in his rendering of pastiche late Romanesque styles, but now his work appears dated; in some cases, for instance where Rackham published the original head of Abia, since lost, it is possible to see how far the painter interpreted the original design in his copy (fig. 1).[2]

In this century some extremely misleading restorations were carried out by Samuel Caldwell Jr., but most of these involve panels made up from glasses that are in part old, in part treated with acid and a false patina to look old.[3] In some of these panels old glass was used as a palimpsest, that is the original paint was cleaned off, or turned to the outside, and a new design painted on it. Much old glass was thus refired, in the wood kiln at the Blackfriars studio. However, the practice of repainting medieval glass in order to strengthen the original design was very seldom used; I illustrate a rare example, where it is apparent that the white drapery over the shoulder had deteriorated on the inside to the extent that the unpainted areas were deeply excavated; probably the ridges which marked the position of the trace lines no longer had any paint on them, and it is here that the restorer applied his brush; no modelling washes were supplied so the result is dry and expressionless (fig. 1). On the whole the Caldwells preferred to make their modern pieces look old, by immitating the appearance of old paint. No measures were taken to protect the ancient glass, except in the occasional use of backing glasses to support edge-mended pieces. Since patina was admired for its mellow effect, little attempt was made to clean the glass, except for a light sponging with water.

After a complete break in the continuity of restoration work at Canterbury, following the retirement of Samuel Caldwell Jr. and his assistant in the 1950's, a new atelier was set up in 1973 that is devoted almost entirely to working on the Cathedral glass. Study of the glass from exterior and interior scaffolding in 1967 and 1971 had precipitated widespread concern about the condition of the glass; much of this concern was reported in the 1972 CVMA Colloquium.[4] In view of the pressure of work at other centers in England, notably in Norwich and York, and the hazard posed by transportation of the Canterbury glass, the decision was made to create a new center close to the Cathedral. However, there was no personnel available with experience in handling and treating ancient glass, and it was considered necessary to train new people, and to place the operation of the center under the scrutiny of an Advisory Committee; it was the intention of the Committee that trained personnel from the continent would spend a period of time in Canterbury in order to familiarize the new team with the best accepted methods of glass conservation, but this alliance never took place. A stained glass artist who had trained at the William Morris Studio and who had had a full career as a practicing designer assumed responsibility for the Centre. His aesthetic philosophy had been formed long since, as quoted by Armitage.[5]

Since 1973 a series of experiments have been conducted. In each case important original panels have been risked. One of the first experiments involved "improvements' to the face of Elizabeth Woodville, a portrait of the queen executed during her lifetime. A piece that was already missing through the neck and jaw in 1789 had been replaced subsequently, and edge-mended to the original fragments; some paint-loss had

2. Portrait of Queen Elizabeth Woodville, ca. 1485; state in 1945 (after Rackham).

occurred at the upper lip at the time of the fracture (fig. 2). Mr. Cole elected to clean and re-fix the edges, using araldite for the bond, which he cured at 100° F in the kiln. He then repainted the mouth, principally touching in the deficient upper lip (fig. 3). Extant contemporary portraits were not consulted. It is not known whether the pigment used, though applied cold, is reversible without damaging the original paint.

Since that time it has been the policy of the Advisory Committee to allow the restorer to supply painted details that are lost in the original only on backing glasses; this has had the advantage of leaving the original undisturbed and intact, while "completing" the image; at such time as responsible art historical opinion prevails, the backing plates can be removed (figs. 4, 5, 6). The solution was a compromise. It was arrived at only after examination of several pieces that had been plated in the 1940's and a report by Dr. Newton to the effect that moisture had not penetrated between the old and new glass; in any case the decision to provide exterior protective glazing at Canterbury considerably lessens the chance of such backing plates holding moisture against the ancient glass. One might, however, question the great expense of making these plates in view of the probability that a more enlightened administration will require their removal. And clearly, in some cases, the expense has been needless; for instance the white stop-gap with a fan of drapery folds

3. The same, after cleaning, refixing, and repainting in 1975.

which had been used in Neri's lower stomach was strengthened in this way, though it had no meaning in the design (fig. 8).

