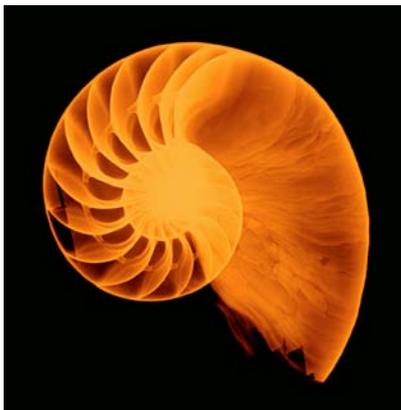




Smithsonian  
*Museum Conservation Institute*

## *Project Summaries 2009*



*October 2008 through September 2009*

## MUSEUM CONSERVATION INSTITUTE OVERVIEW FOR 2009

The Museum Conservation Institute (MCI) is a scientific research unit of the Smithsonian Institution. Our mission is to conduct research on collections and their preservation and to be the center for technical collections research and conservation studies for all Smithsonian museums, collections, and research centers. To this end, MCI's staff of scientists and conservators combines their knowledge of materials and the history of technology with state-of-the-art instrumentation and scientific techniques to provide technical research studies and interpretation of art, anthropological, and historical objects. Our studies may elucidate provenance, composition, and cultural context, as well as degradation phenomena. We are always looking for ways to improve the Smithsonian's conservation and storage capabilities, as well as solve other collection care issues.

### **Spanning Smithsonian Themes**

In 2008, the Smithsonian Institution appointed a new permanent secretary and developed a new strategic plan. While the overall mission of the Smithsonian—the increase and diffusion of knowledge—remains the same, specific priorities are now being focused on. They are: unlocking the mysteries of the universe, understanding and sustaining a biodiverse planet, valuing world cultures, and understanding the American experience.

Here is how MCI's research spans these four themes:

#### *Unlocking the mysteries of the universe*

One of MCI's most fascinating projects has sought to examine an ancient question: Did the fabled King Midas really have a golden touch? MCI conservator Mary Ballard got a chance to analyze textiles from a tomb said to be that of Midas or his father. While the fabric had no gold, it *was* yellow, a hard-to-obtain color, in a non-fading form, for ancient Phoenician artisans. This ongoing project is leading MCI staff to feel that it was actually Phoenician chemists who had the Midas touch in that they were technologically sophisticated enough to figure out how to use a form of iron oxide to color textiles this desirable hue.

Fast-forwarding to today, scientists' capabilities in atomic and molecular analysis are ever-expanding. This past year MCI has partnered with the Smithsonian Astrophysical Observatory (SAO); government agencies, such as the National Institute of Standards and Technology; the SOLEIL Synchrotron center near Paris; the Josef Stefan Institute, Ljubljana, Slovenia; and the EU engineering center at the University of Maribor, Slovenia. These partnerships will allow us to probe the underlying chemical and molecular states of nano-materials and their implications for helping to preserve Smithsonian collections.

MCI's geochemist and microbeam analysis expert, Dr. Edward Vicenzi, is leading our research program in nanotechnology. His collaboration with SAO's Senior Astrophysicist, Dr. Eric Silver, is providing the technology transfer expertise necessary to adapt an X-ray micro-calorimeter and optical design used in space exploration to nano-beam microscopy instruments for use on earthly collections. A new instrument has been created—a micro-calorimeter X-ray analysis system coupled to a high-resolution scanning electron microscope—that we at MCI are very excited about. The new instrument's X-ray spectral resolution greatly exceeds that of

existing solid-state technology, and allows scientists to probe the chemical composition of material surfaces with lower-energy electron beams than was heretofore possible. These lower beam energies allow for exceedingly high spatial resolution (quantitative) analysis at the nano-scale, with no damage to the object.

### ***Understanding and sustaining a biodiverse planet***

Proteomics, the study of proteins, is an area of rapid growth in biological and medical research. Developed in the mid-1990s, this field was made possible by newly available genetic sequences and by developments in molecular separation and mass spectrometry technology. The field has been called “the new genomics,” and shares with genomics a potential for rapid acquisition of data to drive the discovery and identification of organisms, the linking of genotypes and phenotypes—especially human disease and cancer phenotypes—and the development of novel biological and medical markers.

MCI is building a central proteomics facility for the Smithsonian. We are in the process of securing the instrumentation as well as funds for operating the facility, for travel to partner facilities and key conferences, and for interns, students, and fellows to participate in this burgeoning field. The facility will allow us to take our research to a new level as we delve further into the materials in SI collections, as well as their origins, and their deterioration processes.

One of MCI’s focal areas is biological deterioration of cultural heritage, ranging from fungi and insect pests on priceless works of art to microbial communities threatening the prehistoric cave paintings of Lascaux, France. We feel that proteomics techniques are an important way to move beyond mere identification of organisms to look at the dynamics of their populations, and at ways to control harmful organisms. For the past six years, MCI has supported Fellow and Research Associate Dr. Caroline Solazzo in using proteomic technology in scientific studies that identified food residues on arctic pottery shards and the fibers in Bronze-Age textiles.

MCI Fellow Greg Henkes, in collaboration Dr. Albert Yergey of the National Institutes of Health, developed a pilot project to look at protein differences between the early- and late-growth shell of *Nautilus pompilius*. In captivity, the *Nautilus* exhibits poor shell growth and eventual death; understanding shell changes may contribute to better long-term management of the species in captivity. Also, in late 2009 MCI hired proteomics expert Dr. Medhi Moini to help build this program for MCI.

### ***Valuing world cultures***

The Smithsonian is a treasure trove of cultural objects from around the world. But without context— where they were collected, how they were made, how they were used, who produced them – they have little meaning beyond their beauty or uniqueness. This is where MCI comes in, as we use state-of-the-art analytical techniques to elucidate provenance, composition, and cultural context of a wide range of objects. In 2009, MCI staff, led by Head of Conservation Harriet (Rae) Beaubien, in collaboration with the Smithsonian Tropical Research Institute, the National Museum of Natural History (NMNH), and the National Museum of the American Indian, continued their study of gold collections excavated in Panama, using information about

alloy composition, forming, and finishing techniques to examine the ancient movement of gold-working technology in this region. Similarly, MCI Head of Technical Studies Jeff Speakman, working with NMNH researchers, used the volcanic glass obsidian to track the earliest movement of people over the Bering Strait land bridge between northeastern Russia and the Americas. Obsidian — widely used by prehistoric people to manufacture tools — has unique chemical fingerprints specific to individual volcanoes, which allows artifacts found in Alaska to be traced to geologic sources in Russia, supporting the idea that they were brought over the land bridge 12,000 to 15,000 years ago. Another project, led by MCI Deputy Director Dr. Paula DePriest, in collaboration with NMNH researchers, has documented ancient and modern aspects of Mongolian culture. These include Bronze Age “deer stones,” stone slabs engraved with elaborate depictions of flying “spirit deer,” and historic and contemporary ovoos, piles of stones or tipis of sticks that hold religious significance to the indigenous people.

Preserving the world’s valuable cultural heritage requires, first, an understanding of the complex chemical, physical, and biological threats to its integrity. This is one of the reasons I chaired a panel on microorganisms in subterranean environments for the French Ministry of Culture at their international symposium “Lascaux and Preservation Issues in Subterranean Environments,” in February 2009. This meeting was convened to investigate anthropogenically induced changes over the past decade to one of the greatest world’s cultural treasures – the Paleolithic painted cave at Lascaux, France. The almost 2000 vivid animal paintings made from luminous iron and manganese oxide, dating back some 16,000+ years, are suddenly threatened by the rapid growth of garden-variety soil molds. Some experts have proposed that the mold damage was a consequence of global climate change, although this is still unproven.

In April 2009, MCI convened its own international workshop on the topic of preserving stone. “Biocolonization of Stone: Control and Preventive Measures” provided a forum for biologists, materials scientists, and conservators to share ideas on new methods to detect and prevent microbial deterioration and colonization on stone, and to plan future directions for collaborative research.

### ***Understanding the American experience***

The Smithsonian Institution’s collections are an unparalleled repository for objects that define our American experience, and MCI has long had a role in providing scientific research to improve the Institution’s preservation of these unique collections. We’re particularly proud of our track record of establishing scientifically based environmental standards for museum collections, detecting unsafe conditions and materials for museum exhibition and storage, and partnering with federal agencies such as NASA and NIST.

In 2009 MCI instituted an umbrella theme, *Healthy Environments, Healthy Practices, and Healthy Collections*, to focus this work. Variations in museum environments – in terms of temperature, relative humidity, and light – can have serious effects on the aging of collection objects by changing their appearance, mechanical properties, and even chemical compositions. Senior Research Scientist Dr. Marion Mecklenburg has continued his profitable research program in this area and has been busy disseminating his results to an international audience. When objects are exposed to the outdoor environment, pollutants, contaminants, and climate change may speed material degradation and encourage biodeterioration. MCI’s Biocolonization of Stone workshop, organized by Research Associate Dr. A. Elena Charola, was a first step in developing international collaboration to study these problems. Our staff of senior conservators

has taken on the challenge of developing conservation protocols and identifying products that are safe for the staff, the collections, and the environment.

A significant influence on American life beginning in the 20<sup>th</sup> century has been the development of plastics and Space-Age materials; indeed, the past half century can be considered the Age of Plastics. The Smithsonian is a repository for many different forms of modern materials, from fine arts in the Cooper-Hewitt and Hirshhorn museums to industrial objects in the National Air and Space Museum to domestic products in the National Museum of American History (NMAH). Now, some of these modern materials are exhibiting signs of deterioration; past exposure to light, heat, and moisture, as well as chemical and gaseous pollutants, are reducing their integrity and longevity. MCI's modern materials program is trying to understand why these materials are deteriorating and how to mitigate the damage; our goal is to keep the dawn of the Age of Plastics from vanishing from collections. One example of MCI's efforts is a study carried out on a set of 1930s Lumarith cellulose acetate samples from the Division of Medicine and Science of the NMAH to discover why only a few of the 49 color samples on a salesman's ring were deteriorating. This research was reported on in *Studies in Conservation*.

### **Isotope ratio (or stable isotope) mass spectrometry (IRMS) facility**

Our first full year of operation of this new Smithsonian facility saw 48 research projects begun, some 9000 analyses, one high-profile publication (Marra, P.P., et al., Migratory Canada Geese Cause Crash of US Airways Flight 1549. *Frontiers in Ecology and the Environment* 7(6): 297-301. 2009), and many more papers in preparation. For more information on the projects, please see the section devoted to this below.

### **MCI technical studies and collaborative projects**

During FY2009, MCI staff worked on 161 projects for 22 Smithsonian museums and research units, and a number of other collaborators, such as the Folger Shakespeare Library, the Library of Congress, the National Park Service, the Office of the Architect of the Capitol, the U.S. House of Representatives, and the Senate. Most of the projects are listed herein, with synopses.

If you would like more information on any of the projects or programs at MCI please feel free to contact our Technical Information Specialist, Ann N'Gadi ([Ngadia@si.edu](mailto:Ngadia@si.edu)), or me ([Koestlerr@si.edu](mailto:Koestlerr@si.edu)) directly.



Dr. Robert J. Koestler  
Director  
May 2010

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## Staff

**Mary W. Ballard**, Senior Textile Conservator

B.A. (1971) Wellesley College; M.A. and Diploma in Conservation (1979) Institute of Fine Arts, New York University

Areas of interest: textile preservation, storage, and treatment.

**Harriet (Rae) F. Beaubien**, Head of Conservation/Senior Objects Conservator

B.A. (1972) Beloit College; M.A. (1976) University of Chicago; Diploma in Conservation (1986) Institute of Fine Arts, New York University

Areas of interest: archaeological objects, on-site conservation; decorative arts.

**Lynn B. Brostoff**, Analytical Chemist

B.A. (1980) Vassar College; M.A. (1986) Art History, Institute of Fine Arts, New York University; Certificate in Conservation (1987) Institute of Fine Arts, New York University; M.S. (1994) Polymer Materials Science, University of Cincinnati; Ph.D. (2003)

Chemistry/Conservation Science, University of Amsterdam, Netherlands

Areas of interest: ICP-MS and chemistry of museum objects.

**Roland H. Cunningham**, Senior Paintings Conservator

B.A. (1962) New York University

Additional studies: Institute of Fine Arts, Conservation Center, New York University

Areas of interest: inorganic characterization of paints, pigments, and archaeological materials; technical studies of artists' materials and techniques on canvas, panel paintings, and polychromed wood sculpture.

**Paula T. DePriest**, Deputy Director

B.A. (1978) Union University; M.S. (1983) University of Tennessee; Ph.D. (1992) Duke University

Areas of interest: systematics, chemotaxonomy and molecular evolution of lichens, especially *Cladoniaceae* and *Parmeliaceae*.

**Melanie E. Feather**, Assistant Director for Operations

B.A. (1984) Franklin and Marshall College; M.S. (1986) University of Michigan

Areas of interest: scientific administration, application of electron and X-ray techniques to the study of art objects, archaeological material, and other museum specimens.

**Christine A. M. France**, Physical Scientist

B.S. (2001) University of Maryland; M.S. (2004) Geology/Paleontology, North Carolina State University; Ph.D. (2008) Geology/Paleontology, University of Maryland

Areas of interest: Stable isotope characterization of organic and inorganic materials; diagenetic alteration of archaeological and paleontological specimens; late Pleistocene/early Holocene archaeology and paleontology.

**Jennifer Giaccai**, Conservation Scientist

B.A. (1995) Macalester College; M.S.E. (1999) Johns Hopkins University

Areas of interest: conservation science; characterization and identification of artists' materials using chromatography and spectroscopy, primarily GCMS and FTIR microscopy; technical studies of works of art.

**Martha Goodway**, Metallurgist, Emerita

S.B. (1958) Massachusetts Institute of Technology

Areas of interest: archaeometallurgy; the study of the traditional technologies of mining, smelting, refining, and forming of metals and their by-products in Europe, Egypt, and Southwest Asia; the metals of music.

**Carol A. Grissom**, Senior Objects Conservator

B.A. (1970) Wellesley College; M.A. (1974) Oberlin College

Areas of interest: sculptures in bronze, stone, zinc, plaster, and wood.

**Walter R. Hopwood**, Organic Chemist

B.S. (1966) University of Pittsburgh

Areas of interest: synthetic polymers and effects of commercial products on conservation treatments, museum display and storage, carbohydrate gums.

**Robert J. Koestler**, Director

B.S. (1972) SUNY Stony Brook; M.A. (1977) CUNY Hunter College; M.Ph. (1983), Ph.D.

(1985) CUNY City College

Areas of interest: biodeterioration of cultural property.

**Francine T. Lewis**, Management Support Assistant

Certificate (1980) University of the District of Columbia; Certificate (1984) Prince George's Community College

Responsibilities: management/administration support, travel coordinator, internship/fellows/visiting scientist liaison, timekeeper.

**Nicole C. Little**, Physical Scientist

B.A. (2001) University of Missouri – Columbia; M.A. (2005) Anthropology, University of Missouri – Columbia

Areas of interest: chemical characterization of archaeological materials utilizing inductively coupled plasma-mass spectrometry, x-ray fluorescence, and neutron activation analysis; prehistory of Mesoamerica and the American Southwest; historic archaeology of the Mid-Atlantic.

**Marion F. Mecklenburg**, Senior Research Scientist

B.S.C.E. (1970), M.S. (1972), Ph.D. (1984) University of Maryland

Areas of interest: mechanical properties of solid materials and the effects of environmental factors such as temperature and moisture; computer modeling of structures under static and dynamic loadings.

**Ann B. N'Gadi**, Technical Information Specialist/Webmaster

B.A. (1987) Anthropology, University of Oregon; M.L.S. (1992) Library Science, University of Maryland

Additional studies: Westminster College (History); University of Pittsburgh (Archaeology); Anne Arundel Community College

Areas of interest: anthropology and archaeology; computer applications for information science and retrieval; Internet applications; public relations; publications and editing.

**Beverly M. Smith**, Assistant to the Director

Certificate in Nursing (1971) American University; A.A. (1984) Center for Independent Studies  
Responsibilities: EEO officer; budget forecasting and administration; office manager; liaison for human resources, fellowships and grants, sponsored projects, plant services, design and construction.

**Robert J. (Jeff) Speakman**, Head of Technical Studies

B.A. (1996) Northern Arizona University; M.A. (2002) University of Missouri; Ph.D. candidate, University of Missouri

Areas of interest: archaeology and museum studies of cultural heritage, development of instrumentation for technical studies of cultural objects, and heavy metals in the environment. Ongoing projects in Alaska, the American Southwest, the Northern Plains, the Andes, and Northeast Asia.

**Jia-sun Tsang**, Senior Paintings Conservator

M.S. (1974) Chemistry, Bowling Green State University; M.S. (1985) Paintings Conservation, Winterthur Museum, Art Conservation Program, University of Delaware

Areas of interest: collections care and preservation standards in museum exhibits; artists' materials and techniques; characterization and surface cleaning of varnishes on paintings; modern painting media and varnishes.

**Edward Vicenzi**, Research Scientist

B.Sc. Earth Sciences, McGill University; M.S. Earth Sciences, University of Oregon; Ph.D. Earth Sciences, Rensselaer Polytechnic Institute

Areas of interest: advanced microbeam analysis techniques using ions, electrons, and photons to probe natural specimens and other materials of interest.

**Melvin J. Wachowiak, Jr.**, Senior Conservator

B.S. (1981) Springfield College; M.S. (1989) Winterthur Museum, Art Conservation Program, University of Delaware

Areas of interest: history, characterization, and surface cleaning of coatings; wood technology and anatomy; microscopy; training.

**Judy Watson**, Physical Scientist

B.Sc. (2006) Archaeological Science, University of Bradford (UK)

Areas of interest: minimally destructive analysis and imaging using SEM-EDS.

**Donald C. Williams**, Senior Furniture Conservator

B.A. (1985) University of Delaware

Areas of interest: furniture finishes and colorants.

**Vernetta M. Williams**, Administrative Officer

B.S. (1954) Howard University

Responsibilities: financial transactions, procurement, and property accounting.

## **Fellows, Interns, Visiting Researchers and Volunteers**

**Renee Anderson**, *Researcher*, Black Fashion Museum Costume Collection  
**Robert Baltrusch**, *Visiting Scientist*, 3-D Scanning Project  
**Genevieve Bieniosek**, *Volunteer*, 'Ain Ghazal and Object Projects  
**A. Elena Charola**, *Visiting Scholar*, Symposia Series  
**Amber Davis**, *Volunteer*, ID of Modern Materials with Portable Instrumentation  
**Brittany Dement**, *Summer Intern*, Analysis and Synthesis of Mineralized Fabric  
**Yyonette Fogg**, *Intern*, Black Fashion Museum Costume Collection  
**Maria Fusco**, *Kress Conservation Fellow*, Glass Bead Conservation and Analysis  
**Claire Gervais**, *Visiting Scholar*, Research and Analysis of Ancient Textile  
**Sara Gillies**, *Summer Intern*, Black Fashion Museum Costume Collection  
**Ainslie Harrison**, *Fellow*, Archaeological Conservation  
**Greg Henkes**, *Contractor*, IRMS; Fellow  
**Javier Iñáñez**, *Post-Doctoral Fellow*, Spanish Colonial Pottery  
**Nadia Jimenez Cano**, *Post-Graduate Chemistry Fellow*, Fatty Acids on Paints and Archaeological Pots  
**B. Vicky Karas**, *Objects Conservator/3-D Scanning Contractor*, 3-D Scanning Project  
**Joe Koles**, *Volunteer*, Mechanics  
**Odile Madden**, *Fellow*, Arsenic and Heavy Metal Pesticides Project  
**Anthony Maiorana**, *Intern*, Anoxic Treatment  
**Allison Martin**, *Intern*, Conservation of Modern and Contemporary Arts  
**Sara McGuire**, *Summer Intern*, Chemical Analyses of Prehistoric Bone and Teeth  
**Rebecca Mendelsohn**, *Volunteer*, Imaging Projects  
**Michele Pagan**, *Volunteer*, Non-Invasive Upholstery  
**Dawn Rogala**, *Post-Graduate Fellow*, Modern painting materials and ground layers  
**Anja Schmidt**, *Researcher*, Imaging Projects  
**Elizabeth Shuster**, *Intern*, Black Fashion Museum Costume Collection  
**Caroline Solazzo**, *Visiting Scientist*, Prometics and animal fiber identification  
**Micaela Sousa**, *Post-Doctoral Fellow*, Textile Projects  
**Lauren Sturdy**, *Summer Intern*, Black Fashion Museum Costume Collection  
**Christopher Wolff**, *Post-Doctoral Fellow*, Analysis of Archaeological Arctic Slate  
**Cathleen Zaret**, *Intern*, Black Fashion Museum Costume Collection

## **Topics in Museum Conservation Lecture Series**

October 23, 2008

Third Symposium on Corrosion and Preservation of Historic Artifacts (NACE)

March 19, 2009

**The Analysis of Organic Materials in Works of Art: An Enduring Challenge**

**Dr. Jan Wouters**, Conservation Scientist/Consultant, The Getty Conservation Institute

The major challenge for analyzing and identifying natural organic materials in art resides mainly in their complex compositions, their low number of atomic species and their complex ageing patterns. Although instrumentation used in non-invasive analytical protocols has greatly improved over the last ten years, the best diagnostic quality of organic analysis is still offered by techniques that involve microsampling and separation of components, prior to their identification. When decisions regarding the analysis of art have to be made in a multidisciplinary environment, then not only the damage resulting from eventual sampling should be discussed, but also the balance of detail of useful information to that damage. Some examples were given to illustrate the importance of analytical detail; a simple formula to help estimating the balance of information quality to damage was presented.

March 24, 2009, and September 24, 2009

**Raman Spectroscopy: A Powerful Tool for the Art Conservator (Webinar)**  
**Odile Madden**, Smithsonian Institution, Museum Conservation Institute, and **Mark Wall**,  
Molecular Spectroscopy Products, Thermo Fisher Scientific

The field of art conservation has regularly turned to advanced analytical instruments to help them with questions of identification of materials to aide in authentication, to identify materials used for restoration purposes, and to understand the composition of artifacts to aide in determining how they should be cared for. Raman spectroscopy is one of the techniques showing up more and more often in art conservation centers.

Raman spectroscopy is applicable to many organic and inorganic materials. It provides a means to: identify and characterize pigments in paintings, frescoes, rock art, and manuscripts; characterize binders and resins; characterize ceramics and glazes; identify and characterize synthetic and natural polymers; identify gemstones and inclusions within stones without damaging specimens; and, characterize bone, shell, and horn based materials.

Recent advances in software and instrumentation have transformed Raman from a technique requiring considerable expertise to one that can be used effectively by the non-expert. Join us to learn about the powerful capabilities of Raman spectroscopy.

Who should attend?

If you have specimens that are proving difficult to characterize, have identification challenges, or if you have heard about Raman and want to learn more about what it might do for you, this is a presentation you should plan on attending.

This live webinar was 30 minutes and was followed by 15 minutes for questions and answers. Join our Raman experts and explore the possibilities for this powerful technique in the field of art conservation. Presented twice.

April 20-21, 2009

## Biocolonization of Stone: Control and Preventive Measures Workshop

Microbiological Studies on the Deterioration of Stones at the Angkor Site and Development of Related Restoration Activities Within the German Aspara Conservation Project

**Thomas Warscheid**, LBW Bioconsult

Diversity of Microbial Communities and the Complexity of Preserving Cultural Heritage

**Juan M. Gonzalez**, Instituto de Recursos Naturales y Agrobiologia, CSIC

Characterization of Bacterial Colonization of Stone at Global and Local Scales

**Christopher McNamara**, Harvard School of Engineering and Applied Sciences

Methods to Prevent Biocolonization and Re-Colonization

**Ornella Salvadori**, Laboratorio Scientifico, Soprintendenza ai Beni Artistici e Storici di Venezia

New Environmental-Friendly Approaches Against Biodeterioration of Outdoor Cultural Heritage

**Francesca Cappitelli**, DiSTAM, Università di Milano

Bioremediation of Algal Contamination of Stone

**Eric May**, School of Biological Sciences, University of Portsmouth

Microbiological Re-Colonization in a Garden Environment

**José Delgado Rodrigues**, Laboratório Nacional de Engenharia Civil

Red Staining on Marble

**Claire Gervais**, Museum Conservation Institute

Biocontrol testing at the San Ignacio Mini Jesuit Guarani mission, Misiones, Argentina

**A Elena Charola**, Museum Conservation Institute

Comparative Study of Commercially Available Cleaners for Use on Federally-Issued Headstones

**Jason Church**

Deer Stones of Mongolia: After Three Millennia

**Paula DePriest**, Museum Conservation Institute

Field Observations: Effectiveness of Zinc Strips to Control Biological Growth

**David Wessel**

June 15, 2009

## Driving Biological Diversity Using Mass Spectrometry

**John R. Yates**, Department of Chemical Physiology, The Scripps Research Institute

A component to understanding biological processes involves identifying the proteins expressed in cells as well as their modifications and the dynamics of processes. Several major technologies, but especially mass spectrometry, have benefited from large scale genome sequencing of organisms. The sequence data produced by these efforts can be used to interpret mass spectrometry data of proteins and thus enables rapid and large-scale analysis of protein data from experiments. More advanced methods for data analysis have allowed the analysis of data from non-sequenced organisms as well. Advances in separation technologies as well as mass spectrometers have improved the scale of experiments for protein identification. This has improved the analysis of protein complexes, and more complicated protein mixtures. Quantitative mass spectrometry can be used to study biological processes such as protein-protein interactions, development or the effects of gene mutations on pathways. Recent studies on the interactions of the Cystic Fibrosis Transport Regulator as it progresses through the folding pathway was presented. This lecture illustrated how mass spectrometry based methods can be used to learn about biological processes.

August 12, 2009

## Paint Technology and the Abstract Expressionists

**Dr. Stuart Croll**, Professor and Chair, Department of Coatings and Polymeric Materials, North Dakota State University

Dr. Croll was previously with Millennium Inorganic Chemicals, a manufacturer of titanium dioxide pigments, where he was the Director of Pigment Research and External Alliances. He earned a degree in physics from the University of London, and subsequently completed a doctorate in physics at the University of Leeds. He first worked in England, then moved to the Division of Building Research in the National Research Council Canada where he studied the internal stresses in coating films that arise during curing. He then worked at the Sherwin-Williams paint company, where he studied film formation in aqueous and non-aqueous coatings, application rheology, the weathering of coatings, adhesion, dispersion stability and polymer characterization and became the Director of Research in the Coatings Division.

In addition to weathering durability, film formation, and internal stresses in films, Dr. Croll's research interests include the application of coatings' and materials science to the preservation and restoration of modern art, and how external events, polymer science, pigment development and analytical instrumentation influence the history of paint technology.

Dr. Croll is an active collaborator in modern paintings conservation research. Dr. Croll's presentation at MCI addressed the rapid changes in paint technology that took place during the era of the American Abstract Expressionists.

## Isotope Ratio (or Stable Isotope) Mass Spectrometry (IRMS) Facility

Our first full year of operation of this new Smithsonian facility saw 48 research projects begun, some 9,000 analyses, 1 high-profile publication (Marra, P.P. et al., Migratory Canada Geese Cause Crash of US Airways Flight 1549. *Frontiers in Ecology and the Environment* 7(6): 297-301. 2009), and many more papers in preparation.



### Laboratory Background

During the past twenty years, the development and widespread proliferation of modern mass spectrometers has made the task of measuring the masses and relative concentrations of atoms and molecules at high precision (from both organic and inorganic compounds) a reality at most research institutions throughout the United States. The availability of modern mass spectrometers offers researchers access to a wealth of new scientific knowledge, with much of it based on subtle variations in composition caused by physical and chemical mechanisms in nature. In recognition of this need, the Smithsonian Institution's Office of the Undersecretary for Science (OUSS), in collaboration with the Museum Conservation Institute, formed a Mass Spectrometry Advisory Panel tasked with the goal of identification, acquisition, and development of scientific instrumentation that will meet the research requirements of the broadest segment of SI researchers and their visiting students.

In early discussions with OUSS, MCI, and the Advisory Panel, it was recognized that the most critical and immediate need was a pan-institutional laboratory capable of high-precision measurements of isotopes of carbon, nitrogen, oxygen, hydrogen, and sulfur (C, N, O, H, S). These elements naturally occur as two or more stable (non-radioactive) isotopes. Isotopic variations arising from mass-dependent isotopic fractionation in organic and inorganic substances can be used to trace the pathways and forms that these key elements take as they are transferred and cycled within biological and geochemical systems. Measurements of stable isotope ratios in soils, animal tissues, and plant samples are used to reconstruct past climates and vegetation, evaluate physiological responses of wild and domesticated organisms, characterize

energy and material transfers and transformations among plant, animal, and microbial components of ecosystems, and understand atmosphere-biosphere interactions. Stable isotopes record information on biological and physical processes operating across space and time, and thus are useful in integrative studies that span disciplines and levels of biological organization. Rapid and precise stable isotope analysis of solid, liquid, and gaseous materials are fundamental to studies in physiology, ecology, hydrology, earth and atmospheric sciences, archaeology, art history, and conservation.

### **FY09 Accomplishments**

Funding to support this initiative was obtained via FY 2007 year-end funding; MCI, with support from OUSS, took the lead in setting up a central laboratory with two stable isotope ratio mass spectrometers and associated peripherals. MCI hired a contractor, Greg Henkes (currently a Ph.D. student at Johns Hopkins) in May 2008 to oversee the installation and initial setup of the instruments. Greg's work was critical for laying the foundation of the



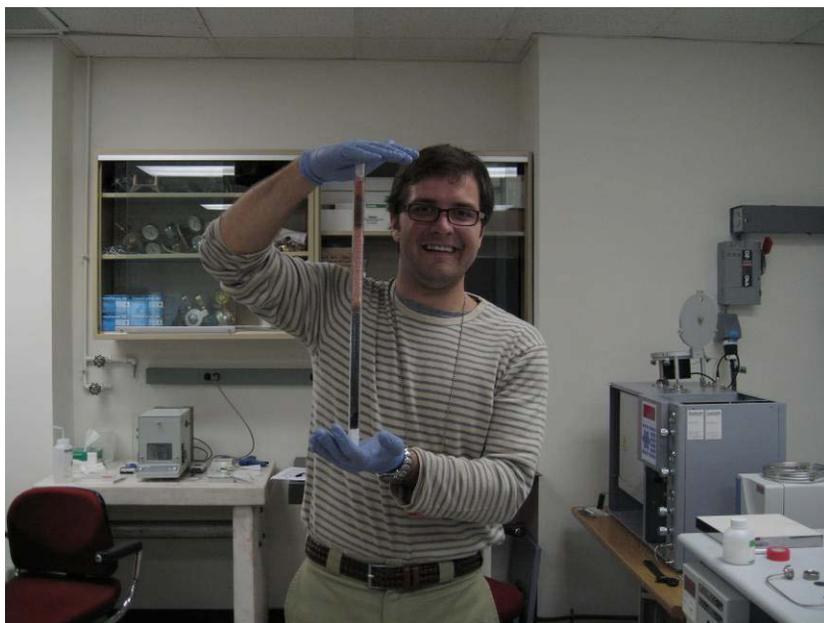
laboratory. Both instruments were installed in June 2008, and MCI hired a full time scientist, Dr. Christine France, in November 2008 to manage the day-to-day operation of the laboratory. Upon starting at MCI, Christine (along with MCI management) faced multiple challenges, including advertising the laboratory's capabilities to the SI community, developing partnerships and collaborations, educating potential researchers on details of stable isotope geochemistry, overseeing the analyses, scheduling instrument time, and training multiple SI students and fellows on issues concerning sample preparation and analytic procedures—all while trying to develop and maintain her own research program.

The laboratory has been a phenomenal success. In the first year of operation MCI scientists collaborated on 48 projects that resulted in more than 9,000 analyses, 1 peer-reviewed publication, and 3 professional presentations. Such productivity is the norm for some of the larger academic-based facilities, but for a brand new laboratory with limited personnel and fiscal resources, this level of productivity is highly exceptional. In addition to the above mentioned accomplishments, we are aware of three grant proposals that were submitted by SI researchers that included data generated at the Isotope Ratio (or Stable Isotope) Mass Spectrometry (IRMS) laboratory and numerous other papers that have been submitted and are in review or in press. We anticipate that the numbers will be much higher in FY10. Of the 48 projects initiated in FY09, 15 were based with researchers at **NMNH** (Anthropology and Paleobiology), 10 with **NZP**, 8 with **SERC**, 1 with **SMSFP**, 2 with **STRI**, and 2 with **FSG**. The remaining projects were initiated by **MCI** researchers. These projects also include numerous collaborations with researchers and

students at external institutions (such as University of Arizona, NIH, Johns Hopkins University, University of Maryland, Indiana University, Nova Southeastern University, Baylor University, University of Georgia, University of Montana, University of Gronigen, and University of Central Florida) which brings a broader depth of knowledge and unique expertise to Smithsonian projects.

Isotopic research conducted thus far, has, or will contribute to the growing body of research on a multitude of topics such as avian migration, wetland ecology, and African wildlife dietary history. In the future we hope develop novel applications for stable isotope analysis in paleobiology conservation and archaeological science as well as provide traditional services to those disciplines already heavily based on stable isotope chemistry. If we look at how the current projects are aligned with the Smithsonian's new strategic plan, we count 33 projects that can be thematically classified as **Understanding and Sustaining a Biodiverse Planet**, 7 are classified as **Understanding the Mysteries of the Universe**, 6 are classified as **Valuing World Cultures**, and 2 can be classified as **Understanding the American Experience**. The IRMS Facility is clearly aligned with SI's new strategic plan and making important contributions to Smithsonian Science.

As we look to the future of the laboratory, funding remains a critical issue for sustained maintenance and future growth of the facility. Some success has been made on this front already. In early FY10, OUSS provided funding to support an interdisciplinary postdoctoral fellowship in the area of stable isotope biogeochemistry. In addition, several stakeholders in the laboratory (OUSS, MCI, Peter Marra, and Ed Vicenzi) pooled funds that provided for



the purchase of a new microbalance for weighing out samples. Although the lab is well equipped, there remain several items that need to be purchased to support the operations of the lab—these include a gas chromatograph for compound specific isotopic research and a micromill for targeted sampling of small areas. The most urgent concern for the immediate future, however, is the maintenance and repair of the instruments. The current service contract is set to expire in July 2010. It is critical that the laboratory stakeholders negotiate funding to either renew the contract or identify funds that can be used for instrument repairs on an as-needed basis.

It is important to note that since the laboratory opened for business, no fees have been charged for any of the analyses that have occurred and that costs for all consumables and gasses have

been borne by MCI. For this laboratory to operate at its maximum potential, hurdles that would limit or preclude access to analytical resources must be minimized. This is especially true given that funding at the unit level oftentimes is limited and access to traditional funding venues, such as the National Science Foundation remain a challenge for SI scientists. It is hoped that at some point in the very near future that MCI and the Stable Isotope Mass Spectrometry Committee can negotiate a dedicated line of funding from SI to support the basic operation and expansion of the laboratory. This is especially important given the demonstrated success of the laboratory and the fact that the laboratory is strongly aligned with the new SI Strategic Plan.

Finally, it is important to underscore the contributions that the laboratory has already made to support scientific excellence at SI and cross unit collaboration. The very first publication from the laboratory was based, in part, on stable isotope analyses of feathers recovered from the engine of US Airways Flight 1549—also known as *Miracle on the Hudson*. Following the crash, the Federal Aviation Administration contacted Carla Dove (NMNH) about identifying the birds that were sucked into the plane's engine. Carla subsequently initiated a conversation with MCI and Peter Marra (NZP); these discussions formed the foundation for a very strong cross unit collaboration that exemplifies Smithsonian science. The analyses were conducted and isotopic data resulted in the determination of a non-local origin for the Canada Geese that struck the plane. These findings were significant on several fronts. First and foremost were the implications from a wildlife management perspective. Had the geese been determined to be from a local New York population, it is highly likely that the local population would have been culled or exterminated. Determining that these particular geese were migratory requires a completely different management plan to prevent future bird strikes. The use of deuterium isotopes to effectively “source” the geese was a novel application of isotopic research—one that will serve as a model for future avian migration based research. Finally, there is the positive public impact that resulted from the research which was highly publicized both nationally and internationally. A search of the AP headline identified 35,000 hits on Google, hundreds of which were direct coverage of the SI press release. For the public which traditionally does not associate the SI with science, this research is yet another of several recent and excellent examples of science at the Smithsonian.

