(CV) NEWS LETTER 17

Corpus Vitrearum Technical Committee

Physics, University of York | 27 November 1975 | Ref. TC/75/8

CONTENTS

1 GENERAL

1.1 CORPUS VITREARUM

Some significant changes were agreed at the Corpus Colloquium held in Paris from 8th to 12th September.

First, the words "Medii Aevi" have been dropped from the title. Thus the Corpus Vitrearum can now concern itself with stained glass later than AD.1500 and this means that Holland can participate because the important glass at Gouda is of the 16th century; in fact, Holland has now been elected as a Member of the Corpus.

Second, more money can be sought (in the UK) for helping in the conservation work because some charitable trusts do not give money for medieval studies.

Third, new Statutes were adopted. These have been discussed during the year, first by CIHA on 5th April, then by the UAI at its meeting on 17th June, again (with modifications) by CIRA on 3rd September and finally by the Corpus on 9th September.

The officers of the Corpus were elected on 12th September, as follows:-

President: Professor Louis Grodecki (France)
Vice Presidents: Dr Rüdiger Becksmann (Federal Republic of Germany)
Frau Dr Eva Frodl-Kraft (Austria)
Professor Roy Newton (United Kingdom)
Secretary: Madame Françoise Perrot.

The membership of the Technical Committee is being revised under the Chairmanship of Professor Roy Newton with M J.M. Bettembourg as Secretary. An active programme of work is envisaged and Czechoslovakia has now appointed a representative, Dr Ludvíck Losos who is both a chemist and an art-historian.

Other significant changes are also expected because Professor Roy Newton has made a personal approach to the European Science Foundation for support for research activities in the field of conservation of windows. The ESF has responded with a proposal to set up a Study Group for this purpose and we look forward to a stimulating exercise in this direction.

1.2 THE PARIS COLLOQUIUM, 8-12 SEPTEMBER 1975

1.2.1 General

This Colloquium was an unforgettable experience for all those who attended it. Underlying the whole week, of course, was the background of marvellous French hospitality whereby everything was arranged for us, the coaches, the meals, the directions, the attractive guides from Champs, the overall planning, the twin projectors for the lecturers, the opportunity of experiencing a "buffet campagnale" at the Château de Champs, and the smoothness with which everything ran.

Each person will have had his own high-lights. For me the supreme moment was that of seeing the restored Jesse window at Chartres because I like to see stained glass windows which glow and let light into the building as they surely did in the 13th century. Moreover, it was a great relief to discover that the coating of Viacryl VC363 on the exterior could not be detected; it did not have the shiny surface which might have been expected. Another fascinating moment was when we saw, Phoenix-like, the new Centre International du Vitrail arising from the ruins of the 13th century building through the efforts of the City of Chartres, MM. Pierre Firmin-Didot, Jean Taralon and the chief architect, M.G. Nicot; Chartres will then have a centre of learning and of documentation to add to its other wonderful attractions, including the église Saint Pierre de Chartres which we also visited.

I was not able to visit the ateliers operated by Mme Gaudin and M Gruber but those who did so were fascinated by seeing the marvellous panels at close quarters. The next high-spot for me was the three Technical Sessions; their contents are listed in Section 1.2.2 but useful and stimulating discussions were evoked by them all.

1.2.2 The Technical Programme

This is merely a list of the contributions for the benefit of those who could not be present; they will all be published within a few months and will be abstracted in the News Letters.

Monday 8th September in the afternoon

1. Dr J.C. Ferrazzini "The influence of corrosion on the spread of deterioration of medieval glasses".

2. Professor R.G. Newton "Using triangular diagrams to understand the behaviour of medieval glasses". (See Abstract No.205.)

3. Ir J.M. Bettembourg "Composition and weathering of ancient window glasses".

4. Professor Collongues, Mme Perez, M. Tilloca and M. Dallas "Some aspects of the phenomenon of corrosion of ancient glasses from French churches". (See item 2.1 below.)

Tuesday 9th September in the morning

5. Dr Martha Spitzer Aronson "A study of ruby glasses from medieval windows".

6. Dr W.P. Bauer "The effect of cleaning techniques on glass surfaces".

7. Mr Dennis King "Problems encountered in the conservation and restoration of windows".

8. Professor G. Marchini "The problem of restoring paintwork".

9. Mr T. Husband "The restoration by the Cloisters (Museum) of six panels of a stained glass window".

Tuesday 9th September in the afternoon

10. Dr Eva Frodl Kraft "Some remarks on the science and craft of restoring stained glass". (See Abstract No.202.)

11. Dr Jane Hayward "Installation of the St Leonhard glass at the Cloisters - protection and conservation". (See Abstract No.203.)

12. Professor R.G. Newton "Experimental studies of the protection of medieval windows using external glazings". (See Abstract No.206.)

13. Ir J.M. Bettembourg "The protection of ancient window glasses and the conservation of the paintwork; the use of synthetic resins".

1.2.3 Acknowledgments

So we have to thank our new President, Professor Louis Grodecki, and the French Inspector General of Historic Monuments, Jean Taralon, for having the inspiration to devise such a marvellous programme, and ICOMOS, ICOM and the Rome Centre for helping to implement it. Also J.M. Bettembourg and all the people at Champs for helping to assist it so effectively at every point, and for demonstrating the interesting research work at the Laboratoire de Recherche des Monuments Historiques, covering not only stained glass but also stone, paintings, polychromed wood, murals and palaeolithic cave drawings. Special mention of course must be made of our charming polyglot, Françoise Perrot, who was an untiring translater, diplomat, pacifier and even vigilante.

1.3 KIRKBY WHARFE CHURCH

Page 2, column 1, of News Letter No.11 contained a comment by Dr Ernst Bacher that the 15th century glass at the small parish church at Kirkby Wharfe does not show the characteristic "English" type of weathering but has the laminar crust which is commonly found in Austria. I added a note that a study would be made of the chemical composition of this glass, and the work has now been done.

Approximate analyses were carried out on the MECA 10-6 equipment (see item 4 of News Letter No.15) by courtesy of Mr M. Jocelyn of Link Systems Ltd., 35 Spring Gardens, Buxton, Derbyshire, England. However, the glass compositions were of a type not usual in England and hence no "standard" glass was available with a suitable composition but it is nevertheless clear that (a) the glass had an "Austrian" type of composition and (b) the five pieces of glass examined fall into two groups with slightly different compositions.

The general composition was unusual because only three oxides were present in significant amounts, silica, potash and lime as shown below, the potash contents of the first group being the highest yet reported. The other oxides are present in only small amounts:- soda (Na_2O) was low, about 1%; magnesia (MgO) about 3%; manganese oxide (MnO) about 0.5% and iron oxide (Fe_2O_3) about 1%.