The use of painted backing plates raises another serious question, that of adequate documentation. The policy is adhered to in principal (with, to my knowledge, only a few lapses in practice) that the glass is photographed in controlled light conditions, panel by panel, before treatment; it is also photographed, in the same conditions, after restoration. However, no record is made after cleaning and before the original glass is leaded together with the backing plates; in other words, there is no way to know how much of the original paint is lost in cleaning and then "replaced" on the backing plate. It is thus impossible to know how much of the pigment we now see on the face of Joanna or Neri is new and how much original even if we compare the pre-restoration and

4. Head of Joanna from the clerestory, ca. 1180, prior to restoration.

5. The same, after restoration.

6. Painted backing plate used in the restoration (figs. 4-6 after Nature/ Science Annual, 1978)

post-restoration photographs (figs. 4, 5, 8, 9); the heavy trace on the backing plate alters the character of the original (fig. 6). This leads me to the second kind of experiment conducted at Canterbury, that of re-surfacing the ancient glasses.

The methods of cleaning in use in 1975 were fully published in the Smithsonian;[6] they were a revelation to several members of the Advisory Committee. The full process involved: 1) Soaking in deionized water 2) Removal from the leads 3) Cleaning in an ultrasonic bath with ammonia and deionized water 4) Airbrasive cleaning of the outer surface. This stage was often entrusted to volunteer helpers, and no indication was given to them whether back-painting was present; a great deal of paint was removed in this era, for instance from the drapery of Phares (figs. 7, 10). 5) The inner surface, acknowledged to be painted, was protected by running an epoxy resin and acetone solution over the trace-lines; the rest of the surface was thoroughly cleaned with a high-speed fiber glass brush. Noone executing this operation knew that medieval glass painters used a three-tone layering of pigments and that they should watch for modelling washes next to the trace-line. Nor did they work with photographs beside them to help in deciphering the painted design; each fragment was handled out of its context. 6) Acid polishing of the outer surface, using hydroflouric acid. This would be guaranteed to remove the last traces of back-painting.

7. Figure of Phares from the clerestory, ca. 1180, exterior before cleaning; note the modelling which defined the knee, since removed.

This experiment, too, caused great consternation among the Advisory Committee and the principal Foundation that was giving financial support. A moretorium was called on cleaning until there had been further consultation. When I last visited Canterbury, in 1977, I was pleased to find that much greater care was being taken to identify original paint before cleaning, though I was unable to assess any of the results.

The practice of supplying lost detail on backing glasses has continued. In many cases these glasses are colored or "tinted" to restore the supposed original color; for instance the hat of Neri, a flashed ruby that had become almost white, was restored to brilliant red (figs. 8, 9). The faces, too, are now to be tinted.

10

9

8. Detail of Neri from the clerestory, ca. 1180; after restoration, 1975 (photo: Canterbury Cathedral Restoration Centre).

9. Head and hat of Neri during restoration: before cleaning. 10. The same, exterior: note the paint on the beard and hair (after Nature/Science Annual, 1978,

Finally, the question has been raised again whether Mr. Cole may dispense with backing glasses and once more paint on the original glass. Mr. Rees-Jones, Professor Emeritus in the Department of Technology of the Cortauld Institute and a specialist in the restoration of panel paintings is to "demonstrate the replacement of lost painted work using a pigment which could be easily removed in the future if necessary;" he is currently working on a piece of border. The imminent possibility that a policy of repainting the original glass may be adopted seems to call for a complete survey of current opinions and practices.