Below is a list of summaries provided by PIs for projects initiated in FY09. Although we do not expect all of these projects to necessarily have the same level or type of impact as the Canada Geese research discussed above, we are confident that the research exemplifies Smithsonian Science and will have far reaching implications both within and beyond the confines of the Institution. For details of specific projects, please contact the primary project PIs; for details concerning the IRMS Facility contact Christine France or Jeff Speakman.



**IRMS #: 0001**

**PI:** Caroline Solazzo (MCI)

**Smithsonian Initiative:** *Valuing World Cultures*

**Title:** Identification of Salish blanket fiber materials

**Project Summary:** This research seeks to resolve questions as to source of protein fiber in blended yarn used by the North West Coast Salish tribes in making blankets, a subject of active debate. The research method involves comparison of provenienced dog and mountain goat hair fibers to unknown fibers from the provenienced Salish blankets, using a range of analytical techniques including proteomics (peptide sequence comparison) and stable isotopic analyses. The results will be of interest to North-American archaeologists and ethnologists first as the use or not of dog hair will change or confirm theories about the Coast Salish and shed new light on Native American weaving and archaeology in general. The second interest is for archaeological sciences: proteomics is a recent discipline, being applied to archeology for the past three years. Its potential is just now beginning to be understood and textile identification can be a huge application for archaeology and conservation. At the same time, it will enlarge the database of provenienced animal fiber sources sequenced by the proteomics methodology.

**IRMS #: 0002**

**PIs:** Ilka Feller and Anne Chamberlin (SERC)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Effects of nutrient enrichment and species diversity on ecological stoichiometry

**Project Summary:** This is a study on how nutrient enrichment alters food webs in the mangroves. These samples cover how different snail species differ their feeding on different species of enriched mangrove leaves.

**IRMS #: 0003**

**PIs:** Mary Ballard and Elizabeth Shuster (MCI)

**Smithsonian Initiative:** *Valuing World Cultures*

**Title:** Isotope ratio mass spectroscopy (IR-MS) analysis of natural and synthetic indigo

**Project Summary:** The purpose of this research project is to determine whether isotope ratio mass spectroscopy can aid in the discrimination of synthetic and natural indigo dyes derived from plants incorporated into cultural artifacts. It is hypothesized that natural and synthetic indigo can be identified in cultural artifacts according to differences in their isotopic makeups, even though their chemical formulas are identical. For example, the carbon isotopes in natural indigo derived from plants and synthetic indigo are likely to be dissimilar because only in natural indigo derived from plants are the isotopes guided by photosynthetic processes. In addition to distinguishing between natural and synthetic indigo, it may be possible to identify the geographic sources of natural indigo used in cultural artifacts, since hydrogen and oxygen isotopes vary geographically. In order to test this hypothesis, the tendencies of carbon, nitrogen, oxygen, and hydrogen isotopes toward fractionation in natural and synthetic indigo at various stages of processing will be recorded.

*Shuster, E., and Henkes, G.,  
2009. Isotope Ratio Mass  
Spectroscopy and Indigo.  
Second Annual SI-Conservation  
Conference, Suitland, MD, June*

**IRMS #: 0004**

**PIs:** Jeff Speakman (MCI) and Greg Henkes (MCI and Johns Hopkins), NZP and National Institutes of Health

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Analysis of *Nautilus pompilius* shell

**Project Summary:** Nautili are a nocturnal species that undergo a daily, vertical migration. In captivity nautilus require cool water, dark, and deep dedicated aquariums. Even in 'proper' environments, they experience buoyancy problems and are unable to properly grow new shell in captivity. In addition, it appears the mortality rate for captive specimens is quite high. Identifiable chemical differences between the 'new' and 'old' shell growth may help determine the cause of elevated mortality rates in captive nautilus. Inorganic chemical differences will be analyzed using XRF, SEM-EDS, ICP-MS, and IRMS techniques. Changes in organic composition will be examined using IRMS and proteomic techniques.



**IRMS #: 0005**

**PIs:** Ashley Coutu and Jeff Speakman (MCI)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Tracing the links between elephants, humans, and land use during the 19th century East African caravan trade: a bioarcheological study

**Project Summary:** This project aims to determine the geographical origins (i.e. source) of ivory traded along 19<sup>th</sup> century caravan routes in East Africa. It will examine the impacts of the East African ivory trade which reached its peak in the mid 19<sup>th</sup> century through the use of stable isotope analyses of historic elephants (bone, teeth, tusk). Isotope analyses of elephant remains will provide a historic proxy of what the elephant was eating (carbon isotopes), what type of climate it lived in (oxygen/nitrogen isotopes), and where it lived (strontium isotopes) in order to build a database of where elephants were exploited. Samples from East African elephants from the 19<sup>th</sup> and 20<sup>th</sup> century from the Smithsonian National Museum of Natural History will provide a baseline for the samples in this project. Additional samples from East African animals known to be browsers or grazers (i.e. hippopotamus, giraffe, zebra, wildebeest) will provide a standard for the carbon isotope values found for the historic elephant populations.

**IRMS #: 0006**

**PIs:** Chris Tonra and Peter Marra (NZIP)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Patterns of stable carbon isotope variation over the arrival period in a long-distance migratory bird

**Project Summary:** This project continues to gather data on how stable carbon isotopes vary over the arrival period for a long-distance migratory bird

**IRMS #: 0007**

**PIs:** Sara Rockwell (U. Maryland) and Peter Marra (NZIP)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Carry-over effects of winter population limitation in the endangered Kirtland's Warbler

**Project Summary:** Factors limiting the population size of the Kirtland's warbler (*Dendroica kirtlandii*), an endangered migratory bird, on their Bahamian wintering grounds and how these factors carry over to affect breeding season events remain unstudied, which could undermine conservation efforts. The objectives of this project are to 1) examine whether the consequences of winter habitat and diet affect arrival dates and body condition of Kirtland's warblers on the breeding grounds, and 2) assess the influence of these carry-over effects on



the reproductive success. We will do this by monitoring eight 30-ha study plots near Mio, MI for the spring arrival dates of male warblers. Incoming males will be captured and banded, condition measured, and tissue samples will be collected for stable isotope analyses. The  $\delta^{13}\text{C}$  of crown feather, blood, and claw material will be used as a measure of winter habitat type (wet vs. dry), and  $\delta^{15}\text{N}$  of these tissues will represent winter diet (proportion of insects vs. fruit). Nests of banded males will be found and reproductive success (number of fledglings per year) will be recorded. Correlations between isotope ratios representing winter habitat and diet and 1) arrival date; 2) body condition; and 3) reproductive success of individual males will be examined. Identifying limiting factors is vital for effective conservation practices, yet the consequences of non-breeding season events on the population dynamics of this species, as well as most Neotropical migratory birds, are not understood. This study will assess the effects of winter population limitation, and increase our understanding of how seasonal interactions shape the fundamental ecology of migratory animals.

**IRMS #: 0008**

**PIs:** Yae Takahashi and Blythe McCarthy (FSG)

**Smithsonian Initiative:** *Valuing World Cultures*

**Title:** Use and selection of natural versus man-made mercury sulfide in china: development of a method for differentiation

**Project Summary:** Both natural (cinnabar) and synthetic (vermilion) forms of the red pigment, mercury II sulfide,  $\text{HgS}$ , are known to have been in use in China where the pigment occurs widely in archaeological contexts. However, differentiation between



vermilion from the Chinese dry-process of manufacturing and natural cinnabar is currently not

possible. The goal of the research is to develop a method that will discriminate between the two, and possibly identify geological sources of mercury sulfide given sufficient analyses of raw materials. The method will be used to increase understanding of the selection, production and use of mercury II sulfide pigments in China in terms of past human and social dynamics. Specifically, the investigators propose to develop a method by 1) producing vermilion using traditional methods and characterizing it for chemical and physical properties; and by 2) performing sulfur isotope analysis, total mercury analysis (to arrive at mercury to sulfur ratios), and x-ray fluorescence analysis on the vermilion as well as other selected reference materials. The method development will lay the groundwork for more extensive studies of mercury sulfide from archaeological sites in Shaanxi province, China, including a study of HgS used for ritual versus decorative purposes and a study of HgS in wall paintings from the Qin, Han, Sui and Tang dynasties.

*Takahashi, Y., McCarthy, B., Henkes, G.A., France, C.A.M., 2009. Analysis of natural and man-made mercury sulfide using sulfur isotope analysis. The Japan society for the conservation of cultural property, 31st conference in Kurashiki, Japan,*

**IRMS #: 0009**

**PI:** Dennis Whigham (SERC)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** A preliminary analysis of plant and animal ecosystems in Alaska

**Project Summary:** Plant and soil samples from Alaskan ecosystems will be analyzed in an effort to reconstruct the food webs of the area.

**IRMS #: 0010**

**PI:** Ben Turner (STRI)

**Smithsonian Initiative:** *Understanding the Mysteries of the Universe*

**Title:** Cross-laboratory comparison and confirmation of standard values for stable isotopic analyses

**Project Summary:** Standards with accurate known isotopic values are critical to proper data handling and linear correction to internationally calibrated isotopic standards. In this study, organic materials developed at the Smithsonian Tropical Research Institute are tested in an inter-laboratory comparison to confirm stable carbon and nitrogen isotopic values.

**IRMS #: 0011**

**PIs:** Christine France and Greg Henkes (MCI)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** IRMS round robin comparison of values for new urea and acetanilide stable isotopic standard materials

**Project Summary:** This study is a round-robin test of several new urea and acetanilide standards for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values. The values obtained from multiple labs around the world will be combined and an average value published for purposes of international use. These standards will be used as new calibration points for purposes of correcting data to international standards.

**IRMS #: 0012****PIs:** Jeff Speakman and Christine France (MCI), Paul Sheppard (U. Arizona)**Smithsonian Initiative:** *Understanding the Mysteries of the Universe***Title:** Stable carbon and sulfur isotopic indicators of volcanic eruptions as recorded in tree rings from Central and North America

**Project Summary:** The identification of past volcanic eruptions as recorded in tree rings is typically accomplished by standard methods of dendrochronology and examination of tree ring morphology. The goal of this study is to add the examination of chemical tracers in the tree rings that may be indicative of an eruption. Specifically, the stable carbon and sulfur isotopic record of the tree rings may reflect an eruption insofar as the isotopic signature of the surrounding atmosphere is often altered by gaseous volcanic input. Tree cores in close proximity to a well dated cinder cone eruption in Paracutin, Mexico will be examined for unique isotopic patterns during the eruption time period. Once a chemical pattern is established, tree cores in proximity to the poorly dated eruption at Sunset Crater, Arizona will be examined in a similar manner. Confirming an exact date for this and other culturally important eruptions will contribute greatly to our understanding of ecologic perturbations as causes for population movements in prehistory.

**IRMS #: 0013****PI:** Amy Hirons (NMNH)**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet***Title:** Identification of water masses through the isotopic signature of marine zooplankton

**Project Summary:** Marine zooplankton will be used in identifying water masses using the stable carbon and nitrogen isotope signature of different zooplankton taxa. Additional tests will be performed to determine how different preservation techniques affect these zooplankton stable isotope ratios. The potential use of  $\delta^{18}\text{O}$  and  $\delta\text{D}$  analyses will be considered in light of results from carbon and nitrogen isotopic analyses.

**IRMS #: 0014****PI:** Amy Hirons (NMNH)**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet***Title:** Diets of mesopelagic fish

**Project Summary:** Mesopelagic fish muscle will be used to discern little known aspects about the diets of these fish. Carbon and nitrogen stable isotopic data will help assess what and where these fish are foraging.

**IRMS #: 0015**

**PI:** Amy Hirons (NMNH)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Examination of trophic structure of the Northwest Hawaiian Islands throughout the 20<sup>th</sup> century: evidence from the stable isotope signatures of monk seals

**Project Summary:** This study looks at the trophic structure of the Northwest Hawaiian Islands throughout predominantly the 20th century in an effort to better understand this species and develop appropriate conservation methods. This study includes monk seal bone collagen as well as vertebrate and invertebrate prey items of these seals which will be used to establish a food web through carbon and nitrogen stable isotope analyses.



**IRMS #: 0016**

**PI:** Amy Hirons (NMNH)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Stable isotope signatures of sea otter vibrissae as evidence for temporal/spatial distribution

**Project Summary:** This study consists of the analysis of sea otter vibrissae. The animals' temporal/spatial distribution will be correlated to the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values.

**IRMS #: 0017**

**PI:** Amy Hirons (NMNH)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Temporal and spatial distribution of sea otters in the Bering Sea and North Pacific: evidence from stable isotopes

**Project Summary:** This study consists of analyses of Steller sea lion vibrissae for carbon and nitrogen stable isotopes. This is a continuation of our long-term temporal sea lion trophic studies, focused on the western side of the Bering Sea and North Pacific.

**IRMS #: 0018**

**PI:** Amy Hirons (NMNH)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Tracking a turtle's ocean journey using stable isotope signatures

**Project Summary:** Many species of sea turtles are known to be highly migratory throughout their lifespan. Understanding these migration patterns is crucial for conservation efforts. This project will analyze the stable carbon and nitrogen isotopic signature of several species of sea turtle scute (shell), egg case and bone collagen. This preliminary project will determine if the turtles' ocean journey can be tracked with stable isotopes.

**IRMS #: 0019**

**PI:** Amy Hirons (NMNH)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Stable isotopic indications of seagrass contribution to diet and habitat

**Project Summary:** This project examines seagrass contribution to diet and as habitat. A variety of organisms such as algae, invertebrates and vertebrate muscle will be examined isotopically for their relationship to the seagrass. Additionally, seasonal variability in the seagrass influence will be examined.

**IRMS #: 0020**

**PI:** Christine France (MCI)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Thermoregulatory adaptations of *Acrocanthosaurus atokensis* – evidence from oxygen isotopes

**Project Summary:** The thermoregulatory strategy of *Acrocanthosaurus atokensis* is currently unknown. This study aims to discern the internal temperature patterns of this large theropod dinosaur and determine if it was a homeotherm or a heterotherm. Oxygen isotopes, which are sensitive to variations in body temperature, will be compared across different bones of the same individual. The overall interbone temperature pattern as indicated by the  $\delta^{18}\text{O}$  values will be compared to the pattern from an ostrich (a known homeotherm and direct descendant of the dinosaur lineage), an elephant (a known large homeotherm), and an alligator (a known large heterotherm).

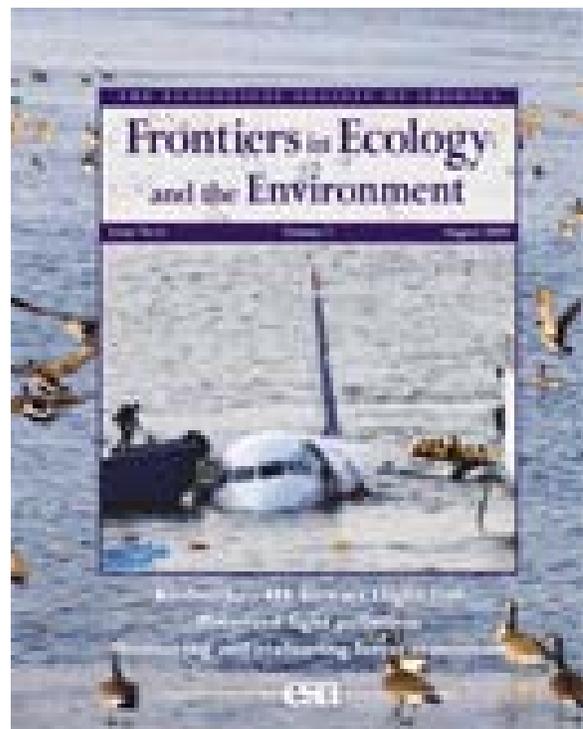
**IRMS #: 0021**

**PIs:** Peter Marra (NZP) and Carla Dove (NMNH)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Investigation of the migratory nature of Canadian geese causing the crash of US Airways Flight 1549

**Project Summary:** In January 2009, multiple engine strikes from Canadian geese forced the crash-landing of US Airways Flight 1549 in the Hudson River. Hydrogen isotopic data for the feather remains of the birds were compared to both migratory and local populations of geese in an effort to determine which of these groups was most similar isotopically to the bird remains. Determination of the migratory status of the birds responsible for the crash is critical to future preventative measures.



**IRMS #: 0022**

**PIs:** Colin Studds and Peter Marra (NZP)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Connectivity of migratory bird populations wintering in the Caribbean Basin

**Project Summary:** Natural selection acts on individual animals throughout the annual cycle, and events during each phase of the annual cycle likely influence subsequent events. For migratory animals, understanding these selection processes has been impossible because of our inability to follow individuals year-round and determine where breeding populations winter and where winter populations breed. In this study, we will construct isotopic basemaps for seven species of Nearctic-Neotropical migratory birds wintering within the Caribbean basin by using stable-hydrogen isotopes in tail feathers grown in North America and collected during the tropical non-breeding season. The final products of this research will include a map linking the breeding and wintering areas of each species. Such data will not only help determine the degree to which migratory bird populations mix between winter and summer, but will also provide an invaluable template for region-specific monitoring efforts.

**IRMS #: 0023**

**PIs:** Dennis Stanford (NMNH), Christine France (MCI) and Jeff Speakman (MCI)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Stable isotopic characterization of a mammoth tusk from coastal Virginia and associated fauna on the east coast of North America

**Project Summary:** A mammoth tusk dredged from the ocean floor off the coast of Virginia represents a unique opportunity to study a mammoth specimen with a known associated spear point. The direct implication of human predation on this species indicates that humans were present in established communities at a time concurrent with this specific animal.



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*Marra, P.P., Dove, C.J., Dolbeer, R., Dahlan, N.F., Heacker, M., Whatton, J.F., Diggs, N.E., France, C., and Henkes, G.A., 2009. Migratory Canada geese cause crash of US Airways Flight 1549. Frontiers in Ecology and the Environment*

Initial carbon dating suggests an age of ~20ka, a time which is older than the currently accepted presence of humans on the east coast of North America. Stable isotopic analyses will determine if this particular animal lived on the coast of Virginia or if it was a “wash-out” from upriver. Establishment of this animal as being from local population is critical to confirming human presence at this time at this location.

**IRMS #: 0024****PIs:** Mary Ballard and Ed Vicenzi (MCI)**Smithsonian Initiative:** *Valuing World Cultures***Title:** Isotopic evaluation of the Midas textiles

MCI is collaborating with University of Pennsylvania researchers on the analysis of 11 textile samples from the prominent Tumulus MM at Gordion, Turkey—widely considered to be King Midas’s tomb. Despite the tomb’s pristine and methodical excavation, no gold was ever found inside it—there was bronze, iron, and exquisite inlaid furniture, but no gold. At first glance, the textiles were unimpressive—either degraded clumps or small fragments in which uneven weaving and knots were hardly of regal quality. At high magnification, the fibers were found to be hollow—with no organic material left. What appeared as yarns seemed simply the artifact of a uniform coating, entirely hollow, as seen with SEM/EDS, and composed of iron. After washing off microbial debris with solvents, an organic infrared spectrum was taken. It matched “Goethite” a gold-colored iron oxide ( $\alpha$ -FeOOH), which in turn matched a recently published textile study. Various innovative analytical systems were employed, unsuccessfully, to prove the link between the Tumulus MM textiles and Goethite. The samples were subsequently analyzed with a TerraSpec VIS/NIR spectrometer which gave a definitive peak at 760 nm, in the near infrared, and proved the close similarity of Goethite in the Midas sample, its match to the modern polyester coated linen, and a known reference spectrum. Other fragments from the tomb, once thought to be green because of their proximity to the copper and bronze artifacts, have been proved to be composed of indigo and goethite—a sophisticated mixing of organic and inorganic chemistry. The Lydian king buried so long ago reigned over a kingdom filled with very capable scientists and textile technologists.

**IRMS #: 0025****PIs:** Dennis Whigham (SERC) and Ryan King (Baylor U.)**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet***Title:** Influence of riparian vegetation communities on stream food web structure

**Project Summary:** This study is focused on how riparian vegetation communities influence stream food web structure, as inferred using hydrogen, carbon and nitrogen stable-isotope ratios. Using samples collected across different wetland geomorphic settings (ecosystems), we will determine if different riparian wetland vegetation along headwater streams differentially support stream food webs. The study will help quantify the hypothesized linkage between uplands, wetlands, and streams in supporting juvenile salmon production. This information will be an important first step for regulators and managers to assess the ecological consequences of development activities in the headwater regions of watersheds on the Kenai Peninsula.

**IRMS #: 0026**

**PIs:** Russell Greenberg (NZIP) and Patti Newell (U. Georgia)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Evaluating quality of winter feeding grounds for declining Rusty Blackbird

**Project Summary:** The Rusty Blackbird is one of the fastest declining songbirds in North America. Rates of population decline are estimated at 80-90% over the last 40 years and the cause is unknown. The decline could be occurring on the wintering ground, on breeding sites, or at migration stopover sites. We are studying the bird on the wintering ground to determine high quality habitat sites. It is thought that sites with pecans available may be higher quality than sites without. We are collecting blood samples from the birds we catch in South Carolina and intend to run stable isotope analyses for C and N and correlate them with body condition via indicators of body condition and blood metabolites assays.

**IRMS #: 0027**

**PI:** Peter Marra (NZIP)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Patterns of stable carbon and nitrogen isotope variation across an urbanization gradient

**Project Summary:** This was an exploratory project to develop some initial patterns of isotopic variation across an urbanization gradient in the feathers of gray catbirds.

**IRMS #: 0028**

**PIs:** Peter Marra (NZIP) and Adam Sepulveda (U. Montana)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Trophic structure of several fluvial ecosystems in the western United States

**Project Summary:** This study aims to reconstruct the trophic structure of several fluvial ecosystems in the western United States. The sample set will include all levels of the food chain from plants to salamanders.

**IRMS #: 0029**

**PIs:** Melissa McCormick and Kerry Good (SERC)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Effects of environmental change on the mycorrhizal relationships of the native orchids *Goodyera pubescens* and *Tipularia discolor*

**Project Summary:** Environmental change poses a many-faceted threat to native orchid species. Not only do habitats threaten to change directly, but the effects these fluctuations can have on necessary mycorrhizal communities also limit the ability of orchids to withstand changing conditions, especially at times of heightened stress when they may be depending on their mycorrhizal partners extensively for nutritional needs. This study incorporates *Goodyera* and *Tipularia* individuals at field sites on the SERC campus. Orchids obtain carbon from photosynthesis and also by digesting their mycorrhizal fungi; carbon can also be transferred from the plant to the fungi. These different nutritional patterns and the different fungal species incorporated into the orchids will be traced using stable carbon and nitrogen isotopes. Additionally, orchids will be exposed to reduced water and light in an effort to estimate the extent to which the orchids rely on their mycorrhizal fungi for nutrition during periods of stress, and whether increased stress induces myco-heterotrophy.

**IRMS #: 0030**

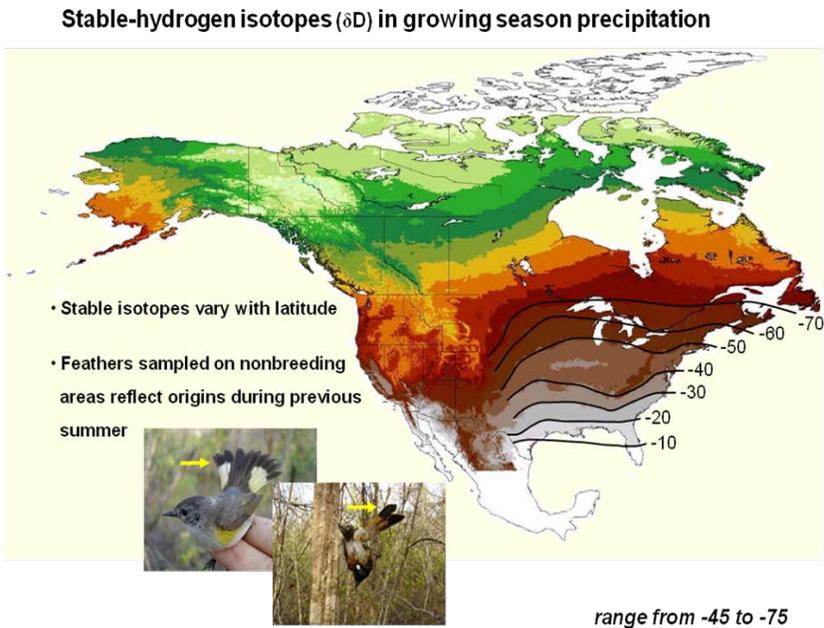
**PIs:** Peter Marra (NZIP) and Clark Rushing (U. Maryland)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Using stable isotopes to study long-distance dispersal in neotropical migratory birds

**Project Summary:** Hydrogen isotopes from feathers collected from neotropical migratory bird species will be used to study patterns of long-distance dispersal. Specifically, we have collected samples from ~200 birds representing 6 species during the 2009 breeding season. Because these feathers were grown the previous year on or near the birds' breeding/natal ground, we hope to use H isotopes to determine the likely origin of these individuals, which will allow us to determine patterns of

long-distance dispersal and how these patterns differ between ages, sexes and species. Subsequent work will combine these methods with experimental work in order to test hypotheses about the causes and consequences of long-distance dispersal.



**IRMS #: 0031**

**PIs:** Bruno Frohlich (NMNH), Christine France (MCI), Jeff Speakman (MCI)

**Smithsonian Initiative:** *Valuing World Cultures*

**Title:** Stable isotopic analysis of Bronze Age burial mounds (Khirigsuurs) in Mongolia

**Project Summary:** This project focuses on the  $\delta^{13}C$ ,  $\delta^{15}N$ , and  $\delta^{18}O$  values from human remains from Bronze Age burial mounds in Mongolia. The stable isotopic values will serve as proxies for reconstructing diet and possibly migratory patterns. These analyses will put into a cultural context to determine status of particular individuals and patterns of movement among separate populations.

**IRMS #: 0032**

**PIs:** Doug Owsley (NMNH), Christine France (MCI) and Jeff Speakman (MCI)

**Smithsonian Initiative:** *Understanding the American Experience*

**Title:** Stable isotopic analysis of Civil War soldiers from an excavated cemetery in New Mexico

**Project Summary:** The remains of several Civil War soldiers were unearthed from an abandoned military fort cemetery in New Mexico. The remains consisted of both native and immigrant persons as well as both black and white soldiers. Carbon and nitrogen stable isotopes will be used to determine dietary differences among these different groups. This information will be placed into a cultural context whereby inferences concerning the quality of life of different soldiers will be considered.

**IRMS #: 0033**

**PIs:** Christine France (MCI)

**Smithsonian Initiative:** *Understanding the Mysteries of the Universe*

**Title:** Development of new in-house standards for isotopic linear correction

**Project Summary:** Development of in-house working isotopic standards is necessary to reduce the use of certified standards. The project aims to find alternative standards to the limited supply of NIST certified USGS40, USGS41, and others.

**IRMS #: 0034**

**PIs:** Anna K. Behrensmeyer (NMNH) and Christine France (MCI)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Incorporating stable isotopic data into the larger biostratigraphic record of the Miocene Siwalik sequence in Pakistan

**Project Summary:** This project aims to incorporate stable isotopic data into the larger biostratigraphic record of the Miocene Siwalik sequence in Pakistan. Specifically, carbon and oxygen isotopic signatures from *Pila* snail opercula will be examined for climate signals and seasonality. Snails from several stratigraphic levels will be examined to determine changes in seasonality strength over time.

**IRMS #: 0035**

**PIs:** Terry Chesser (NMNH) and Camilo Sanin (Columbia U.)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Using stable isotope signatures to examine adaptive radiation of the passerine bird genus *Cinclodes*

**Project Summary:** This project is a study of the adaptive radiation of the passerine bird genus *Cinclodes*, using an integrated approach involving stable isotopes, phylogeny, and physiology. The genus *Cinclodes* consists of 13 species of ovenbirds, several of which have independently adapted to marine environments. This adaptation is unique among passerine birds, which lack functional salt glands and are constrained by their relative inability to produce concentrated urine. The purpose of the project is to track the pathways that led to the evolution of a marine niche in an evolutionary radiation of passerine birds. We are testing the proposition that *Cinclodes* is an adaptive radiation in which diversification was mediated by changes in osmoregulatory function. We are also examining the hypothesis that the evolution of a marine niche in the marine clades of *Cinclodes* has been accompanied by profound changes in the form and function of the kidney. Stable isotopes will allow us to determine the relative reliance of the

different species on marine and terrestrial-freshwater sources, as well as to determine the spatial and temporal changes in the use of these two types of resources in both individuals and populations.

**IRMS #: 0036**

**PIs:** Kenneth Wurdack and James Horn (NMNH)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Evolution of photosynthetic systems in *Euphorbia* (Euphorbiaceae)

**Project Summary:** *Euphorbia* (Euphorbiaceae) is the second largest genus of flowering plants with nearly 2200 species and contains familiar species such as the ornamental poinsettia. The group contains tremendous adaptive life form diversity (especially rich in xeromorphic species such as diverse succulents and cactiform species) and is the only genus to contain all three photosynthetic systems (C<sub>3</sub>, C<sub>4</sub>, and CAM). Fewer than 30 species have been examined for C isotope discrimination, but this has revealed significant variation in  $\delta^{13}\text{C}$  values. A large *Euphorbia* research project has been initiated under the NSF-PBI (Planetary Biodiversity Inventory) program and we are conducting molecular phylogenetic work for this project at LAB. We presently have a large (176 taxa x 9 genes) phylogenetic tree to use for further investigations into the evolution of *Euphorbia*. Our project seeks to understand photosynthetic system evolution by using C isotope analysis of leaf tissue (mostly with the same samples used for DNA extractions), which will be mapped on the phylogeny and correlated with life forms using modern methods of character reconstruction and comparative analysis.

**IRMS #: 0037**

**PI:** Ben Turner (STRI)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Nutrients dynamics during ecosystem development

**Project Summary:** This project examines transformations of nutrients during pedogenesis using a series of soil chronosequences in Australia and New Zealand. Ecosystem development is characterized by a progressive increase in phosphorus limitation of primary productivity, which eventually leads to a reduction in forest biomass (retrogression). Changes in major nutrients (C, N, P) have been relatively well-studied, but evidence from hydrolytic enzymes from one sequence (the Franz Josef post-glacial sequence in New Zealand) indicates that sulfur may limit productivity during ecosystem development when ample nitrogen and phosphorus are available. I've done some XANES work to identify sulfur compounds in soils along the sequence, and would now like to assess total sulfur concentrations and the isotopic ratios in soil and leaf tissue (from the major species along the sequence). Taken together, this will provide detailed information on sulfur pools and dynamics along the sequence with which to assess the long-term sulfur status of the ecosystem.

**IRMS #: 0038**

**PIs:** Doug Owsley (NMNH), Christine France (MCI) and Jeff Speakman (MCI)

**Smithsonian Initiative:** *Understanding the American Experience*

**Title:** Stable isotopic analyses of Eastern US (Chesapeake area) historic human remains

**Project Summary:** Human remains from several North American east coast grave sites spanning time periods from colonization forward will be analyzed for carbon, nitrogen, and oxygen stable isotopes. These analyses will provide insight into diet and migratory patterns. Specifically, isotopic differences between immigrants and native-born citizens as well as among social classes will be examined in an effort to discern patterns that can be applied to individuals of unknown origin.

**IRMS #: 0039**

**PIs:** Peter Marra (NZP) and C. Dorcsey (UCSB)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Reconstructing food web dynamics in the understory of an eastern deciduous forest

**Project Summary:** This project uses stable carbon and nitrogen isotopes to reconstruct and understand the trophic relationships of the ground level food web in an eastern deciduous forest. Samples have been collected from a variety of organisms, plant and animals, from rotting roots to insects to ground foraging vertebrates for the assessment of both stable carbon and nitrogen.

**IRMS #: 0040**

**PIs:** Peter Marra (NZP) and A. Hegemann (U. Gronigen)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Tracking the skylark throughout the annual cycle

**Project Summary:** This project links detailed information at the individual level with regards to behavior, reproduction, physiology and survival in Skylarks. Since 2006 this research has followed color-ringed birds throughout the year, and focused on identifying seasonal patterns of immune function during the annual cycle, on detecting connectivity between different seasons (using isotopes) and on searching for potential bottlenecks in the annual cycle of this species. Thus, this study will result in a unique dataset, one which connects life history stages and events in the annual cycle with immune function within a population of free-living birds and will contribute to understand how birds in general cope with their environment. Furthermore, it will provide the framework needed to establish a powerful conservation strategy for this rapidly declining species.

**IRMS #: 0041**

**PIs:** Amandine Vaslet (SMSFP), Carole Baldwin (NMNH), and Ilka Feller (SERC)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Use of isotopic signatures to assess the importance of mangroves as feeding areas for mangrove fish communities in Florida and Belize

**Project Summary:** The aim of this research is to determine the importance of mangrove ecosystem as fish feeding ground in Florida (Indian River Lagoon – Smithsonian Marine Station in Fort Pierce) and Belize (Twin Cays – Smithsonian Marine Station in Belize). We hypothesize that the importance of mangrove-derived carbon sources in fish food webs may vary on mangrove location (tropical and subtropical latitudes) and physiognomy (offshore islands and riverine mangrove). Moreover, fish residence times in mangroves (resident, transient) may have

an influence on their feeding habits. As stable-isotope composition in a consumer reflects the isotopic ratios of its diet, analyses of the natural abundance of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) stable isotopes provide a powerful method to trace sources and transfer of organic matter through food webs. Provided that primary producers and then consumers have distinct isotopic signatures, carbon and nitrogen stable isotopes are proving increasingly useful as tracers in coastal trophodynamics studies. Mangroves are characterized by negative  $\delta^{13}\text{C}$  values compared with other ecosystems (such as seagrass beds), thus allowing a discrimination of food-source origins. When conducted in conjunction with gut-content analyses to identify prey items, stable-isotopes analyses provide a powerful tool for untangling food webs.

**IRMS #: 0042**

**PIs:** Janet Douglas (FSG) and Christine France (MCI)

**Smithsonian Initiative:** *Valuing World Cultures*

**Title:** Chinese Buddhist Sculptures in the Freer Gallery of Art

**Project Summary:** The Freer Gallery of Art holds a major collection of Buddhist sculpture, many of which are from (or thought to be from) the cave sites of Xiangtangshan, Gongxian and Longmen. Little technical research has been done on these materials to date, and our ongoing collaboration aimed at the integration the art historical aspects of the sculpture with scientific data to construct the most complete understanding of our collections, their origin, and history. Several additional object-specific issues will be addressed, such as whether free-standing sculpture is similar in rock type and treatment to those carved in-situ.

**IRMS #: 0043**

**PIs:** Matt Tocheri (NMNH), Tosha Dupras (U. Central Florida), and Christine France (MCI)

**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet*

**Title:** Stable isotope analysis of faunal remains from Liang Bua, Flores, Indonesia: implications for the disappearance and possible extinction of *Homo floresiensis* and *Stegodon florensis* during the Late Pleistocene

**Project Summary:** On the Indonesian island of Flores, a well-dated faunal and archaeological sequence has been recovered at Liang Bua cave. This sequence spans the last 100,000 years and includes the only anatomical and behavioral evidence of *Homo floresiensis*, a new species of human first discovered in 2003. From 95 to 17 kyr, the faunal sequence contains a host of endemic mammal, reptile, and bird species, including *H. floresiensis* and *Stegodon florensis*. Both *H. floresiensis* and *S. florensis* disappear from the sequence at approximately 17 kyr, however small endemic fauna such as rats and bats persist. After 11 Ka, modern humans appear in the sequence along with several new introduced animals (i.e., non-endemic to Flores) including *Sus celebensis*, *Sus scrofa*, *Hystrix javanica*, *Paradoxurus hermaphrodites*, and *Macaca fascicularis*. The goal of this project is to reconstruct the local diet and ecosystem surrounding Liang Bua from stable isotope analyses of this incredibly rich 100 kyr faunal sequence. Such data are critical to understanding differences in behavior and diet between *H. floresiensis* and modern *Homo sapiens* as well as for testing hypotheses about the disappearance of *H. floresiensis* and other taxa from the Liang Bua sequence.