The main oxides were (weight percentage):-

Sample Nos.	173,174,177	175,176
Silica (SiO_2)	50	62
Potash (K_2O)	27	20
Lime (CaO)	17	11
Total	94	93

These compositions are consistent with other analyses, reported by Dr W.P. Bauer, of Austrian glasses which form crusts on weathering (Corpus samples nos. 9, 47 and 54) and thus it seems that it is the chemical nature of the glass (and not something to do with any "Austrian weather") which is responsible for the special type of deterioration. (See also Fig.6.)

The cost of removing the glass from the Church and then replacing it was met from the Pilgrim Trust Special Grant and we are grateful to the incumbent, the Reverend P. Wood, and the Parochial Church Council for their help in enabling this interesting study to be carried out.

1.4 DANGERS OF USING HYDROFLUORIC ACID

News Letters Nos. 15 and 16 both contained items on the precautions to be taken when using hydrofluoric acid. I am now indebted to Mr D.B. Honeyborne for drawing my attention to the Building Research Advisory Service Technical Information Leaflet TIL 44. This 3-page document describes the precautions to be taken in handling caustic soda, caustic potash, hydrochloric acid and hydrofluoric acid.

The document is particularly useful because page 3 contains instructions (in medical language) to doctors on how to treat injuries from hydrofluoric acid. Copies can be obtained free of charge from the Building Research Advisory Service, Garston, Watford, WD2 7JR, England.

1.5 DIRT IN THE INTERSPACE OF THE ISOTHERMAL GLAZING AT BERN MINSTER

In item 2.1.5 (p.7) of N.L. No.15 there was a comment that part of the 30-year-old isothermal glazing at Bern Minster had been inspected by Konrad Vetter and Derek White. They had found no dirt on face 3 but there was a film of dirt on face 2. Derek White wiped some of the black deposits from face 2 with a piece of white rag and then sent the rag to me.

This bit of old rag then had an eventful journey, being sent to Zurich where Dr J.C. Ferrazzini kindly subjected some of the deposit to X-ray diffraction. On heating the deposit to 300°C it glowed as the soot burnt off and the remainder proved to be anhydrite ($CaSO_4$); the original deposit was probably one third gypsum and two thirds soot. Before the rag was sent back to Switzerland, Professor Heavens at York kindly submitted the deposit to the Isoprobe and detected calcium, silicon, sulphur, iron, zinc, potassium and titanium. It seems that the bulk of the material was air-borne soot and a salt of calcium, probably limestone dust converted to gypsum by the sulphur dioxide in the atmosphere.

1.6 SPONTANEOUS FRACTURE OF MEDIEVAL GLASS

A still unsolved problem in the conservation of stained glass is the occurrence of spontaneous fracturing of one surface only of the glass (see N.L. No.8, abstract No.157). All attempts to explain it have failed to be confirmed by experiments made on the glass but I am happy to say that Dr R.B. Waterhouse, of the Department of Metallurgy of the University of Nottingham, has taken an interest in the problem. He and his colleagues will be using the ESCA (electron spectroscopy for chemical analysis) technique to discover whether there are any detectable differences in the compositions of the two surfaces. We look forward to learning whether they discover something of interest and, in this connection, four relevant abstracts (Nos. 201, 208, 212 and 213) are included in this issue.

1.7 ARE PIECES OF MEDIEVAL WINDOW GLASS THICKER AT THE BOTTOM?

There is a widespread belief amongst physicists and engineers, especially in the USA, that pieces of medieval stained glass are thicker at the bottom than at the top. This is assumed to demonstrate that plastic flow of the glass has occurred during the several centuries that the pieces have been in the window! However, it is also known that plastic flow of glass does not occur at room temperature until the stress is one tenth of the breaking strength of the glass! Thus any tendency for medieval glass to be thicker at the bottom will not be due to plastic flow. Does anyone know of any evidence that pieces of medieval glass really are thicker at the bottom? If so, what is the reason? (One possible reason for glazing the window with the thicker part of the glass downwards might be to gain an additional refractive effect.) Or is it a mistake to believe that the thicker part is downwards?