My own view is unequivocal. As to the claim that the original distribution of paint on the surface of the glass may, in some cases be demonstrated "scientifically" (eg. under the microscope), this does not make it possible to paint in a line of the same density or expressive quality as the original; any new painting is interpretive. And we do not have the right arbitrarily to contaminate and falsify historical evidence, above all not in the name of conservation. Our duty, clearly, is to preserve whatever has come down to us of the original, intact. "Restoration" is inevitable in stained glass when there is a structural defect (lead or glass missing) and the manner in which such gaps are filled--whether by plain glass as in York or colored glass painted in the style of the rest of the window as in many centers--is a matter of opinion; restoration that goes beyond that, to tamper with the appearance of the original parts is not only inacceptable in this century on historical and aesthetic grounds, but may be at variance with conservation. For instance, in the case of reversible pigment which is applied to complete a trace-line that is partly lost, the original pigment is likely to be loose adjacent to the area of loss, so that the new pigment will penetrate under it. If the new paint is later removed, as it is likely to be since the next generation will find this interpretation dated, more original paint will be removed with it. In short, such experiments are extremely costly.

1. See also M. H. Caviness, The Early Stained Glass of Canterbury Cathedral, Princeton, 1977, 16-22.

2. Bernard Rackham, The Ancient Glass of Canterbury Cathedral, Canterbury, 1949, Fig. 50a. In 1975 I identified the original head and hands of Zerobabel, used to make up a figure in the north east transept; they were to be returned to the original figure.

3. Eg. Rackham, Frontispiece, Pls. VII, XI, XIII, Figs. 22, 23, 26, 27a.

4. P. A. T. Burman, "Corpus Vitrearum Medii Aevi," The British Society of Master Glass-Painters Journal, XV, 1972-73, 27-33.

5. E. Liddall Armitage, Stained Glass: History, Technology and Practice, London, 1959, 181-82.

6. Maureen Green, "New Life for famous old stained glass in Canterbury Cathedral," Smithsonian, 6, June 1975, 28-37.

"PROBLEMES DE CONSERVATION ET DE RESTAURATION À CANTERBURY: CHRONIQUE DES METHODES ANCIENNES ET ACTUELLES."

par M. Grodecki

Les restaurations de la vitrerie de la cathédrale de Canterbury, antérieurs à 1960, comporèrent de graves altérations, en particulier dans le remplacement des verres perdus ou cassés par des pièces neuves, vieillies artificiellement à l'acide ou à la patine, et peintes dans un style imitant celui du Moyen Age. Par contre, il y eut peu de repeints sur les verres originaux, repeints destinés à renforcer le trait, et il semble que les nettoyages s'endommagèrent pas la grisaille posée à l'extéreiru du verre.

Depuis 1973, le nouveau Centre de Restauration dirigé par M. Frederick Cole, a utilisé des procédés plus ou moins centestables et dommageables pour le verre. On employa des repeints à froid et des nettoyages par des moyens mécaniques et chimiques qui ont eu pour résultat la perte d'une grande partie de la grisaille sur les deux faces du verre. Après l'arrêt de ces méthodes de restauration, on doubla les verres altérés par des verres peints pour suppléer aux manques de la grisaille, mais cette technique rend l'examen du verre original impossible.

Bien que les verres de doublage puissent être enlevés lors d'une restauration future, ce procédé est long et coûteux. C'est pourquoi, la politique actuelle du Comité Consultatif est de permettre à nouveau au restaurateur de peindre directement sur le verre ancien avec une peinture à froid réversible, pour restituer la grisaille disparue.

5. book reviews

THE STAINED GLASS OF SAINT-PÈRE DE CHARTRES
by Meredith Parsons Lillich

This sumptuously produced book studies the stained-glass windows of Saint-Pere de Chartres, a parish church which before the French Revolution was the church of an important Benedictine abbey. The windows, their splendor apart, are significant for a number of reasons: they are a complete set, in itself a rare circumstance; they follow a sophisticated yet homogeneous subject programm maintained through a period of construction that spanned several generations; they straddle the line between the glowing, color-saturated gloom of the early thirteenth century and the clear, light-passing glass of the fourteenth.

The windows are analyzed from the perspectives of historic documentation; stylistic relationships, both intrinsic to this set and with other monuments; and iconography. The section on iconography involves a most thorough presentation of the development of these subjects in France at this period.
The book is a monograph on a little-known ensemble of stained glass windows; its importance lies in its definition of a style hitherto unrecognized, one of the major styles of Gothic French glass painting.