**IRMS #: 0044****PI:** Glen Havelock (SERC)**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet***Title:** Environmental controls on diatom distribution in the Patuxent Estuary, past and present: implications for Holocene river discharge and sea-level change

**Project Summary:** Present models of Holocene estuary evolution are driven largely by changes in relative sea-level with little reference to long-term changes in fluvial regime and regional climate. Recent US studies of estuarine sequences have shown that decadal-centennial scale fluctuations in river discharge and freshwater inflow can be inferred by changes in estuarine paleosalinity and that the timing of these events reflect changes in regional precipitation. It is therefore becoming apparent that estuarine sequences may hold an archive of mid-late Holocene climate change information, as well as being recorders of RSL change. This study will use the contemporary distribution and salinity preferences of diatoms along the inner Patuxent estuary salinity gradient to quantitatively reconstruct paleosalinity in two dated sediment cores. Relationships between diatom distribution and a range of environmental variables will be investigated over a 12 month period so as to incorporate a range of tidal range and seasonal discharge variation. This will enable the development of a robust predictive transfer function, with smaller errors, that calibrates diatom variation to salinity. This will then be applied to the Holocene diatom record. The Patuxent watershed lies in a jet stream transition zone that is particularly sensitive to climatic variability, including the North Atlantic Oscillation. This should enable a sensitive and high resolution precipitation-driven discharge record to be reconstructed for the mid-late Holocene. The resulting climate record will be compared with other proxy climate records from the eastern United States and North Atlantic region. The methodology used in this study can then be applied to other estuarine systems, such as those affected by a Monsoon climate in south-east Asia.

**IRMS #: 0045****PIs:** Thomas Jordan (SERC) and Thomas Fisher (U. Maryland)**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet***Title:** Assessing denitrification at the watershed scale based on N and O isotopes in nitrate

**Project Summary:** The goal of this research is to determine the fate of nitrogen (N) added to watersheds by agriculture. Building on previous research, this project will apply new methods to assess denitrification in agricultural watersheds. Denitrification consumes nitrate, the main form of N exported from N-enriched watersheds, and produces dinitrogen and nitrous oxide gases. The project will measure accumulations of dinitrogen and nitrous oxide gases in groundwater and surface soils, and changes in the isotopic composition of nitrate that are indicative of denitrification. The study will identify locations within watersheds where denitrification is hypothesized to be most important: damp areas such as stream buffers and wetlands.

**IRMS #: 0046****PIs:** Melissa McCormick and Dennis Whigham (SERC)**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet***Title:** The mycorrhizal status of *Epifagus virginiana*

**Project Summary:** Work in the plant ecology lab has focused on mycorrhizal associations of a variety of plant species. One species that we have studied is the parasitic plant *Epifagus virginiana*. This plant belongs to a plant family thought to be entirely directly parasitic on other plants (Orobanchaceae), yet recent studies have suggested that at least *E. virginiana* may require a mycorrhizal fungus to establish connections with host plants. If the parasitic association is direct, *E. virginiana*  $\delta^{15}\text{N}$  will resemble the soil environment and host plant. If the parasitic association is mediated via a mycorrhizal fungus, then *E. virginiana*  $\delta^{15}\text{N}$  will resemble the fungus. Because *E. virginiana* is parasitic on beech trees, potential fungal hosts are ectomycorrhizal and will have very elevated  $\delta^{15}\text{N}$  (~5-8‰ higher) relative to the tree host or soil. Conducting an isotopic analysis will determine whether mature *E. virginiana* plants use a fungus as an intermediary host.

**IRMS #: 0047****PIs:** Christine France and Jennifer Giaccari (MCI)**Smithsonian Initiative:** *Understanding the Mysteries of the Universe***Title:** The effects of PVA and chemical removal of PVA on stable isotopic signatures in bones and teeth

**Project Summary:** During excavation, treatment of bones and teeth with PVA solution is a common method to maintain the integrity of highly weathered fossil material. Polyvinyl acetate dissolved in acetone has the potential to exchange carbon and oxygen isotopes with the bone/tooth material. Additionally, the removal of the PVA with various organic solvents may further fractionate isotope signatures and alter them from their original state. This study aims to determine if treatment with PVA and subsequent chemical removal alters isotopic values in fossil bones and teeth. The best strategy for removal will become the recommended standard procedure for handling specimens treated with PVA.

**IRMS #: 0048****PIs:** Gerhardt Reidel, Eric Johnson, Anson Hines (SERC)**Smithsonian Initiative:** *Understanding and Sustaining a Biodiverse Planet***Title:** A novel application of bio-geochemical fingerprinting to evaluate the nursery potential of Chesapeake Bay subestuaries to contribute to the blue crab spawning stock

**Project Summary:** The objective of this project is to further develop and optimize a novel application of well-studied bio-geochemical tracers (trace elements, stable isotopes) for the blue crab to understand spatial variation in the production of mature female blue crabs among Chesapeake Bay tributaries. This goal is a key step toward providing managers with spatially explicit information about the value of individual tributaries as nursery habitats to contribute to the female spawning stock of blue crabs in Chesapeake Bay. If successful, this promising technique could be employed with other blue crab populations in the U.S., and potentially for other crustaceans that support valuable fisheries worldwide.

## PROJECT DESCRIPTIONS

The following section gives a short synopsis of most of the technical and conservation projects MCI staff collaborated on during FY2009. There were 161 projects for 22 Smithsonian museums, research units, and 9 other collaborators including the Folger Shakespeare Library, the Library of Congress, National Park Service, the Office of the Architect of the Capitol, the US House of Representatives and Senate.

### Anacostia Community Museum

MCI 6232 Painting: *Sunday Afternoon in the Park North* by James S. Aiken

MCI Staff: Jia-sun Tsang

This serene landscape painting depicts a group of well-dressed African American men and women out and about enjoying a Sunday afternoon in New York City's Central Park North. Mr. Aiken has carefully sketched and painted the landscape of the park as a tranquil backdrop for visitors to stroll freely, converse, and meet.

This conservation project was focused on the removal of surface dirt, darkened varnish and on attaching the picture properly to the frame for display. The conservation of this painting was initiated in preparation for **Jubilee: African American Celebration**, an exhibition organized by the Anacostia Community Museum which opened in December 2008.

Mr. Aiken, a Sunday painter, enthusiastically painted the genteel urban atmosphere of the African American community in New York City and his cityscapes are about what he encountered in his daily life with friends and family in the neighborhood in the 1930s to 1940s. The Anacostia Community Museum owns a series of Mr. Aiken's cityscape paintings. These paintings record "humanity in motion" at a specific time and place in the life of the African American Community. Mr. Aiken's interpretation of the interrelation between society and the urban context is valuable. The Anacostia Community Museum would like to preserve Mr. Aiken's work, celebrate his accomplishments, and plan for a future one-man exhibition.

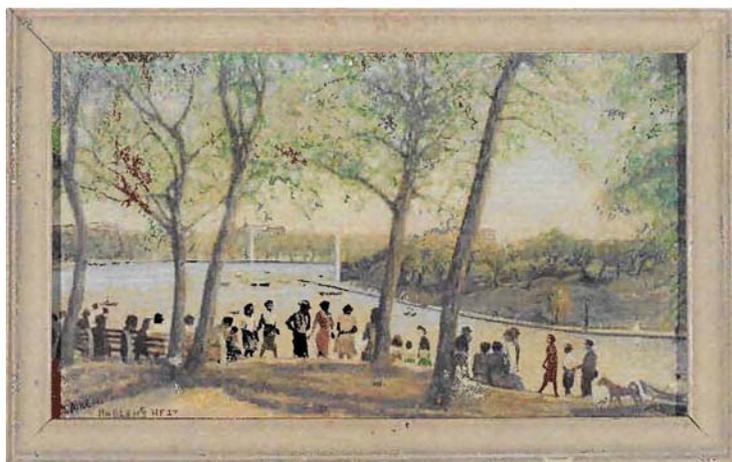


MCI 6260 Paintings: *Harlem's Heat* and *Men Under the Elm Tree in Dewey Square* by James S. Aiken

MCI Staff: Jia-sun Tsang, Mel J. Wachowiak, Ron H. Cunningham, Allison Martin

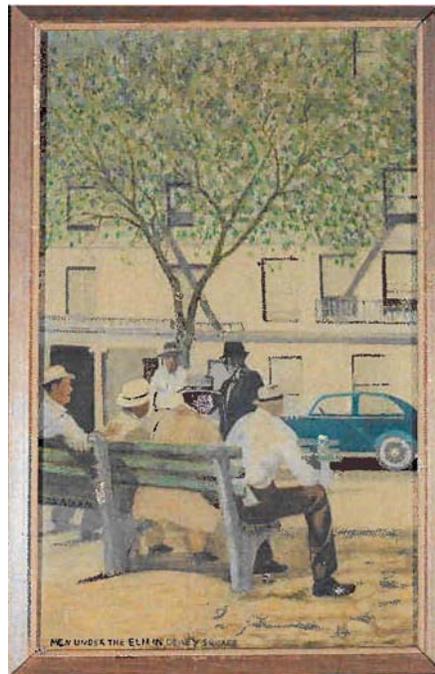
James S. Aikens' *Harlem's Heat* depicts an outdoor riverside scene in Harlem. The painting is dated in the 1930s – 40s and may be an illustration of an average day in the nearby Central Park or along one of the nearby waterfronts. The scene is a line of African American people walking along the waterfront, with boats in the water and trees along the twisting horizon. The artist places himself as an outsider in a position slightly higher than the ground, looking in on the scene. Aikens painted in thin layers of oil that show the ground in places and used a different medium for the yellow paint brightening the foreground. The painting achieves the purpose of showing a stream of families and friends enjoying a leisurely day in Harlem's summer.

In the process of determining a proper treatment for the painting, a great deal of analytical work was completed to learn the most possible information of the artist's materials and techniques. The Xenics XS1076 infrared imaging system was used to document the painting as well as UV photography and X-ray imaging. FTIR analysis was used to classify an interesting yellow paint.



James S. Aikens *Men Under the Elm in Dewey Square* depicts a group of men sitting on and standing around a bench in the historic Dewey Square in Boston, MA. Based on the design of the car in the painting, it can be dated as early as the 1930s. The square was cleared in the 1950's to make way for the Central Artery tunnel system, and as it appears to still be a pedestrian mall in the painting, it can be guessed that the painting was completed before this time. This places the paintings date in the 1930s- 40s. In the image, several men appear in the foreground, backs turned to the artist, lounging and conversing with each other under a large tree. In this way, the artist is an outsider, capturing a snapshot looking in on an ordinary day in Dewey Square in the 1930s – 40s.

In the process of determining a proper treatment for the painting, a great deal of analytical work was completed to learn the most possible information of the artist's materials and techniques. The Xenics XS1076 infrared imaging system was used to document the painting as well as UV photography and X-ray imaging.



## Castle

### MCI 6255 Marquetry Cabinet and Table

MCI Staff: Mary W. Ballard, Nicole C. Little, Don C. Williams

The anoxic treatment of the Secretary's Specimen cabinet and table was logistically difficult. The cabinet was delicate, heavy, and cumbersome; the table was an awkward shape to envelop in plastic barrier film. The support table was separated from the cabinet for packing and transport. The cabinet was kept on its cart and on its pallet during the treatment. The table was protected by bubble wrap booties on each of its feet.

The treatment was carried out separately for each piece of furniture, beginning in August, 2008. Difficulties associated with the logistics of the seams of the plastic led to a retreatment of the Cabinet section in January, 2009. This work was finished February 4, 2009.



## Center for Folklife and Cultural Heritage

### MCI 6122 San Lorenzo Carved Wood *Santo* Figure

MCI Staff: Jia-sun Tsang, Walter R. Hopwood

The *Santo* was carved by Charles Aguilar, a *Santero* from New Mexico, and is currently in the collection of Center for Folklife and Cultural Heritage (CFHC). Visual observation and instrumental analysis confirmed the materials and techniques used by this New Mexico artist. Three broken fingers and the broken handle on the grill were reattached during the conservation treatment.



Before



After

## MCI 6188 “Lacquer” Recording Discs: Material Characterization and Display Guidelines

MCI Staff: Jia-sun Tsang, Rebecca Giesecking, Mel J. Wachowiak, Judy Watson

This preservation project seeks to find proper guidelines for the long-term display of Woody Guthrie’s renowned 1944 record “This Land is Your Land”. The purpose of the visual examination and instrumental analysis is to acquire information about the lacquer disc materials for the continuous expansion of museum accession records as well as for ensuring the long-term stability and preservation of Woody Guthrie’s disc.

A thirteen inch 1943 record produced by the same manufacturer for material identification was selected. Closer examination of 1943 lacquer disc with microscope – scanning electronic microscope (SEM) and Fourier Transform Infrared Spectrometer with Attenuated Total Reflectance (FTIR-ATR) and Fourier Transform Infrared Spectrometer with microscope – revealed that this record is most likely made of shellac mixed with fibers, fillers and carbon black pigments. The first shellac discs date from the early 1900s, gaining popularity in the 1930s and 1940s. After WWII, resins such as Vinsol, Valite, Vynil chloride acetate, and other commercial resins replaced organic shellac as a main binder. Based on appearance, analysis, the 1944 disc is most likely made of shellac mixed with fiber, fillers and carbon black pigments.

Shellac discs are considered moderately stable. The instability of shellac discs is related to high humidity and high temperature, mechanical deformations, and dust and dirt. In addition, shellac can be easily extracted by common organic solvents and dissolved by ethanol and isopropyl alcohol. Heat can cause deformation due to shellac’s low softening point. Acid and alkaline can cause decomposition. In proper storage environments, shellac discs suffer a slow, progressive deterioration where they become extremely brittle and fragile. Shellac discs should not be handled with bare hands. Oil and perspiration from bare hands can damage discs, thus making it imperative to wear lint-free cotton gloves or nitrile gloves. Recommended environmental parameters for storage conditions and long-term exhibition of shellac disc, which are established by music recording preservation community, are 5 °C to 10° C temperature and 30% ± 5% relative humidity. To avoid warpage the disc should be displayed flat, on a slight angle for proper viewing, and on an archival grade platform with proper ventilation equally distributed to both sides of the disc. The recommended light level is a 10-15 foot candle. The display case should have ultraviolet protection.

Results of this investigation not only offer an opportunity to identify the chemical composition of Woody Guthrie’s “This Land is Your Land,” but it also offers insight to a green plastic. This disc is made with non-petroleum based resin from bugs and renewable fibers and stiffeners such as wood flour, flax, and other cellulose based fiber fillers. The development and natural aging behavior of shellac lacquer, an early thermosetting plastic, could offer a historical perspective to the current trends in the plastic industry in its pursuit of green plastic and in its effort to reuse and recycle existing plastics with the strengthening wood fibers as wood plastic composites.



Lacquer Disc dated 1943, CFCH collection



The broken black disc, held together by the white adhesive tape (shown as pale yellow zone at the center of this photo), displayed the characteristic matrix of shellac lacquer, a finely ground mixture of fibers, fillers and black and white particles.

## Cooper Hewitt Museum

### MCI 6190 Ivory-Inlaid and Ebony Cabinet on Stand

MCI Staff: Donald C. Williams, Mel J. Wachowiak, Ron H. Cunningham, Lynn B. Brostoff, Judy Watson, Odile Madden, Michele Pagan, Genevieve Bieniosek, E. Keats Webb

The ivory-inlaid and ebony cabinet on a stand was analyzed for materials and techniques of construction, including woods, inlays, adhesives, coatings and structure; the warped and cracked ivory inlays were stabilized, and cracked ebony; and, some loose pieces from the cabinet were re-attached.

With the stabilization of this finely inlaid chest, which has cracks and lifting pieces in the ivory inlay on wood, it was made more exhibitable. A better understanding of the chest was obtained by an analysis of the specific woods, and methods and materials of construction. This permitted a more precise location and date of creation for the object, assisted in selection of appropriate conservation treatment and helped to establish whether the stand was original to the object.



## **Freer Gallery of Art/Arthur M. Sackler Gallery of Art**

MCI 6286 Mercuric Sulfide Samples

MCI Staff: Jennifer Giaccai

Analysis will be carried out to see if differences are present in cinnabar from different sources that would be visible with Raman. Data may be used to differentiate modern cinnabar from modern vermilion. Samples are from California, Chile, Mexico, China, Indonesia, Germany, Italy, and Russia.

## Hirshhorn Museum and Sculpture Garden

### MCI 6191 A Closer Look at the Characteristics and Compatibility of Materials Used in Modern Paintings

MCI Staff: Dawn Rogala, Marion F. Mecklenburg, Lynn B. Brostoff, Mel J. Wachowiak, Judy Watson, Ron H. Cunningham, Odile Madden

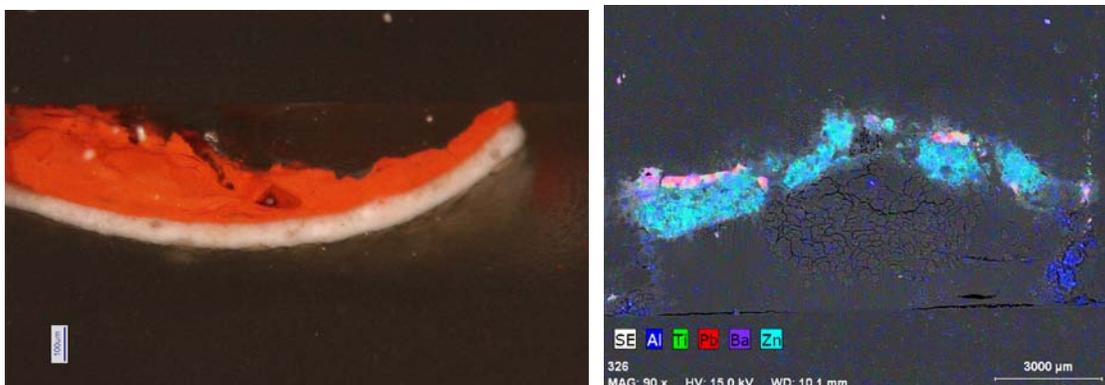
Although some research has been done on the properties of individual modern painting materials, those studies have not considered the materials in their interactive function as part of a composite painting structure. The goal of this project was to begin to address this vital part of modern materials research.

Mid-20th century artists were well-known for their use of experimental painting materials; it is perhaps significant that works from this period are unusually prone to structural- and adhesion-related condition problems. The purpose of this research was to examine works from this time period with similar condition issues, to determine the material characteristics of these paintings, and to test the responses of representative painting structures to various mechanical and environmental stresses.

In drawing attention to potentially incompatible materials and their specific vulnerabilities, this study sought to aid the future care and treatment of these (and similar) works of art.

The objective of this study was to discover potentially incompatible painting materials and to investigate the stress responses of painting structures that include combinations of these materials.

This research began with a group of modern paintings from HMSG with similar condition issues. The structure of these paintings was determined through analysis, and representative models were prepared and subjected to a series of mechanics tests. In this manner, real world examples were used as the introduction to this new area of study.



## MCI 6231 Sculpture: *Hand to Mouth* by Bruce Nauman

MCI Staff: Jia-sun Tsang, Jennifer Giaccai, Mel J. Wachowiak, Judy Watson, Nicole C. Little

This project aimed to identify the chemical compositions of the wax and to provide technical support to HMSG conservation staff. This wax sculpture, *From Hand to Mouth*, is cast from the human figure. The lip and neck are positioned diagonally from the arm and hand. The whole casting is supported on the reverse by a layer of woven fabric strips and a single hook intended for hanging. A secondary hanging loop was placed in 1994 to safeguard the sculpture during display.

The condition of the sculpture had been well documented by the HMSG conservation staff, including prior microscopy and FTIR analysis. There have been concerns over the years about this sculpture. They are 1) structural stability (the sagging head was noted in 1994); 2) the soft tacky wax surface, which is easily dented and imprinted; and 3) the possible light-induced fading of the original colors.

Light microscopy, melting point, SEM and SEM-EDS, ATR-FTIR and XRD were all used to gather further information about the composition of the wax used in the sculpture.



MCI 6253 Painting: *Ocean Park #111* by Richard Diebenkorn

MCI Staff: Judy Watson, Jennifer Giaccai, Mel J. Wachowiak

Pigment and medium analysis using PLM, FTIR, GC-MS, and SEM-EDS have contributed to the knowledge of the artist's working methods and assisted in explaining the cause of overall cracking to the paint and ground layers.



## Museum Conservation Institute

### MCI 4670 Conservation of Zinc Sculptures Book

MCI Staff: Carol A. Grissom

The *Zinc Sculpture in America 1850-1950* book was edited, copy edited, sent to the printer, printed and released. The 700 page book contains more than 500 photographs.



### MCI 4834 'Ain Ghazal Statuary Cache

MCI Staff: Carol A. Grissom, Harriet (Rae) F. Beaubien, Genevieve Bieniosek

The 'Ain Ghazal Project notebooks were compiled, indexed and shelved, and remaining fragments were sent back to Jordan, including larger fragments to be displayed at the new Jordan Museum.



## MCI 5277.1 King Midas's Textile Analysis

MCI Staff: Mary W. Ballard, Odile Madden

MCI was approached for assistance in the analysis of 11 textile samples from the prominent Tumulus MM at Gordion, Turkey—widely considered to be King Midas's tomb. Despite the tomb's pristine and methodical excavation, no gold was ever found inside it—there was bronze, iron, and exquisite inlaid furniture, but no gold.

At first glance, the textiles were unimpressive—either degraded clumps or small fragments in which uneven weaving and knots were hardly of regal quality. At high magnification, the fibers were found to be hollow—with no organic material left. What appeared as yarns seemed simply the artifact of a uniform coating, entirely hollow, as seen with SEM/EDS, and composed of iron.

After washing off microbial debris with solvents, an organic infrared spectrum was taken. It matched “Goethite” a gold-colored iron oxide ( $\alpha$ -FeOOH), which in turn matched a recently published textile study. Various innovative analytical systems were employed, unsuccessfully, to prove the link between the Tumulus MM textiles and Goethite. The samples were subsequently analyzed with a TerraSpec VIS/NIR spectrometer which gave a definitive peak at 760 nm, in the near infrared, and proved the close similarity of Goethite in the Midas sample, its match to the modern polyester-coated linen, and a known reference spectrum.

Other fragments from the tomb, once thought to be green because of their proximity to the copper and bronze artifacts, have been proved to be composed of indigo and goethite—a sophisticated mixing of organic and inorganic chemistry. The Lydian king buried so long ago reigned over a kingdom filled with very capable scientists and textile technologists.



Three samples of Goethite: (1) on modern polyester (light-yellow background), (2) on modern linen to the right, resting on the modern Polyester, and (3) 800 BC Tumulus MM Goethite sitting on glassine envelope (M. Ballard).

MCI 5277.2 Textile Fragments from Tumulus MM, Gordion, Turkey

MCI Staff: Mary W. Ballard, Ron H. Cunningham, Lynn B. Brostoff, Odile Madden, Walter R. Hopwood, Joseph Koles

Eleven boxes of textile fragments were analyzed to characterize the fiber, weave structure and dyes.



## MCI 5277.3 Goethite Coloration of Textiles

MCI Staff: Mary W. Ballard, Brittany Dement, Sara Gillies, Lauren Sturdy, Elizabeth Shuster, Michaela Sousa, Ed Vicenzi, Cathy Zaret

This project was designed to synthesize goethite on linen, wool, and polyester, using modern industrial recipes in order to better understand the coloration process used in ancient Phrygian. Although Kuhn's method would not be feasible in its current form in eighth century Gordion, it was used as a starting point for the experimental design.



## MCI 5927.2 Salish Blanket Fiber Materials

MCI Staff: Caroline Solazzo, Mary W. Ballard, Ron H. Cunningham, Judy Watson, Greg Henkes, Mel J. Wachowiak

This research sought to resolve questions as to source of protein fiber in blended yarn used by the North West Coast Salish tribes in making blankets, a subject of active debate. The research method involved comparison of provenienced dog and mountain goat hair fibers to unknown fibers from provenienced Salish blankets, using a range of analytical techniques including proteomics (MALDI-TOF, peptide sequence comparison). The results will be of interest to North-American archaeologists and ethnologists first as the use or not of dog hair will change or confirm theories about the Coast Salish and shed new light on Native American weaving and archaeology in general. The second interest is for archaeological sciences: proteomics is a recent discipline, being applied to archaeology for the past three years. Its potential is just now beginning to be understood and textile identification can be a huge application for archaeology and conservation. At the same time, it will enlarge the database of provenienced animal fiber sources sequenced by the proteomics methodology. The animal hair used to make a Salish “dog” blanket was found to be goat in at least one instance.



## MCI 5959 Effectiveness of Organic Coatings on Silver Exposed to Hydrogen Sulfide

MCI Staff: Carol A. Grissom, Nicole Grabow, Lynn B. Brostoff, J. Corey Smith, Claire Gervais

Sterling silver coupons and glass slides were coated with fourteen commonly used coating materials and subjected to a high-sulfide environment until the coupons were severely tarnished. Of the coatings tested, Agateen® Air Dry Lacquer #27, Acrysol® WS-24, and PVAc AYAT performed the best, and Renaissance Wax was least effective. Other coatings included HMG Heat and Waterproof Adhesive, Acryloid® B-72, Acryloid® B-48N, and polyvinyl butyral resins, retarded tarnish to varying degrees. Thickness of the coating was a significant variable in performance. A paper summarizing the project has been submitted for publication.



## MCI 6005 Technical Study of Objects from Tomb 1 Burial in Mongolia

MCI Staff: Harriet (Rae) F. Beaubien, Ainslie Harrison, Jennifer Giaccai, Ron H. Cunningham, Mel J. Wachowiak, Caroline Solazzo

The conservation strategy for the disk and organics as a whole had changed several times due to ongoing consultations and communication with Smithsonian conservators, museum staff, and the archaeologists involved in the Gol Mod project. The presence of well-preserved organic remains on the surface of a bronze disk such as this is very rare and presented an excellent opportunity for the study of these materials. The initial goals of conservation were therefore to preserve the organics in-situ on the disk. It was hoped that more information could be preserved for future research by maintaining the original orientation of all the components.

Subsequent correspondence with the museum staff and the archaeologists involved in the project confirmed their desire to display the bronze disk without the organic materials attached. A plan was then developed to produce a replica disk onto which the organics could be attached. While further scanning of the disk was carried out for this purpose, time and funding constraints caused another change in strategy. Ultimately it was decided that the organic features on side A would be stabilized, removed, adhered together if necessary, and packaged in custom made mounts, preserving their original orientations. The cleaned bronze disk could then be returned to the museum as desired, while the context and orientation of the organic materials would be maintained for future research and display. A replica disk could also be produced in the future, to which the organics could be attached.

Conservation work carried out between December 2008 and June 2009 therefore focused on the stabilization and removal of the remaining organic materials on side A of the Gol Mod disk (GM2-1-21.8/133). These materials include the leather fragments, hair bundles, and the textile present on side A. All of these components were found to be extremely brittle and required stabilization before further handling and treatment could occur. Consolidation and/or facing has improved the strength of all the organics, which may now be handled carefully without breakage and loss occurring.

Technical analyses included XRF, proteomics, FTIR, X-Radiography, and 3-D scanning.



## MCI 6039.2 Technical Study of the Remains of Painted Organic Objects from the site of El Perú-Waka', Petén, Guatemala

MCI Staff: Harriet (Rae) F. Beaubien, Colleen Snyder, Judy Watson, Lynn B. Brostoff, Mel J. Wachowiak, Fabien Pottier

While objects made of painted wood, gourd and other organic materials were assumed to have been produced and used in ancient Mesoamerica, information about them has largely relied on much later ethnohistorical records dating from the time of European contact and beyond. Archaeologically, these types of objects are rather rare, with find spots almost exclusively in burials where the deposits have been relatively undisturbed. The substrate materials are presumed to have been organic materials because of the totality of their degradation, a condition not surprising in a subtropical environment. When found, these objects survive only as concentrations of paint flakes.

MCI conservation assistance with lifting several painted organic objects from a burial at the ancient Maya site of *El Perú-Waka'* (Petén, Guatemala) led to a technical study at MCI of selected paint flakes from these objects, along with three others from a second burial. Optical microscopy, SEM-EDS and XRD analyses were carried out on small whole flakes, small samples mounted in cross-section, and scrapings of color to investigate the composition of the various paints, the paint application process, and texture on the back sides that might provide evidence of the disintegrated organic substrate.

Analyses showed the use of stucco (lime plaster composed of calcium carbonate) as the basis for the preparation layer and pigmented paints. Colors included cinnabar (mercuric sulfide) and to a much lesser extent hematite (iron oxide) for reds, malachite (basic copper carbonate) for green, goethite (iron oxy-hydroxide) for yellow and Maya blue (a lake pigment composed of indigo and palygorskite clay); bone black or charcoal was used for black outlines. A variety of ground or preparation layer types were identified, including white, cream, orange-ish and brown, in both smooth and coarse textures. Some of the ground layer variation may reflect qualities suitable for particular organic substrates, as well as differences in texture found in a single type of substrate, such as the inner and outer surfaces of a gourd.



## MCI 6080 Studies on the Identification and Degradation of Mordanted and Weighted Textiles

MCI Staff: Mary W. Ballard, Anne-Marei Hacke, Lynn B. Brostoff, Marion F. Mecklenburg, Walter R. Hopwood, Odile Madden, Ron H. Cunningham

A comprehensive research study was designed by Marei Hacke as a postdoctoral postgraduate Fellow. The research was divided into four sections: a full scale review of all the published literature on weighted silk in English and German; an investigation of metal ion containing textiles using XRF and ICP-MS; an investigation of the deterioration of metal ion containing silks and also silk materials used in the conservation treatment of Asian Scroll paintings; and finally an assessment of chemical protective agents for the amelioration of metal ion catalyzed degraded silk.

This project was helped by the loan to MSC/SIL of dye sample catalogues from Dibner Library at NMAH. The catalogues, dating from the turn of the 20<sup>th</sup> century through the 1930's, had several examples of silks, including weighted silk samples. These were very helpful in developing a protocol used elsewhere (see MCI #6095) to determine the presence of metal mordants and pesticides in textiles housed in the Smithsonian.

Dr. Hacke's research study was not completed, but her excellent review of the literature was published by *Reviews in Conservation* (Number 9, 2009).



## MCI 6099 10,000 Springs Pavilion Exhibition

MCI Staff: Paula T. DePriest, Jia-sun Tsang, Marion F. Mecklenburg, Mel J. Wachowiak, Donald C. Williams, Ann B. N'Gadi, other staff as needed

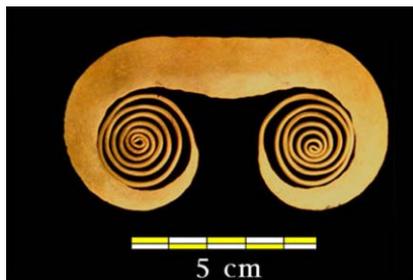
An exhibit was produced to showcase the red sandalwood replica of the 10,000 Springs Pavilion. The carved sandalwood architecture model, a 1:5 scale, was a gift from Dr. Chan Laiwa, founder and curator of the China Red Sandalwood Museum. The 10,000 Springs Pavilion was made ready for Lakeview Museum exhibit in Peoria, IL, where it stayed for several months, de-installed, and then the exhibit was re-installed at the Irving Arts Center in Irving, Texas.



## MCI 6100.1 Pre-Columbian Goldworking in Panama: Illuminating Its History, Preserving Its Heritage

MCI Staff: Harriet (Rae) F. Beaubien, R. Jeff Speakman

More than 600 pre-Columbian gold objects from Panama were included in this in-depth investigation, among them over 100 well-provenienced artifacts, recovered during excavations by archaeologists from STRI, as well as gold artifacts in the collection of the Museo Antropológico Reina Torres de Araúz, in Panama City. Technical and scientific data were gathered about the objects' alloy composition and manufacturing techniques, through X-ray fluorescence spectroscopic analysis and detailed microscopical examination. The objects were fully photographed, recorded with notes on condition and contextual information. Treatment was carried out on selected items and all were protectively re-housed for accessible study and safe storage.



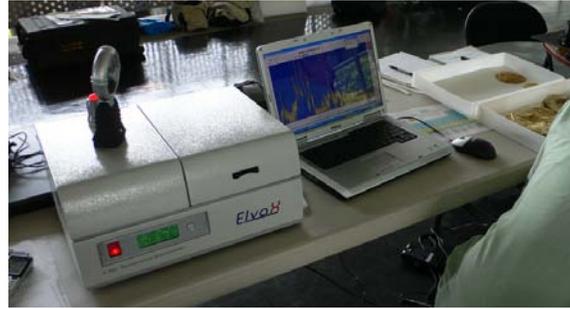
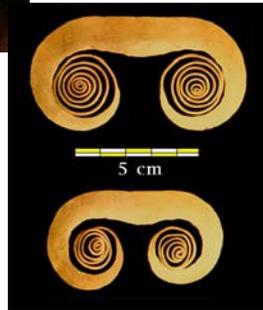
## MCI 6100.2 Technology of Pre-Columbian Gold in Panama: A Study of Fabrication and Compositional Analysis—Smithsonian collections

MCI Staff: Harriet (Rae) F. Beaubien, Ainslie Harrison, R. Jeff Speakman, Nicole C. Little, Judy Watson, Ron H. Cunningham

Pre-Columbian gold artifacts have long been appreciated for their complex technologies and impressive craftsmanship. Yet, Panama's contribution to this rich heritage is not well understood, despite its apparent role in the dispersal of goldworking technology from northern South America, where it first emerged, eventually spreading to Mesoamerican and central Mexican regions. By about 200 CE, the technology had reached the Isthmus, and the early goldwork found in Panama shows a close connection to that of metalworking centers in Colombia. Over time, however, a splendid local style developed, epitomized by the impressive gold adornments of high-status males buried at the Sitio Conte cemetery, dating from between 700 and 1000 CE; many centuries later, ornaments similar to these were described by the Spaniards related to a chieftain's burial.

While metalworking production in neighboring centers of Central and South America has received considerable attention, no systematic study has been carried out with a focus on its long history in Panama. To bridge this gap, the Smithsonian's Museum Conservation Institute (MCI) initiated a broad investigation of Pre-Columbian Panamanian goldworking from a technological perspective, bringing together the perspectives and skills of the conservator, conservation scientist, and archaeologist. In partnership with colleagues from participating institutions, over 1000 gold objects have been studied to date in collections belonging to the Museo Antropológico Reina Torres de Araúz in Panama City, the country's premier museum of its kind (during the first research phase in 2007); the Smithsonian's National Museum of Natural History and National Museum of the American Indian, in Washington, DC; and the Smithsonian Tropical Research Institute in Panama City, which is curating finds from several recent excavations in Panama.

New data about alloy composition, forming and finishing techniques are being generated using non-destructive analytical techniques, including optical microscopy, portable x-ray fluorescence spectroscopy, digital radiography, and energy dispersive x-ray analysis coupled with scanning electron microscopy. These data are expected to lend significant support, along with iconographic, archaeological and ethnohistoric lines of evidence, to the development and testing of hypotheses about the origins, development and regional relationships of goldworking in Panama.



*Images:*

Gold spirals found in STRI excavations at Cerro Juan Díaz (Azuro Peninsula)

Portable XRF analysis of gold objects at the Museo Antropológico Reina Torres de Araúz

## MCI 6110.1 Red-Slipped Maya Pottery

MCI Staff: Nicole Little, R. Jeff Speakman, Ron H. Cunningham

In order to better understand the mechanics behind pottery manufacture in northwest Belize, laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) was used to determine the chemical composition of slips and pigments from pottery samples previously characterized by neutron activation analysis (INAA). Samples without extensive surface erosion were analyzed in the hopes that patterns similar to previous research would be detectable in surface treatments. Because slips and pigments do not have the same inherent problems as paste (i.e., heterogeneity due to temper), LA-ICP-MS is the ideal technique for the compositional analysis of surface treatments on pottery, and has shown to be successful in the chemical characterization of ceramic pigments. Examination of the black slips and pigments yielded significant differences in the raw materials used in their manufacture.

## MCI 6133 Naturally Aging Conservation Polymers Spectral Reference Collection

MCI Staff: R. Jeff Speakman, Odile Madden, Jennifer Giaccari, Nadia Jimenez-Cano, Amber Davis, Technical Studies Group

The 50 thermoplastic resins sold in The ResinKit were analyzed to form the basis of spectral libraries for the FTIR and Raman. The ResinKit is published and distributed by ResinKit and the Plastics Group of America as a test kit for identifying commercial standard resins. The commercial resins include acetal resin, acrylic, acrylonitrile-butadiene-styrene (ABS, multiple types), cellulose acetate, cellulose acetate butyrate, cellulose acetate propionate, ethylene vinyl acetate, ionomer, modified acrylic, nylon (multiple types), phenylene oxide, polyallomer, polyaryl-ether, polybutylene, polycarbonate, polymethyl pentene, polyphenylene sulfide, polyester elastomer, polyethylene (three densities), polypropylene (multiple types), polystyrene (multiple types), polysulfone, polyvinyl chloride (PVC, flexible and rigid), styrene acrylonitrile (SAN), styrene butadiene, styrenic terpolymer, synthetic elastomer (styrene-block co-polymer), thermoplastic polyester (PBT), thermoplastic rubber, and urethane elastomer (polyester).

