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978-1-107-40860-9 - Materials Issues in Art and Archaeology VIII: Materials Research Society  
Symposium Proceedings: Volume 1047

Editors: Pamela B. Vandiver, Blythe McCarthy, Robert H. Tykot, Jose Luis Ruvalcaba-Sil  
and Francesca Casadio

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**MATERIALS RESEARCH SOCIETY  
SYMPOSIUM PROCEEDINGS VOLUME 1047**

**Materials Issues in Art  
and Archaeology VIII**

Symposium held November 26–28, 2007, Boston, Massachusetts, U.S.A.

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\*Invited Paper

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## DEDICATION



Edward V. Sayre



Frederick R. Matson

This volume is dedicated to two pioneers who were close friends, Edward V. Sayre and Frederick R. Matson. Each passed away last year, 2007. Both scholars provided many new insights into the understanding and preservation of artistic and cultural heritage. Both were dedicated to achieving answers to archaeological, artistic and conservation questions through scientific inquiry and interdisciplinary teamwork. Ed Sayre initiated our first Materials Issues in Art and Archaeology conference at the Materials Research Society in 1988. He had at least three careers, first in the Chemistry Department at Brookhaven National Laboratory and teaching at the Institute of Fine Arts, New York University, then as head of the Conservation Laboratory of the Boston Museum of Fine Arts, and lastly as the senior physical scientist at the Conservation Analytical Lab, Smithsonian Institution. Ed Sayre's accomplishments are cited in the volume, *Patterns and Process: A Festschrift in Honor of Dr. Edward V. Sayre*, edited by Lambertus van Zelst (Smithsonian Center for Materials Research and Education, Smithsonian Institution,\* Suitland, Maryland, 2003). In the entertaining first chapter, Professor Fred Matson recollects the first collaborative effort that considered use of neutron activation analysis for the chemical characterization of well-provenanced ceramics. Fred Matson's accomplishments were documented in 2008 by an exhibition entitled "The Ceramic Legacy of Frederick R. Matson" at the Matson Museum of Anthropology, Department of Anthropology, Pennsylvania State University, that was curated by Clare McHale Milner and Tracy Peshoff. Matson's archaeological studies of ceramic provenance using petrography, of ceramic processing and firing, of early glass technology and his ethnographic study of village potters in Southwest Asia and Egypt are legendary, as is the book he edited, *Ceramics and Man* (Wenner-Gren Foundation and Aldine Publishers, 1965)—a book that began the study of "ceramic ecology." Both men were generous with their wisdom, shared wonderful but pointed, heuristic stories, and they mentored many thankful, enlightened students, including several authors in this volume.

\*The Center is now called the Museum Conservation Institute, and the volume is available at no cost from Ann N'Gadi, Information Officer, at [ngadia@si.edu](mailto:ngadia@si.edu).

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## PREFACE

“Materials Issues in Art and Archaeology VIII” is the result of Symposium Y, held November 26–28 at the 2007 MRS Fall Meeting in Boston, Massachusetts. This volume is the eighth in a series, and represents our goal of presenting cutting-edge and interdisciplinary research used to characterize: (1) cultural materials and intangible cultural properties; (2) the technologies of selection, production and use through which materials are transformed into objects and artifacts; (3) the science underlying their deterioration, preservation and conservation; and (4) the development of sensors and tools for non-destructive, in-situ examination of artifacts as well as innovative technology for their characterization. Studies were solicited that use the methods and techniques of materials research to understand degradation and design strategies to promote long-term preservation of material culture and cultural heritage, e.g., works of art, culturally significant artifacts, and archaeological sites and complexes and their environments. Preserving cultural heritage extends beyond artifact preservation. It includes developing a critical understanding of how our predecessors used technology and craft to solve problems of survival and organization and to make the symbols or representations of what was important to them. It discloses patterns of technology-transfer from one field to another and allows us to gain insights into artists’ intentions and processes. It provides evaluation tools and skills such that preservation expectations are based on performance criteria and life histories of the constituent materials.

The call for papers solicited contributions that included a wide range of topics, as follows:

- Materials science applied to promote understanding and long-term preservation of cultural heritage
- Analytical studies of art objects and archaeological artifacts; of particular interest are developments in non-destructive techniques and replicative studies
- Production, microstructure, and performance parallels between ancient materials and processes, and modern technologies, especially surface and nanoscale interactions
- Application of new instrumental techniques to the study and environmental monitoring of art and archaeological materials and to materials for display, storage and transport, including development of new instrumentation and protocols
- Nanotechnology and its impact on conservation treatments and diagnostics

This symposium gave evidence of the proliferation of successful multi-disciplinary collaborations among researchers in museums, universities and laboratories, as well as the interdisciplinary maturity of many researchers whose research has spanned fields of endeavor at a world-class level of expertise and experimentation.

