Smithsonian
Museum Conservation Institute

Mitigation of Pesticides on Museum Collections Workshop/Symposium

Monday, April 23, 2007, 9:30 am - 4:00 pm
Museum Conservation Institute Theater

9:30-9:45 am Coffee, MCI Entry
9:45-10:00 am Welcome by **Robert Koestler**, MCI Director

10:00-10:45 am Peter Reuben, Tonawanda Band of Seneca

Mitigation of Surface Contaminants on Haudenosaunee Medicine Masks.

Surface contaminants were discovered on Haudenosaunee Medicine Masks during the repatriation process in 1998-1999. Based on this event, the Seneca Nation of Indian's Tribal Historic Preservation Program with the support of the Haudenosaunnee Standing Committee on Burial Rules and Regulations and Seneca-Iroquois National Museum began the search for culturally acceptable mitigation methods. Several destructive and nondestructive methods were considered or attempted with limited success. A significant reduction in surface contaminants was achieved using a multi-step approach featuring the application of a **S**urface-**A**ctive-**D**isplacement-**S**olution (SADS). Mercury residues were reduced from a range of 140 to 13,200 µg per side to trace levels on painted and unpainted wood upon application of a SADS formulation

10:45-11:00 am Coffee Break

11:00-11:45 am Peggi Cross, Arizona State Museum, University of Arizona

The Removal of Arsenic (III) and Mercury Salts from Materials using Aqueous alpha-Lipoic Acid Solutions

Arsenic and mercury salts have been used as pesticides on museum artifacts since the late 1700's. The Arizona State Museum has recorded metal levels over 1000 µg/cm^2. When sacred objects have been treated with these pesticides, their repatriation and use for cultural ceremonies may pose contact hazards. In some cases, treated objects or human remains are being buried and pose an environmental risk. We have used α-Lipoic Acid as a means to decontaminate artifact-like materials that have been treated with arsenical and mercurial poisons. α-Lipoic Acid is a naturally occurring compound that is used as an in-vivo chelating agent to prevent mortality due to mercury and arsenic poisoning. A cleaning process sequence was developed to remove both arsenic and mercury from non- sulfur bearing test materials (filter paper and cotton) and sulfur bearing materials (wool and feathers). Test solutions of α-Lipoic acid facilitated the removal of high levels of arsenic from both non-sulfur containing and sulfur containing materials; levels of up to 500 µg/cm^2 could be reduced to < 5 µg/cm^2. In contrast, α-Lipoic acid reacted with mercuric chloride to form a precipitate that discolored the substrate, especially wool. Mercury salts were removed from non-sulfur bearing materials with extensive rinsing, but were not effectively removed from sulfur containing substrate materials.

12:00-1:00 pm Lunch

1:00- 1:45 pm Timberley Roane, University of Colorado at Denver and Health Sciences Center

Bacterial Removal of Mercury from Museum Materials: A New Remediation Technology?

Bacteria -- capable of detoxifying and, in some cases, sequestering metals -- are being investigated in the remediation of contaminated environments such as soil and water and, in this project, the removal of mercury from museum type materials. Mercury on such materials poses a unique remediation challenge because it forms non-degradable, persistent chemicals. Because mercury-resistant bacteria have the ability to convert mercury into a gaseous form, they may facilitate mercury removal. In the work presented here, a diverse bacterial community was isolated from mercury-treated items; two of the non-pathogenic bacterial isolates were capable of reducing 10 ppm mercury concentrations. One, *Arthrobacter* sp. 2604, reduced the mercury associated with a gelatin medium by 30% and a paper matrix by 20% within 7 days at 28^{o}C. Another, *Cupriavidus metallidurans* CH34, reduces up to 50% and 60%, respectively. Current work is optimizing the conditions for bacterial mercury removal including the nutritional requirements and appropriate food sources for bacteria during the remediation process.