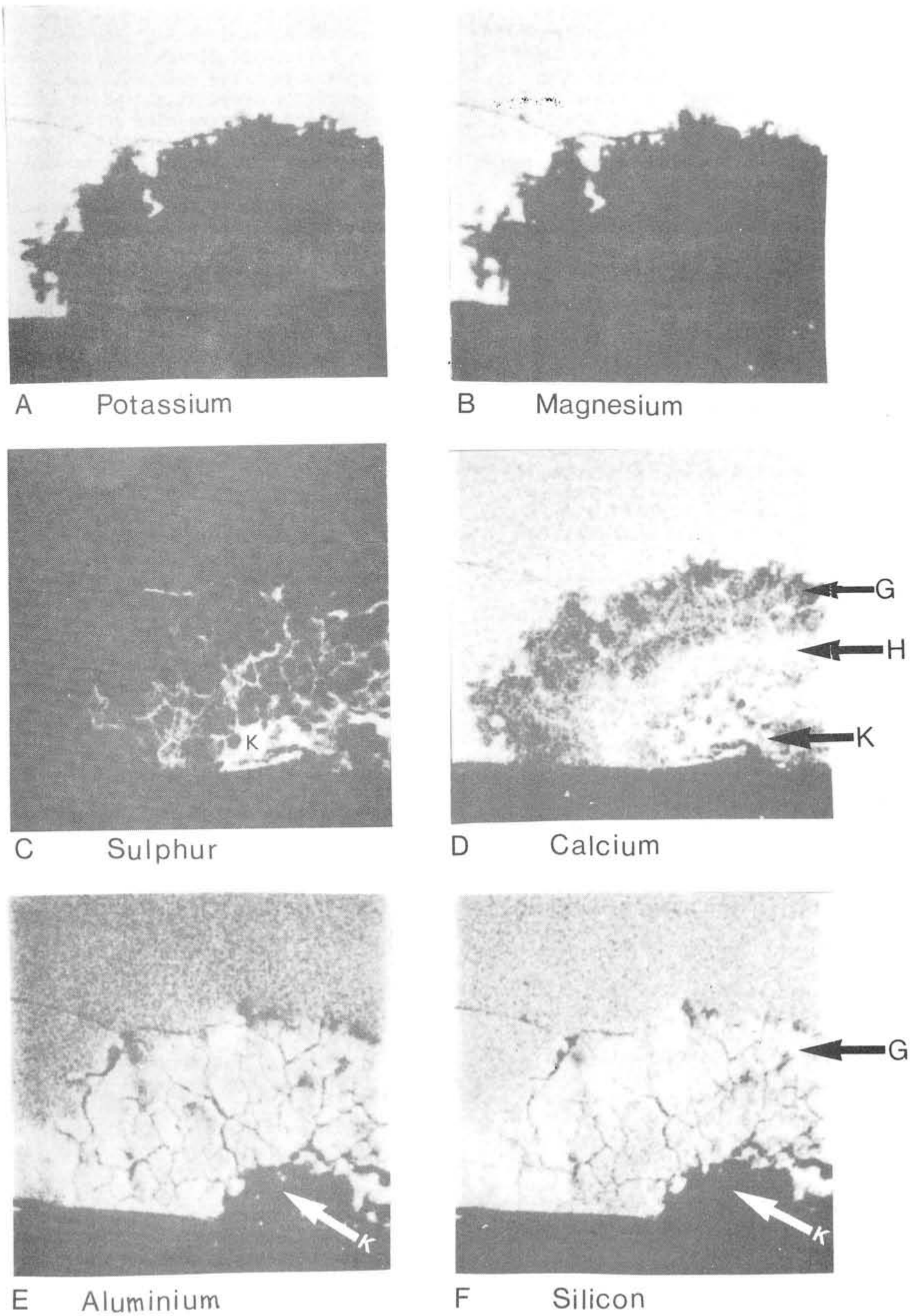

Fig. 1 These electron microprobe 'pictures' of a section through a pit in a piece of glass from Amiens cathedral reveal the sequence in which corrosion takes place. A and B show that all the potash and magnesia are lost from the pit (because the area of the pit appears dark whereas the glass at the top is lighter in colour). The pit contains calcium sulphate (gypsum) in region K because both C and D have a pale area at K, which is dark in all the other pictures. It is concluded that atmospheric sulphur dioxide does not attack the glass directly, but it attacks the corrosion products which were formed earlier.

2 WEATHERING OF GLASS

2.1 MECHANISM OF ATMOSPHERIC ATTACK ON MEDIEVAL GLASS WITH SPECIAL REFERENCE TO ATTACK BY SULPHUR DIOXIDE

In News Letter No.15, page 12, I made use of the text of a paper, presented at the Paris Colloquium on 8th September by Professor R. Collongues and Mme Perez y Jorba, in order to discuss their remarkable demonstration of the effect of sulphur dioxide. I now have permission from Professor Collongues to reprint Fig.5 of that paper and it appears here as Fig.1. I also have pleasure in stating that this work was funded from the Laboratoire de Recherche des Monuments Historiques and forms part of the research programme at Champs-sur-Marne, under the general supervision of M Jean Taralon, Inspecteur Générale des Monuments Historiques.

Fig.1 shows six electron microprobe "pictures" of the same much enlarged (x260) section through a pit in the glass; each is 300 µm square. The material at the top of each picture is the unaltered glass and the semicircular shape at the bottom and towards the right is the pit. Fig.1A shows the distribution of potassium; it occurs in the glass (the white part) but it is not present in the pit because potassium compounds are soluble in water and they were washed away by rainwater (syngenite was not formed in this pit).

Fig.1B shows the distribution of magnesium; again it is present in the glass but not in the pit because magnesium compounds are also soluble in water and B looks exactly like A. The absence of magnesium compounds here reminds us that it is an over-simplification to assume that magnesia is exactly equivalent to lime in giving protection to glass against attack by water.

Fig.1C will be discussed below. Fig.1D shows the distribution of calcium; it is present in the glass and in the pit but it is absent from zone G, close to the glass. The present hypothesis is that zone G is free of calcium because the attack at the bottom of the pit is by water only. The calcium hydroxide thus produced is soluble in the water and moves towards the surface, so that zone G tends to be free of calcium. In zone H the calcium hydroxide reacts with carbon dioxide from the atmosphere to produce insoluble calcium carbonate (calcite). In zone K the calcite reacts with sulphur dioxide to produce calcium sulphate (gypsum), see below.

Fig.1E shows the distribution of aluminium; it is uniformly present in the glass and it is also present in the pit but apparently in a more concentrated form which has many fissures in it. Note that it is absent from area K at the top of the pit. We do not yet know in what form the aluminium exists in the pit.

Fig.1F shows the distribution of silicon; it is present in the glass and in the pit but NOT in area K. It appears to be somewhat richer in zone G and the fissures which can be seen in E also appear in F.

We can now return to Fig.1C which shows the distribution of sulphur. It is not present in the glass (at least not in enough concentration to be detected) and it occurs chiefly in area K. This area must therefore be gypsum because it occurs in both C and D but NOT in A,B,E or F. Sulphur also occurs in the fissures seen in E and F. The glass was "Amiens No.2" (Corpus Vitrearum sample No.27) which has the weight percentage composition: SiO_2, 52.6; Na_2O, 2.29; K_2O, 13.4; MgO, 6.70; CaO, 14.4; MnO, 0.85; CuO, 0.14; Al_2O_3, 2.0; Fe_2O_3, 0.65; TiO_2, 0.12; P_2O_5, 5.2; CoO, 0.11; NiO, 0.11.

Much discussion will take place over these important photographs for many years to come, but here I want to point out that the sulphur is found in area K and not in contact with the glass. I therefore conclude that, at least in this pit, atmospheric sulphur dioxide did not attack the glass directly and the gypsum is the result of a secondary reaction. Also, the absence of calcium from zone G supports the hypothesis that, in the production of this pit, the only attacking agent was water. Even carbon dioxide seems to have only a secondary effect, in producing zone H.

2.2 GLASS WHICH HAS BEEN AFFECTED BY DAMP SAWDUST

Item No.3 (pages 10-12) of News Letter No.16 described an experiment in which a sample of No.2 glass, partly fire-polished and partly airbraded, had been buried in damp oak sawdust for six months. The fire-polished surface had become pitted but the airbraded surface had apparently lost about half of its roughness.

I have been worried as to how to explain what happened. In Fig.7 (of N.L. No.16) the line ABE surely represents the original surface but in Fig.8 (of N.L. No.16) the line EGH probably does NOT represent the original surface. It now seems that the sawdust eroded both kinds of surface, as well as producing pits in the fire-polished surface, because Mr Peter Gibson had the forethought to frame the sample in lead and the parts of the surface protected by the lead are now at a higher level than the remainder. Fig.2 of this report shows an enlarged (x 12) photograph of the edge of the sample; here A is the part protected by the lead, B shows an eroded part of the polished area, C shows a pit in the fire-polished area and D shows the eroded airbraded surface. It is clear that the sawdust has produced a generalised attack on the glass in addition to producing the pits.

Attempts were made to measure the height of A compared with B using the Talysurf but the experiment was defeated by the general curvature of the surface. The best that can be said is that the original surface may well have been about 10 μm above the present surface and thus the reduction in roughness of the airbraded surface by about 9 μm could be attributable to a general attack all over the surface by the sawdust in the period of six months. The pits, also, would no doubt have been some 10 μm deeper in relation to the original surface!