We thank and congratulate the presenters for producing strong contributions to the understanding and safeguarding of our diverse, yet global heritage. Some contributions in this series have reported world-class research, and that research has later been reported in top-quality journals. Other contributions have been the first professional contributions by students or researchers who, for one reason or another, were not able to publish outside their local specialty or country. Thus, this conference always has had a didactic and heuristic function. Of the first-time, pre-doctoral student authors, the editors (without Vandiver) voted to recognize Israel Favela with a special student award at this conference.

We welcome contributions to the next symposium that will be proposed for the 2010 MRS Fall Meeting in Boston. If you intend to submit an abstract and would like to be considered as an invited speaker, or if your topic and research have the potential of high impact in the popular press, please contact Vandiver directly ([Vandiver@mse.arizona.edu](mailto:Vandiver@mse.arizona.edu)) and the group of editors will consider your request. We are interested in organizing a workshop for the next meeting. Please contact us if you are interested in contributing to this workshop with a demonstration, or if you

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have recommendations or suggestions for another successful meeting in Boston. We have thought about presenting a workshop at MIT focusing on the topic of coatings and coverings, colored and decorative, or protective and invisible, including foils, lacquers and others, and would be interested in comments or suggestions on this topic.

Of the thirty-four papers that were presented, twenty-nine are included in this volume, one of which is from a previous meeting. The invited speakers were allotted double time at the conference and double space in the proceedings, and their contributions are noted in the “Contents” with asterisks. Award winning papers are also noted by special symbols. Many of these papers are connected by current research themes and problem orientations in technical art history, archaeological science and conservation science. However, the significance of the papers may be elusive to a non-specialist. To educate students and non-specialists and excite them about our field, MRS spends considerable effort to involve the lay press. Based on the abstracts that conference attendees submitted and our knowledge of the field, we constructed 10 lay abstracts of the conference highlights for the press that answered the question of “Why the press might be interested?” You can read the articles in this volume and make comparisons with our expectations. For the next symposium, we invite you to contextualize your problem and formulate its potential impact on non-specialists by composing and submitting your own lay abstract directly to P. Vandiver.

#### **In the Area of Technical Art History:**

Jennifer Mass and students from the Winterthur Museum and Sculpture Garden:

A valuable painting has been entrusted to analysis at the Cornell High Energy Synchrotron Source. The confocal XRF technique was tested on a synthesized painting with many paint layers, and it was able to non-destructively see into the painting and to differentiate the compositions of the various paint layers. This test study was presented at the last MRS symposium four years ago. The present paper solves a problem of attribution or collaboration between two famous northern Renaissance painters by using this and other analytical techniques to reconstruct the processes of fabrication of the oak panel and the sequence of application of the paint layers.

Katherine Eremin of the Strauss Conservation Center, Harvard University, and Jennifer Giaccai, Walters Art Gallery, each present a paper on Thai painting: No one has ever studied the materials and techniques of Thai painting. Rumor has it that gum from the tamarind tree was used as a medium for the pigments. The harsh tropical conditions in Thailand have prevented preservation of painted works of art much beyond 400 years, unlike the paintings of China and Japan, a few of which have lasted 1300 to 1400 years. Eremin has found a previously unidentified green pigment, a hydrated copper citrate. She synthesized the pigment according to a seventeenth century Venetian recipe, and then she tested the stability and effects of various binders to determine whether the green color was the result of weathering or an intentional colorant. Eremin’s analyses show a change in the palette of pigments that documents the opening of Thailand to pigments imported from further to the west. Giaccai adds further data to track the changes in pigment type and use over time using banner paintings from the Walters collection.

Marc Walton of the Getty Conservation Institute and Getty Villa: Attic Greek ceramic vase painting in the 6<sup>th</sup> to 4<sup>th</sup> centuries BCE consisted of red and black slips, and a rare coral red color, compared in Greek poetry to the color of red wine. Walton analyzes the composition and microstructure using some new, high magnification equipment (FIB/STEM) to reconstruct, for the first time, a special process for the production of the coral red color.