The resins were analyzed by ATR-FTIR, the spectra saved in an archival format, and the spectra imported into a searchable library for future FTIR searches. The IR spectra will be submitted to the IRUG library so they will be available for searching by other museums and conservation laboratories. The resins were also analyzed by dispersive Raman (532 nm), the non-fluorescent spectra saved in an archival format, and both baseline corrected and non-baseline corrected spectra were imported into a searchable library using GRAMS Spectral ID for future Raman searches.

## MCI 6153 Oxygen Deprivation via Argon and Its Visible Effects on Prussian Blue and Indigo

MCI Staff: R. Jeff Speakman, Mary W. Ballard, Dan Koestler, Jennifer Hau, Robert J. Koestler, Cathleen Zaret, Tony Maiorana

Prussian blue and indigo painted and dyed onto various commercially-available materials, such as Whatman's #1 filter paper, silk, cotton, and wool were analyzed to determine if treatment of these materials and pigments in an anoxic environment would result in a detectable change in sample color and/or appearance. This project has expanded to include analytical measurements using a microfademeter system.



## MCI 6164 Organic Synthetic Pigments: Phase II

MCI Staff: Lynn B. Brostoff, Polonca Ropret

Synthetic organic pigments in powder samples, layered paint systems, and commercial artists' paints bound in acrylic, alkyd, and oil media were examined by X-ray diffraction (XRD) and Raman spectroscopy. The potential and limitations of the techniques to identify and characterize mixtures of these pigments, along with inorganic extenders, in works of art are exemplified and discussed. Stratified model paint systems that mimic the layering structure typically found in modern paintings are used to evaluate the effect of the  $\mu$ XRD experimental parameters, as well as extenders or fillers commonly found in modern artists' paint formulations, on the quality of the patterns recorded in microsamples of paint. XRD was demonstrated for the first time to be an effective tool for the specific identification of synthetic organic pigment mixtures and fillers in acrylic and alkyd bound artists' paints, while the identification of these pigments by XRD in oil bound paints appears problematic. Detailed crystallographic information provided by XRD is shown to be complementary to molecular information provided by Raman analysis. The combined use of these techniques allows for more frequent unambiguous compound identification than would be possible using one technique alone.

## MCI 6167.2 Vani Bronze Torso

MCI Staff: R. Jeff Speakman, Nino Kalandadze, Mel J. Wachowiak, B. Vicky Karas, Harriet (Rae) F. Beaubien, Carol A. Grissom

A cast bronze torso from the archaeological site of Vani, Republic of Georgia, was scanned by MCI conservators and 3-D imaging specialists in the collections storeroom of the Smithsonian's Freer/Sackler Galleries. The sculpture was on loan from the Republic of Georgia to the Smithsonian's Sackler Gallery of Art for the exhibition *Wine, Worship and Sacrifice: The Golden Graves of Ancient Vani* (December 2007-March 2008). 3-D digitization of the sculpture was carried out to provide high quality and metrologically precise archival documentation of the artifact.



## MCI 6172 Spanish Colonial Glazed Pottery

MCI Staff: Javier Iñáñez, R. Jeff Speakman, Nicole C. Little, Judy Watson, Lynn B. Brostoff, Odile Madden

This research project focused on the technological characterization of colonial pottery dating from the 16th to 17th centuries, such as majolica ware and glazed utilitarian pottery, produced in Latin America, and the impact of those technologies on the Native American pottery.

Majolica and glazed pottery exports were very important European trade items during the colonial period. It is historically and archaeologically known that other kinds of glazed pottery played an important role, not only as part of the cargoes in the ships, but also in the way of life of these societies. A deep knowledge of these two kinds of pottery is vital for a better understanding of trade and especially colonization including acculturation processes of the autochthonous societies under the colonial impact. The identification of differences between autochthonous and colonial ceramics helped to determine social and cultural features of the acculturation process.

This project provided an important step in understanding colonial pottery in the Americas. Moreover, it represented one of the first attempts to assess acculturation processes in North American autochthonous societies through the study of ceramic materials using archaeometric techniques. In addition, this work represented an important achievement on the knowledge of ancient technology pottery of this historical period. Finally, this project represented a combination of analytical techniques and anthropological studies to deepen the understanding of the colonial impact and acculturation processes.

## MCI 6187 Salts in Ceramics Standard

MCI Staff: Carol A. Grissom, R. Jeff Speakman, A. Elena Charola

This project is intended to result in the development of a tell-tale standard that would show a visible signal when relative humidity falls below a given threshold. It was envisioned that new ceramic bodies impregnated with highly deliquescent salts could be placed in small containers on shelves alongside ceramic sherds in storage units. Crystallization of salts or evidence of their deliquescence (moisture, rings) would give an early warning or testimony of low humidity.

The present experiment was meant as a test run to determine which salt might be best employed for further testing. Advantageous qualities selected for were rapid crystallization, high visibility, and ease of analysis of the salt. More extensive testing using the optimal salt in cycling chambers was anticipated afterward.

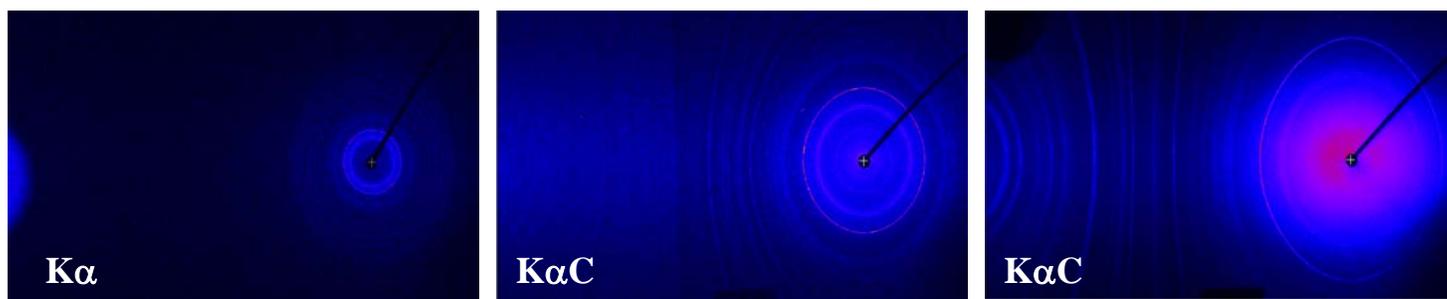
## MCI 6197 Characterization of Iron-Oxide Pigments

MCI Staff: Lynn B. Brostoff, Fabien Pottier, Judy Watson

The goal of this project was to obtain a better general understanding of the composition and structure of iron oxide-based pigments, as typically encountered in works of art and historic artifacts, and to optimize the analytical processes for their characterization, especially by XRD. The first step was to analyze pure commercial pigments and other references, via different techniques, and compare the results to literature and other published databases. This gave information about the amount of iron oxides, their crystallinity level, and their nature. It also permitted characterization of the whole matrices in which iron oxide pigments are typically found. Once the best conditions and instrumental parameters were determined, and the pigments were well characterized, the next step was to use these methods to analyze more complex samples such as rocks, hand-made artist pigments, as well as paint flakes and pottery sherds and to apply these analyses to conservations issues.

Iron oxides are a widely used family of pigments since ancient times, partly due to their availability in geological formations everywhere in the world. They can also be prepared simply by grinding, without complex processes. Therefore, they are very common in artists' materials. Identification of pigments and other artists' materials allow us to better understand artists' practices, as well as to understand the history of art technologies.

XRD is a useful method to analyze solid, crystalline samples, since the technique yields information about the specific identity of the materials. However, iron oxides are not always very well crystallized, and therefore can be difficult to analyze by XRD. In addition, this method is subject to interferences, since common compounds such as quartz, calcite and gypsum, which are often present in natural and synthetic pigments, are very good X - ray scatterers and may overwhelm the patterns and/or overlap with peaks from the material of interest. Therefore it is important to fully understand the composition of the whole potential matrices, as well as to determine the capabilities of this method.



## MCI 6201 Distinguishing Reindeer Antler from Bone Using Raman Spectroscopy

MCI Staff: Judy Watson

This project was designed to determine whether it is possible to distinguish between modern antler and bone using FT-Raman spectroscopy. The ultimate goal of this project was to develop this method to provide a non-destructive way to confidently discriminate between antler and bone in archaeological objects. This technique would have applications within the Smithsonian's collections as well as anywhere this very common material is curated or conserved.

Distinguishing between reindeer antler and bone can often be challenging as they are essentially the same material, with antler being morphologically similar to rapidly formed bone. Determination can be aided by observation of function, macrostructure, texture, color, shape, and size of an object. Adding to the challenge is the fact that archaeological objects have often been modified, either in the manufacture of the object, or in the burial environment, or both. Accurate determination is important to archaeologists, anthropologists, ethnographers, and others because it provides information about a wide range of areas including resource management, material preferences, economy, exchange and ritual behavior.

Raman spectroscopy is a non-destructive analytical technique that has been demonstrated to be of value in distinguishing between keratinaceous material from different species (as well as identifying imitation materials). Recent research has shown that it is possible to distinguish between human finger- and toe-nails using Raman spectroscopy, most probably as a result of the fact that fingernails grow more quickly. If collagens behave similarly (i.e. if the more rapid formation of antler as compared to bone results in a difference that is reflected in Raman spectra), this would offer archaeologists a non-destructive method of accurately classifying this important material regardless of the size or nature of the artifact. The results of a study testing the applicability of this approach on collagens, using vouchered samples of modern reindeer (*Rangifer tarandus tarandus*) antler and bone were presented.



Human figurine carved in reindeer antler or bone. From Advik, Finnmark, Northern Norway (2200-1800 BC).  
Photo: A. Icagic, Tromsø University Museum.

## MCI 6205 Arlington Cemetery's Memorial Amphitheater

MCI Staff: Carol A. Grissom, Claire Gervais, Paula T. DePriest, Robert J. Koestler, Nicole Little, Fabien Pottier, Judy Watson, R. Jeff Speakman, Elyse Canosa, Colby Phillips, Odile Madden

The Memorial Amphitheater at Arlington National Cemetery, made of Danby Vermont marble (Mountain White grade) and constructed between 1915 and 1920, presented an example of red staining. Preliminary microbiological analysis had resulted in the isolation of a red-pigmented bacterium, but in all cases stained areas were found to contain lead corrosion products, in particular the bright orange-red minium. Scanning electron microscopy (SEM) accompanied by energy dispersive spectrometry (EDS), X-ray diffraction (XRD) analyses, X-ray fluorescence spectroscopy (XRF), and Raman spectroscopy revealed considerable diversity of lead compounds in the stains, as well as in their shapes, sizes, and distribution.

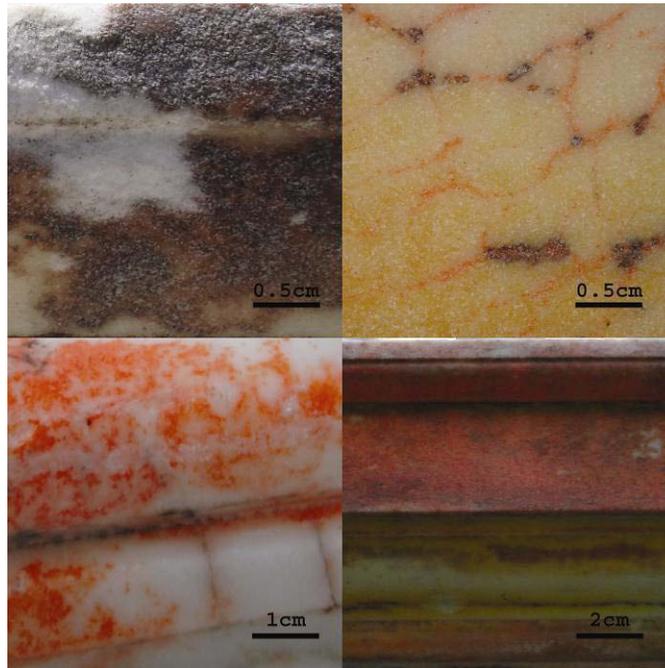
Staining on the amphitheater occurs at discrete locations, most often on exterior paving blocks between columns. The most striking example of staining, however, is located on the outer corner of a column base to the left of the amphitheater's stage. This area features a Liesegang-ring-like pattern, with purple, coral red, orange, and yellow areas located sequentially outward from the white corner. Comparison of photographs taken in 2004 and 2009 shows a net progression of staining, with migration away from the corner and expansion of the area of yellow washes. In-situ XRF analysis showed that the largest quantity of lead was found in purple stains and a white area that had been purple in 2004.

Sources of lead identified near stained areas include lead sheet found in the joint above one stained block and a lead-coated copper water-proofing membrane with a visible drip edge. The edge is heavily corroded, with minium found in red corrosion products by XRD analysis. Yellow stains below were found to contain the yellow lead compound litharge, also identified by XRD. We believe that lead is present near all other stains, hidden by the stone or pointing.

Lead sheets corrode rapidly in the presence of Portland cement, which can give rise to pH values in the pore-water of up to 13.5. At this very high pH, PbO becomes a stable oxide, as does Pb<sub>3</sub>O<sub>4</sub> when the environment is slightly oxidizing. Portland cement was determined to have been used for pointing, and, thus, it is not surprising to find examples of red staining consisting of lead corrosion products. Unfortunately, the stability of the colored lead compounds means that removal or decolorization is unlikely to be successful.



Red staining on Arlington Cemetery's Memorial Amphitheater



Typical colors and textures of colored stains observed at the Memorial Amphitheater (scale is approximate). Clockwise starting from top left: (i) purple stains, sometimes very dark and almost brown, often thickly incrustated, found mainly between the columns; (ii) yellow thin washes on a stairway corner post with red stains along fissures (note the presence of black *Verrucaria* lichens); (iii) typical staining of vertical areas on marble blocks between columns, with presence of dark crusts, red stains, and yellow washes, (iv) patchy orange-red stain on the stairway corner post.

## MCI 6206 Morphological Comparison of Alcohol and Formalin Preparation to 3M Novec Fluids

MCI Staff: Mel J. Wachowiak, Paula T. DePriest

The purpose of the analysis was to determine if the Novec fluids provided tissue preservation that was at least as good as the traditional formalin or alcohol methods. Preparations of invertebrate specimens tissues (earthworm) were prepared for microtomy, stained, and documented. All were prepared in the 3M research laboratory. The earthworm tissues stored in various fluids: formalin, alcohol, and 3M Novec were prepared by microtomy, stained for light microscopical examination, and documented. Formalin fixed tissue subsequently stored in Novec was at least as good as alcohol preserved tissue after one year of storage in each solution.



## MCI 6207 Cleaning of Marble with Ammonium Citrate

MCI Staff: Claire Gervais, Carol A. Grissom, Nicole C. Little, Ron H. Cunningham, Mel J. Wachowiak

This study focused on cleaning marble with ammonium citrate, a product often used with success by conservators, but for which almost no critical evaluation can be found in the literature. A systematically investigate was conducted to better understand its action on the surface and establish –if possible- the optimal conditions of utilization of this cleaning agent. In particular, the solubility of calcite (the main component of marble) as well as its kinetics of dissolution in solutions of ammonium citrate at different pH and different concentrations were established. The impact on marble surface was monitored by characterizing the surface of polished marble tiles before and after application, by means of several techniques (e.g., gloss measurements, micro-drop experiments, scanning electron microscopy, and 3-D scanning). In a final step, the optimized solution (formulation and mode of application determined by previous analyses) was applied on weathered/dirty marble statues or fragments. A paper on this project has been submitted for publication.



## MCI 6210 Saturn V Rockets

MCI Staff: Ray Barnett, Carol A. Grissom, Odile Madden

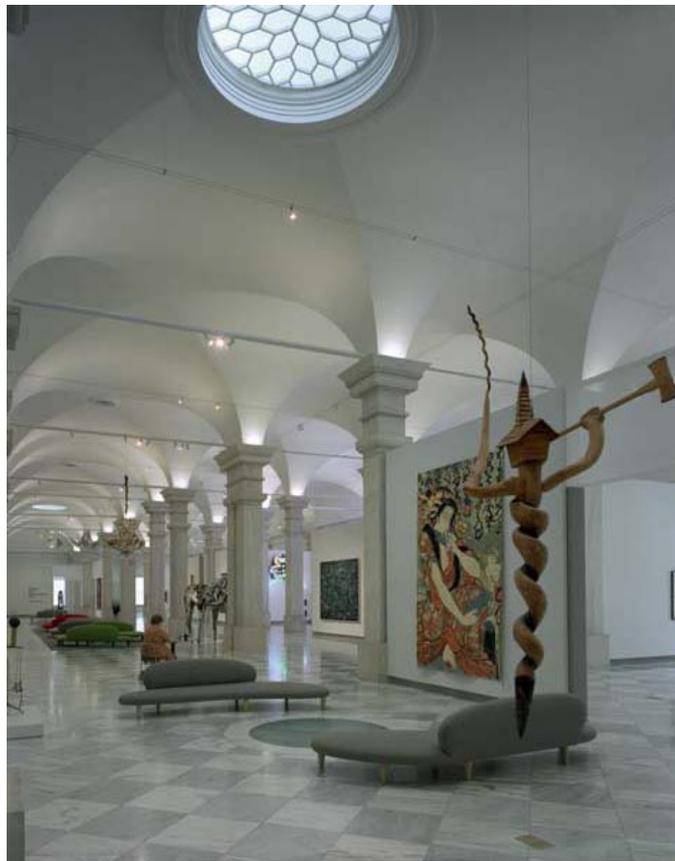
The three remaining Saturn V rockets were treated for display in recent years. This investigation relied on reports generated by those who treated the rockets, curatorial files at NASM, and MCI files. Information about these treatments and their history were collated, and the methods and techniques used in the stabilization, restoration, and preservation were analyzed and compared. In particular, the investigation focused on corrosion of the exotic aluminum and other metal alloys; removal of flora and fauna infestations; preservation of rubber, plastic, Mylar, and other organic materials used in the rockets' construction; and retention of original paint and decal schemes. The information collated was the basis for treatment evaluation.



## MCI 6211 Studying the Effects of Light on Sensitive Museum Objects and Materials and the Application of Research Results in Setting Lighting Levels in Museums

MCI Staff: Julio del Hoyo, Marion F. Mecklenburg, Mel J. Wachowiak

This research studied the environmental conditions in which collections are stored or exhibited. Environmental conditions normally include ambient temperature, relative humidity, air quality and filtration, and illumination levels. This study specifically addressed measurement and calibration of illumination levels in the newly renovated Old Patent Office Building (POB), now called the Donald W. Reynolds Center for American Art and Portraiture (DWRC), which is the repository for the collections of the Smithsonian American Art Museum (SAAM) and the National Portrait Gallery (NPG). With the recently completed renovation, numerous windows and skylights were reopened raising light levels in the DWRC. This study is evaluating the new light levels to ensure the safety of the collections. Coincident with measuring light levels, research is being conducted to determine the fading rates of sensitive objects and materials in the collections. The combination of data will help set the most appropriate light levels for display objects.

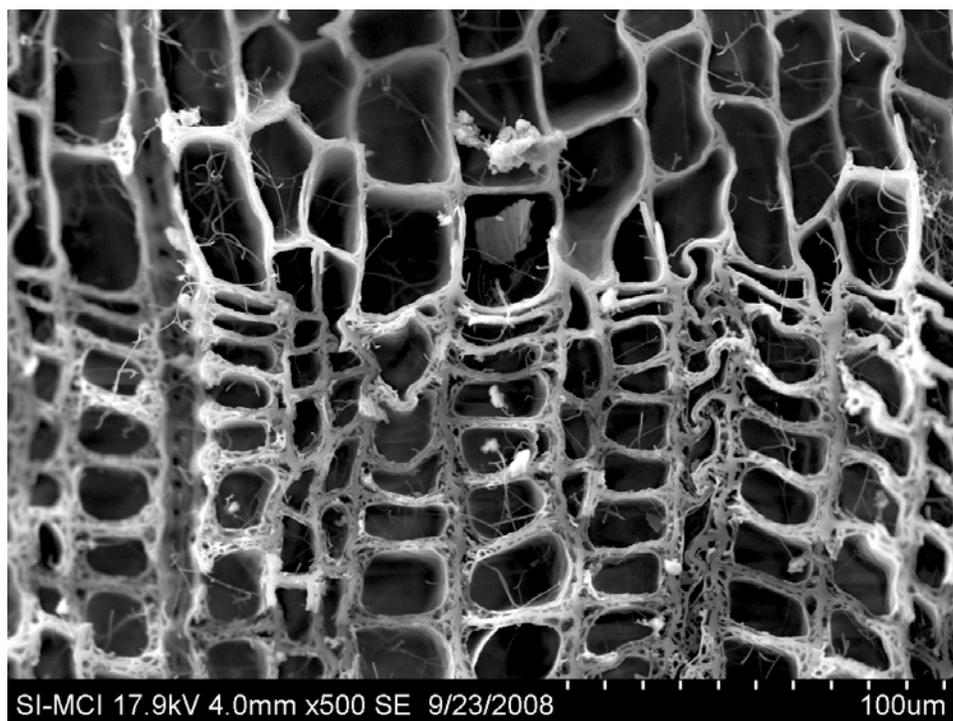


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## MCI 6212 Investigation of Microorganisms and Composition of Archaeological Wood Charcoal

MCI Staff: Magdalena Moskal, Robert J. Koestler, Mel J. Wachowiak, Judy Watson

During the analysis of wood charcoal remains from archaeological sites, it is common to find different microorganisms present in the plant tissue. However, one may encounter difficulties when attempting to identify these microorganisms and the time of their attack. The biodeteriorated structure of wood and the fungi responsible for its decay exhibit similar characteristics in both wood and charcoal samples. The factor of limited or unlimited oxygen supply seems to have little influence on the preservation of fungi because in both kinds of samples hyphae were documented as individual hypha, mass of mycelia or as hyphal imprints. The pattern of decayed wood attacked by the three major wood-rot groups (white-rot, brown-rot, and soft-rot) may be a valuable source of information when conducting a charcoal analysis. This is because the preservation of altered wood structure is found in macrostructure of archaeological charcoals as well as the ultrastructure of the wood. The results presented in this project show the possibility of recognizing pre-burning microbial activity because of the preservation of both fungal hyphae and wood deteriorated structures after burning. However, the identification of the fungal agent still presents several problems due to the similar morphology of the fungi, the analogous features of wood-decayed pattern, and the limited analytical techniques available to study archaeological charcoals.



MCI 6220 Archaeological Obsidian from the Kuril Islands, Russian Far East  
MCI Staff: S. Colby Phillips, R. Jeff Speakman, Nicole C. Little

The directions and distances associated with the exchange of lithic raw materials can provide insight into the social organization of widely dispersed hunter-gatherer groups. In order to infer network patterns of transport and trade from the archaeological distribution of obsidian across a region, it is necessary to determine the geographic and geologic source of the obsidian material. X-ray fluorescence (XRF) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) are two chemistry-based analytical approaches for matching obsidian artifacts to their geologic sources that are available at the Smithsonian Institution's Museum Conservation Institute.

New data from the Kuril Biocomplexity Project (KBP), specifically the recovery of nonlocal obsidian, can be used to test these conclusions as well as develop new hypotheses about the procurement, consumption, and roles of non-local raw material in the Kuril Islands. During the 2006 and 2007 KBP field season, more than 950 obsidian artifacts were recovered from 16 sites on 8 islands across the Kuril archipelago from contexts spanning at least 2,500 years, suggesting a wide-ranging distribution of obsidian throughout the island chain. While the Kurillithic assemblage includes a number of different raw materials, the presence of obsidian is important in regards to research on Kurillithic technology. Obsidian can be flaked predictably and to create extremely sharp edges, though the edges dull quickly with use and need frequent re-sharpening or replacement. Currently no sources of obsidian native to the Kuril Islands are known to have been used prehistorically.

Because obsidian can be matched to its geologic source with a high degree of reliability based on elemental analysis, chemistry-based approaches can be utilized to address issues such as raw material procurement, transport and exchange, networking, and social identity.

These analyses are crucial for understanding the geographic and geologic sources of obsidian that were utilized in the Kuril Islands, and provide a foundation for inferring social affiliation networks based on the transport and/or trade of obsidian throughout the island chain over a period of several thousand years.

Additionally, compared with Hokkaido to the south and Kamchatka to the north, relatively little archaeological research has been conducted in the Kuril Islands. Recent archaeological work in the Kuril Islands as part of the Kuril Biocomplexity Project (KBP) in 2006 and 2007 provides the means to synthesize the archaeology of the entire island chain into a coherent regional framework for the first time. Obsidian exchange networks have been identified in Japan, Sakhalin Island, Kamchatka, and mainland areas of the Russian Far East, and while non-local obsidian has been recovered from the Kuril Islands, there is currently an overall lack of obsidian source reference data for this region. The research proposed will create a significant database of source characterizations for the Kurils, and would complement the ongoing research that the Smithsonian Institution is conducting in this region of the world.

## MCI 6233 Isotope Ratio Mass Spectroscopy (IR-MS) Analysis of Natural and Synthetic Indigo

MCI Staff: Mary W. Ballard, Elizabeth Shuster, Cathy Zaret, Greg Henkes, Odile Madden

This research project is to determine whether isotope ratio mass spectroscopy (IR-MS) and Raman spectroscopic analysis can aid in the discrimination of synthetic and natural indigo dyes derived from plants incorporated into cultural artifacts.

The chemical compositions of natural and synthetic indigo are the same, so differentiating between the two in the analysis of art and historical artifacts has been problematic. Indigo played an important role in early trade patterns between East and West, where the indigo plant matter had only 10% of the tinctorial strength of the *Indigofera* plants did not grow. In 1897 synthetic indigo became available and nearly completely superseded natural indigo by 1920.

The differentiation of natural vs. synthetic indigo in a cultural object can contribute significantly to establishing its authenticity and provenance. Isotope ratio mass spectroscopy potentially offers a minimally invasive means to this end because the carbon isotopes in natural indigo derived from plants are guided by photosynthetic processes, which makes them easy to distinguish from the carbon isotopes in synthetic indigo. In addition to identifying natural and synthetic indigo, it may be possible to pinpoint the geographic sources of natural indigo used in cultural artifacts, since hydrogen and oxygen isotopes vary geographically. In order to test this hypothesis, the tendencies of carbon, nitrogen, oxygen, and hydrogen isotopes toward fractionation in natural and synthetic indigo at various stages of processing will be recorded.



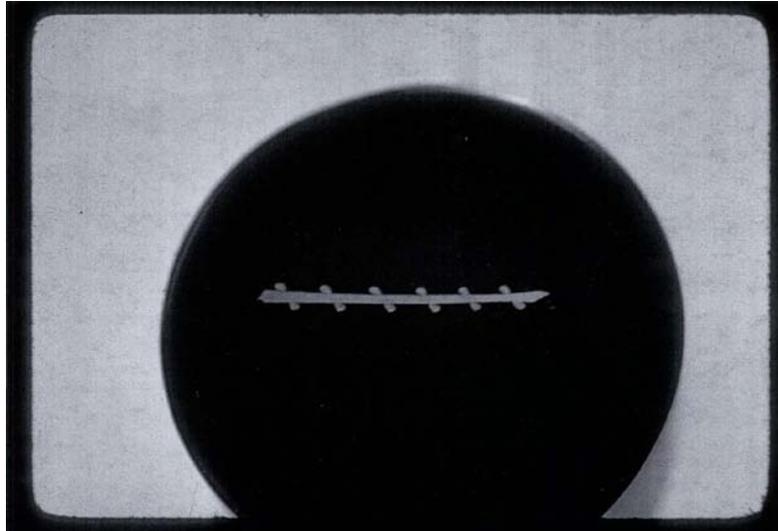
## MCI 6235 Mongolian Deer Stone Catalog Project

MCI Staff: Harriet (Rae) F. Beaubien, B. Vicky Karas, Mel J. Wachowiak

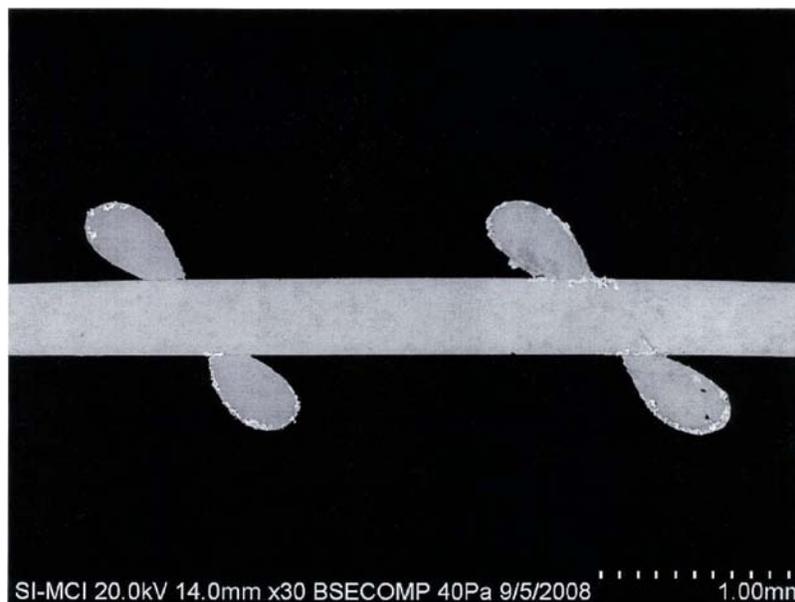
A catalog, comprising narrative overview of deer stone documentation activities and entries for each deer stone monument, based on work carried out by MCI during the 2005, 2006 and 2007 field seasons of NMNH's American-Mongolian Deer Stone Project is in production. The publication of the catalog, proposed for the Smithsonian Press series, entitled Smithsonian Contributions to Museum Conservation, would serve as a comprehensive report of MCI's deer stone documentation program and as a fundamental record for Mongolian national registry (archive) of deer stones.

MCI 6236 18<sup>th</sup> and 19<sup>th</sup> Century Piano Wire  
MCI Staff: Martha Goodway, Judy Watson

Four samples of overspun strings from English square pianos were imaged and analyzed for the core and overspun wire using the SEM-EDS to determine the presence and distribution of silver, as well as the copper and zinc (and other elements if present) content, in order to answer questions relating to the manufacture of these objects and the technological knowledge and abilities of the manufacturers. A paper on this project has been published.



Cross section of the sample of overspun wire from the Beck in 1" diameter mount.



Heavily silvered overspun string from the ca. 1790 Beck. The thick silver coating on the copper wire did not adhere well and pulled out during repolishing.

## MCI 6240 Imitation-Metal Paint Study

MCI Staff: Carol A. Grissom, Mel J. Wachowiak, Judy Watson

Metal-flake containing paints (especially the imitation-bronze paints) from the latter half of the 19<sup>th</sup> century through the early 20<sup>th</sup> century were technically examined with conventional polarized light microscopy and SEM-EDS to better understand the range of imitation-metal paints used during this period as well as their deterioration. A paper on this project has been submitted to a conference.

## MCI 6244 Sourcing Slate in the Far Northeast: An Examination of Prehistoric Exchange Systems in Newfoundland and Labrador

MCI Staff: Chris Wolff, R. Jeff Speakman, Nicole C. Little, Judy Watson

The study focused on the characterization of slate recovered from Maritime Archaic sites and known quarries in Newfoundland and Labrador using a variety of geochemical and mineralogical techniques, all of which can be conducted at the MCI. This included X-ray diffraction (XRD) analyses to determine the principal minerals present, X-ray fluorescence spectroscopy (XRF) to determine the total chemical composition, and scanning electron microscopy with X-ray microanalysis (SEM-EDS) to determine the chemical composition of individual minerals. The study also included macroscopic and microscopic petrographic analyses to characterize the physical properties (e.g., inclusions, texture, and color) of the slate varieties. These resulting data then was used to assess the diachronic distribution of specific slate varieties through the Maritime Archaic period, and to map out social connections and/or seasonal migration routes by various regional groups.

## MCI 6245 Development of SERS Active Vapor Sensors for Detection of Volatile Museum Contaminants

MCI Staff: Odile Madden, Ron H. Cunningham, Nicole C. Little, Judy Watson

The project is to develop surface enhanced Raman spectroscopic (SERS) substrates that absorb, concentrate and amplify the Raman signal of organic compounds that are present in air as gases or vapors. In the museum context, such vapor sensors could be applied to the detection of volatile pesticides, acids, and other organic compounds such as plasticizers that emanate from museum collections as a result of artifact degradation or past applied treatments.

Several conservation departments have requested that MCI undertake analysis of volatile compounds that may be toxic to human health or deleterious to susceptible artifacts located in the vicinity. In particular, detection and identification of pesticide residues on museum artifacts is a serious and urgent challenge. Organic artifact materials, such as wood, animal hide, basketry, textiles, paper, horn and bone, have traditionally been treated with pesticides in order to eradicate and prevent infestation by insects, rodents, and mold. A broad range of chemicals have been used; these include salts of mercury and arsenic; DDT and other organochlorines; organophosphates; carbamates; strychnine; naphthalene; paradichlorobenzene; and ethylene oxide, among others. These poisonous substances can persist for years in the controlled environment of a museum storeroom and present a poisoning risk to people who come in contact with the

objects. Concern about this problem has come to a head since passage of the Federal Native American Graves Protection and Repatriation Act (NAGPRA) in 1991, which dictates that certain classes of Native American objects must be given back to tribal communities. Repatriated objects may be held in a museum, but they are just as likely to be used in ceremonies, worn as clothing, stored in private homes, buried, or destroyed by the recipients. It is incumbent upon museums to determine whether these artifacts are contaminated, and identify the pesticide(s) and amount present so that any health risk to the recipient Native communities can be assessed. In the absence of archival documentation of the pesticide treatment history for most objects, analytical detection methods are necessary. Analysis of the air surrounding artifacts, either in an enclosed environment such as a plastic bag or the larger environment of a storeroom, offers a noninvasive, non-destructive method for detecting these substances on culturally sensitive or fragile material.

The substrates would be made of an absorbent phase that contains SERS-active nanoparticles. In theory, the substrate could be placed in the vicinity of objects contaminated with volatile organic pesticides, and pesticide vapors emanating from the object(s) will be absorbed into the SERS substrate. After a given amount of time, the exposed substrate can be removed and transported to a Raman spectrometer for analysis. With the advent of truly portable Raman spectrometers, some of which weigh as little as six pounds, it is possible that the analysis ultimately could be done on site, for example in collections storage areas. The effectiveness of the SERS substrates as vapors sensors will be assessed through comparison with other analytical techniques including gas-chromatography (using solid phase microextraction (SPME) sampling), gas phase Fourier-transform infrared spectroscopy (FTIR), and indirect measurement techniques including evaluation of corrosion on exposed metal surfaces. Chemical compounds to be evaluated include volatile organic pesticides, acetic acid, nitric acid, and phthalate plasticizers. All are compounds that would be expected to occur in storage areas of Smithsonian Institution museums. Additional analysis that can be carried out at MCI by existing staff includes X-ray diffractometry, scanning electron microscopy, X-ray fluorescence spectrometry and optical microscopy.

## National Air and Space Museum

### MCI 5990 Wiley Post's 1934 Pressurized Flight Suit

MCI Staff: Mary W. Ballard, Ron H. Cunningham

The pressure suit worn by test pilot Wiley Post was also designed by him in 1934. After years on display, the suit has acquired stains, discolorations, and tears. It no longer conforms to the stance with which Wiley Post graced it. The current project will remove the wood mannequin, long underwear, rubber suit before treating the cotton outer suit. Because of the diverse types of stains and materials (leather reinforcements, metal reinforcing rings), the unprimed cotton duck fabric will be treated locally and specifically. The rubber suiting shows the deterioration that oxygen, and especially ozone ( $O_3$ ), can produce on natural vulcanized rubber.

An associated project on anoxic storage planned by MCI and the Cooper Hewitt may assist in the storage of these materials.