Meredith Parsons Lillich is Associate Professor of the History of Art at Syracuse University.
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6. abstracts

345. PEREZ-Y-JORBA, M., DALLAS, J.P., COLLONGUES, R., BAHEZRE, C., and MARTIN, J.C. (1978) "Étude de l'alteration des vitraux anciens par microscopie electronique a balayage et microsonde" (Study of the weathering of ancient windows, using the scanning electron microscope and the microprobe) Silicates Industriels, 1978, 43, 89-99.

The authors have produced another of their excellent studies of the weathering of glass, where sections have been cut of corrosion pits and the contents have been analysed with the electron microprobe. Their Fig.3 shows the distribution of K, Mg, Na, Ca, S, Si, Al & P in a pit in 13th century glass from Amiens Cathedral; the first three are completely absent from the pit, though present in the glass, and the last three are generally present fairly uniformly. The sulphur is present only in the fissures of the contents of the pit and does not reach the surface of the unaltered glass; Ca and P are deficient in a wide band near the surface of the unaltered glass.

The case of the weathering crust on the internal face of 13th century glass from Evreux Cathedral (Fig. 4), where the potash content of the glass is higher (18%) than at Amiens, is different because the sulphur is no longer restricted to the fissures but is distributed in an almost homogeneous manner. On the external face of the Evreux glass (Fig. 5) the sulphur is again associated with fissures in the crust.

There is an important discussion of the relative solubilities of ten different possible weathering products (the hydroxides, carbonates, bisulphites, sulphites and sulphates, of calcium and magnesium) in an attempt to explain the reason for the layer near the glass which is deficient in calcium and the complete absence of magnesium according to the hypotheses of R.G. Newton and N.H. Ray; the former considers that hydroxides are formed first and the latter considers that bisulphites are formed first (but see abstract No.355 below).

The final part of the paper considers the effects of cleaning agents, and Figs 10 and 11 show how a 16th-17th century window from Beauvais Cathedral was damaged, apparently by a metal brush, during an earlier restoration, and these scratches have corroded. In another example (Fig.12) scaling and fissuring of the surface of glass from l'Aube Cathedral is similar to the damage caused when glass is cleaned with hydrofluoric acid. (Commentary by Roy Newton).

346. COX, G.A., HEAVENS, O.S., NEWTON, R.G. and POLLARD, A.M. (1979) "A Study of the weathering behavior of medieval glass from York Minster', J. Glass Studies, 1979, 21 (forthcoming).

The authors analysed 199 samples of medieval glass from York Minster, using energy-dispersive X-ray fluorescence analysis.

This study suggests that medieval glasses do not weather noticeably in 500 to 800 years, provided the "SiO_2" content is larger than 60%. In such cases it seems to be immaterial whether the balance of the glass is made from "R_2O" or from RO, at least within the limits 4%-16% "R_2O" and 23%-35% RO. In this compositional region significant differences are found between glasses of different ages; for example, the average alkali content decreases from a value of 12% "R_2O" for twelfth-century glass (25.5% RO) to 10% for fourteenth-century glass (27% RO), and 8.5% "R_2O" (29.5% RO) for glass from the fifteenth century.

In glasses made toward the end of the medieval period, especially in the fifteenth century, pieces are found which contain much less than the usual amount of magnesia (4.5 to 5.7% MgO, compared with 8 to 11%). These have a relatively superior durability and seem to have had a different place of origin because they also contain less than the usual proportion of potash in the alkali. There is also a very rare kind of blue twelfth-century glass which contains an exceptionally large amount of silica (about 72% "SiO_2") and a high proportion of soda in the alkali; these pieces also must have had a different place of origin.

When the silica content falls below the level required for resistance to weathering, then either pitting or crusting can occur. There is a marked change in chemical behavior because the replacement of silica by "non-bridging" ("R_2O") oxygen atoms now seems to be about twice as damaging to the durability as replacement by "bridging" (RO) oxygen atoms. Within this compositional field, pitted glasses can have less than 60% "SiO_2" and crusted glasses rarely have more than 60% "SiO_2", but if they do, then the "R_2O" content will generally be above 13% because the "SiO_2"/"R_2O" ratio tends to be about 4.5 for crusted glasses. Unweathered glasses (except the rare blue 'extra-durable' type glass) rarely contain as much as 13% "R_2O".