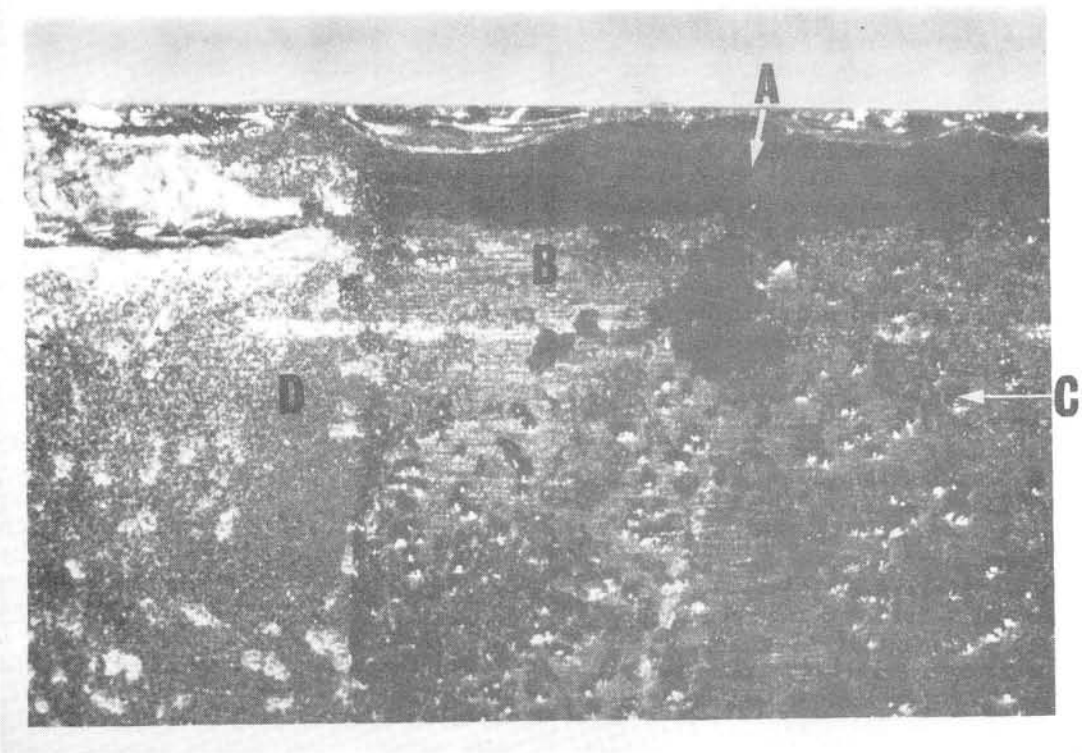

Fig. 2 This is an enlarged view (×12) of part of the sample of No. 2 glass which had been stored in damp sawdust for six months. The dark area at A is the original polished surface where it had been protected by the leading. The surface at B had mistakenly been thought to be the original surface (see N.L. No. 16, Fig. 8, line G to H) but the sawdust has eroded the surface to a depth of about 10μm *and* has also produced isolated pits (as at C) which can sometimes be as much as 60μm deep. The area to the left (at D) is the part which had been airbraded and it also has been eroded by the sawdust, *but* no pits were produced in this area, only the whitish spots which can be seen in the photograph. We do not know why pitting occurs only on the part which had been fire-polished and not the part which had been airbraded.

3 LEADING OF WINDOWS

My item in News Letter No.15 "Reworked old leads or new ones?" (item 1.7 on page 4) has produced several replies, the most erudite of which was from M Jean Taralon in Paris who drew my attention to his important remarks on pages 242 to 246 of "Les Monuments Historiques de la France" 1962, No.4. Whereas my query had been along the lines of Aladdin's lamp and the cry of "New lamps for old", Jean Taralon says "No, keep the old lamps!".

He points out that the belief that "leads need renewing every 100 years" is a misconception because many cases have come to light where 12th or 13th century original leading is in a good state of preservation; it should be kept and it may only need to be repaired, not replaced (16th C and later leads are a different matter). His article should be consulted for the full discussion but, briefly, he points out that these early original leads are different from modern leads, being (a) a different material which may contain as much as 30% tin and (b) a different shape (see below) which gives much more rigidity to the window.

Mr Rowan LeCompte wrote from New York also to comment on the weakness of the thin, wide-flanged, modern lead usually employed in re-leading ancient windows compared with a dome-flanged lead which again gives rigidity to the window and greatly reduces buckling. The sections of these leads are shown, full size, below, (A) being the modern French lead with flanges 0.3mm thick and (B) being that from Sens Cathedral of the first quarter of the 13th century (both from Taralon's paper); (D) is the weak American lead with flat flanges and (C) is the domed variety which gives stiffer windows and was used by Lawrence Saint in Washington Cathedral in 1934.

Mr Frederick Cole wrote from Canterbury to draw attention to a difficulty in saving the old original leads in their entirety. He says "We have in the past tried to preserve the lead pattern but have abandoned this on account of the fragile glass. The lead has to be cut in order to release the glass and, even so, the glass is at risk.". If there is an easy way of removing the glass without cutting the lead he would like to know it. Exactly this point is made by Dr Eva Frodl-Kraft (Abstract No.202) who remarks that old lead-work can only be broken by inserting a sharp instrument between it and the glass, and it is impossible to do this without causing breakages and cracks. Mr Cole also remarks that leads of type B do not, in the long term, provide sufficient "coverage". Vibration by the wind causes the glass to "creep" from the leads and he prefers the domed type C.

A B C D

4 CORROSION OF GLASS AND THE PAINTED LINES

Mr Dennis King, of Norwich, England, has shown me an interesting piece of glass from the church at Norbury in Derbyshire. The weathering product is a particularly hard crust which makes the glass quite opaque. It occurs on both sides of the glass and Mr King's cleaning treatments differ.

On the inside of the glass the airbrasive is required to remove the hard crust between the painted lines; the resultant surface is matt and a coating of Viacryl VC363 (hardened with Desmodur N75) was applied experimentally to about one half of this surface to improve the translucency. There was no paint on the outside of the glass and it is therefore rendered transparent by the quicker and more-effective method of grinding and polishing.

Fig.3 is a photograph (at a magnification of x5.5) taken from the outside (face No.1) through the ground and polished surface and it shows the underside of two painted lines at A. Note that the lines are on face No.2 but seen from face No.1. At A the painted lines can be seen quite clearly but at B and C the lines are not so clear because the corrosion of the glass has undermined the paint. The paint had appeared to be quite firmly fixed when seen from face No.2 but Fig.3 shows that it is in some danger.

This technique of grinding and polishing face No.1 could be used in researches on methods of "fixing" paint.

Fig.4 shows face 2 of the glass at an even higher magnification (x11.3) at a point where the Viacryl coating has been applied. The dividing line is at D and the area to the left has been airbraded only. To the right of D the airbraded surface has been treated with Viacryl and it can be seen that the surface is now less reflective. The white lines at E,E show where some of the crust still remains close to the painted line and it can be seen that the airbrasive jet had successfully been guided to within 0.3mm of the painted line by the skill of the operator (the scale at the top is in millimetres).