Wiley Post was the first to test a pressure suit (NASM credit); current staining, deterioration

## MCI 6073 WWI Balloon Basket

MCI Staff: Mel J. Wachowiak, Marion F. Mecklenburg, Alaina Schmisser

Conservators at NASM requested condition examination and recommendations for treatment of this balloon basket. The wicker basket is deformed and they hoped that it could be reshaped and better supported. Once it is treated, it will be prepared for exhibit at the Udvar-Hazy Center.

This large hot air balloon basket (63" long x 51" wide x 41" high) was reportedly used by the Marine Corps in the period immediately following WWI. The basket is constructed of a wooden frame, wicker material, canvas and metal grommet strips, rope, and metal tacks and nails. It is in fairly stable physical condition, but there are three major condition issues pertinent to the successful conservation of the object.

First, the entire basket is warped and is skewed to one side at an approximate angle of 100°. This warp is very established and would be difficult to correct without humidifying the entire object. Humidification tests indicated that all of the wicker materials would potentially react well to reshaping. In addition, the fragile structure of the basket does not lend itself to reshaping by any method. Approximately 80% of the perimeter of the base is broken. Since the bottom has lost structural integrity, wires and an armature could suspend a shallow tray of acrylic.

Secondly, mold stains cover large portions of the surface. This is not currently active and should not pose any additional problems if the relative humidity level is kept at approximately 35-50%. Tests showed that removal of the mold and mildew spotting could be achieved.

Finally, the basket is covered in a thick layer of dirt and accumulated dust from years of storage. This significantly alters the visual appearance of the object and removal is desirable. Recommendations were made for the treatment.

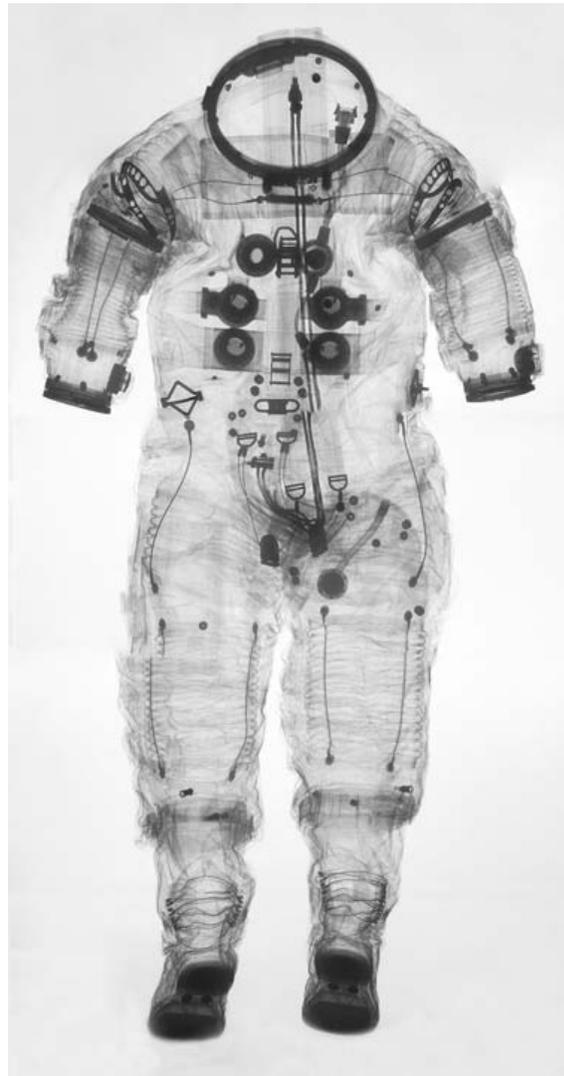


Note slumping/warp. At right, skew is corrected with image editing.

## MCI 6079 Lunar Dust on Apollo Spacesuit Systems

MCI Staff: Mary W. Ballard, Mel J. Wachowiak, Lynn B. Brostoff, Ron H. Cunningham

Apollo spacesuits of Teflon and Teflon-coated fiberglass textiles from the late 1960s and early 1970s were examined close-up with scanning electron microscopy for imagery of the textiles and the associated embedded dust from the lunar surface. NASA is researching the effects of the lunar soil on the textiles of the spacesuits, especially the level of abrading and damage to the textiles as a result of this close association. Research will be applied to the design and construction of future spacesuits. Charles Duke's Apollo 16 pressure glove and Harrison Schmitt's Apollo 17 spacesuit, glove assembly and lunar boot were reviewed. Extensive optical microscopic images, SEM low vacuum imaging, Beta radiograph, and XRF analysis were all used to analyze the spacesuits.



## MCI 6082 Heinkel He219 A German WWII Aircraft Wing

MCI Staff: Jia-sun Tsang, Lynn B. Brostoff, Walter R. Hopwood, Julio del Hoyo, Marion F. Mecklenburg, Mel J. Wachowiak, Judy Watson, Tony Maiorana, Rebecca Geiseking

The purpose of the analysis was to determine if original German WWII aircraft paint remains, as well as its identity.

ATR-FT-IR spectra obtained from different surfaces of the paint samples, as well as the acetone extract residue, indicate that the paint medium is a cellulose-nitrate based formulation that most likely contains other unresolved additives. Pigments were not identified by IR.

The Heinkel He219A aircraft is part of NASM's collection. Outdoor storage of this aircraft has resulted in prolonged exposure to sunlight. As a result, alterations to the original paint colors have occurred. There is an area on one of the flaps that was protected from solar radiation and has been used as an approximated reference of the original paint. This assumption was based on both the color of the paint relative to other areas which have been exposed to light and also on the way the flap was assembled indicating that the edge was protected from sunlight. The surface has several layers of paint but the interest was to test the pale blue paint in order to understand its discoloration process.



## MCI 6144 Fokker D-7 Aircraft Fabric

MCI Staff: Mary W. Ballard, Walter R. Hopwood, Jennifer Giaccai

The Fokker D-7 aircraft fabric was analyzed to determine the type of clear coating that is present on the fabric, identify the dyes used on the fabric, and characterize the fabric as to material and weave.



## MCI 6219 Gemini 8 Thruster Resin

MCI Staff: Jia-sun Tsang, Judy Watson, R. Jeff Speakman

The cast resin was analyzed to determine if it contained sulfur compounds or other compounds harmful to the artifact materials. The results were used to evaluate whether the cast resin should be removed from the artifact.

The artifact, a nozzle section from Gemini 8, is considered a piece of space history. In the 1970s, it was mounted in a Lucite-like resin as a paperweight. Silver items set in similar Lucite-like resins were found to be darkening. While Lucite is not reported to contain sulfur, information from manufacturers indicates that some formulations may contain sulfur. Removal of the object from the resin may be desirable if the resin is found to contain destabilizing ingredients.



## MCI 6228 Marine Flare

MCI Staff: Ron H. Cunningham, Donald C. Williams

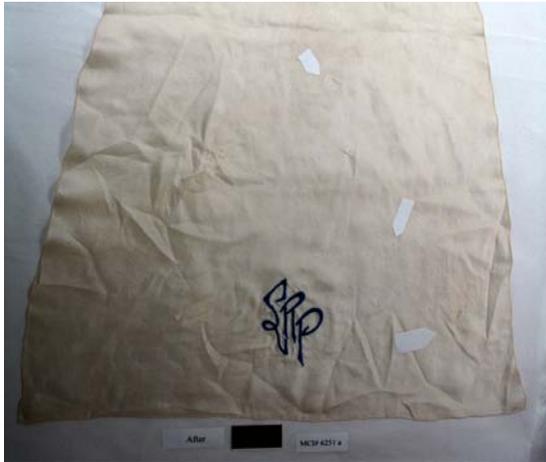
The object is a flare that has been selected for display in the *Interwar Military Exhibit*. No NASM records have yet been located that would indicate whether the flare is inert and/or deactivated. Additionally, there is no tag on the object or in the box that indicates the status of the flare. The flare is a marine floatlight that was designed for use in water. The flare has a wooden body that would likely be filled with some flammable material. It is weighted on one end to keep the flare side out of the water. The end that would have stayed out of the water is sealed with wax. Given that the wax visually appears to be old, it could be original. There are two cracks that appear to have been glued. It is not possible to tell if the flare had been opened. Radiography was used to determine if the flare side of the canister is empty and safe for display without opening the object. The flare was found to be empty and safe.



# MCI 6251 Aviator's Goggles, Scarf and Helmet

MCI Staff: Mary W. Ballard, Jennifer Giaccai

A rubber residue from a pair of goggles had chemically changed and contaminated the scarf and helmet. The residue was analyzed to determine if the material was synthetic or natural latex-based rubber compound. Once the rubber type was identified, the appropriate treatment was undertaken on the canvas helmet and the silk scarf. Improved storage and display environments for other artifacts made of the same material were determined.



MCI 6282 Painting: *The Fledglings* by Rudolph Dirks

MCI Staff: Jia-sun Tsang, Allison Martin

*The Fledglings* by Rudolph Dirks was structurally stabilized by improving the attachment of the painting to the stretcher. Conservation stabilization of the painting was completed.



## National Museum of African-American History and Culture

MCI 6070.2 Black Fashion Museum Costume Collection Phase II Rehousing  
MCI Staff: Mary W. Ballard, Cathleen Zaret, Elizabeth Shuster, Micaela Sousa,  
Lauren Sturdy, Sara Gillies

During FY2009, the documentation and photodocumentation was reorganized and streamlined as more than 150 garments were accessioned, examined, and evaluated for condition. With the consent of the curator, basic treatment was carried out to stabilize the specimen for storage. The records are now filed electronically as soon as its photography or documentation is completed. The records are accessible remotely and in a timely manner. For some garments, the documentation was a serious undertaking because the construction was so complex. For others, complex stain removal and wet cleaning treatments (Ann Lowe sari dress, pillow, drapery, coatdress) were completed with the permission of the curator. Finally, a few needed careful mending and repair of losses or tears. Examples are included here to describe the range of the collection and treatments carried out. All together, eleven storage units of processed material were transferred to NMAAHC storage at Pennsy Drive.



Glinda the Good Witch's costume was designed by the director of *The Wiz*, Geoffrey Holder. Worn by DeeDee Bridgewater for the opening Broadway run, the nylon 6,6 net gown had been repaired in several places, primarily on the back. As a net tricot, tears that had not been repaired, curled around itself. In this instance, conservation treatment involved gently unrolling the curl and persuading the tricot to lie flat while being secured to a polyester net of a similar tone. Prior repairs were left in place, as part of the history of the use of the costume. These treatments stabilize the costume, allowing it to be photographed with a greater uniformity of tone. Other costumes designed by Geoffrey Holder were also donated to the Black Fashion Museum, including the Tin Man's.

Light weight printed fabrics like this rayon georgette are disfigured if the rips and tears are crudely patched, but the yellow and deep violet print on a grayish plain weave was a challenge to match. Dyed silk crepe and dyed 'hair silk' (a very thin silk thread) were used to couch down the tears of this dress. This choice preserved the light and airy character of the fabric. The dress belonged to Rosa Parks, dressmaker and union organizer. She had been planning to finish sewing it, the evening she was arrested for sitting down in a bus seat in Montgomery City, Alabama December 1, 1955, on her way home from work. She was jailed instead and only later was able to finish this dress, which she subsequently donated to the Black Fashion Museum.



One of the outstanding black fashion designers was Ann Cole Lowe (1898-1981). Her couturier gowns were worn at many formal parties in the mid-20<sup>th</sup> century. Several of these gowns are found in the Black Fashion Museum collection. The 'Silk Sari Gown' appeared during Fiscal 2009 but was seriously marred by a yellow

stain—an eyesore that would prevent its exhibition as an example of the exquisite work the Mrs. Lowe created. The stain on the outer silk was removed section by small section with an aqueous treatment. Such stains on silk require great care, as the silk is susceptible to water marks; a special feathering technique is necessary to dry the fabric successfully. The source and age of the stain is not known; it certainly predates the acquisition by the museum, perhaps by decades. A slight shadow of the discoloration remains. MCI documentation includes advice on exhibit lighting that will obviate even that shadow.

**MCI 6070.3 Black Fashion Museum McGee Collection Anoxic Treatment**  
MCI Staff: Mary W. Ballard, Nicole C. Little, Renee Anderson, Cathleen Zaret

Argon anoxic treatment of 20 selected items from the Arthur McGee collection, newly accessioned to the Black Fashion Museum collection at NMAAHC, was completed. The collection was disinfested, vacuumed, photographed, rehoused, and packed for storage and eventual transfer to NMAAHC.



MCI 6165 Wooden Kitchen Table  
MCI Staff: Donald C. Williams

A wooden, hand-joined mid-19<sup>th</sup> century kitchen table was examined for its construction characteristics and photographed in situ.



## MCI 6217.2 Five Thomas H. Porter Slave Buttons from the Danny Drain Collection

MCI Staff: Carol A. Grissom, R. Jeff Speakman, Mel J. Wachowiak

Two copper alloy and three pewter buttons were examined prior to acquisition by NMAAHC. They are believed to have been worn during the 1820s by the slaves of Thomas H. Porter, a slave trader from Barbados said to have trafficked in slaves along the coasts of Alabama, Louisiana, Mississippi, Georgia, and the Carolinas. Compositions of the buttons were determined by X-ray fluorescence analysis, and, in the absence of gilding on the copper-alloy buttons, an inscription on their reverses reading “FINE ORANGE STANDARD GILT” was determined to indicate an imitation-gold finish. Reflectance Transformation Imaging (RTI) was performed in an attempt to decipher a second inscription on the back of the copper-alloy buttons, but unfortunately they were too corroded for this to be successful. From a materials standpoint it was determined that the buttons were likely early nineteenth-century artifacts.



## MCI 6217.3 Chief's Bag

MCI Staff: Carol A. Grissom, Genevieve Bieniosek, Jennifer Giaccai, Nicole C. Little

An African (Nuna [Gurunsi], Burkina Faso) bag made of tanned leather with flap, closure and strap, decorated with tooling, leather fringe with cowrie shells, wooden whistles and carving, iron tweezers, and iron picks was acquired by the National Museum of African American History and Culture. White spew, present over much of the leather on its front and in areas of the back and fringe, was visually disfiguring and needed to be removed. Analysis of the white spew showed it was composed mainly of fatty acids, which could result from the tanning process or post-production application of leather dressing/conditioner. An initial cleaning by mechanical means and, in a few places, with Stoddard solvent removed all visible spew. However, after one week white spew reappeared in multiple areas on the front and back of the bag. Analysis showed the new spew had a similar composition of fatty acids. The bag was again mechanically cleaned to remove the majority of the spew. Reappearance of spew cannot be prevented without causing serious damage to the object, and so it was put in storage with the understanding that future outbreaks may occur.



Front and back of bag before cleaning

## MCI 6229 Leather Bound Magazines

MCI Staff: Mary W. Ballard, Nicole C. Little, Yyonette Fogg

Twenty one books containing issues of *Esquire Magazine* (1934-1940) were treated with Argon gas as requested by the National Museum of African American History and Culture, prior to their formal accessioning. These books were bound with the owner's name, E. Simms Campbell. He was a major cartoonist for the magazine and an African American illustrator and author. After the Argon treatment each bound book was examined and its condition reported. SIA has provided a detailed condition report and treatment proposal to address the condition of the book covers.



## MCI 6238 Madam C.J. Walker Pin

MCI Staff: Carol A. Grissom, Jennifer Giaccai, R. Jeff Speakman

A pin in the collection of the Smithsonian's National Museum of African American History and Culture was probably made for an "agent" of the Madam C. J. Walker Manufacturing Company. It was likely worn as a badge at a convention sponsored by the company, which manufactured hair care products and cosmetics for African Americans. The pin has four decorative elements. At the top is a gilt-brass-framed photomechanical representation of a handshake, likely printed on cellulose nitrate. At the center is a rectangular white cellulose nitrate plate with the name Alice Gauser or Garner written in ink on it, hanging by a pair of brass chains from the handshake frame. At the bottom is a gilt-brass-framed photomechanical reproduction of a photograph of Madam Walker by the Washington (DC) photographer Addison Scurlock, hanging by a second pair of brass chains from the name plate. This image is likely also printed on cellulose nitrate. A ribbon, now missing, almost certainly hung from a large attachment hook on the back of the pin.

The purpose of the technical study was to determine if the pin could or should be cleaned prior to exhibition. Scattered galvanic corrosion was apparent on the gilt-brass frames, but its removal might accelerate corrosion and is not recommended. Cleaning of cellulose nitrate portions of the pin is also not recommended, as it could increase the rate of cellulose nitrate deterioration. Cellulose nitrate-containing objects should be stored at low humidity, e.g., 20%, in order to reduce the risk of hydrolysis of the cellulose nitrate. The pin should not be kept in a tightly sealed container in order to avoid build up of nitric acid, should hydrolysis begin.

An additional concern was scratching of the photomechanical reproductions of Madam Walker and the handshake. Use of soft materials is recommended around these elements for packing. Cavity packing in Ethafoam is recommended to prevent the chains or pins from scratching the cellulose nitrate prints.



MCI 6247 Painting: *Behold Thy Son* by David Driskell

MCI Staff: Jia-sun Tsang, Allison Martin

A technical study of the painting was performed to gain an understanding of the material involved and to assist decision-making about appropriate conservation treatment to ensure the safety of the paint and canvas and to set proper guidelines for the care of the painting. The technical study included x-ray, UV photography and binder analysis.



MCI 6279.1 Painting: *Robbing the Eagle's Nest* by Robert Scott Duncanson

MCI Staff: Jia-sun Tsang, Allison Martin, Mel J. Wachowiak, Don C. Williams, R. Jeff Speakman, Ron H. Cunningham, Marion F. Mecklenburg, Jennifer Giaccai, Nicole C. Little

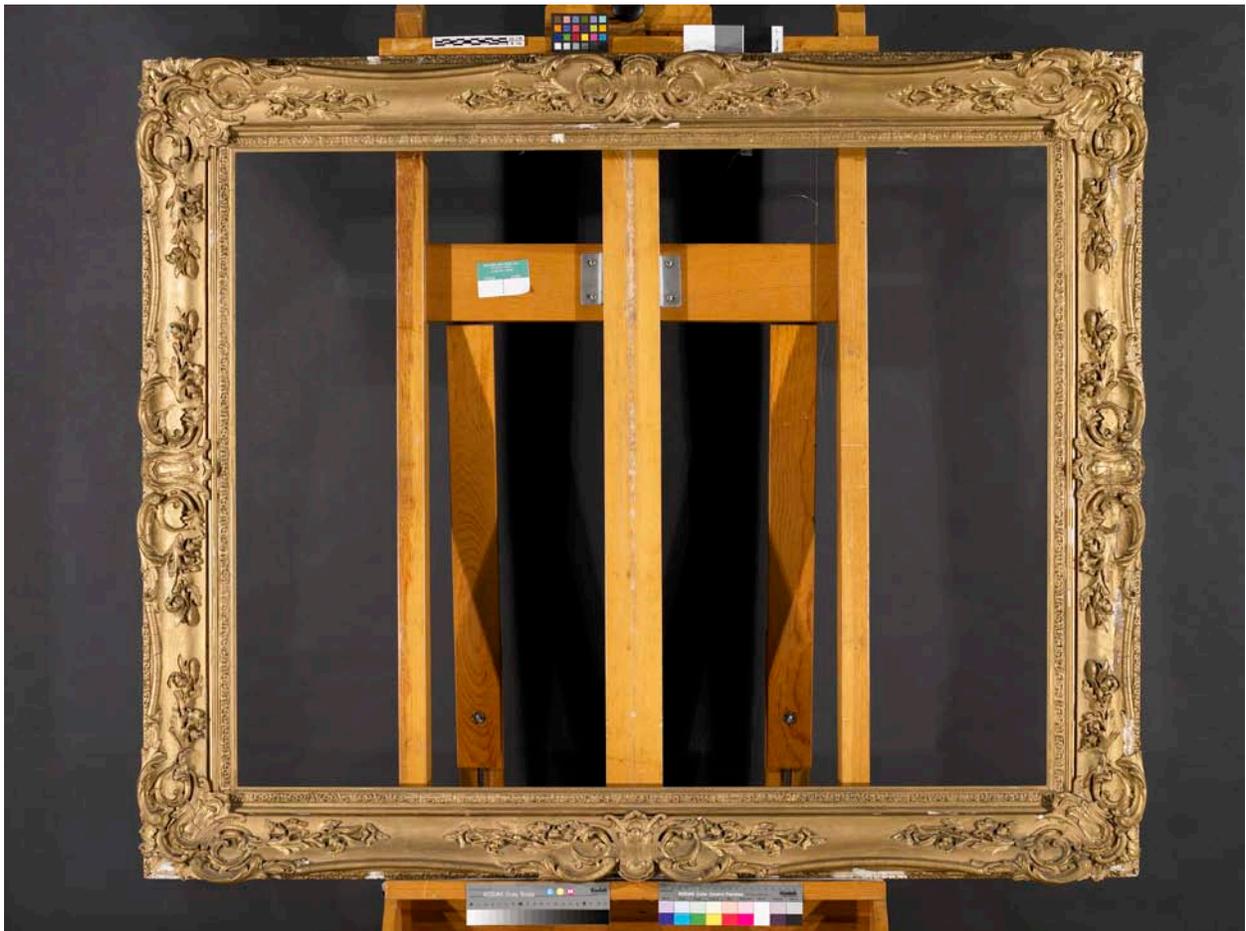
A condition review of the painting was completed, including examination of the painting under visible and ultraviolet light, microscope, IR reflectography and XRF.



MCI 6279.2 Gilded Frame for Painting: *Robbing the Eagle's Nest* by Robert Scott Duncanson

MCI Staff: Don C. Williams, Mel J. Wachowiak, Michele Pagan, Allison Martin, Genevieve Bieniosek

In preparation for future exhibition an examination of the frame including microscopical analysis of cross sectional samples to understand stratigraphy, conservation of the frame including replacement of missing elements, removal of metallic overpaint, and compensation with gold leaf and toner as appropriate was undertaken.



## MCI 6284 Emmett Till Casket

MCI Staff: Carol A. Grissom, Mary W. Ballard, Nicole C. Little, Don C. Williams, Genevieve Bieniosek

The original glass-topped casket that held the battered body of [Emmett Till](#), the 14-year-old African American boy brutally murdered in Mississippi in 1955, was given to the [National Museum of African American History and Culture](#). The donation was announced prior to a memorial service at the Roberts Temple Church of God in Christ, the site of Till's 1955 funeral, on Friday, Aug. 28, the 54th anniversary of Till's death.

MCI provided immediate atmospheric (anoxic) stabilization of the casket and evaluation of its condition. Appropriate options were provided for transport, storage, and treatment.



The original glass-topped casket of lynching victim Emmett Till was found in a shack at the Burr Oak Cemetery in Alsip, Ill. (Associated Press photo)

## National Museum of African Art

### MCI 6248 African Beaded Dress: Characterizing Deterioration Issues and Investigation of Cleaning Treatments

MCI Staff: R. Jeff Speakman, Nicole C. Little, Judy Watson, Jennifer Giaccai, Maria Fusco

An intensive study on South African Ndebele beaded objects in the collection of the National Museum of African Art has been completed. The Ndebele objects are all beaded on a textile, frequently leather, but occasionally canvas, and even one case on a synthetic knit textile. Among the beaded aprons, a number of glass beads that have degraded in contact with a fatty substance have been found. The aprons all have a distinctive appearance—as if an ointment was rubbed onto the beaded aprons. The ointment on both the leather aprons themselves as well as the greasy substance found on the beads was analyzed extensively with FTIR, XRD, SEM-EDS and XRF at the Museum Conservation Institute. As the glass beads deteriorate they form fatty acid soaps with the ointment that was rubbed onto the apron. It is still unclear whether the fatty ointment causes the bead deterioration, or if the ions freed during deterioration of the glass later interact with the fatty ointment to make fatty acid soaps.



## National Museum of American History

### MCI 6004 Ben Franklin's Suit

MCI Staff: Mary W. Ballard

In honor of Benjamin Franklin's 300<sup>th</sup> birthday, the silk suit held by the National Museum of American History but belonging to the Massachusetts Historical Society was taken out of storage in preparation for display and for patterning a reproduction. The suit's weave has small horizontal stripes and vertical bands—cannetillé and lousine with two lisières—deceptively



simple in appearance but more complex to weave. A tailor was commissioned to reproduce the suit. While taking pattern with white cotton gloves, he noticed the color crocked onto his gloves! It appears that the suit was painted over with ink. In addition, the suit is stained and discolored. In examining the suit, no change in handle or feel was apparent—there is no discernable differentiation where the suit is over-treated and where it is not.

Although the suit was scheduled for display for only one month, exigencies of the museum plans, extended this for two additional months. Before and after the exhibition the suit was measured to ensure that neither the ink nor the original dye changed in appearance. Measurements were taken using the tristimulus colorimeter. It divides color into three categories: lightness/darkness ( $L^*$ ), redness/greenness ( $a^*$ ), and blueness/yellowness ( $b^*$ ). A change beyond a delta E of 0.73 was determined to be probably relevant.

Initial characterization of the colorant was completed, but further characterization awaited the presence of an organic chemist familiar with modern dye analytical methods. An MCI visiting scientist from New Lisbon University arranged to describe early modern synthetic dyes (selected by Helmut Schweppe) from the MCI student standards on FTIR and HPLC. Her work on the fugitive colorant indicates that it is an azo dye with sulphonic acid substituent groups; she found it to be soluble in ethanol. This would support the probable use of an early synthetic dye, such as Fast Acid Magenta B, Fast Red B, or Fast Red AV. The last two dyes date respectively from 1878 and 1877, so a late 19<sup>th</sup> century or early 20<sup>th</sup> century “touch-up” is quite possible.

None of this explains the colorless areas on the britches (beige), brilliantly disguised by Senior Costume Conservator Sunae Park Evans draping and dressing of the mannequin for exhibition. Generally neither incontinence nor food stains would decolor the original (natural) dyestuffs from the 18<sup>th</sup> century (see the Interim Dye Report Chart). There is still some mystery associated with these garments.



Sunae Park Evans and Mary Ballard measure the color of the suit at registered places.

MCI 6032 Painting: *American Clipper Ship Coeur de Lion in Hong Kong Harbor*  
by Chong Qua

MCI Staff: Jia-sun Tsang, Maria Melendez

*Coeur de Lion* was an outstanding example of the golden age of the American clipper ship, a medium clipper, measuring 198 feet in length (overall) and 1098 tons. She was built at Portsmouth, NH for a local captain and a Bostonian and the figured head portrayed British King Richard the Lionhearted. The ship was launched January 3, 1854 and was lost in a collision in the Baltic Sea in 1915. The clipper ship *Coeur de Lion* was painted in oil on canvas during her maiden voyage in 1854 by the Chinese artist Chong Qua. Chong Qua's classic portrait of *Coeur de Lion* is his only known example of the genre. The ship is depicted in a standard pose of a classic ship portrait entering the Hong Kong seaport with house, signal, and American flags flying from all three masts and the spanker gaff.

The painting is glue-lined on a heavier weight canvas and the stretcher is not original. The natural resin varnish has yellowed over time and has shifted the tonal quality of the entire painting. The oil based retouching has darkened significantly, and it is noticeable even to the casual observer. This disfiguring and blotchy retouching covers almost 50% of the entire sky. Technical study including FTIR analysis of the medium of retouching was carried out and a special safe and sound cleaning technique was developed to remove the stubborn oil retouching.



Full View

photo credit: NMAH



Mapping of Retouching from Previous  
Restoration

compiled by Jia-sun Tsang, MCI

MCI 6169 *American Committee Model of the Statue of Liberty* by Auguste Bartholdi

MCI Staff: Carol A. Grissom, Ron H. Cunningham, Judy Watson, R. Jeff Speakman, Mel J. Wachowiak

This *American Committee Model* of the statue of *Liberty Enlightening the World* had been loaned by the National Park Service to the Smithsonian's National Museum of American History for display in the exhibition "Communities in a Changing Nation" which opened in November 2008. This statue was originally intended to be brought to the Museum Conservation Institute for repair of the figure's crown prior to exhibition. It was first exhibited at the White House, however, and the crown was repaired prior to display there. Hence, at the Museum Conservation Institute treatment was limited to removing old wax from the surface, coating the surface with microcrystalline wax, and ameliorating fills on the crown. Technical study included identification of casting techniques, X-radiography, X-ray fluorescence spectroscopy of the metal alloy, and microscopy of paint cross-sections.

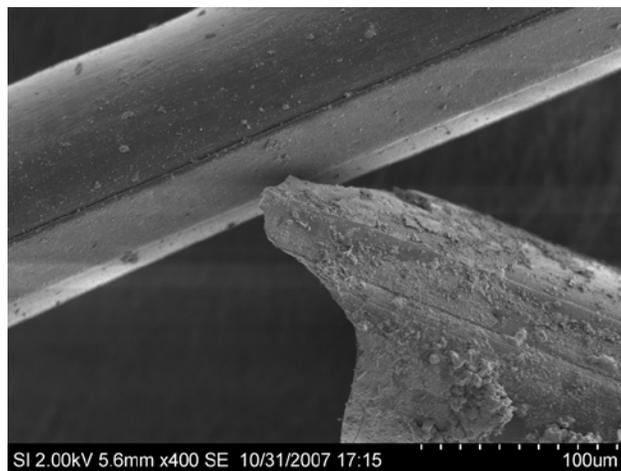


*American Committee Model*, before treatment, front and back views. Photos by Don Hurlbert.

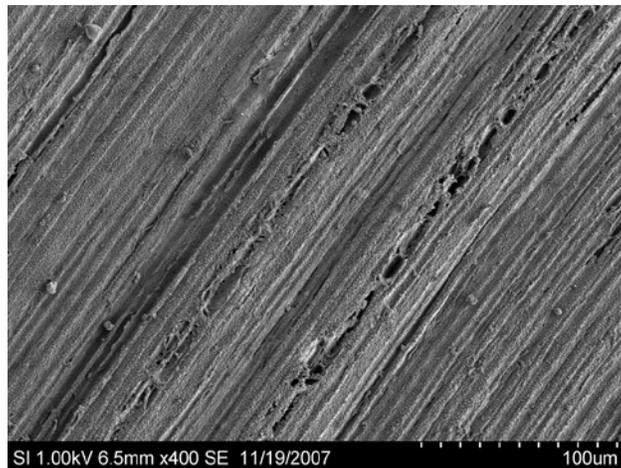
## MCI 6175 Edison's Light Bulb

MCI Staff: R. Jeff Speakman, Judy Watson, Lynn B. Brostoff

Questions have arisen regarding the method of manufacture and composition of Edison's earliest light bulb filaments. Specifically, what were the filaments made of and how did the technology change (through the addition of different additives to the filaments) during the early years of light bulb manufacture. It is hypothesized that Edison would not have had to add anything to Bristol board and Madake bamboo filaments because the former contains kaolin and the latter has lots of silica; both of which would contribute to the formation of a conductive ceramic if heated properly in the absence of oxygen and the presence of fluxes (such as any salts in the organic material). However, it is uncertain if this is the case, or if Edison did indeed use additives.



Two filaments viewed with MCI's SEM



SEM image of processed and used bamboo

## MCI 6215 Plastics Survey in the Division of Medicine and Science

MCI Staff: Jia-Sun Tsang, Rebecca Giesecking

The goal of the survey was to re-house the plastics collection at American History to minimize degradation of the plastics. To accomplish this, the plastics must be sorted by type. For many objects in the collection, the type of plastic was known, but many others were unidentified.

In an effort to identify these unknown plastics, small samples were taken for analysis by ATR-FTIR. The sample size was typically around the size of the head of a pin, and samples could usually be taken from the underside or inside of an object or a place where the object was already damaged so that the small sample would not be noticeable. Most of these samples could be easily identified by matching the spectrum or a sample to a spectrum of a known standard of a type of plastic.

Samples were taken not only of unidentified plastics but also of objects that did not have the typical appearance of the plastic they were identified as. In some cases the analysis confirmed the prior identification, but in other cases the original identification was incorrect and the object could be identified as a different type of plastic. For example, several white objects and translucent objects catalogued as Bakelite were correctly identified as either thiourea formaldehyde or Glyptal. The data gathered from survey guided the drafting a comprehensive re-housing plan.

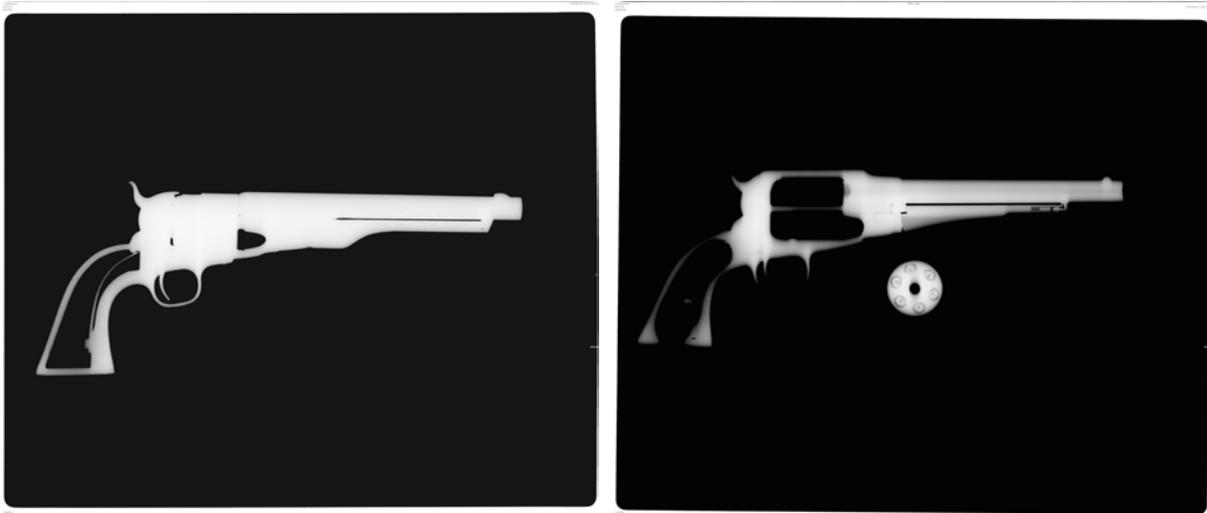


Auto Dashboard, NMAH, 1981.0976.70  
Gift of Union Carbide; molded Bakelite with  
cellulose acetate dials and cellulose acetate  
covers for speedometer and odometer

## MCI 6252 Locke Device Revolvers

MCI Staff: Ron H. Cunningham

A series of eleven sequenced radiographs were taken of a post Civil War Colt .44 Cal. Revolver, ranging from 90 – 140 kV. The original request called for the imaging of four revolvers, two of which were prototypes containing a “Lock Device” or safety system tested by the U.S. War Department in the 1870’s. The revolver’s large cylinder and handgrip prevented good contact with the image plate, resulting in loss of detail. Some good details were obtained by removing the cylinder prior to radiography, however the safety system could not be imaged under existing conditions. If possible, removal of both handgrips and the cylinder may serve to improve image quality.



MCI 6287 Painting: *Samuel Blodget* attributed to John Trumbull

MCI Staff: Jia-sun Tsang, Allison Martin, Mel J. Wachowiak, Ron H. Cunningham, R. Jeff Speakman, Jennifer Giaccai, Nicole Little

As part of the overall donation of firefighting, maritime and institutional history material by CIGNA International in 2005, NMAH received several portraits of company founders, directors and presidents. One such portrait is purportedly of Samuel Blodget, a founding director of the Insurance Company of North America, attributed to John Trumbull. By submitting the portrait to analysis, we are hoping to establish a date range for its creation. A technical study of the artist materials and painting techniques will be compared with existing materials and techniques to further understand the painting. Non-destructive analysis including close examination of painting under Vis and UV with naked eye and microscope, X-radiography, IR reflectography, and XRF analysis were used. FTIR, XRD cross-sections for microscopy, SEM, and GC-MS will be considered if necessary.

