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Short Communication

Diversity of Patina and Patinelles on Weathered Glass in Australia –Windows into Processes and Products In Patination

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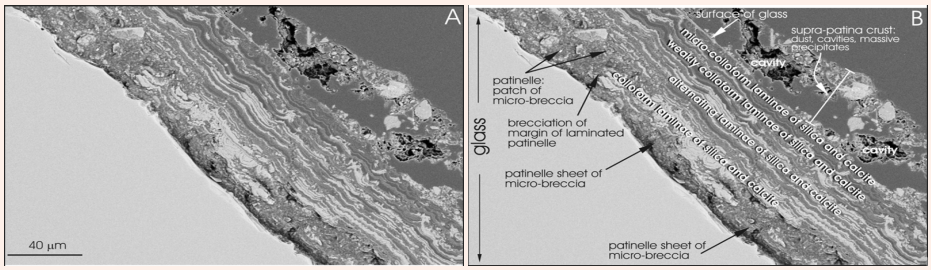
Abstract

Weathering of glass results in an ultra-thin patina that exhibits a multitude of structures, micro-structures, and micro-lithologies that record its (geological) parageneis and diagenesis. Scanning electron microscopy of patina from Australia shows it to be simply laminated, complexly laminated, colloform, to micro-brecciated, to mottled and clotted, with micro-unconformities, and micro-lithologies of laminated silica, or inter-laminated silica and calcite. These intra-patina features are termed 'patinelles'. There are also desiccation cracks, vughs, and exogenic infiltrations of dust. This range of structures, micro-structures, and micro-lithologies are arrayed as lenses, sheets and as intra-patina masses. The diversity of patina structures and micro-lithologies, and patinelles can be used to determine the history of patina and patinelles.

Introduction

Patina is the ultra-thin weathering crust developed on glass, and has been the subject of many studies in relation to determining its origin, its usefulness for aging archaeological artefacts, and chemical processes involved in its development [1-6]. Recently, using ~ 100-year-old patinated glass and scanning electron microscopy, the myriad of structures developed within patina was described and classified by Clifford & Semeniuk [6] illustrating the range of its various structural, micro-structural, and compositional diversity. These intra-patina elements were termed 'patinelles' [6]. Corrosion of glass is the first stage of patination, as shown in Figures 1- 4, but this paper only describes and discusses patina and patinelles, leaving corrosion features to be described in a later article. The focus of this paper is on the diversity of patina and patinelles from Australian occurrences of patinated glass, and description of these features is annotated on the Figures 1-4. Patina ranges from simple (simply laminated) to complex (with a variety of structures and patinelles). Listing of patina structures, micro-structures, and composition (micro-lithologies), diversity of patinelles, and other intra-patina and supra-patina features is provided below.



Figures 1A & 1B: Illustration showing features of 1. laminated patina with an invading leading edge of a micro-breccia patinelle, 2. the former surface of the glass as a straight, sharp edge (arrowed), and 3. thin sheet of supra-patina crust composed of (a) massive (structureless) silica, (b) silt- and dust-sized mineral particles, and (c) micro-vughs or 'caverns'.

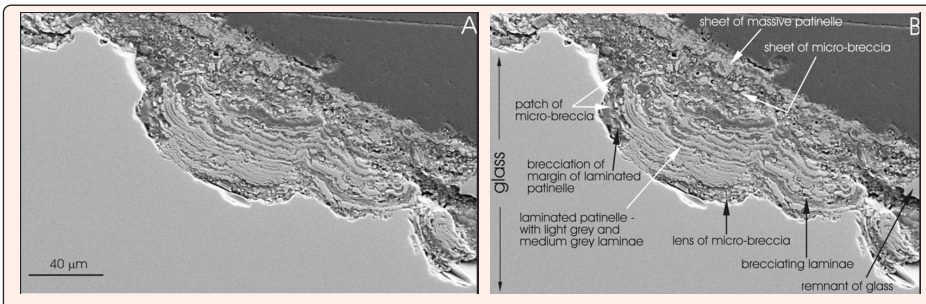


Figure 2: An interesting image showing scallops and adjoining cusps along the glass/patina contact, and the lower part of the patina image shows laminae of light-grey and medium-grey silica and laminated calcite; the left margin of the laminated patina passes into a patch of micro-breccia and here can be observed the fragmentation of the laminae passing into micro-breccia that has a matrix of massive silica; the upper part of the image is a sheet of micro-breccia that has silica shards floating in a massive silica layer.