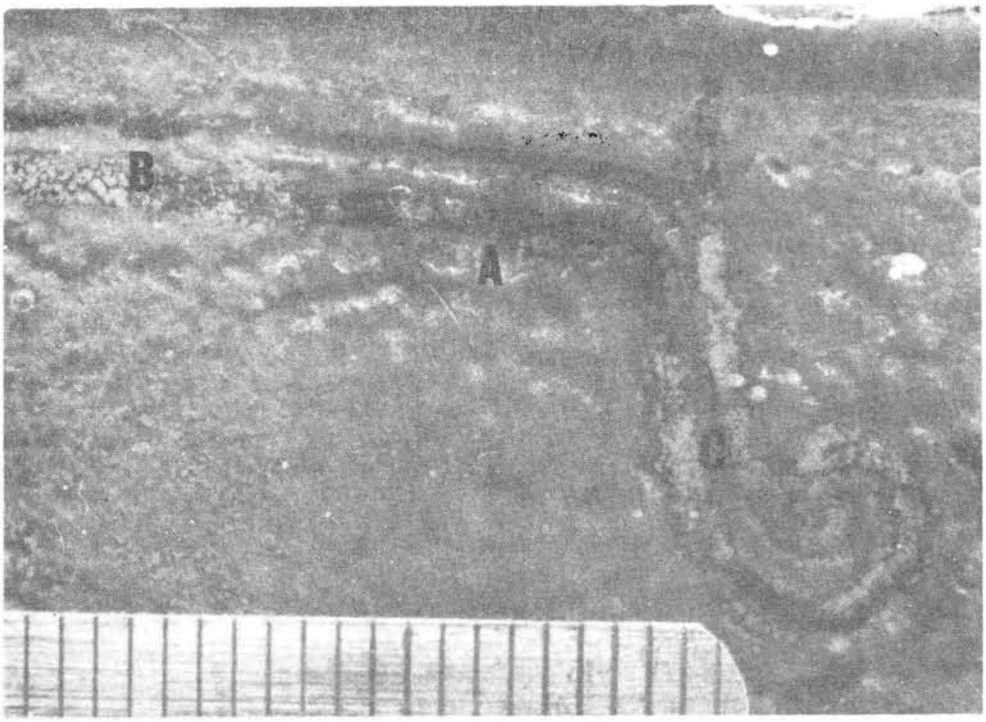

Fig. 3 This interesting photograph (×5.5) shows what painted lines can look like when viewed from their underside. This glass from Norbury Church has a low durability and both sides are badly crusted. The crust on the outside of the glass was removed by grinding and polishing and, as the glass is quite transparent, it is possible to look through the near outer surface and examine the underside of the painted lines. At A the paint is clearly visible but at B and C it is not easy to see because the corrosion of the glass has crept underneath the paint.

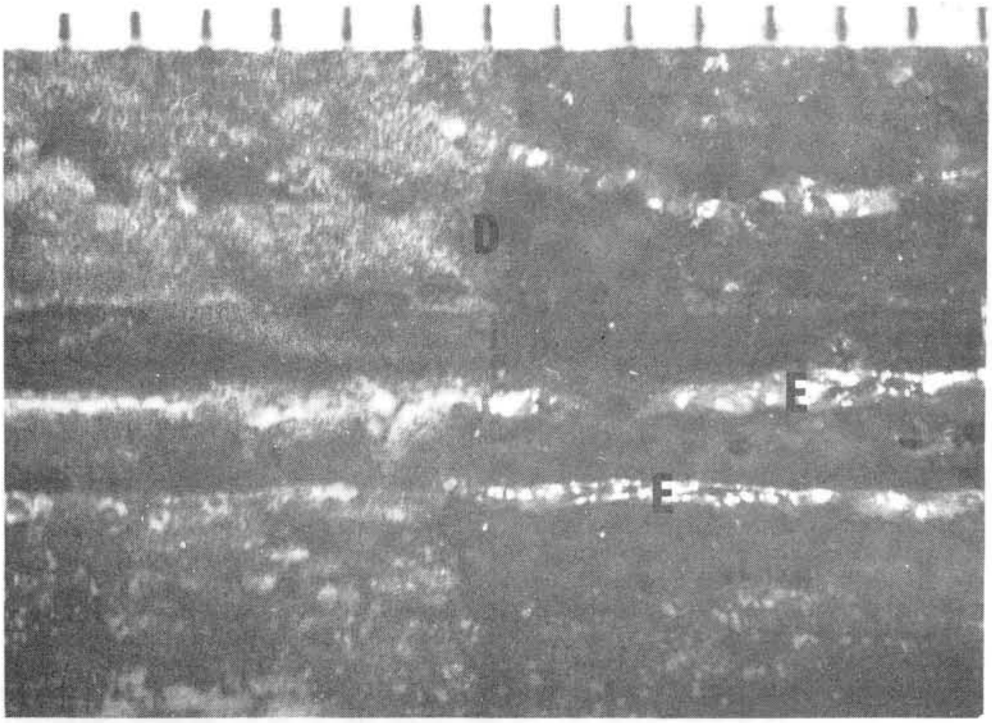

Fig. 4 This is an enlarged view (×11.3) of the inner surface of the glass at a point where an experimental application of Viacryl resin had been made on the airbraded surface. The part to the left of D has had its crust removed by airbrasion and it therefore appears matt. The part to the right of D was also airbraded but the surface has been coated with Viacryl; it is now dark and non-reflective (it is in fact translucent). The white lines at E, E show where the operator did not remove the crust close to the line; he had skilfully airbraded to within 0.3 mm of the painted line, leaving this thin line of white crust. The scale at the top is in millimetres.

5 NEW ABSTRACTS

199. BISHOP, F.L. and MOWREY, F.W. (1952) "Deterioration of the surface of sheet glass", Ceramic Bulletin 1952, 31, 13-15.

The authors give a brief review of the mechanism of the deterioration of the surface of sheet glass under atmospheric conditions and draw attention to the existence of a thin surface layer of higher refractive index than that of the inside which is modified, by the water in the atmosphere, to attain a lower refractive index. This layer is less than 10 nm thick.

They devised an accelerated weathering test in which moist air at 100°F (38°C) is circulated over the glass, which is examined at 60-hour intervals. The pair of samples touch at the top and are separated by 0.009 inch (0.25mm) at the bottom (so that water would presumably collect between them - RGN). Other samples were kept in an unheated warehouse in order to test the effects of packaging materials. Examination of the weathered surfaces under a microscope (x400) showed that 144 hours in the accelerated test were equivalent to 216 days in the warehouse; much surface deterioration could be seen after 2 years in the warehouse.

Packing of the glass in a highly-absorptive, non-alkaline paper halved the deterioration after 2 years. A change of alkali content from 14.27% to 15.11% (alkaline earths from 11.83 to 11.15%) roughly doubled the deterioration after 2 years. Packing the glass in wood flour increased the deterioration about 3 times, compared with packing in paper.