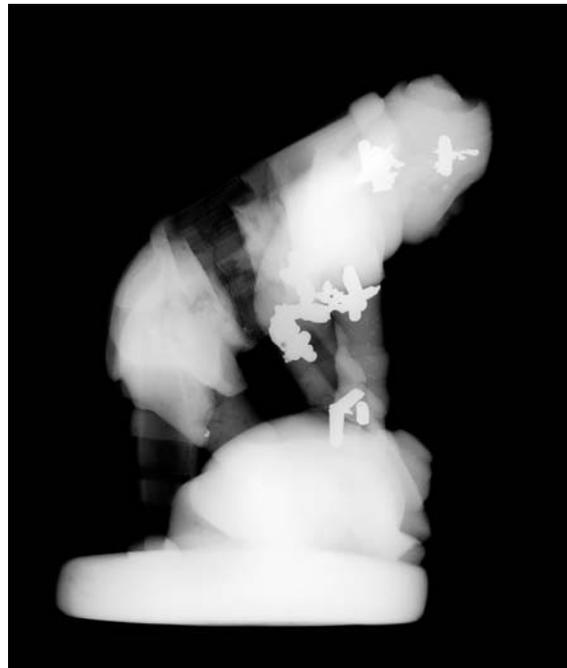


## National Museum of the American Indian

### MCI 6065.2 *Conquering Warrior* Figurine

MCI Staff: Mel J. Wachowiak, Ron H. Cunningham

This piece is a famous Cahokia-style figurine which has been well published. Though long-known to be restored, the extent of restoration is very unclear because of heavy overpaint. Previously, PIMA (portable infrared mineral analyzer) was used on this piece and identified areas of plaster restoration. In November 2006, MCI did X-rays that showed a number of strange restoration materials used in the piece, possibly lead, other metal pins and some corrugated material (reference MCI 6065.1), but it is still hard to define what is original flint clay, and what is plaster. By using various imaging processes, digital X-ray, 3-D scanning, IR or UV photography and other techniques as needed, and perhaps using other spectroscopic techniques to define edges restoration/original, the extent of restoration, including fills and overpaint would be determined. Information will be used to benefit future art historical and archaeological analysis, and potentially to justify modification of the current restoration.



## MCI 6068.2 XRF Training for Heavy Metal Pesticide Identification

MCI Staff: R. Jeff Speakman, Odile Madden

MCI provided assistance with upgrading and standardizing the use of NMAI's new NITON portable XRF analyzer for the identification of heavy metal pesticide contamination of NMAI's collections to help ensure health and safety of NMAI staff and constituents and to further the standardization and quantification of portable XRF analysis of heavy metal contamination.

## MCI 6108 Northern Great Plains Painted Hides

MCI Staff: Lynn B. Brostoff, Fabien Pottier

Painted hides from the Northern Great Plains collection were examined to determine the pigments used on them. The initial study focused on the yellow-green and the red pigments on a Crow buffalo hide. Pigments were analyzed by X-ray diffraction spectroscopy and portable X-ray fluorescence spectroscopy, and neutron activation analysis; results were compared to materials and techniques described in the historical and ethnographic records and to a published study of similar pigments.

MCI 6192.2 Painting: *End of Season* by Fritz Scholder  
MCI Staff: Jia-sun Tsang, R. Jeff Speakman

This is a daringly abstract expressionistic painting which references a large mass of fire that descends upon a starkly painted black space. Layers of vivid red, yellow, purple and fuchsia are placed in drastic contrast to a seemingly flat dark space. The void, however, is actually carefully filled with countless vigorous, small black and dark blue brush marks. This painterly style that expresses an aura of spontaneity and immediacy was achieved by varying brush texture, brush size and brush movement. This heterogeneous mixture of brush marks captures and reflects the artist's signature style of drips and splashes of the paint.

The painting appears to be mixed medium of water-based acrylic emulsion paint and drying oil paint. The acrylic paint was used for the flat dark and occasionally colorwashed background. The heavier impasto in the fireball appears to be oil paint. A heavy build up of the oil has caused paint loss. FTIR analysis of a small paint chip from the loss confirmed the observation that impasto near the paint loss was executed most likely in alkyd resin. Alkyd resins are oil-modified polyester and were introduced in the early 1930s. The visual difference between traditional drying oil and synthetic alkyd can be similar and yet different, depending on how the paint was prepared and applied. In general, alkyd tends to be more brittle than oil. There is no visible evidence of varnish on the painting.

The most visible setback of the painting was the airborne dust and grime that had accumulated over time and the two visible areas of paint loss in the fireball. Due to the time constraint of the exhibition opening schedule, the current treatment focused on short-term aesthetic integration of the two paint losses so the painting could be displayed without noticeable distractive qualities. A minimally invasive method using inserts was used to fill the losses. There was no attempt to remove the dirt.

The conservation was initiated through an upcoming retrospective exhibition of Fritz Scholder entitled *Indian, Not Indian* which simultaneously opened in November 2008 at NMAI's Washington, DC and New York locations.



Overview of End of Season by Fritz Scholder, 1960s  
Photographed in NMAI exhibition facility.  
Photo by: Rajshree Solanki, Registration Loan Specialist at NMAI

## MCI 6195 Moundville Bowl

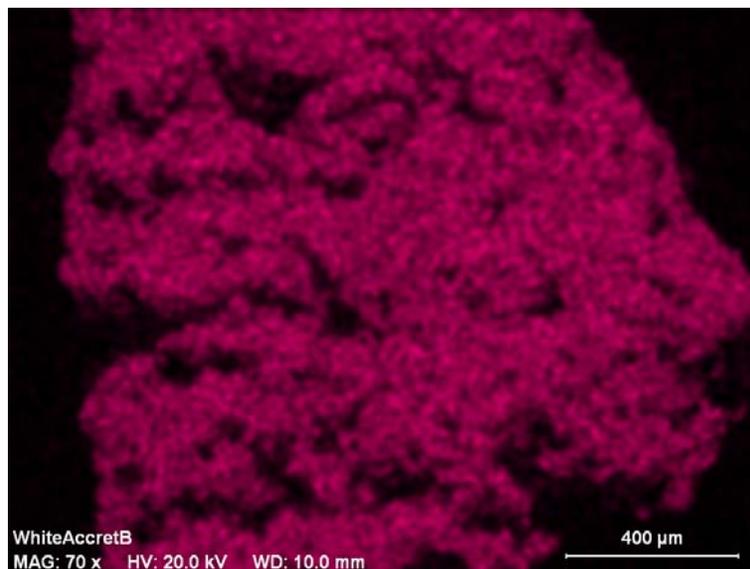
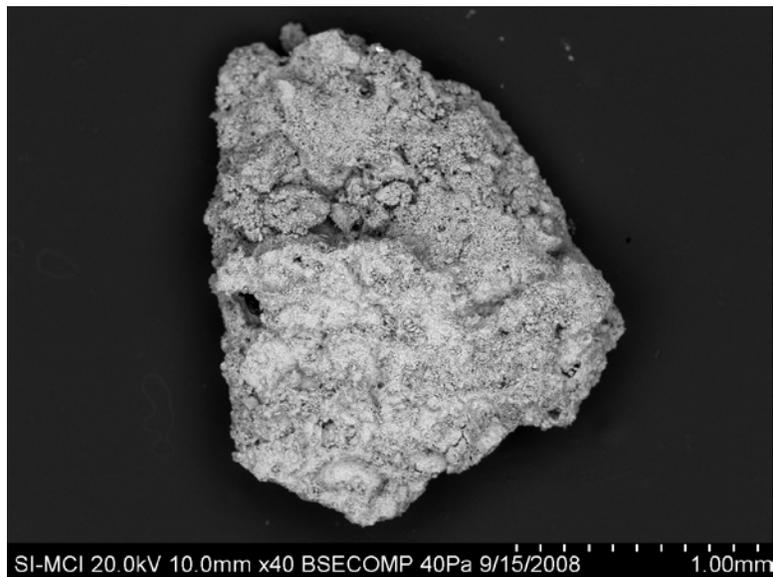
MCI Staff: Mel J. Wachowiak, B. Vicky Karas

The bowl was submitted for 3-D scanning to make a reproduction that can go on long term loan to the Moundville State Park, an exhibit venue close to modern descendants of the original creators of the object. The original is one of the iconic objects of NMAI and is regularly used for NMAI exhibits and other loans. However, NMAI wishes to make a copy of the object available for permanent exhibit at the park.

## MCI 6216 Maya Polychrome Stucco Head

MCI Staff: Nicole C. Little, Judy Watson, R. Jeff Speakman, Jennifer Giaccai

The Maya polychrome stucco head was submitted for characterization of the stucco to determine and distinguish original material. The characterization of restoration material was used to inform the treatment (removal) procedure in areas where the disfiguring restoration material covers the original surface.



## MCI 6234 Residue on Exhibit Case Windows

MCI Staff: Jennifer Giaccai, Nicole C. Little

White efflorescence was observed forming on the inside of the glass window in sealed drawers in the NMAI exhibition *Windows on the Collection*. Two different manifestations were observed; some samples were obviously crystalline while others appeared more as a slight fogginess or cloudiness on the glass. More drawers were affected than were sampled. Drawers labeled AN did not show any cloudiness in the front one inch of the drawer. The raking light used in the exhibition drawers highlights the formation of the crystals, so that the crystals are extremely distracting to the observer although there is only a small amount of sample present.

Although there was variation in the samples collected, the overwhelming composition of most of the samples was sodium formate. This salt was most likely formed when formic acid or formaldehyde was released from one of the components making up the case or from improperly sealed wood. The formic acid reacted with sodium present as a component of the glass, and formed sodium formate crystals on the inside glass of the sealed exhibit drawers.

## MCI 6241.1 Anchorage Loan: Tlingit Stikine Copper Rattle

MCI Staff: Nicole C. Little, Ron H. Cunningham, Harriet (Rae) F. Beaubien

This Tlingit rattle is included in the SI loan (NMNH and NMAI) to the Anchorage Museum of History and Art, and will be on display for 12 years. It is suspected that several corroded areas on the mask may have "bronze disease", which is caused by chloride contamination and is indicated by the following products: atacamite  $\text{Cu}_2\text{Cl}(\text{OH})_3$ , paratacamite  $\text{Cu}_2\text{Cl}(\text{OH})_3$ , or nantokite  $\text{CuCl}$ . Past photographs indicate that this has been present for an extended period of time and has not worsened. This is of greater concern now, as the object will be travelling to Alaska and will be installed in a new facility with a new HVAC system, which might expose it to unstable environmental conditions, thus exacerbating the problem. The characterization of the corrosion product through XRD analysis can determine if bronze disease is present. The results of this analysis will inform our treatment decision. X-ray analysis will elucidate construction methodology.

## MCI 6241.2 Anchorage Loan: Athabaskan Garments

MCI Staff: Mary W. Ballard, Elizabeth Shuster, Cathy Zaret, Michaela Sousa

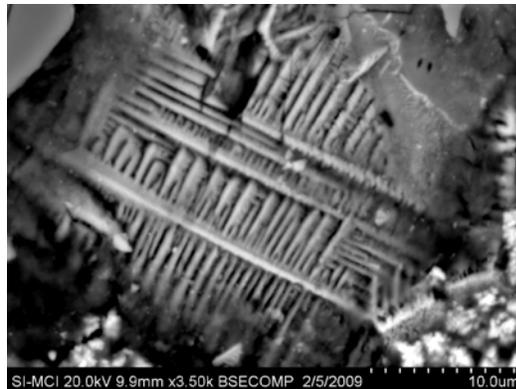
Due to an unexpected staff absence, the National Museum of the American Indian, requested the assistance of the MCI textile conservation interns in the preparation of garments for the loan and exhibition at the Anchorage Museum of History and Culture, Alaska. MCI textile interns worked on a group of objects associated with a Chipewyan's man's outfit, included tunic, hood, leggings/moccasins, and knife sheath; the treatment of a Kutchin or Loucheux child's rabbit skin trousers with feet and matching hooded coat; and prepared an Ahtna moose skin coat.



## MCI 6249 Mongolian Iron Slag

MCI Staff: Judy Watson, Martha Goodway, Nicole C. Little

Thirty-three samples from an archaeological context at the Khyadag East deerstone site in Mongolia were analyzed using SEM-EDS and XRF in order to determine whether they presented evidence of local iron smelting around 500 BC. Results indicate no evidence of iron smelting, but most of the objects are consistent with copper smelting slag.



MCI 6261 Nineteen Contemporary Paintings

MCI Staff: Jia-sun Tsang

Condition surveys were conducted on 19 contemporary NMAI paintings.

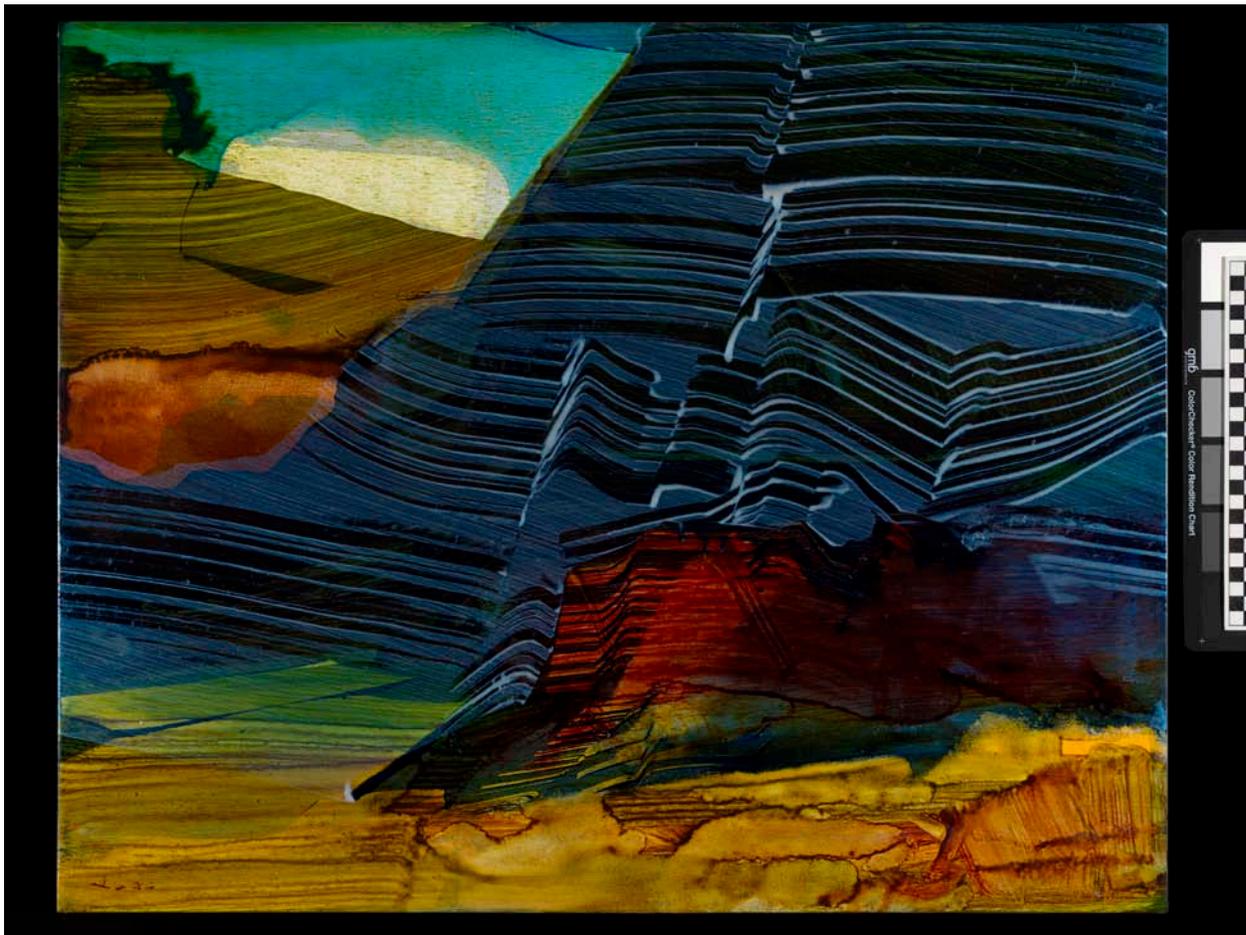


*Hummingbird Angel* by Jesse T. Hummingbird

MCI 6267 Fifty-Six Contemporary Paintings for Exhibits *Recent Acquisitions* and *Infinity of Nations*

MCI Staff: Jia-sun Tsang, Allison Martin

Condition of 56 contemporary paintings was evaluated with appropriate documentation and recommendations for conservation. Fifty-one (51) paintings are proposed for the "Recent Acquisitions" exhibition scheduled for 2010 at NMAI, Washington DC. Five (5) paintings are proposed for 2010 "Infinity of Nations" exhibition at NMAI George Gustav Heye Center, NY. Examination was carried out onsite at the NMAI CRC collection storage space on June 30, 2009. Conservation and curatorial files were provided by NMAI conservation staff.



Part of *Blanket* by James Lavadour

MCI 6272 Mobile Piece: *Crux (as seen from those who sleep on the surface of the earth under the night sky)* by Brian Jungen

MCI Staff: Jia-sun Tsang, Jennifer Giaccai, Marion F. Mecklenburg

Brian Jungen's monumental piece *Crux (as seen from those who sleep on the surface of the earth under the night sky)*, is a recent acquisition and was installed in the NMAI rotunda, known as the Potomac, in the summer of 2009. Members of the NMAI exhibit production and conservation departments have worked with the artist as he has made changes and determined how he wants the piece hung. This has been a unique opportunity at NMAI to work with a living contemporary artist.

The main purpose of the analysis of the materials of *Crux* was to establish recommendations for display and storage for this new acquisition. While there is literature about the characteristics and conservation of a wide range of plastics, there has not been significant conservation research regarding ABS plastics, which is one of the types of plastic featured in *Crux*.

Using samples provided by the artist and collected from the packing material, of three of the five animal figures (shark, emu, crocodile, possum, and sea eagle), and as well as foam, possibly polyurethane, from a fourth, this is an excellent opportunity to more specifically characterize the plastics used in the object using analytical equipment and expertise at MCI. As this object will be hung in an area which can get high levels of natural light, it is thought that testing the plastics will help anticipate aesthetic change and further substantiate the need for light filtering and reduction. And as the object will be hung, it is important to know if long-term exposure of the piece to the conditions in the Potomac will affect the piece's physical integrity.

Sharing these findings with the artist, as well, may facilitate further discussion about his opinions about changes to the aesthetics and structure of the piece over time. There will also be a substantial web-based component, in the form of an online blog through the NMAI website, following the conservation aspects of the installation of *Crux*. Data found during analysis performed at MCI could be an interesting component to share on this web-based forum.



## National Museum of Natural History

MCI 6084.2 Deer Stone #15 from Ushkiin Uver, Hovsgol, Mongolia  
MCI Staff: Mel J. Wachowiak, B. Vicky Karas, Harriet (Rae) F. Beaubien

3-D imaging and post-processing of two fragments of deer stone #15 from the site of Ushkiin Uver, Mongolia, were carried out. Scanning took place on location in northern Mongolia at the Hovsgol Museum, Muren (Hovsgol aimag, Muren sum), using a Breuckmann GmbH, triTos™ scanner, purpose built for heritage scanning. Post-processing was with Rapid Form™ graphic software on a desk top computer.



## MCI6094.1 Lepidoptera Genitalia Slides

MCI Staff: Walter R. Hopwood, Mel J. Wachowiak

Five samples from microscopic slides where the medium was crystallized were provided. NMNH would like to recover the pieces and remount them. Previous trials at remounting were not good. Medium is soluble in xylene, but the pieces were too far gone. Recommendations on how to best treat the slides for recovery were needed.

## MCI 6094.2 Degradation of Embedding Medium on Prepared Microscope Slides

MCI Staff: Mel J. Wachowiak, Jia-sun Tsang, Tony Maiorana, Rebecca Giesecking, Marion F. Mecklenburg

Eight cleared-leaf specimen slides in transparent and translucent resin under cover glass were submitted to determine the type (natural or synthetic) or brand of resin, if there were any additives detectable, if the resin was homogeneous, if there were alternatives to these resins, and if the procedure used to remount samples in Paleobotany was practical for large numbers (thousands) of slides. If the medium of older samples of cleared leaf specimens can be dissolved and transferred to a new slide, it would be ideal; if it can be done more efficiently, and they will not degrade, it is preferred. Predicting when, and which samples might degrade, would be useful.



## MCI 6118.1 Colonial American Skeletal Material

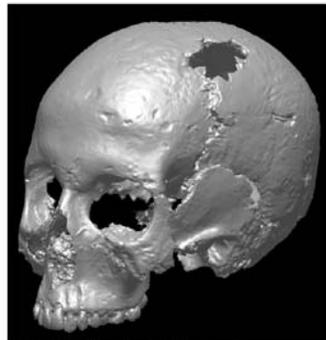
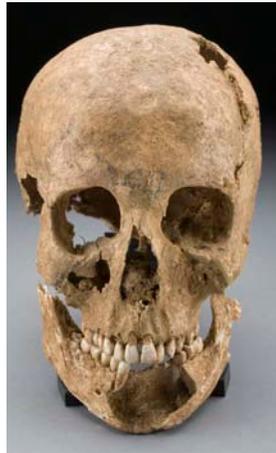
MCI Staff: Nicole C. Little, R. Jeff Speakman

The health of historic populations from Jamestown and St. Mary's City was assessed. Lead and other heavy metal concentrations in skeletal remains were determined by ICP-MS for the exhibit entitled *Life and Death in the Colonial Chesapeake*. Although 101 bone samples were submitted for this preliminary study, additional samples were analyzed to determine the health and social status of 17<sup>th</sup> century colonial populations.

## MCI 6118.2 Colonial American Skeletal Material

MCI Staff: Mel J. Wachowiak, B. Vicky Karas, Ron H. Cunningham, R. Jeff Speakman

Three 17<sup>th</sup> century colonial skulls were 3-D scanned, photographed, and re-housed. A 3-D hardcopy of one of the skulls was manufactured by the Smithsonian's Office of Exhibits Central, using 3-D data generated by MCI, for facial reconstruction and integration into a NMNH exhibit entitled *Life and Death in the Colonial Chesapeake*.



MCI 6118.2: 3D Scan Data (Solid Views)



## MCI 6118.4 Historic Human Bone

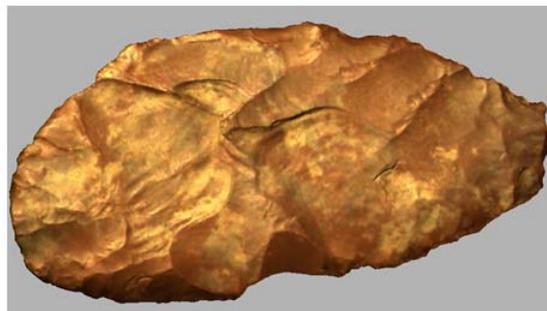
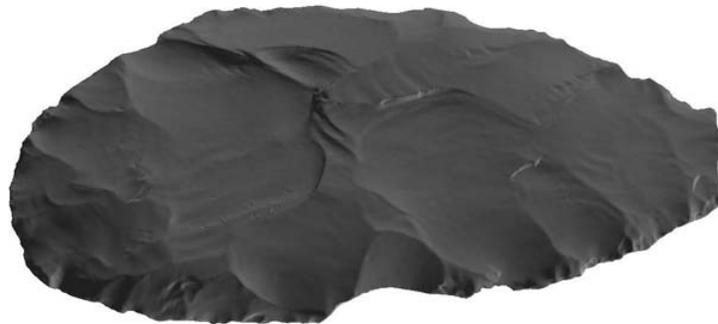
MCI Staff: Nicole C. Little, Irma Molina, R. Jeff Speakman

This preliminary study determined whether external contaminants (i.e., adhered dirt) affect lead concentrations as measured by X-ray fluorescence (XRF), in comparison with measurements obtained by ICP-MS. Lead standards will be manufactured and analyzed by digestion ICP-MS for cross-calibration. Successful calibration of XRF for analysis of lead in bone will potentially be used as a non-destructive determination of health and social status in early colonial populations.

## MCI 6126.1 Clovis Obsidian Biface from Idaho

MCI Staff: Mel J. Wachowiak, B. Vicky Karas, Christie N. Pohl, R. Jeff Speakman

3-D scanning of a Clovis obsidian biface was carried out to assess the quality of 3-D scan data and to determine the data's potential for producing precise physical replicas of this object. The Clovis biface is a stone tool over 10,000 years old, it is important to maintain the stone's intrinsic research value through replication without compromising its complex geometric angles and other diagnostic surface characteristics. Using 3-D digital data collected from non-contact 3-D scanning would significantly mitigate the possibility of damage to the object. In addition to creating a physical replica, the decision to document and archive this object by highly accurate metrological 3-D imaging will allow for high resolution virtual study and presentation to a much broader audience.



## MCI 6126.3 Late Pleistocene Stone Tool

MCI Staff: R. Jeff Speakman, Mel J. Wachowiak

3-D scanning and post processing of the prehistoric projectile point was carried out to produce 3-D scan data that the requester could assess for quality and the potential for producing precise physical replicas of these objects. Because the projectile point is over 8,000 years old, it is important to the requestor to maintain the stone's intrinsic research value through replication without compromising its complex geometric angles and other diagnostic surface characteristics. Methods for replicating stone tools have traditionally been carried out by casting a mold from the original object. However, these established molding and casting techniques could compromise the stone's surface integrity through 1) excessive handling of the object and 2) by possible surface staining or other harmful effects from the molding materials. In contrast, using 3-D digital data collected from non-contact 3-D scanning would significantly mitigate the possibility of damage to the object.

The decision to digitally document the projectile point at MCI by highly accurate metrological 3-D imaging, and to archive the files at the Smithsonian, will allow for high resolution virtual study and presentation to a much broader audience. Access to 3-D archival records of this projectile point, as well as possible 3-D models based on the digital files, will enhance the research value of the NMNH Paleo-Indian collection.



## MCI 6126.4 Late Pleistocene Biface from Ocean City, New Jersey

MCI Staff: Mel J. Wachowiak

3-D imaging and post-processing of two (2) prehistoric projectile points from the Anthropology Department of the National Museum of Natural History (NMNH) were carried out at remote locations. 6126.4 was scanned and processed by visiting scientist Anja Schmidt. A Breuckmann GmbH, triTos™ scanner, purpose built for heritage scanning, was used to digitize the projectile point. Post processing 3-D digital data was carried out using Rapid Form™ (2006 and XOS).



MCI 6174.5 Anchorage Project: Wooden Doll, Yup'ik, St. Lawrence Island  
MCI Staff: Ron H. Cunningham

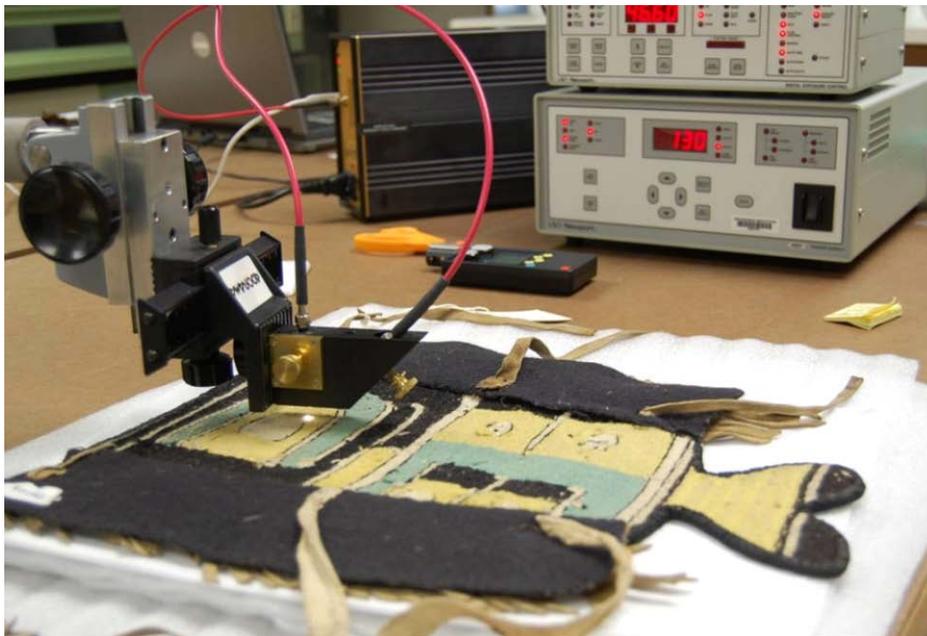
Radiography was requested to determine the structure of the doll's supporting armature, method of articulation and the presence of any supportive metallic elements, e.g., nails, tacks or screws. It was determined that the doll's armature consists of wood. Articulated tongue and groove joints permit movement at the elbows, shoulders, ankles and waist. Some articulation of the shoulder joints appears to have been secured with wire nails or screws.



## MCI 6174.6 Anchorage Project: Lightfastness of Boot Fabrics and Leather

MCI Staff: Marion F. Mecklenburg, Julio del Hoyo

A series of lightfastness tests were conducted on a group of ethnographic objects that will be on long-term loan at the Anchorage Museum in Alaska starting in 2010. The objects belong to the Smithsonian's National Museum of Natural History and the Smithsonian's National Museum of American Indian. The project was designed as a feasibility study on the use of the micro-fading tester to examine materials present in ethnographic collections. A broad range of objects containing a wide variety of materials were selected for the study in order to assess their lightfastness properties. This survey helped the conservation staff in establishing exhibition recommendations taking into consideration the light levels in the building and the estimated light exposure based on the duration of the exhibit. The diversity of objects and the complexity of their materials made this a very challenging testing program. There is a need for studying the light fading stability of ethnographic artifacts since the amount of scientific information on this subject is limited. The results of this investigation demonstrate that the micro-fading tester is a useful tool for determining the permanency of these materials without causing any harm to the objects.



## MCI 6174.7 Anchorage Project: Fur from Yup'ik Hood and Boots; Siberian Apron and Boots

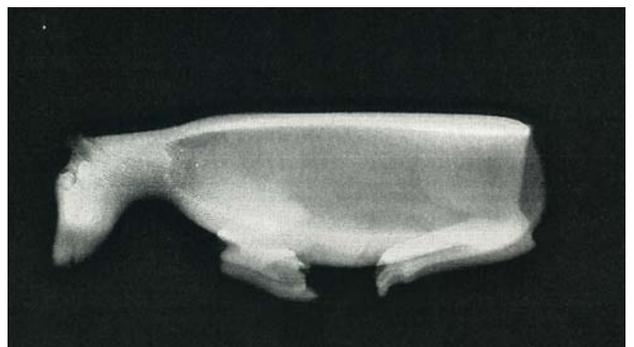
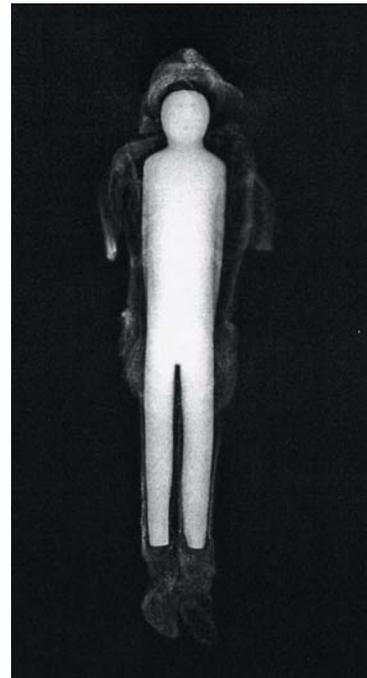
MCI Staff: Ron H. Cunningham, Mary W. Ballard, Caroline Solazzo

The features of hair samples from various fur objects, for use in species identification, were examined by SEM imaging. After discussing these objects with Alaskan cultural consultants and NMNH mammalogists, there were still questions about what types of fur and hair were used for the decorative features on these objects. Attempts to characterize/identify the hair from these objects using PLM had been unsuccessful. Identification and/or characterization of this hair are important for a greater understanding of these objects; in particular which hair and/or fur might be chosen to decorate clothing.

## MCI 6174.8 Anchorage Loan: Inupiaq Objects – Seal Retriever, Doll, and Caribou-shaped Tobacco Box

MCI Staff: Ron H. Cunningham

Three objects – a seal retriever, a doll and a tobacco box – were radiographed to document and ascertain the objects' method of fabrication, structural condition and supporting elements, e.g., nails and tacks. The objects are part of the "Anchorage Project," a three year effort requiring the conservation and documentation of over 600 Alaskan Native objects. The exhibit will represent all nine of the major Alaskan native groups and will be housed in the new wing of the Anchorage museum.



## MCI 6174.9 Anchorage Loan: Harpoon Head

MCI Staff: Jennifer Giacciai, Nicole C. Little, Judy Watson

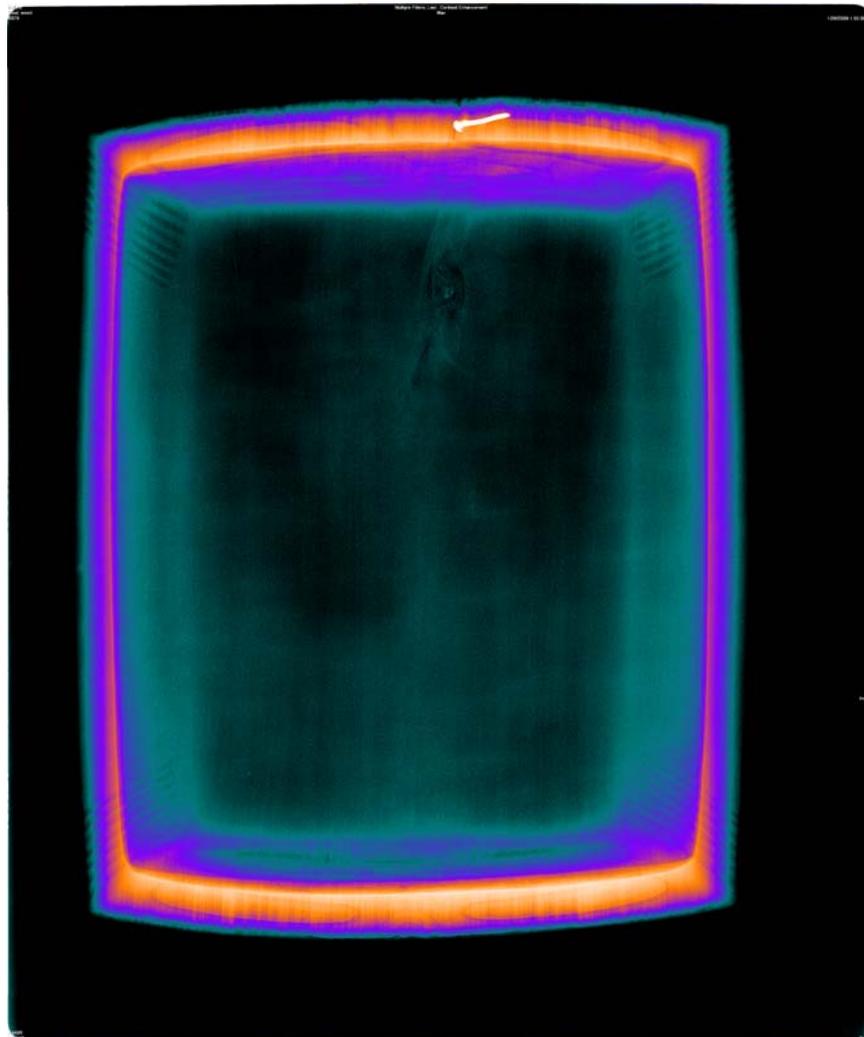
White crystalline material was observed on a harpoon head between the seaweed wrapping material and the steel harpoon head, under what appeared to be a brown paint layer. Infrared analysis showed that the white material was hydrocerussite,  $2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$ , a common corrosion product of lead. XRD of the two samples confirmed the presence of hydrocerussite and did not identify any other crystalline components to the sample. XRF analysis of the white material and the harpoon head itself confirmed that lead was present in the area where the corrosion product was found, but that the harpoon head itself did not contain high levels of lead.



## MCI 6174.10 Anchorage Project: Tsimshian Wood Dish

MCI Staff: Ron H. Cunningham

Radiography was requested to help ascertain the method and extent of any repairs made to the dish. The grain pattern in the dish indicates that it has been carved from one piece of wood. A series of six computed radiographs were taken of the wooden bowl. Radiography of the carved, painted dish indicates the presence of one clear attempt at repair in an area of knot formation. A wire nail or brad approximately ½” in length was located within an area of fragmenting knotted wood. Its position suggests that a hole may have been drilled first and the brad inserted for reinforcement and filled in. The possible application of the area with glue was not determined.