The boundaries of the compositional areas seem to be quite critical and it can now be more readily understood now one piece of glass (e.g. their No.250) can have half of its area unweathered, and half markedly pitted.

In the compositional regions for pitted and crusted glasses, the differences in average composition for glasses of different ages tend to disappear. For example, crusted glasses have "SiO_2"/"R_2O" ratios around 4.5, and hence it is only those fourteenth-century glasses having the higher alkali contents which form crusts; fifteenth-century glasses form crusts so rarely that examples are difficult to find. (Only one was discovered.)

In the light of these conclusions, pitting is now regarded solely as a less-severe form of crusting, accompanying a somewhat lower "R_2O" content and hence a higher "SiO_2"/"R_2O" ratio. This is borne out by the existence of many pieces which could not be described as being either pitted or crusted. (Abstract by Roy Newton)

347. HENCH, L.L., CLARK, D.E. and YEN-BOWER, E.L. (1979?) "Surface-leaching of glasses and glass ceramics" (forthcoming)

This is a particularly interesting technical paper concerned with predicting the durability of glasses, based on modern accelerated-weathering tests and on observations made on glasses which have been buried for various lengths of time, from about 300 years to 1700 years and, in the case of chert, for 30 000 years! The work was funded by the Nuclear Regulatory Commission in the USA, but most of the ancient glasses were derived from British sources and it is therefore a good example of co-operation between the USA and the UK. The work was carried out to help in predicting the behaviour of glasses used for the encapsulation of nuclear waste material but medieval and Roman glasses were included and hence the results are of interest to conservators.

Water was used as the "attacking agent" to produce corrosion of the glass and the extent of weathering was assessed by measuring the thickness of the leached layer on the surface. Great attention was paid to the ratio of the surface area (SA) of the glass and to the volume (V) of the water used. A small volume of water produced greater attack on the glass than a larger volume of water (because the alkalinity increased more rapidly in the smaller volume). Thus a high value of SA/V produced rapid attack on the glasses and a low SA/V value produced slower attack. But all the glasses were attacked to some extent. The chemical composition of the glass, the roughness of its surface, and the presence of scratches were also of importance in affecting the rate of attack by the water.

The success of this work was made possible by the introduction of new instrumental analytical techniques; ion-beam spectrochemical analysis (IBSCA) is so sensitive that the relative durabilities can be determined on different parts of the surface of a single piece of medieval glass. Moreover, no glass is so durable that its weathering rate cannot be detected by IBSCA. For example, the corrosion rate of the very durable Pyrex glass was found to be 0.02 µm per day in distilled water at 99°C, whereas bottle glass corroded at the rate of 0.18 µm/day under the same conditions.

They found that a marked change in the kinetics of the attack on glass by water occurred when the pH reached a "critical value" at some point between 8.5 and 9.5, depending on the composition of the glass. It was also found that certain materials, such as alumina, had a strongly "passivating" effect on the glass (the durability was greatly increased) when it was present either in the water or in the glass. (Commentary prepared by Roy Newton.)

348. OLSEN, D.A., JOHNSON, R.E., KIVEL, J. and ALBERS, F.C. (1969) "Kinetics of leaching lead glass by ethylene diamine tetraacetic acid" J.Amer.Ceram.Soc., 1969 52 318-322.

This paper provides a warning that glasses which contain lead oxide can be attacked by EDTA solutions, even at pH=7. A silica-enriched layer remains on the surface and an increase in effective surface area takes place, indicating that "honeycombing" or roughening of the surface has occurred. (Note by Roy Newton)

349. PAUL, A. (1978) "Influence of complexing agents and nature of buffer solution on the chemical durability of glass. Part 1. Theoretical discussion. Glass Technol., 1978 19 162-5.

This rather theoretical paper shows that the attack on glass by water depends on the nature and concentration of the buffering ions in the water, as well as on the pH value. When EDTA is used for cleaning glass, the effect on alumina in the glass is a maximum at a pH value of 5.5, much lower than is generally believed.