200. ENGLE, Anita (1973a) "3,000 years of glassmaking on the Phoenician Coast", Readings in Glass History, No.1, 1973, pages 1-26.

This article is not concerned with conservation nor with glass windows but it is of interest to anyone who wants to learn more about the first origins of glass, glazes and faience. Among other interesting points, the author makes the suggestion that the 8-ton slab of glass found at Beit Shearin may in AD300 have been intended as a source of cullet for other glassmakers.

201. FREIMAN, S.W. (1974) "Effect of alcohols on crack propagation in glass", J. Amer. Ceram. Soc., 1974 57, 350-353.

The author was actually concerned with drilling holes in glass and he found that less cracking occurred in some alcohols than in water; in fact, the water-content of the alcohol was important. Water causes cracks to propagate under certain conditions which may have a bearing on the spontaneous cracking that sometimes occurs in medieval windows.

202. FRODL-KRAFT, Eva (1975b) "Einige Bemerkungen zu Wissenschaft und Handwerk in der Glasgemälde-Restaurierung" (Some notes on the science and practice of restoring stained glass). Paper read at the 9th Colloquium of the Corpus Vitrearum on 9th September 1975; 12 pages of typescript.

The author discussed several questions referred to in News Letter No.15 because it contains comments by Dr Frenzel (item 1.2) and also abstracts of the papers given at the Stockholm Conference (Abstracts 186-192), and she stressed the close inter-relationship which is required between the scientists and the craftsmen because neither can be effective without the other.

Despite the progress made in the last few years the scientific understanding of the problems of conservation is still too restricted, especially as each new restoration situation presents problems which must be considered afresh. Anne Moncrieff's Stockholm paper (Abstract No.190) is held up as a model of the way in which the characteristics of each restoration technique are set out so that anyone can understand them. Her approach should be revised from time to time in the light of conservational experience, in particular that of avoiding alterations to the original artistry; thus it is not the "most effective" cleaning agent which should be used but the one which does the least damage to the glass (especially the painting on the glass), even though it may be harder to use and take longer to do its cleaning. In fact, there is an urgent need for a systematic critical summary, "Heute, da sich auch der mit dem Fach Vertraute kaum mehr einen Überblick über die laufenden Forschungen verschaffen kann, ist eine thematisch geordnete, kritische Zusammenstellung ein dringendes Desideratum.). (RGN - Perhaps the International Technical Committee can undertake this as its first task!)

Craftsmanship It must not be forgotten that the craftsman's skill is all-important. He uses coarse brushes to remove excess cement from the outside of the window and might use the air-brasive or glass-fibre brushes in such a way that the often hardly-discernible half-tones are harmed or otherwise. She comments rather pithily that few restorers are prepared to have any doubts about their personal skill and sensitivity. (RGN - but no doubt this applies to scientists also!)

Cleaning She points out that water must be present for the deterioration of glass to occur and then argues that "dry" methods of cleaning are to be preferred. (RGN - but I am not convinced that this is necessarily so; if the cleaned glass can be kept dry, then the water used in "wet" cleaning methods will dry out; if the glass cannot be kept dry - because it is exposed to the weather - then it will get wet anyway. Nevertheless she is probably right when she says that "solution" processes of cleaning may loosen paint which is undermined by corrosion products - see Fig.3 of this News Letter.) She also claims that any mechanical damage encourages weathering. (RGN - but I believe that this requires further study because some airbraded surfaces seem to be more resistant to weathering, at least when accelerated tests are used.)

Mending cracks J.M. Bettembourg's researches have shown (see Abstract No.181B) that silicone adhesives are better than epoxy resins, and any yellowing is likely to be insignificant provided the joint is thin and the adhesive is removed from the face of the glass. (RGN - if adhesives are accidentally allowed to set hard on the surface of the glass, it seems that they can be removed with Green-label Nitromors or with Cital 12-12.)

Plating The author claims that laminating is unsatisfactory because it cannot be reversed after several years have elapsed, at least not without damaging loose paint. (RGN - but I suppose that Dr Jacobi will dispute this, as will the Dommeister at Cologne) (RGN - she queries what happened at Canterbury with defective paintwork, and the answer is that Mr Cole used to touch-up defective paintwork when the guide-lines were clear but he has now ceased doing this.) Plating will be an ideal method of protecting medieval glass provided the edges can be properly sealed; some has certainly been well-sealed but there are cases where water has entered the cavity.

Leading She asks whether painted glass is preserved better by using new leads or by repairing the existing damaged leads, and concludes that old lead-work can only be broken by inserting a sharp instrument between it and the glass; that it is impossible to do this without causing breakages and cracks; and that it may therefore be better to repair the old lead (if the panel can again be properly stabilised) than to replace the leads by new ones. In Austria much original lead-work still remains and it is much better to re-use them. Regarding Mr Cole's analysis of 12th century Canterbury leads, she points out that high tin-contents can be obtained if soldered joints have been melted down; Dr Bauer (OZKD 1967 21 208) found that most of the early leads contained less than 1% of tin but the amount could occasionally be much higher, suggesting contamination by solder.

203. HAYWARD, Jane,(1975) "Installation of medieval stained glass at The Cloisters", Paper read at the 9th Colloquium of the Corpus Vitrearum on 9th September 1975; 9 pages of typescript.

This paper discusses the adaptation of the medieval glass to the windows of the modern building, the "isothermal" protective glazing system used, and the means of providing external protection in the Cloisters Museum with its extreme climatic conditions (temperatures ranging from 0° to 35°C), high humidity in the summer, air pollution, etc. The study concerns the 14th C. St Leonhard glass from Austria, and the problems of adapting the panels to the modern building, including the introduction of tracery lights and the incorporation of new stained glass are fully discussed (3 pages).

The isothermal glazing arrangement is novel, the medieval glass being set in the original glazing grooves which were made much wider and deeper to permit ventilation air to flow around the edges of the panels. The grooves were originally 5/8 inch wide (16 mm) but were widened and deepened to 1¼ inches (32 mm), and a tee-bar just above the sill level also allowed air to flow freely below the window, as was confirmed by smoke tests. Each panel was framed in stainless steel to stiffen it, and this also prevented light penetrating around the widened and deepened groove in the stonework. The tracery lights were supported in a different manner which is explained fully.

The external protective glazing was itself a double window, consisting of a 6mm external sheet of "Plexiglas", a 9.5mm air space and a 3mm sheet of "Lexon" which absorbs ultra violet light; the edges were sealed with silicone. This assembly is set 3½ inches (90mm) outside the stained glass. The author states that this Plexiglas system "... does not heat up like glass", but there must be a misunderstanding somewhere here because her figures show that the stained glass protected in this way does not heat up as much as does stained glass protected by an external glass sheet; hence the Plexiglas system must itself heat up more than an external sheet of glass would. In direct sunlight on a clear day when the temperature of the outside air was 28.6°C, a stained glass window with an outside protective glass reached 37.4°C, or a rise in temperature of 8.8 deg.C. A similar temperature was recorded on a window protected by a single sheet of Plexiglas, but one protected by the new system showed a rise of 1.65 deg.C, ie, reaching a temperature of about 30.2°C. This system was only 19% more costly than ordinary storm glass.