## MCI 6174.11 Anchorage Project: Haida Halibut Hook

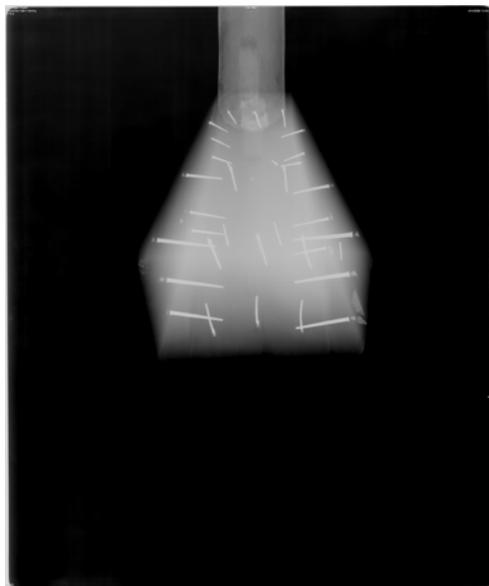
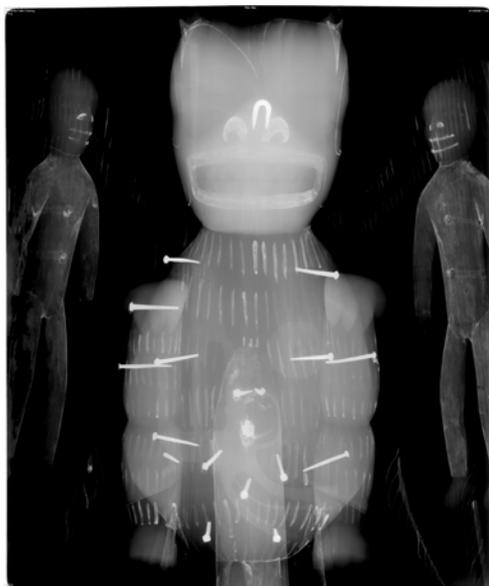
MCI Staff: Jennifer Giaccai

Identification of the coating was requested to help the conservator determine if the coating is a Native application. If the coating was found to be Native it would not be removed from the object. The coating is very soluble, and remains soft and easily penetrated with a needle. FTIR of the sample shows that the sample contains a resin, most likely shellac. The physical properties of the coating are explained by the use of an aged shellac solution, that results in a very soluble, soft coating, or a mixture of shellac with at least one other component.

## MCI 6174.12 Anchorage Project: Tsimshian Model Totem Carving

MCI Staff: Ron H. Cunningham, Don C. Williams

Radiography was requested to determine the carving's method of construction and the presence of any supportive metallic elements, e.g., nails, tacks or screws. Radiographs of the object indicate that the central figure's component parts have been secured with nails, as have its base and stand. The possible reinforcement of parts with glue was not determined.



## MCI 6198 Mineral Microprobe Standards

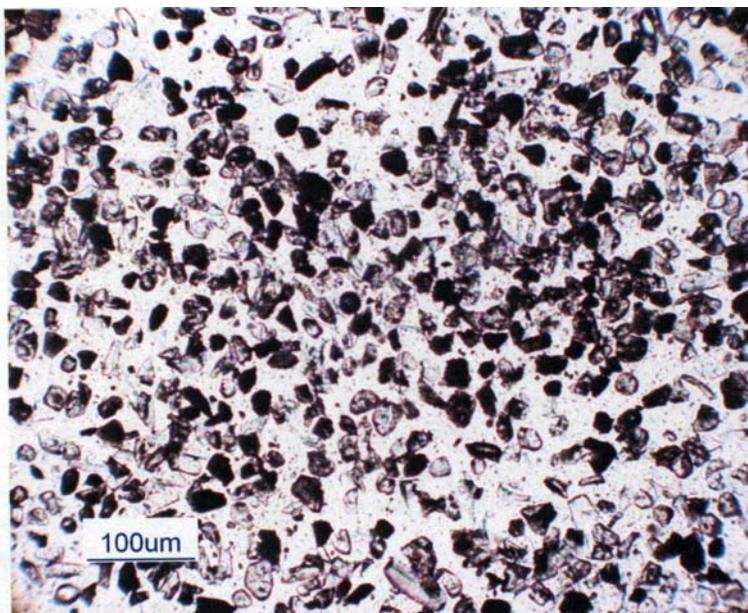
MCI Staff: Judy Watson

Twenty-six mineral and glass standards from the Mineral Sciences department of the National Museum of Natural History were analyzed using SEM-EDS in order to determine the precision and accuracy of our instrument both under ideal analytical conditions and under the less than ideal conditions that are commonly used at MCI in order to offer non-destructive analysis to our clients.

## MCI 6199 Volcanic Glass Particles in Archaeological Sediment

MCI Staff: Judy Watson, Nicole C. Little, Mel J. Wachowiak

Microtephrochronology is a stratigraphic dating method used by archaeologists and Quaternary scientists involving the location and characterization of volcanic glass particles present in soils and sediments in sizes and amounts invisible to the unaided eye. Accurate determination of the presence or absence of volcanic shards in a soil or sediment sample precedes quantitative analysis. This determination is typically accomplished using optical microscopy and is one of the most time-consuming and laborious steps in the process, with great potential for misclassification or miscounting error. Here a novel method of identifying and counting volcanic glass particles while simultaneously providing a rough geochemical characterization of all the particles present in the sample (glass and non-glass), using an Aspex PSEM 3025 Particle Analyzer with Automated Feature Analysis™ (AFA) software is presented.

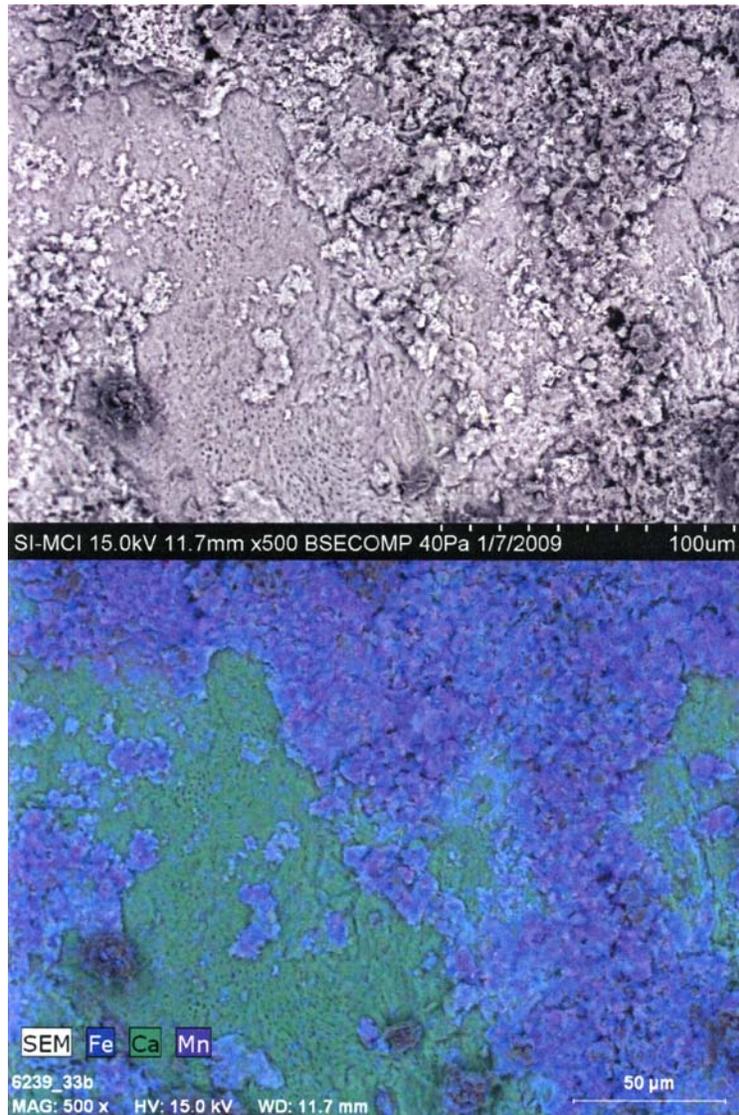


An example of a sieved tuffaceous sand showing glass and non-glass grains of various morphologies from the flanks of Göllü Dağ, Turkey. (Photo: M.J. Wachowiak)

## MCI 6239 Fossil Bone from Olorgesailie, Kenya

MCI Staff: Judy Watson, Nicole C. Little, Mel J. Wachowiak

A fossil bone (possibly modified by hominines) from Olorgesailie was presented for analysis in order to determine whether a layer of sediment partially encasing it was pigment. The bone sample was examined intact by SEM-EDS, and small samples were taken from several areas for analysis by XRD. Results of the XRD were inconclusive. SEM-EDS confirmed the presence of manganese both on the bone surface and in a discrete layer on top of the sediment crust on part of the bone. The presence of material which may be used as pigment does not address the issue of intent.

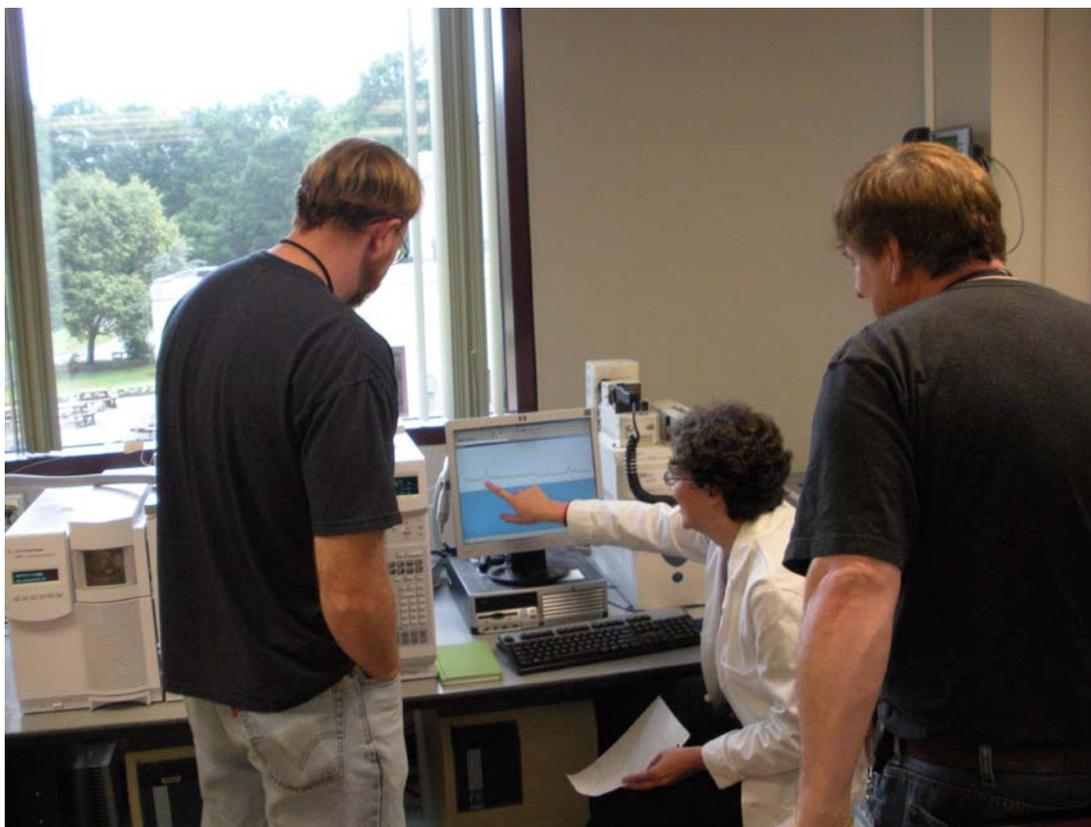


Scanning electron micrograph and EDS elemental map (at 500x) of the object's surface, showing both bone surface (green) and manganese-containing material on the surface (which also contains iron).

## MCI 6242 Recycled Alcohol Used with Natural History Collections

MCI Staff: Jennifer Giaccai

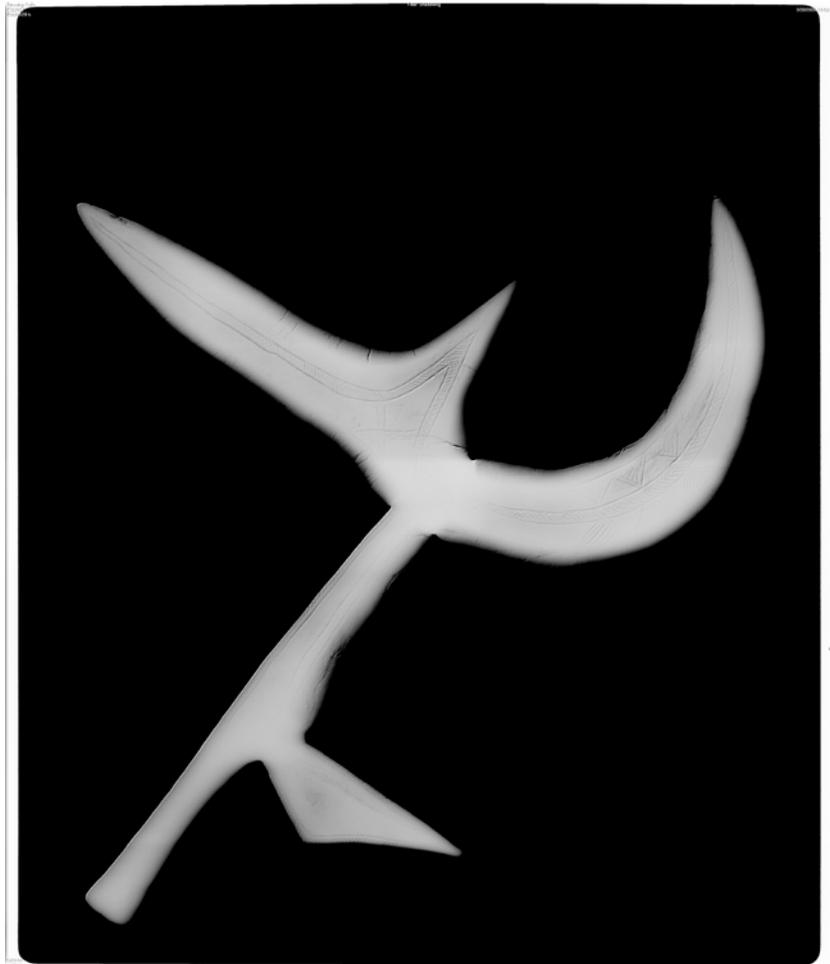
This project explored the use of a commercially available alcohol distillation unit to recycle waste alcohol from various specimen jars in the collection of the National Museum of Natural History. If the recycled alcohol was proven to be of high purity it could be reused in sample processing and storage, minimizing the amount of hazardous waste produced and the amount of new alcohol purchased. The alcohol was sampled both before and after distillation for analysis. Although there is a clear visual difference in the alcohol before and after distillation, a strong fish odor remained in the recycled samples. GC-MS confirmed that many compounds present in the alcohol before distillation were also present after distillation and that the recycled alcohol was never as pure as fresh alcohol. In at least one case, contaminants from earlier distillation runs remained in the still and were carried over into a subsequent distillation run.



## MCI 6250 Congo Throwing Knives in the Herbert Ward Collection

MCI Staff: Ron H. Cunningham

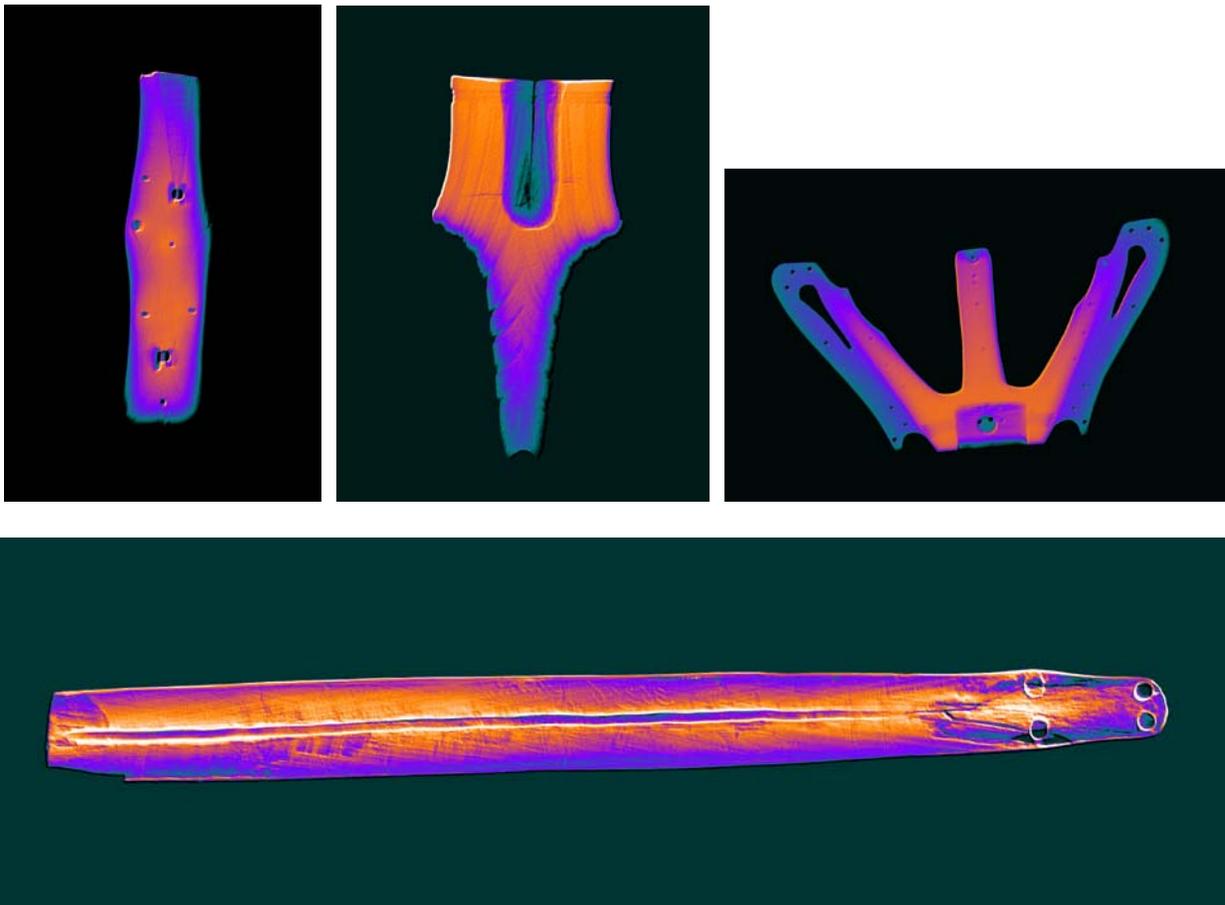
Digital radiography was requested for all five of the throwing knives to help ascertain their method of fabrication. Two sets of computed radiographs were taken for each of the knives. While all the sets of images were comparable in showing stress cracks, surface patterns and losses due to corrosion, those knives arranged to minimize handle thickness appeared slightly sharper. It was also noted that no clear visible evidence of welding or join marks could be found.



## MCI 6265 Five Archaeological Alaskan Ivory Objects

MCI Staff: Ron H. Cunningham

Computed radiography has been requested to document the present condition of the artifacts and to determine the extent of cracks or other damages, in preparation for transfer to the Alaska Museum in Anchorage for a multi-year loan. All of the objects – a handle from a decorated ivory box, two harpoon counterweights, an ornament, and a quiver stiffener - appeared structurally sound enough for transit and prolonged exhibition.



MCI 6269 Human Skeletal Remains from the Richards Family Vault,  
Congressional Cemetery, Washington, DC

MCI Staff: Nicole C. Little

The crystalline structures on bones interred in iron and wooden coffins in the vault were analyzed with XRD and micro-XRF and identified.

MCI 6273 Native North American Engraved Whelk (*Busycon*) Shell Ornaments

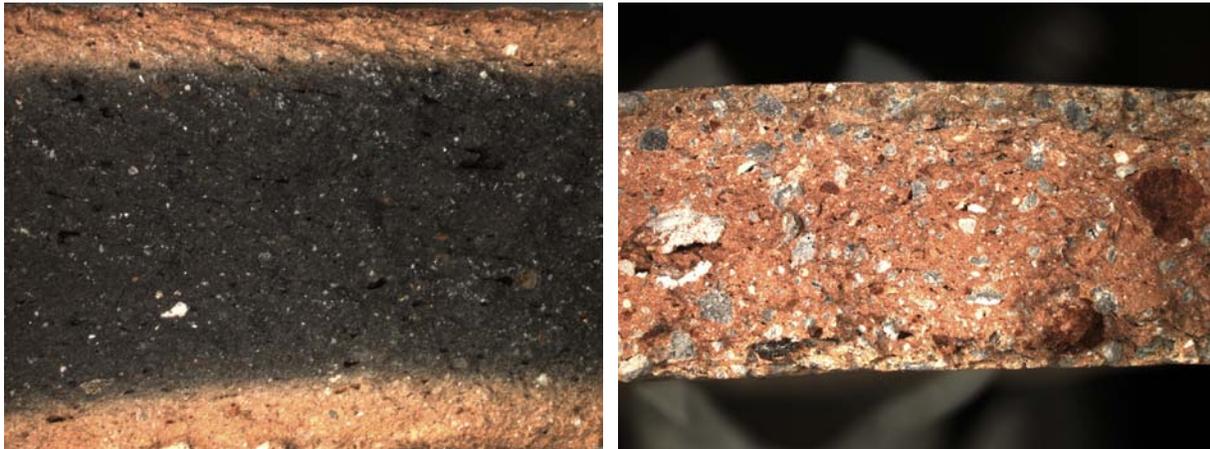
MCI Staff: Mel J. Wachowiak

The effectiveness of reflectance transformation imaging (RTI) and other imaging techniques in identifying traces of manufacture and use-wear on engraved shell surfaces not visible using conventional photography or examination under visible light was assessed. The analyses will be used to examine additional collections from the study region curated at the Smithsonian museums. The results will contribute broadly to developing non-destructive analytical techniques for the examination of shell ornaments recovered from archaeological contexts. A strategy to produce visual evidence of fabrication, wear, and weathering of shell ornaments, using non-destructive methods and traceable standards for comparison of large groups was developed. Selected methods, which may include, macro photographic documentation, 3-D microscopy, and reflectance transformation imaging/polynomial texture mapping, were documented.

## MCI 6283 Maya Ceramic Texture and Temper

MCI Staff: Mel J. Wachowiak

Multifocus microscopical imaging of ceramic sherds' texture and temper will capture high resolution, extended depth of field not possible with traditional imaging. Trials of this technique were conducted to demonstrate the methodology which yielded excellent results. The breaks were fresh and avoided destruction of painted or incised decoration while preserving the maximum diameter and rim to base structure. The high-resolution reference base of images will contribute to the facilitation of the characterization of archaeological ceramic texture and temper classes. The advantages of this method are: it permits a sufficiently large number of characterization leading to statistical assessment; it provides inexpensive characterization of potentially "local" versus "non local" manufacture; and it provides a sort according to temper-texture classes prior to more intensive, and expensive means of characterization.



## National Portrait Gallery

MCI 5957 A Statuette after Clark Mills's *Andrew Jackson on Horseback* (ca. 1860) made by Cornelius and Baker

MCI Staff: Carol A. Grissom

Treatment of this early American cast-zinc statuette consisted principally of partial removal of black overpaint on the figure's proper right arm and the horse's rump, inpainting, waxing, and the design and installation of a new mounting system. Prior to treatment, the statuette was examined in some detail in comparison to a similar statuette owned by the Smithsonian American Art Museum (No. 1983.101.5). This revealed that apart from differences in the bases, the two statues were made using the same molds, since the same mold-based flaws appear on both copies. Moreover, comparison showed many small differences in assembly and finishing. This copy, for example, has delineated seams on Jackson's pant legs and jacket sleeves, which the other copy lacks. The statuette was also X-rayed, which revealed original metal armatures in the horse's legs and metal rods used to attach the horse's legs, as well as a modern metal bolt used to repair the horse's tail. While the SAAM copy appears to have only its original "bronze" paint, this copy has been repainted a number of times with "bronze" paint, and a sticky coating seems to have been applied more recently. A sample of this coating was analyzed by Fourier transform infrared spectroscopy.

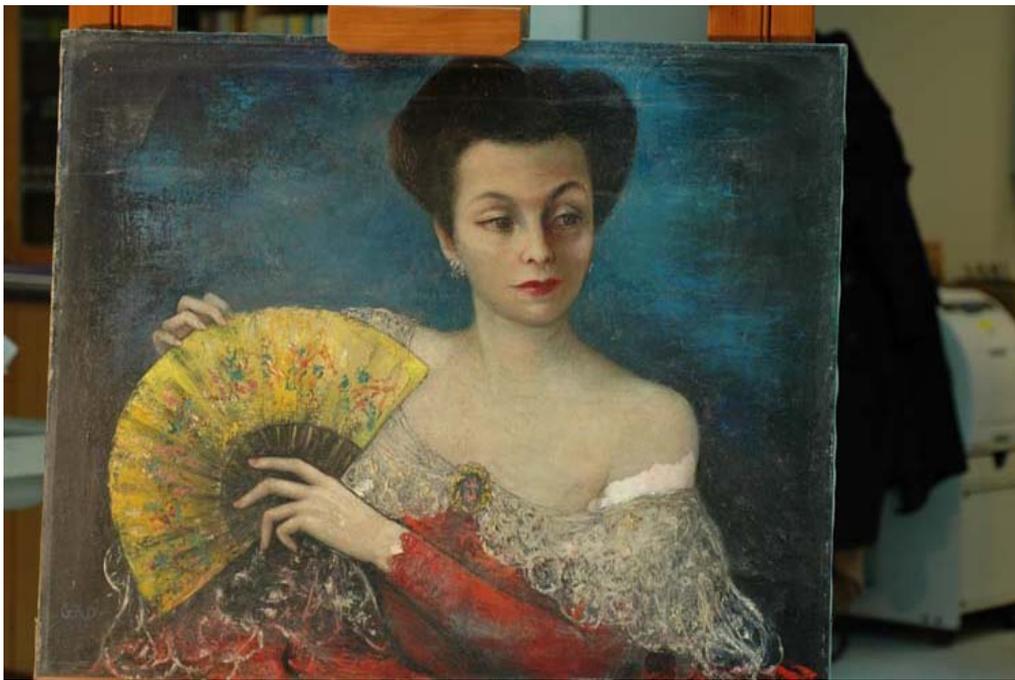


MCI 6181 Painting: *Cornelia Otis Skinner* by Gladys Rockmore Davis

MCI Staff: Jia-sun Tsang, Mel J. Wachowiak, Judy Watson

The goal of this project was to identify the surface coating on this painting to assist in the conservation treatment. The dark color of the coating, either from intended tinting or natural aging, had significant visual impact on the sitter or limited the conservation treatments. The dark surface coating was soluble in mild solvent. The solubility behavior and type of solvent it dissolved in indicated that the coating had not aged extensively. The darkened coating could have been from tinting or from the native color of coating material itself.

In addition to visual examination with light microscopy and higher magnification examination of the morphology of paint cross-sections made by scanning electron microscopy (SEM), SEM-EDS was used to profile the inorganic elements in the coating. An additional paint sample that included a coating layer was subjected to 3-D microscope examination under the visible and ultra-violet light.

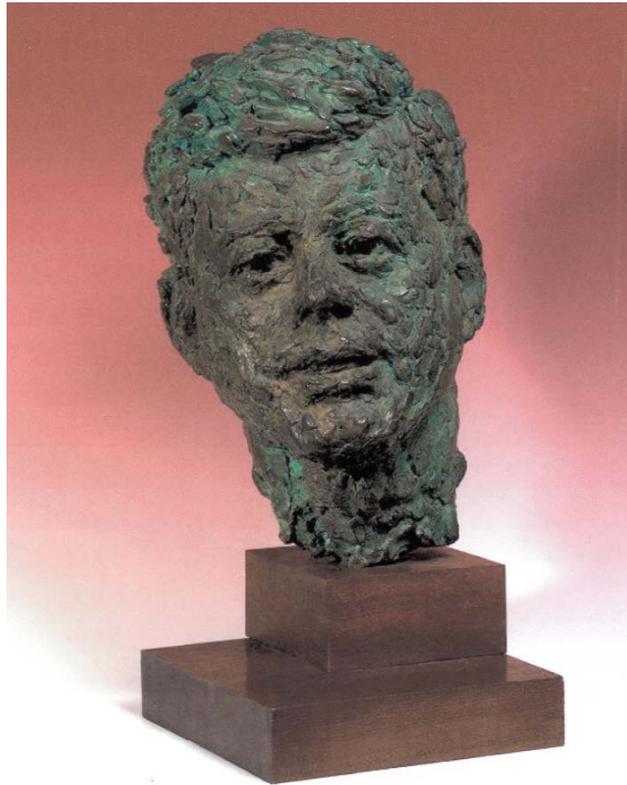


Cornelia Otis Skinner by Gladys Rockmore, During Treatment,  
National Portrait Gallery, Smithsonian Institution

MCI 6270 Sculpture: *Head of John F. Kennedy* by Robert Berks

MCI Staff: Carol A. Grissom, Nicole C. Little, Judy Watson

Berks' s *Bust of John F. Kennedy* was requested for loan by the Secretary of the Department of Interior for his office, and the head of conservation at the National Portrait Gallery was concerned that the highly colored patina on Berks's bust would react adversely in the uncontrolled environment at the Department of Interior. The cast-bronze head generally has a dark brown patina, but its many interstices, which are part of its style, have duller surfaces coated in an irregular pattern of powdery green, red, and rusty orange-colored material. Low magnification did not indicate any active formation of crystals in the green patina, which might suggest the presence of copper chlorides such as the deleterious paratacamite, but copper chlorides are commonly present in solutions used to produce green-colored patinas. X-ray diffraction analysis of a sample was inconclusive, but SEM-EDS analysis clearly showed the presence of chlorides. Thus, it was advised that the head not be lent, since copper chlorides can be activated in the presence of moisture.



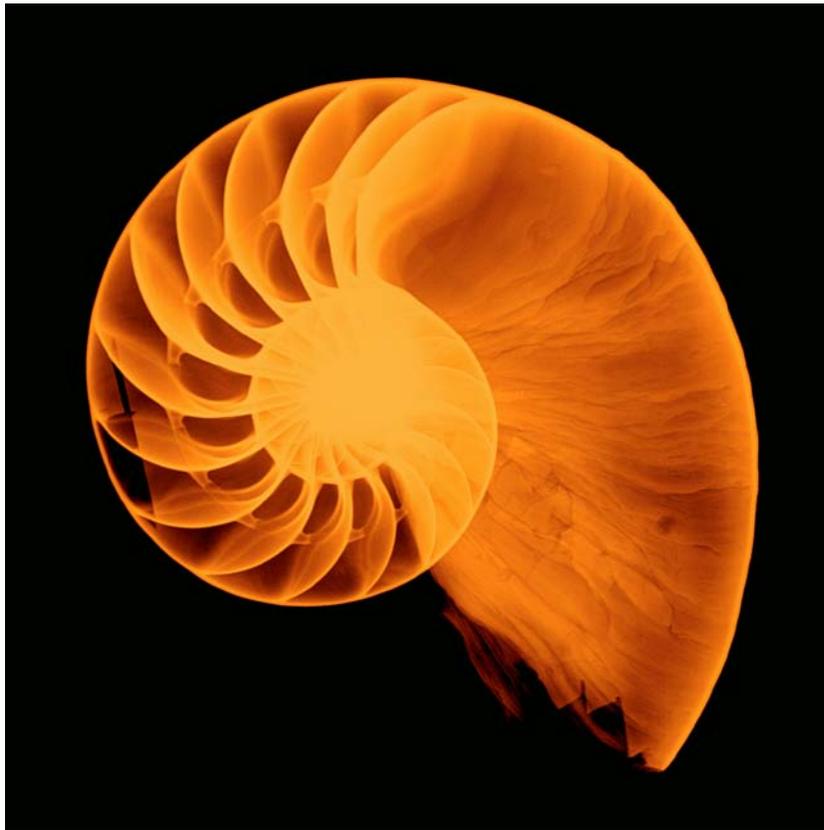
## National Zoological Park

### MCI 6222 *Nautilus pompilius* Shell

MCI Staff: R. Jeff Speakman, Nicole C. Little, Judy Watson, Greg Henkes

A *Nautilus pompilius* shell from a specimen that died in captivity at NZP was analyzed by XRF, XRD, SEM-EDS, ICP-MS, and other appropriate techniques to determine if there were identifiable inorganic chemical differences between the early- and late-growth shell. Organic analyses were incorporated as necessary.

Nautili are a nocturnal species that undergo a daily, vertical migration. In captivity, nautilus require cool-water, dark, and deep, in dedicated aquariums. Even in 'proper' environments, they experience buoyancy problems (they float), and they are unable to properly grow new shell in captivity. In addition, it appears that the mortality rate for captive specimens is quite high. Identifiable chemical differences between the "new" and "old" shell growth may point to/help determine the bigger picture.



## MCI 6285 Bird Feathers

MCI Staff: Nicole C. Little

Twenty one bird feathers were analyzed by ICP-MS to quantify the lead content of birds in urban and rural settings. Although lead content for urban and rural birds has previously been determined by the quantification of blood lead, this study attempted to find a less intrusive way of tracking the spatial distribution of lead in bird populations. Data generated for this project was successfully correlated with previous studies, demonstrating the usefulness of this technique for the analysis of heavy metals in organic materials. ICP-MS results were ultimately combined with stable isotope and blood lead data to facilitate a grant proposal for additional analysis.

## **Office of Exhibits Central**

MCI 6186.2 Exhibition Case Materials

MCI Staff: Jia-sun Tsang

Case materials and sealants were analyzed by Oddy test to retest the off gas behavior and to evaluate the possibility of using these materials and wood sealed with the sealants.

MCI 6189 SI Exhibit: *Classically Greek: Coins and Banknotes from Antiquity to Today*

MCI Staff: Jia-sun Tsang, Ximena Pezoa

The bank notes in this exhibition are from the National Bank of Greece and the coins are from the Welfare Foundation for Social and Cultural Affairs. The culture, history, and mythology of ancient Greece were portrayed in the images on Greek coins and bank notes. These bank notes used for everyday exchange preserved the story about the people, the politics and the power that shaped both ancient and modern Greece

This exhibition was organized by the National Bank of Greece Historical Archives and sponsored by National Bank of Greece, the Benaki Museum at Athens, and the Welfare Foundation for Social and Cultural Affairs (KIKPE), Athens, Greece with assistance from the National Numismatic collection staff at the National Museum of American History, and was coordinated, designed, edited and produced by the Office of Exhibits Central.

The conservator from Greece hand carried objects to DC and the objects were checked for condition and prepared to be mounted and, in preparation for the exhibition at the Smithsonian Castle. OEC requested MCI to interact with Greek conservator to ensure the lender's requirements were met. SI's conservator for the exhibition, provided collection care of coins and worked closely with visiting conservators from Greece to secure local conservation materials and supplies for the mount and encapsulation.



## Smithsonian American Art Museum

MCI 5964 A Statuette after Clark Mills's *Andrew Jackson on Horseback* (latter half of the 19<sup>th</sup> century)

MCI Staff: Carol A. Grissom

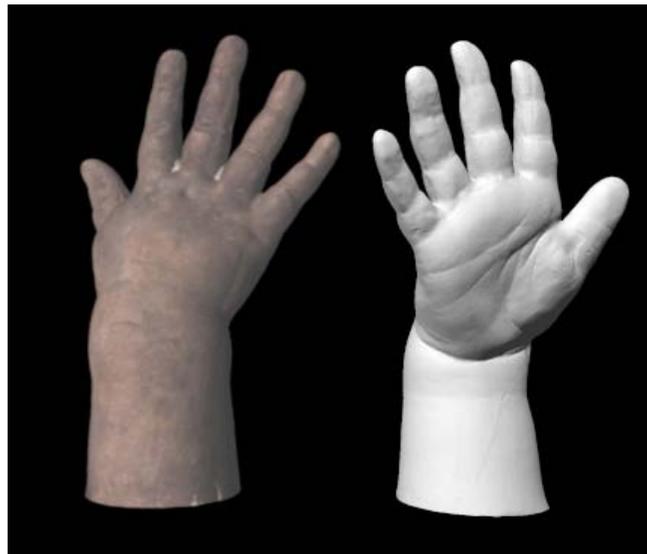
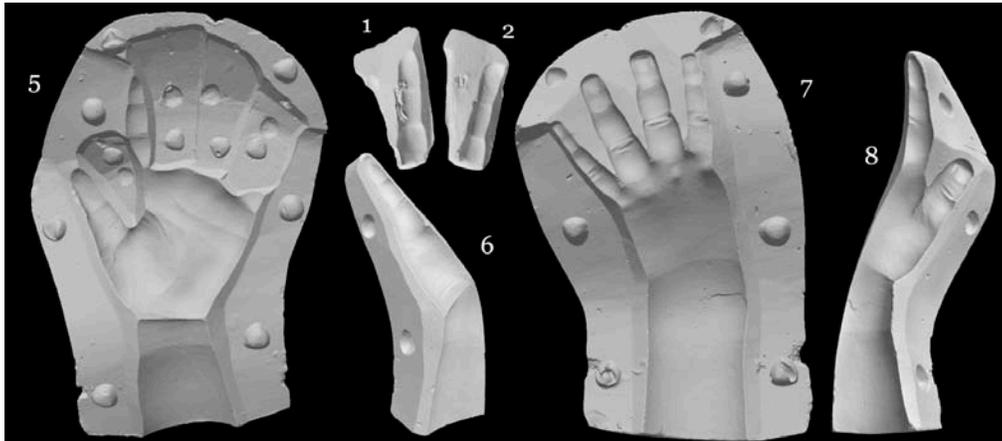
Treatment of this early American cast-zinc statuette consisted of repairing the broken proper right arm so that the statuette could be displayed in the Luce Center when the museum reopened in the Patent Office Building. In preparation for treatment, the statuette was examined in some detail in comparison to a similar statuette owned by the National Portrait Gallery (No. 85.8). The SAAM copy's "bronze" paint appears to be original and in relatively good condition. While it has a smaller base than NPG's copy and lacks an inscription for Cornelius and Baker, close examination revealed that it was made using the same molds since the same mold-based flaws appear on both copies. Comparison of the two copies also revealed many small differences in assembly and finishing. This copy, for example, lacks delineated seams on Jackson's pant legs and jacket sleeves, which the other copy has. The statuette was also X-rayed, showing metal armatures in the horse's legs and metal rods used to attach the horse's tail and legs.