1:45-2:45 pm Open Discussion led by **Nancy Odegaard**, Arizona State Museum, University of Arizona

2:45-3:00 pm Coffee Break

3:00-4:00 pm MCI facilities tour

Tuesday, April 24, 2007
Museum Conservation Institute Theater

9:30-9:45 am Coffee, MCI Entry

9:45-10:00 am Welcome by **Robert Koestler**, MCI Director

10:00-10:45 am Helene Tello, Ethnologisches Museum Staatliche Museen zu Berlin with Achim Unger, Rathgen-Forschungslabor Staatliche Museen zu Berlin,

The Decontamination of Ethnological Objects with Supercritical and Liquid Carbon Dioxide

Currently there are two ways to decontaminate dangerous substances in the objects with carbon dioxide. One is by super fluid extraction using carbon dioxide above its critical point (+ 31 °C and 74 bar), often called supercritical carbon dioxide. Another uses liquid carbon dioxide below the critical point that experiments have shown had a good cleaning effect on ethnological objects, especially for degreasing of overly lubricated materials. The goal of this work is to find the right conditions for effective pesticide-extraction and for cleaning and degreasing of ethnological objects without damaging them. Some objects treated with supercritical carbon dioxide lost mass, which can be attributed to the removal of dust, grease and pesticides. Supercritical carbon dioxide treatment reduced by 70-90% the amount of mercury, by over 80% DDT, by over 60% lindane, and up to 50% PCP on an object. Similar loss of mass was detected for treatments with liquid carbon dioxide. This treatment reduced by over 70% DDT, up to 75% PCP, up to 70% lindane, up to 50% arsenic, and up to 45% mercury on an object.

10:45-11:00 am Coffee Break

11:00-11:45 am Werner S. Zimmt, Arizona State Museum,
Presented by David Smith, University of Arizona
Pesticide Mitigation Using Supercritical Carbon Dioxide

Supercritical carbon dioxide ($scCO_2$) has been reported to be a suitable solvent for removing DDT from museum artifacts without leaving a residue. When $scCO_2$ was used to remove diazinon, a commonly used pesticide, from leather samples the results were unsatisfactory. However, addition of small quantities of co-solvents, a common technique, achieved complete removal.
Testing for the presence of the pesticide was achieved with a novel technique, which did not require a specific analytical procedure for detecting diazinon. Instead, toxicity was established by exposing extracts of the leather samples to Rat Lung Epithelial cells and determining the LD_{50} concentration. Removal of the pesticide was considered complete when the extract was no more toxic than a control. The advantage of this approach is that it works without having to develop a test method for each suspected pesticide.

12:00-1:00 pm Lunch

1:00- 1:45 pm Werner S. Zimmt, Arizona State Museum,
Presented by David Smith, University of Arizona
Suggestions For New Approaches To Remove Pesticide Residues
Supercritical CO_2 has been shown to be a useful solvent for the removal of various organic pesticides, some requiring the presence of a co-solvent. Theoretically it should be possible to do this for removal of inorganics such as arsenic or mercury salts. While CO_2 may not be a good candidate for removal of inorganic salts, other potential supercritical solvents can be considered. A number of such solvents, N_2O, NH_3, CHF_3, etc. are known although for some toxicity or environmental considerations may restrict their use.
Another approach to removal of surface pesticides is the use of fluidized beds with absorbent powders. Fluidized beds consist of small particles that are suspended in an air stream and behave like liquids. The absorbent powders are like carpet cleaning systems that use a powder containing small quantities of solvent that is rubbed into the carpet, allowed to dry, and then vacuumed to remove powder with adsorbed dirt. It may be possible to develop absorbent powders that will adhere to pesticide residues. Then the air stream of the fluidized beds could be used instead of vacuuming to remove from the object the powders with absorbed contaminants. If the pesticide was dusted onto the object this process may remove it efficiently.

1:45-2:45 pm Open Discussion led by **David Smith**, University of Arizona
2:45-3:00 pm Coffee Break
3:00-4:00 pm Wrap-up panel discussion by **Robert Koestler**, **Nancy Odegaard**, and **David Smith**