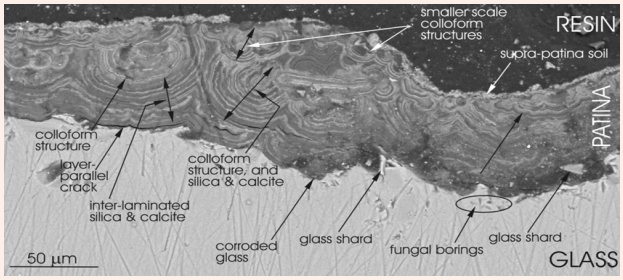


Figure 3: Crust of patina on glass showing a selected range of microstructures; prominent here is the corroded contact between patina and glass, colloform structures, the inter-lamination of silica (medium grey) and calcite (light grey), and layer-parallel desiccation cracks (thin black lines).

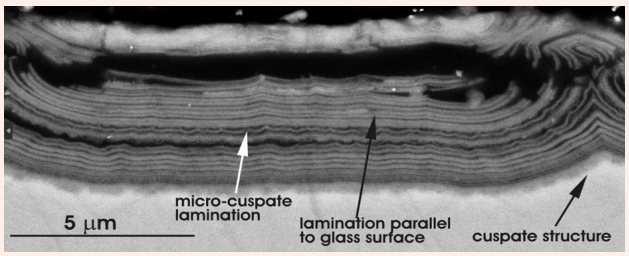


Figure 4: Largely parallel laminated patina, with thin layer of smaller-scale micro-cuspate structures.

Diversity of Structures, Micro-Structures, and Composition in Patina

The ultra-thin weathering crust on glass exhibits many structural, micro-structural, and micro-lithological features; these include:

a. bundles of lamination parallel to the glass surface;
b. bundles of lamination parallel to the glass surface, but showing micro-cuspate structures;
c. bundles of lamination parallel to the glass surface, but showing larger-scale cuspate structure;
d. lamination arrayed in colloform structures (30-40 µm in diameter);
e. lamination arrayed in smaller-scale colloform structures (7-10 µm in diameter);
f. micro-unconformities;
g. inter-laminated silica and calcite;
h. laminated silica;
i. massive (structureless) silica laminae.

Diversity of patinelles

There are numerous types of patinelles within the ultra-thin crust; these include:

i. micro-breccia lenses, sheets, and clots;
ii. matrix-supported breccia;
iii. isolated fungal borings, ~ 18 µm long (often lined with patina ~ 0.90 µm thick);
iv. clusters of fungal borings (often lined with a film of patina);
v. clotted and mottled massive patina.

Other intra-patina features

a) scattered glass shards, and residual glass shards;
b) infiltrated dust within patina;
c) vughs;
d) polygonal desiccation features;
e) laminoid fenestral structures (layer-parallel sheet desiccation features);
f) dust on glass surface (a supra-patina feature);
g) cemented soil sheet on glass surface (a supra-patina feature);
h) exogenic minerals within the patina.

Discussion/Conclusion

The various patina structures, micro-structures, and micro-lithologies, as well as patinelle structures have formed under definitive climatic, hydrological, and hydrochemical conditions. Thorough documentation of patina and patinelles in terms of their diverse features will assist in the interpretation of their (geological) paragenesis and diagenesis. It will also assist in the interpretation of past environmental conditions that formed the patina and patinelles. Of particular interest would be precipitation of silica laminae versus inter-laminated silica and calcite, the transformation of laminated patina laterally into brecciated structures, the formation of layer-parallel fenestrae, the formation of vughs, the transformation of massive silica into mottled and clotted patina, and the use of these variations in patina and patinelles in environmental reconstructions. Some of these features are described and discussed as to origin in Clifford & Semeniuk [6].

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