350. PAUL, A., and YOUSSEFI, A., (1978)"Influence of complexing agents and nature of the buffering solution on the chemical durability of glass. Part 2. Effect of EDTA, ethyl alcohol, and sugar in the leach solution.

This paper, originally abstracted in N.L. No.26, as No.295, has now been published in Glass Technol., 1978 19 166-170. The authors show that EDTA will extract both lead and potash from glasses which contain lead. Ethyl alcohol also forms soluble complexes with lead, and twice as much lead is extracted by a 50% alcohol solution than by water alone but, in time, a protective layer of ethyl silicate forms on the surface. In the absence of lead, the alcohol greatly reduces the attack on the glass due to the formation of ethyl silicate. The addition of sugar to water can double the extraction of lime from glass.

351-356. MEETING OF THE GERMAN ENGINEERS' ASSOCIATION ON EFFECTS OF SULPHUR OXIDES ON MATERIALS (Verein Deutscher Ingenieure, VDI - Kommission Reinhaltung der Luft. Kolloquium Sauerstoffhaltige Schwefelverbindungen) Augsburg 30 May - 1 June 1978.

Many papers were given to this Colloquium and it appears that, although sulphur dioxide will attack stonework and other materials, and affect plant life, it does not seem to harm people when present in the concentrations found in polluted air. A few of the papers are abstracted below:

351. BATTIGELLI, M.C. (1978)"Realistic assessment of respiratory effects of SO_2 and sulphates", p.52.

The author states: "Unequivocal effects caused by ... SO_2 are not clinically evident nor have ever been documented. Effects of this sort have been claimed or conjectured but they have not been proven or documented by any controlled observation study." There is no evidence that SO_2 affects human subjects at concentrations below 500 $\mu g/m^3$. (Abstract by Roy Newton)

352. FERRAZZINI, J.C. (1978) "Die Einwirkung von Schwefeloxiden auf mittelalterliche Glasgemälde" (The effect of sulphur oxides on medieval painted glass), pp37-40.

The chemical composition of the glass determines its resistance to attack by atmospheric agents. Many medieval glasses are no longer able to withstand present-day atmospheric impurities and are decaying with varying degrees of rapidity. Particularly at risk are unprotected painted glasses which are continually exposed to weathering. These valuable works of art become opaque and lose their radiance and visual impact beneath thick weathering crusts.

Forest glasses, with their high potash content, are particularly vulnerable and the resistance of a glass can largely be explained by its compatibility with acids; it is on this that the basicity value depends. The basicity of both a melt and of the cooled glass increases as the alkali content rises and in the sequence Li-Na-K.

Atmospheric impurities - taken as a whole - are acid and represent a significant danger for highly basic forest type glasses. This chemical reaction is an ion exchange which reduces the amount of alkali ions in the glass. The alkali ions which have been set free emerge on the surface of the glass and are washed away by rain water. During the leaching of soda-lime glasses in a temperature range below 80°C a water molecule also enters the glass structure with about every third proton. This is one reason, among others, why restorers should never heat ancient glasses, as even material which appears to be intact can suffer unforeseeable damage if it dries out.

The worst atmospheric impurities for stained glass in today's polluted air are sulphur oxides. With water these gases form acids. In the presence of oxygen and, for example, iron as catalyst (both present in sufficient amounts in the atmosphere) sulphurous acid and sulphuric acid can be present alongside each other. The weathering crusts on the outside of the glass contain the mixed sulphate syngenite ($K_2SO_4 \cdot CaSO_4 \cdot H_2O$) and careful analyses enable conclusions to be drawn about the direction of flow of the rain water. It thus becomes possible to make statements about the position of a piece in the panel once it has been removed; which part was at the top and which at the bottom.

Slight leaching, of the kind which can be observed on all glass, even modern material, does not have any harmful effect. On the contrary, the surface becomes impoverished in alkali ions and thus more resistant. However, if the reaction gets out of control, as is so often found with forest glasses having an alkali content of more than 15 mol%, then leaching causes a weakening of the glass network. The corrosion phenomena described were checked by means of laboratory investigations and the synthetic weathering crusts compared with natural corrosion products.

