ABC Dry Chemical Powder and Cultural Materials: Cleaning Method Effectiveness

WILLIAM & MARY
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INSTITUTE of Museum and Library SERVICES

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In 2013 the Colonial Williamsburg Foundation (CWF), in conjunction with Hughes Associates, Inc. and the Fire Protection Research Foundation received an Institute of Museums and Library Services (IMLS) grant to study the effects of portable fire extinguishers on cultural heritage materials. In order to address some questions raised by the larger project, the College of William and Mary's Applied Research laboratory and CWF embarked on a small study focusing on assessing how easy it is to remove ABC dry chemical powder , a common component in portable extinguishers, from cultural heritage materials.

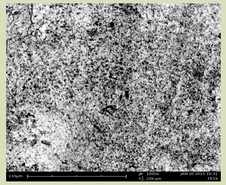
ABC Dry Chemical Powder

ABC dry chemical fire extinguishing agent varies in percentages, but has the following chemical make-up:
Monoammounium Phosphate (50-80%)
Ammonium Phosphate (20-45%)
Magnesium Aluminum Silicate (1-5%)
Tricalcium Phosphate (1-5%)
Silica Gel (0-3%)
Methyl Hydrogen Polysiloane (0-1%)
Yellow Pigment
The extinguishers are pressurized with either nitrogen or air. The agent is discharged as a fine powder. The measured particle size ranges from 25-95um with an average of 31um [Finnerty and Vande Kieft, 1997].

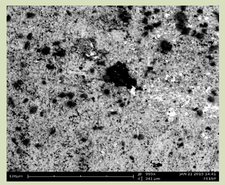
Deer Hair Unexposed

Deer Hair Exposed

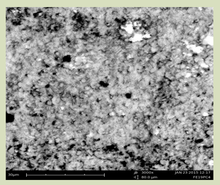
Deer Hair Cleaned



Iron Unexposed



Iron Exposed



Iron Cleaned

Examination

To interpret the effectiveness of each cleaning method on each sample, our team developed the following categorizations to describe the overall cleanliness. The categorizations are as follows:
Exceptional: Cleaned image has the same amount or fewer particles as original image. Cleaned image looks the same or better (fewer particles) than unexposed image. Indicates a cleaning method almost entirely effective at removing ABC dry chemical agent.
Good: Cleaned image looks clean, with the exception of only a small amount of ABC dry chemical particles on surface. Only small particles are present (less than 10 micrometers in diameter)
Okay: Cleaned image has easily identifiable ABC chemical on surface. 10 or greater small particles and/or the presence of large particles.
Subpar: Cleaned image has less than 50% decrease in particles from exposed image. ABC powder visible and obviously present
Poor: Cleaned image has little to no change from unexposed image
The categorization results were averaged for each of the samples tested of the same material type for a particular cleaning method, with privilege given to consistency over singularly good method performance. If a cleaning method exhibited damage to a material, it was considered subpar or poor (depending on the level of damage) despite effectiveness.

Cleaning Method	Description
1	Soot Eraser
2	Brush
3	Vacuum
4	Water Swab
5	Water Swab w/detergent
6	Vacuum + Soot Eraser + Water Swab
7	Vacuum + Water Swab

Acknowledgements:

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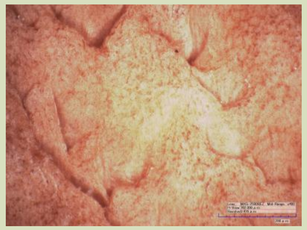
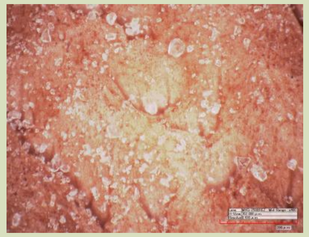
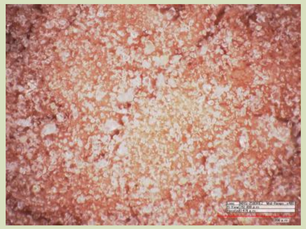


Leather Unexposed

Leather Unexposed



Leather Exposed



Leather Exposed

Leather Cleaned (4)

Leather Cleaned (2)

Sample Type	Best Cleaning Method	Cleaning Effectiveness
Aluminum	7	Exceptional
Brick	7	Exceptional
Copper	6	Good
Deer	3,7	Good
Iron	7,5,3	Good
Leather	4,7	Good
Marble	1,6	Exceptional
Painted Canvas	7	Exceptional
Travertine	1	Good
Varnished Wood	6	Good
Tile	7	Good
Unvarnished Wood	1	Good

Methods

To simulate true cultural heritage materials, our team selected twelve material types: aluminum, iron, copper, deer fur, leather, tile, canvas, brick, marble, travertine, varnished wood, and unvarnished wood. Each sample was examined under a HIROX 3D digital microscope, and, when applicable, a PHENOM Scanning Electron Microscope. Samples were examined at the unexposed, exposed, and cleaned stages for general cleanliness, the presence of ABC dry chemical powder, and any visible damage from cleaning methods. The cleaning methods tested include:
Soot Eraser
Brush
Vacuum
Swabbing with Water
Swabbing with Water and Detergent
Vacuuming, followed by soot eraser, followed by swabbing with water
Vacuuming, followed by swabbing with water
Three samples of each of the twelve materials were tested for each cleaning method type (266 total).

Conclusions

Although this study is preliminary, it indicates that there is no single cleaning method that works uniformly well for all materials. The materials tested, representing the most common materials comprising cultural artifacts, had varied responses to the cleaning methods. This indicates that cultural environments should cater their plans for cleaning ABC dry chemical to the materials mostly directly affected and most common in the artifacts they are attempting to conserve. Likewise, many of the cleaning methods determined to be the best were not categorized as "exceptional" indicating that other methods for cleaning should be explored.