204. NEWTON, R.G. (1975b) "The unusual weathering of one of Dr Jane Hayward's samples" a note presented to the 9th Colloquium of the Corpus Vitrearum on 8th September 1975.

This brief note, and Fig.5, is intended to draw attention to an extra-ordinary type of weathering which the author has seen only once, on a sample of blue glass from The Cloisters. His attention was drawn to this piece by Dr J.C. Ferrazzini and he is indebted to Dr Jane Hayward for the opportunity of discussing it. As can be seen from Fig.5, the corrosion is characterised by deep narrow pits which are surrounded by a wide shallow circle of corrosion. Superficially it is reminiscent of the cathodic corrosion of stainless steel, which is an electro-chemical phenomenon. The author does not suggest that electro-chemical phenomena are responsible for this type of attack but he does ask the question whether we pay enough attention to the possibility of such phenomena. Although glass does not conduct electricity readily, it conducts sufficiently for ion-selective electrodes (eg pH meters) to function, and hundreds of years are available for any small effects to manifest themselves.

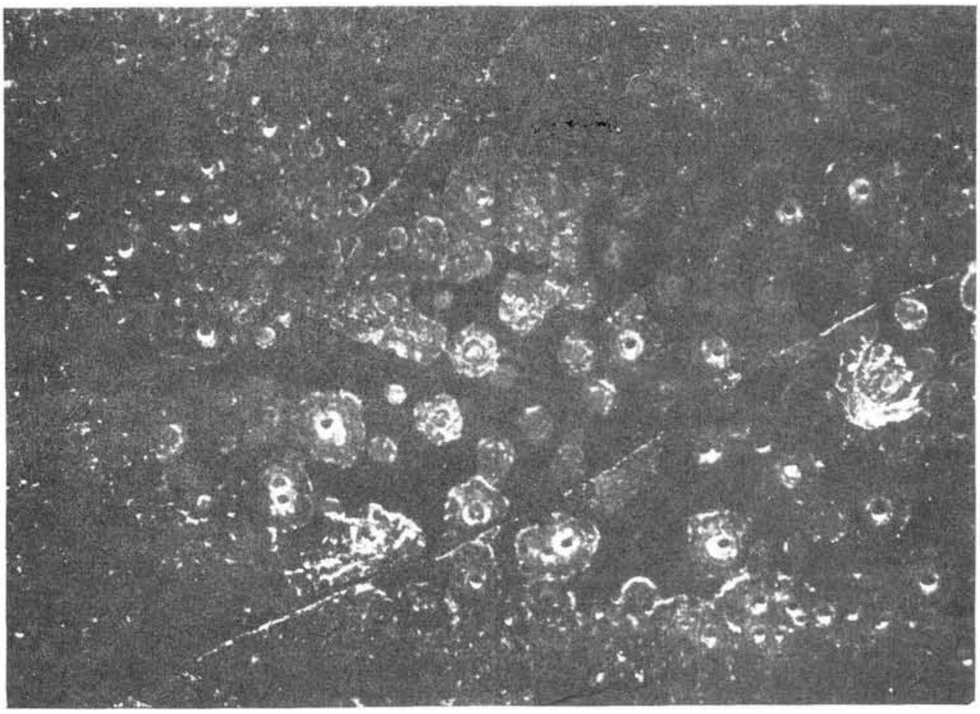

Fig. 5 This sample from The Cloisters Museum, New York, shows an exceptional type of weathering which is discussed in Abstract No. 204. The small deep pits and their surrounding flat areas of corrosion are reminiscent of the cathodic corrosion of stainless steel.

205. NEWTON, R.G. (1975c) "Using triangular diagrams to understand the behaviour of medieval glasses", a paper presented to the 9th Colloquium of the Corpus Vitrearum on 8th September 1975.

The author explained how the apparently complicated chemical analysis of medieval glasses can be simplified so that only three items need be considered. These three items are essential characteristics of the glass and largely determine its durability. As can be seen from **Fig.6**, glasses with good durability fall near the middle of the triangle (A,M,R) and the least durable glasses (H,J,Q) lie towards the bottom right-hand corner. Glasses which lie to the left of the centre also have poor durability because they "weep" (W) or crizzle (Z). A similar diagram on a larger scale also helps to clarify the different kinds of weathering encountered among medieval glasses.

206. NEWTON, R.G. (1975d) "Experimental studies of the protection of medieval windows using external glazing", a paper presented to the 9th Colloquium of the Corpus Vitrearum on 9th September 1975.

This account of the results obtained from the instrumented window at York Minster is exactly the same as pages 4-10 of News Letter No.16.

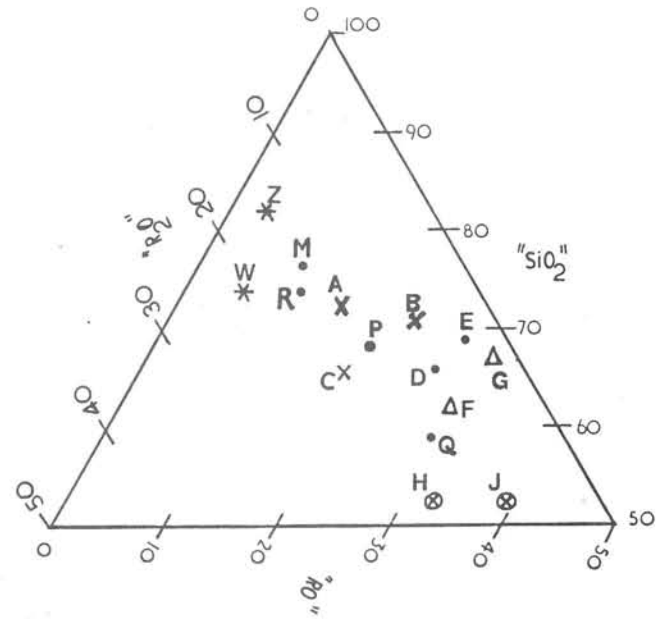

Fig. 6 This triangular representation of glass compositions helps to characterise them according to their durability. Those with good durability (A = modern window glass; M = Saxon glass from Monkswearmouth; R = durable Roman glass) fall near the centre. The least durable stained glasses (H = Austrian crusted glass; J = crusted glass from Ely cathedral; Q = poorly durable 12thC. green glass from York Minster) lie towards the bottom right-hand corner. Glasses which lie to the left of centre also have poor durability; those at W 'weep' under museum conditions and those at Z form crizzles on the surface. See Abstract No. 205.