The author concludes that atmospheric agents and especially sulphur oxide, when present in extremely high concentrations, have an overwhelming effect on painted glass so that unless protective measures are taken these valuable examples of medieval culture will be destroyed in the foreseeable future. (Abstract prepared by Roy Newton)

353. FRENZEL, G., and ULRICH, Eva (1978) "Führung durch den Augsburger Dom - unter besonderer Berücksichtigung der Glasmalerei" (A guided tour round Augsburg Cathedral, paying particular attention to the stained glass.) pp.41-2.

Rather surprisingly, for a contribution to a symposium on air pollution, this paper is exactly what it claims to be: a guided tour of the Cathedral in which the history of the building is described, the five prophet windows, etc., without any mention of SO_2. No doubt it was provided for the benefit of the delegates at this Symposium held in Augsburg. (Commentary by Roy Newton)

354. LANDAU, E. (1978) "Basis of the U.S. Standard for SO_2 and the recent state of discussion", pp.59-60.

The author discusses the way in which the "national primary ambient air quality standard" (NAAQS) was set up and how, as with all studies of epidemics, it has its limitations. He concludes "... We are not able to specify the role, if any, played by sulphur dioxide." He also finds no evidence that ozone and SO_2 (0.37 ppm of each pollutant) had any effects, or that SO_2 is a co-carcinogen. (Abstract by Roy Newton)

355. PENKETT, S.A. (1978) "Oxidation of SO_2 in the liquid phase" pp.12-13.

This rather technical contribution contains an interesting comment that oxidation of SO_2 can occur in stored rainwater because it contains small traces of manganese ions. "This is completely different from the kinetics in distilled water solutions and demonstrates the importance of using rainwater for these studies." (Might this kind of effect sometimes be important in conservation work?)

The author also found that, even in "clean" air, any SO_2 will be oxidised very rapidly, so that we need to consider the presence of sulphuric acid (and sulphates) rather than sulphurous acid (and sulphites). "The reactions are probably complete within a few minutes at $10^{\circ}C$ and allow sufficient sulphate to be formed to account for most of the levels observed in rainwater within the expected lifetime of a normal cloud system"

This paper suggests that SO_2 is not available in the atmosphere to form the sulphites or bisulphites which are discussed in abstract No.345, above, and the hypothesis of N.H. Ray may be wrong. (Commentary by Roy Newton)

356. SCHIMMEL, H. "Evidence for possible acute health effects of ambient air pollution from time series analysis: Methodological questions and some new results, based on New York City daily mortality 1963-76, pp.54-5.

The 14-year period, 1963-76, is of special interest because the SO_2 levels fell greatly, the average in the first half of the period being approximately 5 times as much as in the second half. There was no significant statistical association between daily SO_2 and daily mortality when the data were corrected for other known effects, such as the temperature. The author goes on to state "The SO_2 standard which was nominally and erroneously set on the basis of health considerations does not stand up in the face of the new situation when one considers the high economic burden of the present electricity costs ..."

357. LILLICH, Meredith (1978) The Stained Glass of Saint-Père de Chartres, Middletown, Conn., Wesleyan University Press, 1978, 212 pages, 12 color plates, 101 black and white plates, 15 figures, bibliography, index.

A monographic study of the stained glass of the church of the former Benedictine abbey of Saint-Père (now the parish church of Saint Pierre) in Chartres, France. The remaining windows occupy the clerestory and choir triforium and date ca. 1240 to ca. 1315. Chapter I presents documentation of the abbey and its building programs and restorations. Chapters II-V contain stylistic analyses of three groups (choir, hemicycle, nave), including the development of grisaille and of the "band window" formula. Relationships to other ensembles in the Western French school of stained glass: Cathedrals of Le Mans, Tours, Sées; former abbey-churches of La Trinité de Vendôme, Evron. Chapters VI-IX study the iconographic program, textual and visual sources, relationships to French and non-French iconographic practice in the Gothic period. (Author's abstract.)