## MCI 6171 Hiram Powers Hand

MCI Staff: Mel J. Wachowiak, B. Vicky Karas

MCI conservators and 3-D imaging specialists scanned a plaster piece mold of a child's hand used by American sculptor Hiram Powers. The purpose was twofold: restore the lost pieces to protect the assembled piece mold, and 2) attempt to recreate the now lost casting. The piece mold is comprised by six components and belongs to the Smithsonian American Art Museum (SAAM). A Breuckmann GmbH, triTos™ scanner, purpose built for heritage scanning, was used to digitize the piece mold ensemble. The lost two lost pieces were digitally restored, and then the virtual cast was created.



## MCI 6208 Marble Columns

MCI Staff: Claire Gervais, Carol A. Grissom, Marion F. Mecklenburg

During renovation of the Patent Office Building prior to the reopening of the Smithsonian American Art Museum in 2006, temporary walls were erected by a contractor between stone columns in the Lincoln Gallery to provide additional wall space for display of artwork. Full-height walls were adhered to original marble columns or pilasters and new marble floor tiles with silicone adhesive. Over “entryways” in temporary walls, by contrast, metal plates were attached to the upper portions of stone columns or pilasters with epoxy resin, and acrylic headers were mechanically attached to the metal plates. When one of these walls in the southern area of the gallery was removed in late 2007, disfiguring white silicone was left on one column and the adjacent floor where the wall had been attached with that adhesive. Detachment of the epoxy-attached metal plate on the other column resulted in removal of a layer of stone crystals embedded in the epoxy, while residues of epoxy were also left on the stone.

After testing, white silicone adhesive residues were removed from the column and floor with poultices containing a proprietary chemical mixture, Amtex-CCR Silicone Dissolver. Residual silicone oils remained on the stone column, however, leaving a dark snake-like pattern where adhesive had been applied. Following test application with dilute resins, including methyl cellulose, Acryloid B-72, Butvar B-98, and Aquazol 50 and 200, a dilute coating of methyl cellulose was applied around the stains to reduce contrast with the stone. Epoxy residues were partially removed from the column with commercial methylene-chloride-based paint stripper. Pencil lines were removed with an eraser from where edges of walls had been, and paint lines were removed with isopropyl alcohol. Experiments were made in the laboratory on the detached metal plate using heat, liquid nitrogen, solvents, and a strong base in order to simulate alternative methods for future removal of metal plates adhered with epoxy.

In future, residues of the white silicone adhesive could be removed with the Amtex-CCR Silicone Dissolver when walls are taken down, although the process is somewhat tedious and odiferous. Remaining stains could be disguised with a dilute coating of methyl cellulose, but advances in silicone stain removal should be investigated at that time. The most promising solution for future removal of epoxy-attached plates is application of heat by induction to allow the epoxy/stone or metal/paint bond to be broken without damaging the stone.



Claire Gervais applying poultices to the silicone adhesive-stained column.

MCI 6258 Sculpture: *Group of Deer* by Paulanship

MCI Staff: Mel J. Wachowiak

On-site 3-D scanning was coordinated with MCI equipment to produce an accurate documentation of the sculpture to prepare for the replication of the sculpture to replace the object in Central Park New York, missing since the 1970s. The SAAM sculpture is too fragile for mold-making. MCI acted as the liaison with data processing specialists and the foundry for the replication of the sculpture.

## MCI 6274 Christo's *Running Fence* Nylon Panel

MCI Staff: Mary W. Ballard, Cathy Zaret, Elizabeth Shuster, Michaela Sousa, Sara Gillies, Lauren Sturdy



*Running Fence* 1976 while installed  
(image:  
<http://www.christojeanneclaude.net/rf.shtml>)

*Running Fence* was an installation piece by Christo prepared between 1972 and 1976, and on display for 14 days in 1976. The piece consisted of 24.5 miles (2050 panels) of undyed heavy woven nylon, 18 feet high, strung on steel cable and poles across Sonoma and Marin Counties, California. The panels were attached to the cables with 350,000 hooks, through grommets affixed to the panels. After the de-installation of the work, all materials were given to the ranchers whose land *Running Fence* had crossed. One panel of this work has since come into the possession of the Smithsonian American Art Museum.

This piece is being prepared for exhibition in early 2010. Upon retrieval from storage visual examination of the fabric revealed blue-green stains that appeared to be transfer stains from the brass grommets. The grommets themselves were coated in a blue-green waxy surface deposit and etching was apparent on the grommet surfaces. Staining occurred whenever there was contact between the nylon and grommets. Before display it was considered desirable to remove these stains as they occurred in storage conditions, unlike the surface soiling which occurred during the outdoor installation period of the work. For aesthetic reasons, so the audience sees the panel not the colored stains, a removal method was sought that would not otherwise impact the visual appearance of the piece.

A method for cleaning the original waxy deposit on the grommets had been determined before consulting on the cleaning of the textile. The goal was to find a time-efficient method for removing the blue-green stains without any visible sign, such as lightening of the nylon at the location of the stain. Both wet and dry-side cleaning agents were tested for efficiency and efficacy, with consideration for economy.



Grommet and adjacent stain before cleaning

MCI 6278 Painting: *Les Clochards, Montmartre, Paris* by Loïs Mailou Jones

MCI Staff: Jia-sun Tsang, Mel J. Wachowiak, Jennifer Giaccai, Judy Watson, Ron H. Cunningham

The painting is undergoing a conservation treatment in preparation for an exhibition loan. The painting will be surface cleaned, and areas of loss will be consolidated, filled, and inpainted by SAAM conservators. It is hoped that the areas sampled will provide material identification that will assist the SAAM conservators in understanding the material techniques used by this artist and provide information which will assist in the preservation, storage, care, and display parameters of this artifact.

The objectives for the samples provided for analysis to the MCI laboratories is to classify any organic and inorganic materials found in the paint and ground layers, and to classify the type of coating applied by the artist. Examination of the painting at SAAM using infra-red reflectography has revealed some compositional changes, such as the painted over letters 'BOUCHE' in the area to the proper left of the seated female. It appears that there may be a separate painting beneath the visible layers. X-radiography will be used to investigate this further, and cross-section analysis will aid in the sequencing identification of paint layers.



MCI 6280 Painting: *Self Portrait* by Lois Mailou Jones

MCI Staff: Jia-sun Tsang, Mel J. Wachowiak, Jennifer Giaccai, Judy Watson

The painting is undergoing a conservation treatment in preparation for an exhibition loan. The painting will be surface cleaned, and areas of loss will be consolidated, filled, and inpainted by SAAM conservators. It is hoped that the areas sampled will provide material identification that will assist the SAAM conservators in understanding the material techniques used by this artist and provide information which will assist in the preservation, storage, care, and display parameters of this artifact.

The primary objective is to identify the coating so we may select the appropriate methods for preservation and protection of the surface, and the secondary objective to investigate the ground and paint composition in order to contribute to the body-of-knowledge on material techniques used by the artist.



## Smithsonian Environmental Research Center

MCI 6263 Terpenes in Spicebush (*Lindera benzoin*) Leaves

MCI Staff: Jennifer Giaccai

Freshly collected leaves of the spicebush were used to determine whether the identity and relative amount of terpenes change in leaves following browse of the plants by white-tailed deer. The GC-MS was used to examine the presence and increase or decrease of terpenes in the spicebush leaves.

## Smithsonian Institution Archives

### MCI 6013 Various Paper Documents and Enclosures

MCI Staff: Nora Lockshin, Walter R. Hopwood, Ron H. Cunningham

Various paper documents and enclosures were sampled from several selected collections in NMNH and SIA. Heavy metal pesticide residues were identified on paper archives associated with natural history collections using non-destructive and rapid technique of energy dispersive X-ray fluorescence (XRF).

### MCI 6246 Leak at Pennsy Drive, SIA

MCI Staff: Jennifer Giaccai

The NMAAHC contract registrars and curator have noted recurrent leaks over collections stored at Pennsy Drive. At least one object, a "Vote Change" corrugated plastic sign from the Obama campaign office NMAAHC (temporary receipt number of TR2008-28), has been directly affected but was able to be wiped clean of the liquid substance without resulting embedded damage. They have brought up the matter repeatedly with OPEC, and are seeking more information. Results will provide support to address potential structural faults in an unmanned collections storage area. Based on the infrared spectra collected, the brown substance collected from the leak appears to be a plant gum. Although no specific source of the plant gum could be determined, this was likely something collected on the route of the water leak between the origin and the collection storage area. X-ray fluorescence analysis of the substance showed mainly elements expected in a plant gum, as well as the presence of chlorine. It is possible the chlorine is indicative of either the source of the leak or another material on the route of the water leak.

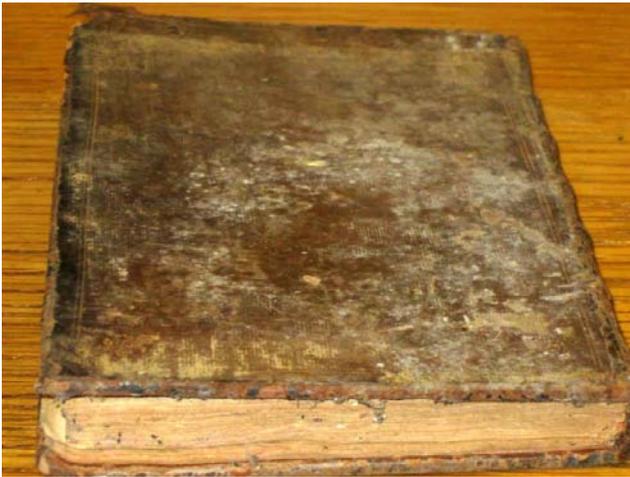


## Smithsonian Institution Libraries

MCI 6259 Book: *A Father's Legacy to his Daughters* by John Gregory

MCI Staff: Mary W. Ballard, Nicole C. Little

The book, *A Father's Legacy to his Daughters*, by John Gregory (1775) was brought to MCI for disinfestations prior to cataloguing. It had pronounced mold and insect frass. The book was bagged and contained in an Argon atmosphere below 0.1% oxygen for 35 days. When the treatment was completed, the book was removed from the Argon atmosphere and vacuumed on the exterior and interior, page by page. All frass and loose debris were removed.



## MCI 6275 Darwin's Neckerchief

MCI Staff: Mary W. Ballard, Cathy Zaret, Elizabeth Shuster

Darwin's scarf is included in exhibition cases entitled *Darwin's Legacy* at the Constitution Avenue entrance of the National Museum of Natural History (by the main entrance to the Library branch at NMNH), from September 10, 2009 to September 12, 2010 . A mount was made for Darwin's scarf using 8 ply rag board and the dark brown twill fabric to be used throughout the exhibition cases. A ¼" pellen envelope was used to pad the surface; the brown exterior fabric was squared into alignment. All layers were sequentially stitched in place. The mount was delivered to a SIL book conservator for installation preparation and review by the Office of Exhibits Central.

As a precaution, the fabric was tested for its stability to crocking and solvents, including water. Crocking is the propensity of a dye to rub off upon an adjacent fabric; both the horizontal, weighted crockmeter that rubs lengthwise and the vertical, weighted crockmeter that rubs in a single, circular spot. The dye and fabric were fast to both treatments. In addition, the fabric proved stable to the following: water (as from a ceiling leak), acetone (a ketone used with nail polish and nail polish remover, old label removal), trichloroethylene (analogue for methylene chloride, solvent in Plexiglas mount manufacture), ethanol (active component in drinks at an soirée), sodium lauryl sulfate (anionic surfactant), and octyl phenyl ethoxylate (used in nonionic surfactant). The fabric did not bleed in a saturated sandwich with any of the above.

It is anticipated that MCI will review and monitor the scarf and, as needed, assist with refolding or adjusting the scarf during the months on exhibition.

## Smithsonian Latino Center

MCI 6173 SI Exhibit: *Spiritual Visions: The Religious Images of Borikén, Puerto Rico*

MCI Staff: Jia-sun Tsang

The Smithsonian Latino Center's (SLC) planned celebration of the 2008 Hispanic Heritage Month was initiated in September 2007 with an exhibition to highlight the culture and accomplishments of Puerto Rico. The plan was to include approximately 70 objects from the George Latimer Collection (acquired by NMNH in 1869) and Teodoro Vidal Collection (acquired by NMAH in 1997), to be displayed in four 4' x 3' cases. A new proposal was written and successfully changed the theme to highlight the posters from NMAH Archives Center. Because of the change, the current exhibit has more objects and more space.



## Smithsonian Tropical Research Institute

MCI 6021 Rock samples from La Pintada Site, Panama

MCI Staff: Harriet (Rae) F. Beaubien, Lynn B. Brostoff

Four rock samples, analyzed at MCI, were collected from the site of La Pintada, near Penonomé, Panamá, which shows evidence of having been a pre-Columbian mining site of some kind. Among its features are a large gallery carved into the vertical face of a rocky outcrop, identified as basalt and tuff by archaeological project members, and a flat platform area in front of the entrance. Tool marks are evident on various surfaces, and various tools that could be used for mining, including hammer stones, have been found there. Pronounced green coloration in the roof area of the chamber has led the researchers to hypothesize that copper was being mined, with some processing taking place on the cleared spaces nearby. If this interpretation is correct, it would be a significant contribution to research that has recently focused on the origins and development of metalworking in pre-Columbian Panamá.

Because mineral products exploited for metal production are often highly colored, these components of the rock samples were of particular interest, especially the green covered fragments flaked from the chamber roof. Unfortunately, they proved not to be copper-bearing as hoped. The green material was identified as green algae, both by the morphological characteristics of the granules, as seen under a microscope, and by the cellular structure apparent at high-magnification. This biological identification was further supported by the absence of a crystalline pattern with X-ray diffraction analysis, the absence of a copper signature by portable X-ray fluorescence spectroscopy, as well as indications of a proteinaceous material by Fourier transform infrared spectroscopy.

That said, there is clearly some ancient mining activity at the site and further investigation is warranted to determine the material for which mining tools, such as hammer stones found at the site, were being used.



The La Pintada site, showing gallery entrance and possible working surface in front and a view of the gallery ceiling's green coloration

## MCI 6223 Volcanic Rocks from Panama

MCI Staff: Nicole C. Little, Agustin Cardona, R. Jeff Speakman, Javier Iñáñez

Major and trace element data were gathered to geochemically characterize volcanic rocks from Panama, tracing the tectonic evolution of the Central American Isthmus. ICP-MS analyses of approximately 200 pulverized rock samples were performed for major and trace element analysis: SiO<sub>2</sub>, TiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, MnO, MgO, CaO, Na<sub>2</sub>O, K<sub>2</sub>O, P<sub>2</sub>O<sub>5</sub> and Sc, V, Co, Ni, Cr, Zn, Rb, Sr, Y, Zr, Nb, Ta, Cd, Cs, Ba, Hf, Pb, Th, U, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Th, Yb, and Lu. Results provided insights on how the composition of the volcanic rocks of the Central American isthmus has changed during the last 70 million years, and how these changes reflect the evolving geological configuration of the margin and the final emergence of the American land bridge.

## MCI 6256 El Caño Archaeological Project : Field Conservation in Panama

MCI Staff: Harriet (Rae) F. Beaubien, Ainslie Harrison, Kim Cullen Cobb

In 2009, conservators from the Smithsonian's Museum Conservation Institute joined the El Caño Archaeological Project to provide conservation assistance and training during excavations in the El Caño Archaeological Park (Coclé Province), as well as the laboratory phase at the Smithsonian Tropical Research Institute in Panama City. Much of the excavated material is funerary in nature and, based on initial stylistic analysis, dates to the Conte period (c.700-950 CE).

During their March-April visit, the two-person conservation team assisted with lifting fragile finds, and carried out micro-excavation of lifted objects, as well as cleaning, consolidation, reconstruction, and re-housing of recently excavated material. A wide range of materials was treated, including gold, copper-alloy, ceramic, bone, and whale tooth. In July-August, working with project researchers at STRI, the conservators treated 17 ceramics originating from a child's burial, which will be a featured display as part of the inaugural exhibit of the Museum of Biodiversity in Panama City. In each phase, the conservators provided advice and training to team members on a variety of conservation topics, including supports for fragile finds to aid lifting, and basic ceramics conservation techniques. In September, a three-person conservation team returned to analyze gold finds from the site, as part of a large-scale MCI study of goldworking in Pre-Columbian Panama. Several gold ornaments found in the child's burial were among nearly 200 finds that were investigated using the non-destructive analytical techniques of optical microscopy, to reveal details of fabrication, and x-ray fluorescence spectroscopy to determine alloy composition.



Ceramics offerings *in situ*, associated with the child burial (Individual 1) in UE087 Tomb 2. The gold plate and bracelets were previously lifted from the central area.



Reconstructed ceramics including small jars and plates from the child's burial

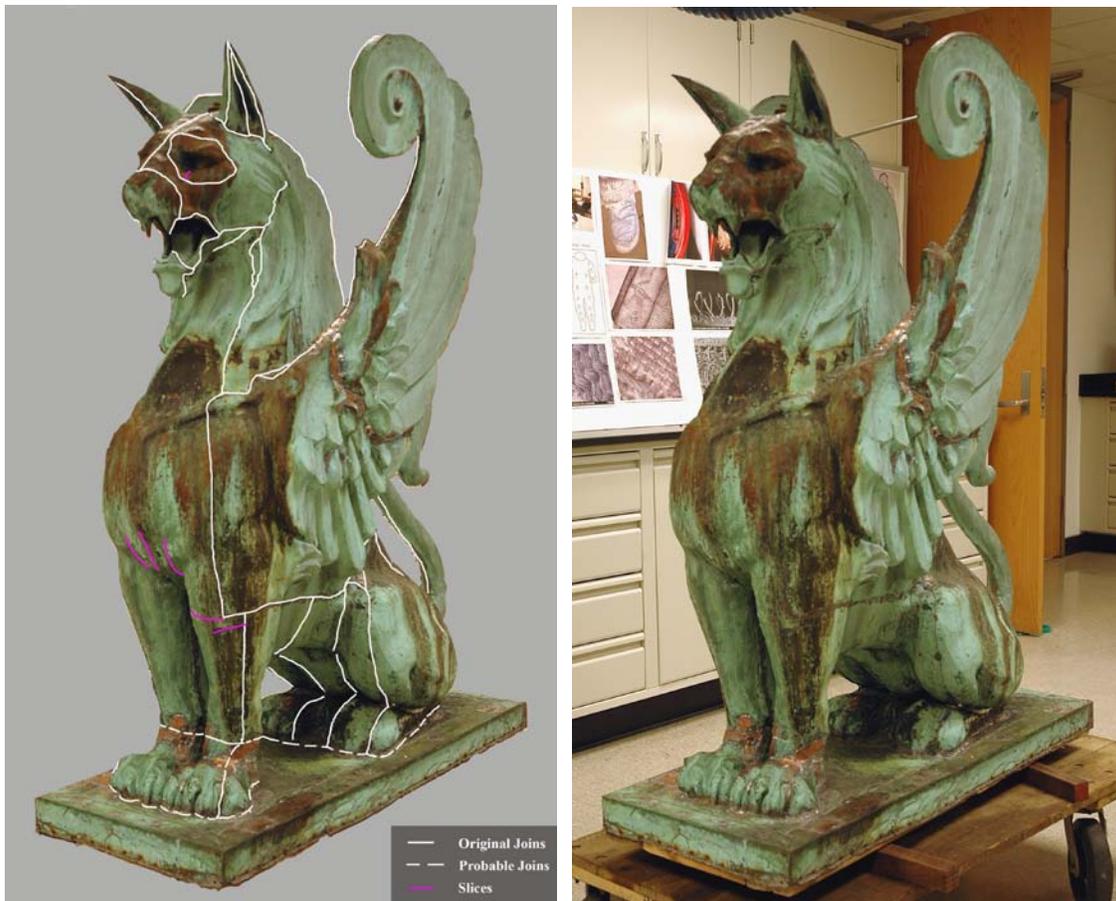


## Corcoran Gallery of Art

MCI 6271 W.H. Mullins Griffin

MCI Staff: Carol A. Grissom, Ron H. Cunningham

A pair of stamped sheet-copper *Griffins*, which had been fabricated by W.H. Mullins and placed on the roof of the Corcoran Gallery of Art in 1901, was examined and X-radiographed as part of a major roof renovation at the museum. Original fabrication was documented, and the sequence of armature installations was determined based on both physical examination and the X-radiography. The condition of armatures to be used as part of lightning rods for the building was determined to be adequate.



## Dumbarton Oaks

### MCI 6266 Five Mayan Shell Objects

MCI Staff: Harriet (Rae) F. Beaubien, Mel J. Wachowiak, Judy Watson

Five accessioned shell objects (6 items) from the Maya Classic period, in the Pre-Columbian collection of Dumbarton Oaks, were examined and documented at MCI by a visiting researcher and shell specialist, in collaboration with MCI staff. The researcher's study focused primarily on toolmarks and other details of manufacture, visible on the shell surfaces. Because only non-invasive methods were permitted by Dumbarton Oaks, the study employed optical microscopy and variable pressure ("environmental") scanning electron microscopy. The images taken of the five pendants (including one matched pair) and a carved ornament will be included in the chapter on shell, in a forthcoming catalog of the Dumbarton Oaks' Maya collection.



**PC.B.543 Carved ornament**

Thumbnail image (courtesy Dumbarton Oaks) and a photomicrograph detail, taken at MCI

## Folger Shakespeare Library

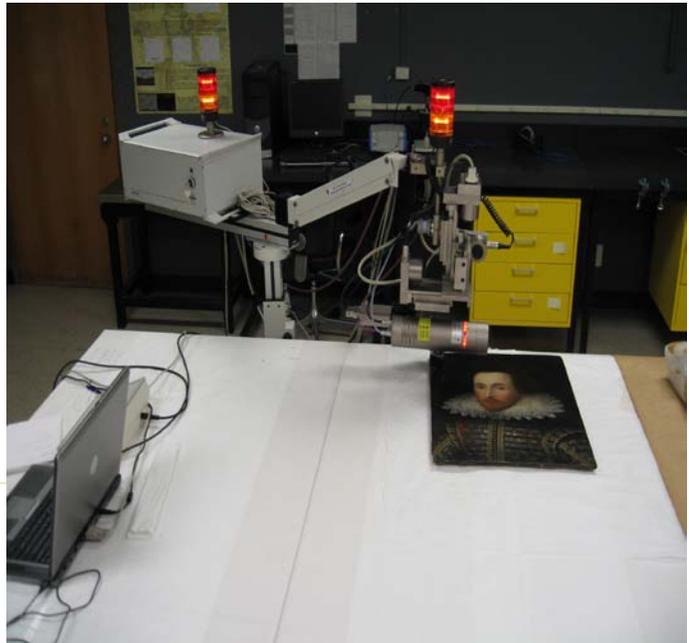
### MCI 6264 Janssen Shakespeare Portrait

MCI Staff: Jennifer Giacciai, Jia-sun Tsang, Mel J. Wachowiak, Judy Watson, Nicole C. Little, Ron H. Cunningham

A technical study of the portrait is underway, including analysis of both the original paint and overpaint. Close examination, UV fluorescence examination, X-radiography, infrared reflectography, wood identification, radiocarbon dating, optical and fluorescence microscopy, SEM imaging, FTIR, XRD, GC-MS, X-ray fluorescence and X-ray fluorescence imaging will all potentially be used to analyze the portrait.



Janssen Portrait (post-1988) Folger Library



## Library of Congress

MCI 6090.1 Malby Globe Stand

MCI Staff: Donald C. Williams

The 1882 Malby and Son globe stand was stabilized and the appearance of the globe stand was conserved for an exhibit in the office of the Vice President of the United States.



## MCI 6090.2 Malby Globe and Stand

MCI Staff: Donald C. Williams, Mel J. Wachowiak, Jia-sun Tsang, R. Jeff Speakman, Michele Pagan, Jennifer Giaccai

The 1882 Malby and Son globe belonging to the Library of Congress was damaged as a result of the OEOB fire in December, 2007. The damage was assessed, the soot encrustation from the surface was removed and analyzed, and the globe was returned to the appearance as before the fire. The globe was returned to the Office of the Vice President (OVP) as part of the permanent exhibit in the newly refurbished (and presumably newly re-refurbished) executive offices of the Vice President of the United States.



## National Park Service

### MCI 6227 Sherman Monument Sword and Statue

MCI Staff: R. Jeff Speakman, Carol A. Grissom, Colby Phillips

A bronze sword confiscated from an auction by the FBI was being considered by the National Park Service as one having been stolen in the early 1950s from the life-size bronze statue of *Artillery* located on the northeast corner of the *General William Tecumseh Sherman Monument* in President's Park in Washington, D.C. Examination of the sword on site indicated that it is too short for the statue. In addition, the pebbly, unweathered and mostly "as cast" surface of the sword, in contrast to the weathered but highly finished surface of a similar sword on the monument's *Cavalry*, also suggests that it is not the lost sword. X-ray fluorescence analyses were conducted to determine if the alloy composition of the sword is consistent with that of *Artillery* and other elements of the monument. The composition of the confiscated sword is not consistent with the composition of the statues proper, but it is not very different from that of *Cavalry*'s sword, which is believed to be original. Hence, XRF results are inconclusive.



## Office of the Architect of the Capitol

### MCI 6183 Statue for Freedom Model

MCI Staff: Carol A. Grissom

The plaster model for the 19½-foot-high bronze statue of *Armed Freedom* atop the U.S. Capitol was cast from a clay model completed by Thomas Crawford in Italy just before his death in 1857. In Washington, D.C., Clark Mills cast the bronze statue in sand from impressions made by the plaster sections, and in 1863 the statue's five bronze sections were bolted together atop the new Capitol dome. In 1993 the model was transported in pieces to the Russell Senate Office Building, where it was reassembled by Capitol staff in the basement-level rotunda adjacent to the subway leading to the Capitol. In 2007 Carol Grissom began advising Curator of the Capitol Barbara Wolanin regarding proposed cutting, transport, and reassembly of the model for display in the new Capitol Visitors Center. Cutting of the statue began in June 2008 under the jurisdiction of the Capitol's Construction Division, and reassembly and painting of the statue were completed at the beginning of September 2008.

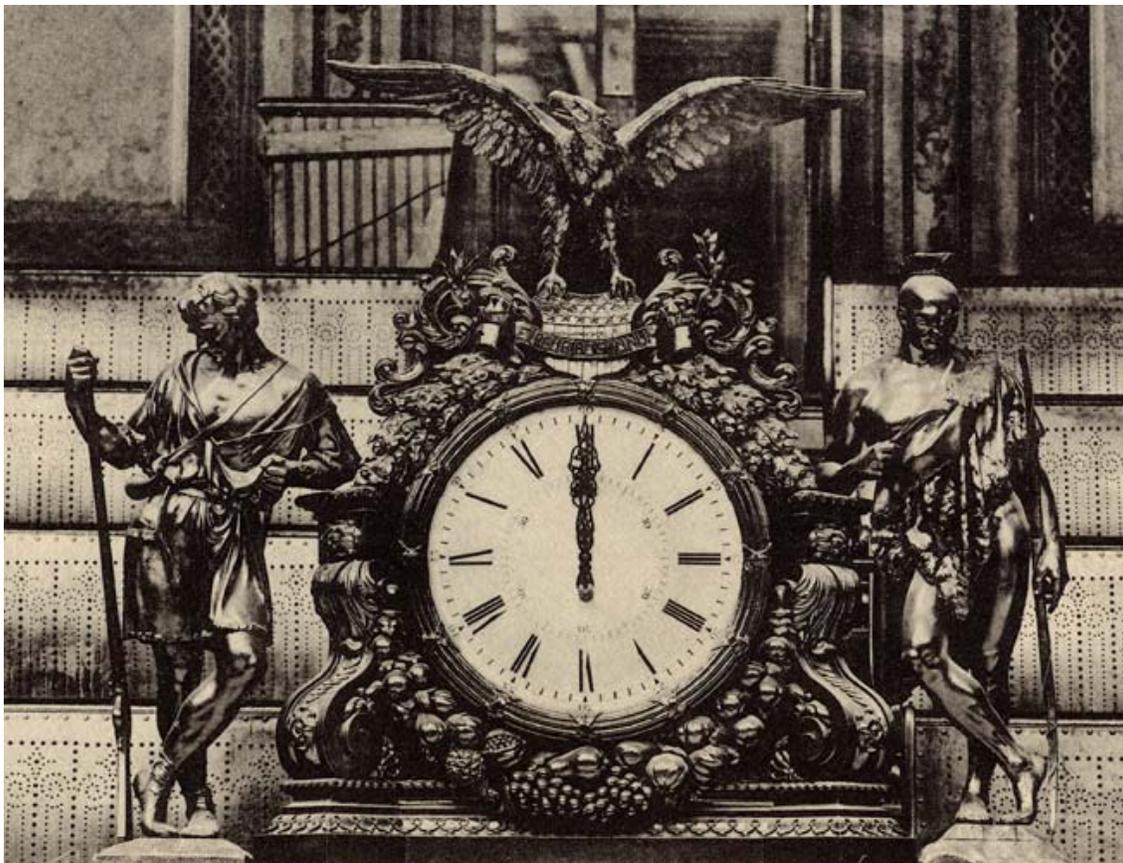


## MCI 6237 Statues: *Pioneer* and *Indian* by William Rinehart Surrounding a Clock Made for the US House of Representatives of the US Capitol

MCI Staff: Carol A. Grissom, R. Jeff Speakman

William Rinehart (1825-74) modeled statues of a *Pioneer* and *Indian* to be placed on either side of a clock for the U.S. House of Representatives. The statues were said to have been cast in bronze by the Philadelphia firm of Cornelius and Baker in 1857. Other copies of Rinehart's statues are known in zinc, however, and Cornelius and Baker specialized in making brass and zinc gasoliers. The company is not otherwise known to have cast statues in bronze, and correspondence about the statues between the Capitol and Cornelius and Baker refers to "bronzing," which normally signifies bronze paint. Hence, the question arose as to whether the clock statues were indeed cast in bronze or might instead have been cast in zinc and painted to imitate bronze, as was more typical for the company.

Non-destructive X-ray fluorescence analyses showed definitively that the statues were indeed cast in bronze, although with a mixture containing more zinc and less tin than the "Antique Bronze" specified by Captain Montgomery Meigs for the clock statues. The company's capacity to cast relatively large bronze statues in 1857 is noteworthy.



## US House of Representatives

### MCI 6072 Mace of the United States

MCI Staff: Donald C. Williams, Carol A. Grissom, J. Corey Smith, Lynn B. Brostoff, B. Vicky Karas, Mel J. Wachowiak, Walter R. Hopwood, Martha Goodway

Continuing a longstanding practice of more than four decades, staff at MCI examined, analyzed, and conserved The Mace of The United States House of Representatives. The Mace normally resides immediately adjacent to The Speaker's dais, and must be present for the House of Representatives to convene. MCI's examination and analysis focused on the aggressive corrosion which had suddenly beset the silver and ebony artifact and the fabrication details during the original manufacturing in 1841. Noteworthy observations included 1) the probable source of the sudden onset of tarnish, and 2) the fabrication method of the hollow silver globe. The conservation treatment dealt with removing the previously applied coating from conservation treatment in 2001, and cleaning, polishing, and re-coating the silver. The conservation of The Mace was featured on C-SPAN, the nation's premier public affairs broadcaster, when they re-broadcast their major documentary, "The Capitol."



## MCI 6254 Taxidermy Specimens at the US House of Representatives

MCI Staff: Don C. Williams, Odile Madden

An on-site examination was conducted of taxidermy specimens, including surface analysis by portable X-ray fluorescence for pesticide residues to determine whether or not the taxidermy artifacts are at any particular or imminent risk, including to visitors. Recommendations for care and handling were provided.

## US Senate

### MCI 6177 Creation of Minimally Invasive Upholstery Prototypes

MCI Staff: Donald C. Williams, Michele Pagan

MCI created a fully functional prototype of minimally invasive upholstery systems for the Office of the Curator, U.S. Senate so that they can instruct their own craft shops in the treatment of historic upholstered pieces in their collection. This involved the treatment of three pieces, two from MCI holdings (one commissioned by us, the other acquired at a flea market) and one piece from the Senate collections.

MCI provided contextual and conceptual examples of treatment options for the decision-making strategies employed in preserving Senate collections. The projects products included: physical examples of minimally invasive upholstery for both exhibit and utilitarian applications, a detailed monograph on the processes used to create the prototypes, which will be used as an instruction manual by the Senate offices and would also be published independent of that application, and a hands-on workshop for/in the Senate craft shops on the techniques, and hopefully a workshop at MCI for professional practitioners as well.



## MCI 6209 Daniel Webster Desk

MCI Staff: Donald C. Williams

Scholarly guidance was provided to the U.S. Senate Curatorial Offices and Cabinet Shop for their replication of the desk reserved for the Senior Senator from New Hampshire (the "Daniel Webster Desk"), considered the most important desk in the well of the Senate. MCI provided information, demonstrations, and education for the Curatorial Offices and the Cabinet Shop artisans in the traditional methods of veneer fabrication and application, and the use of traditional adhesives (animal hide glue) for both veneer work and joinery. MCI worked with the unfinished sample boards provided by the Senate Curator (and other samples), created a series of finish protocols and samples reflecting historical precedents of the early 19th Century U.S. cabinetmaking practices. Once the samples were done, MCI provided demonstration, instruction, and ongoing oversight to Senate cabinet shop staff for the successful completion of the project.

MCI provided visual and informational context regarding craft practices for the creation of historic furniture, especially pertaining to veneered surfaces and transparent finishes. This assisted the Cabinet Shop in making a set of newly constructed desks for the U.S. Senate compatible with existing historic artifacts (the "Daniel Webster" desk currently in the well of the Senate chamber.) The information transmitted to the Senate Cabinet Shop will in turn further their understanding of historic artifacts and their ongoing preservation, restoration, and use of them.

## **The Walters Art Museum**

MCI 6230 Pair of Coronelli Globes

MCI Staff: Don C. Williams

The Coronelli globes were examined to assess any damage and propose recommendations for future care and packing.

MCI 6243 Altarpiece Triptych: *Madonna and Child with the Crucifixion and the Annunciation, the Coronation of the Virgin and the Presentation in the Temple*

MCI Staff: Jennifer Giaccai, Nicole C. Little, Judy Watson

A technical study was undertaken as part of the conservation of the altarpiece triptych and to compare the painting techniques with other Catalan and Italian painters in its time period (14<sup>th</sup> century). FTIR, XRD, GC/MS, and SEM-EDS were used to analyze the samples and cross-sections to determine the binding media, gilding media, and complete pigment identifications.

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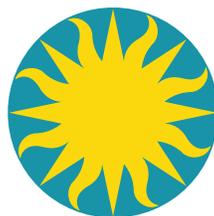
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