207. RITTER, John E., Jr. (1973) "Stress corrosion susceptibility of polymeric coated, soda-lime glass", University of Massachusetts Report No.UM-73-5, March 1973.

The author studied the effectiveness of resin coatings (acrylic, epoxy, and silicone) in preventing stress-corrosion of glass by water. The coatings limited the availability of water to the surface of the glass to some extent but they did not eliminate it entirely because stress corrosion occurred. Although none of the resins entirely prevented attack by water it may be of interest to know what they were. The acrylic coating was prepared from Lucite Transparent Molding Powder L-149 (from Fisher Scientific Co., Pittsburg, Pa.); the epoxy coating was made from Conapoxy PA-122 and Conacure EA-011 diluted with Conap S-1 thinner and cured at 60°C for 3 hours (all from Conap Corp., Allegany, N.Y.); and the silicone was PanShield cured at 60°C for 3 hours (from Dow Corning, Midland, Mich.).

208. RODERICK, Hilliard (1975) "Projected emission of sulphur oxide from fuel combustion in the O.E.C.D. area 1972-1985: the international issues with special reference to transfrontier migration of pollution", a paper presented to the IPIECA Symposium held in Tehran in April 1975. 36 pages of typescript.

Dr Roderick is the Director of Environmental Affairs, OECD, Paris and his paper is not directly concerned with conservation but it will be of interest to everyone who wants to know what changes in air pollution are expected in the future. After making a number of assumptions about the changes in the demand for energy, the cost of removing sulphur from the fuel or from the waste gases, and the prices of oil and coal, including the more expensive low-sulphur grades he concludes that sulphur emissions are expected to decrease until 1980 after which they may rise again if a greater proportion of solid fuel is used. The major contribution to local air pollution is by households and residential areas, not major industry. The harmful effects of sulphur oxides (to humans) is believed to be linked to the presence of particulate matter (particularly sulphates) in the atmosphere.

209. SPITZER-ARONSON, Martha (1975a) "Étude de vitraux rouges médiévaux à l'aide de microscope optique, microscope à balayage avec image par électrons rétrodiffusés et microsonde électronique à rayons X" (A study of medieval red window glass using optical microscopy, the scanning electron microscope with back-scattered electrons, and electron microprobe analysis), Verres et Refractaires 1975 29 145-153.

Dr Spitzer-Aronson is well-known for her careful studies of the nature of medieval copper-ruby glasses. Her papers are generally not involved with problems of conservation but this one, and No.211, have a bearing on the techniques used for making these early glasses and hence perhaps with their conservation. The present paper shows that the earliest rubies were multilayered through their thickness but in the 14th century these inhomogeneous ruby glasses were "flashed" on to a colourless support glass (and hence deep pitting on the flashed side will lead to the formation of white spots). Later still the modern type of flashed ruby came into existence, where the red layer is thin and homogeneous, and is sandwiched between two colourless glasses, one thick and one very thin. In the 15th to 17th centuries there were "false-flashed" red glasses in which there is no clear boundary between the red and white glasses.

A full description is given of the sophisticated experimental techniques which she used in making these studies, and in exploring the copper contents, micron by micron, right across the thickness. An interesting point is her conclusion that some diffusion of copper occurs from a coloured region into a colourless one, for about 50 µm each side of the boundary, despite the abrupt cessation of colour at that boundary. (RGN - this conclusion and also her finding that the colourless glass inside "hairpin" folds of red colour can be richer in copper than the red glass, seems to support my long-held view that these glasses were not made by repeated dipping in alternate "red" and "white" melts but a badly-stirred mixed melt was used, some of which "struck" to give a red colour and some did not. The glass is so viscous that repeated dipping would not give such thin layers, without some "stretching" also taking place; I hope to arrange some practical trials on this point.)

210. SPITZER-ARONSON, Martha (1975b) "Diffusion sélective du cuivre et de l'arsenic dans les vitraux rouges médiévaux. Étude quantitative de la concentration du cuivre pour des 'plaques' de techniques différentes" (Selective diffusion of copper and arsenic in medieval red glasses. A quantitative study of the concentration of copper in flashed glasses made by different techniques), C.R. Acad.Sc. Paris, 280 (9 June 1975) Série C - 1343 to 1346.

This paper does not have a bearing on conservation but she found relatively strong concentrations of arsenic in some places. The regions where the ratio of arsenic to copper had a maximum value were black zones where metallic copper had been precipitated. The paper will be of interest to those who are concerned with the compositions of medieval glasses.

211. SPITZER-ARONSON, Martha (1975c) "Contribution à la connaissance des vitraux du Moyen-Age. La présence du plomb et du cuivre et leur diffusion sélective dans les vitraux rouges des cathédrales françaises" (A contribution to the understanding of medieval glasses. The presence of lead and copper and their selective diffusion in French cathedral ruby glasses), C.R. Acad.Sc. Paris 280 (August 1975) Série C - 207 to 209.

This paper is again primarily of interest for its chemical content. The distribution of copper and lead (in 16th C. glasses) was studied using sophisticated techniques and it was found that copper played a protective role in preventing the reduction of lead oxide by arsenic; if the copper content was reduced by diffusion, precipitation of metallic lead occurred with consequent blackening of the glass.

212. WIEDERHORN, S.M. (1967) "Influence of water vapor on crack propagation in soda-lime glass", J. Amer. Ceram. Soc. 1967 50 407-414.

The author used a novel experimental technique to measure the rate of crack growth in glass, as it was affected by the moisture content of the environment and the stress in the glass. Water vapour had a profound effect on the rate of crack growth, 100% humidity producing about 10,000 times the speed of growth which occurred with 0.017% relative humidity. The rate also depended on the applied stress; doubling of stress produced an increase of about 1,000 times in the crack growth rate. The fastest rates observed were about 0.5mm/sec and the slowest was about 0.01 μm/sec (about 0.1mm per hour). (RGN - even this speed must be vastly greater than the rate of spontaneous crack growth in medieval glass and it seems that we have to look for some additional explanation, such as extremely low applied stresses in one face only.)

213. WIEDERHORN, S.M., JOHNSON, H., DINESS, A.M., and HEUER, A.H. (1974) "Fracture of glass in vacuum", J.Amer. Ceram. Soc. 1974 57 336-341.

This is a highly technical paper in which the rates of crack growth in a vacuum were studied for six glasses at temperatures from 25°C to 775°C. The interest of the paper for specialists lies in the fact that crack growth in a vacuum occurred in some glasses but not in others, and theories of elastic behaviour are used to explain the differences. It is hoped to interest one of these experts in the spontaneous fracture of some medieval glasses.

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NOTE: Will readers of these News Letters please draw my attention to any papers which should be abstracted here. It would be particularly helpful if photocopies of the papers could be supplied. My address is 5, Hardwick Crescent, Sheffield, S11 8WB, England.

Roy Newton

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