#### **In the Area of Conservation Science and Engineering:**

George Scherer et al., Princeton University: As salts in groundwater rise and precipitate in outdoor stone sculpture, gravestones, and building stones among others, the pores in those stones enlarge and cracks cause the stone to weather and break apart. Scherer presents results of modeling and experimentation that demonstrate both the mechanism and a process to reduce the pressure in the pores below the breaking strength of the stone.

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Rui Chen, and her mentor, Prof. Paul Whitmore, Art Conservation Research Center of Carnegie Mellon: Materials proposed for use in the display of museum objects often outgas and may deteriorate objects unless tested. The authors propose and have made and tested a nano-particled, silver-film sensor that will serve as a proxy, or singing canary, to warn of corrosion or deterioration processes from the proposed material. This sensor works because the silver film is composed of particles in the range of 30 nanometers that react more rapidly than the objects they protect.

#### **In the Areas of Archaeological Science and Reconstructions of Past Technologies:**

Charles Kolb of the National Endowment for the Humanities: This is the first presentation differentiating various ceramic traditions and technologies of northern Afghanistan that were excavated at archaeological sites active in the 4<sup>th</sup> to 2<sup>nd</sup> millennia BCE as the Silk Road was being established as a trade route. These sites were excavated in the 1960s prior to the period of war that has engulfed Afghanistan. Such studies are important to establish our knowledge of Afghan culture and to rebuild Afghan cultural heritage.

Tomoko Katayama of Kyoto University: Five hundred to seven hundred year-old clothes from Mongolia were dated and found to contain gold, copper, iron and lead. The textiles were analyzed nondestructively using synchrotron radiation. The analyses add to our knowledge of the manufacture, use and degradation of textiles by members of the culture of ancient Mongolia in the time of the Mongolian Empire.

Lesley Frame of the University of Arizona: The experimental research involves the first application of modern metallurgical analysis for determination of solidification rates and modeling of process temperature to ancient metallurgy. The study shows that in the second and third millennia BCE at the site of Godin in northwestern Iran, arsenical-bronze and tin-bronze knives were made with a limited range of processing variability to produce functional, well-engineered blades; whereas, pins, bracelets and other decorative objects appreciated for their beauty were made with a wide range of heat treatments. Their use did not mandate as precise processing control, and their variability also indicates the probability of wider knowledge of the processing of bracelets.

Andrew Shortland, Cranfield University; Katherine Eremin and James Armstrong, Harvard University, et al.: Nuzi was a second millennium BCE provincial capital city that is near the Kirkuk oil-fields in northern Iraq. It was excavated in the 1930s and the artifact collection is housed at the Semitic Museum of Harvard University. This study of glass, metal, faience and ceramic technologies is significant because it aims to understand the inter-relationships among these technologies. For instance, the first brass alloys are found at Nuzi, but glass beads are colored blue-green by pure copper, indicating separate streams of raw materials for these two crafts. In addition, analyses of many now-deteriorated objects have established the chemical traces of their original colors and helped to reconstruct their original technologies.

Chandra Reedy, University of Delaware: Just as UNESCO has legislation to designate and preserve World Heritage sites, its new program aims to preserve intangible cultural heritage, such as music, dance, theater, festivals and craft knowledge. Reedy's study documents the modern practices of making Buddhist ritual objects in eastern Tibet, Amdo region (where the present Dalai Lama was born and now part of Sichuan, China), such that we can better understand and preserve both the tangible craft technologies and intangible aspects of decision-based and ritual-based behaviors. Based on study of traditional practices of making ritual objects, barley dough sculptures (*torma*) and unfired votive clay objects (*tsha-tshas*) often covered with a thin foil of gold, we better document and preserve the intangible, knowledge-based elements of cultural heritage. This paper makes a theoretical breakthrough and presents both ethnographic and analytical data.

The MRS science museum exhibition, *Strange Matter*, is still circulating throughout North America, and we recommend that readers see it or visit the MRS website (<http://www.strangematterexhibit.com/>). In particular, the beginning of the exhibition draws parallels between materials engineering in the Bronze Age and the present, and then proceeds to modern wonder of materials, analysis and underlying science.

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We thank the MRS staff for its support. They labor for months to make the meeting progress with flawless organization and order. We appreciate their support of this symposium which probably is the only venue that offers interaction among conservation scientists, archaeological scientists and materials scientists. We wish to thank the participants, the session chairs, the reviewers and our home institutions for their contributions to making this symposium and proceedings a success. We acknowledge the considerable time and effort spent in the review process by Jennifer Giaccai and Michelle Taube.

Pamela B. Vandiver  
Blythe McCarthy  
Robert H. Tykot  
Jose Luis Ruvalcaba-Sil  
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