Art and Cultural Heritage: Reverse Engineering: Art and Cultural Heritage: Reverse Engineering I
Program Organizers: Glenn Gates, Walters Art Museum; John McCloy, Washington State University

Wednesday 8:00 AM
October 17, 2018
Room: B232
Location: Greater Columbus Convention Center

Session Chair: Jamie Weaver, NIST; Marie Jackson, University of Utah

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8:00 AM Invited
Conservation of Historical Coin from 1853 Rescued in the Fortin Villa 25 de Mayo-Mendoza: *Patricia Carrizo*[1]; [1]Universidad Tecnológica Nacional Regional Mendoza(UTNFRM)

This article deals with the cleaning treatment of an old copper coin (1853) and the conservation problems. The objective of the research was to study metallographically the coin found in archaeological rescue in fort of villa may 25 in san rafael, mendoza and apply an appropriate method of cleaning and subsequent conservation of it. To achieve this, first, the composition of the metal is analyzed with x-ray fluorescence equipment, subsequent study of micro hardness and the material was studied by means of FTIR equipment and finally metallografic studies was carried on. Then the coin was cleaned in an electrolytic cell, the adequate oxidation potential of the sacrificial anode to be combined with the coin material was studied, a good practical and economical cleaning method was found. Finally, an additional work is done for its conservation and exhibition in the museum.

8:20 AM Cancelled
Degradation Makers of Cellulose Acetate during Aging: *Liu Liu*[1]; Lukasz Bratasz[2]; [1]Northwestern Polytechnical University; [2]Yale Institute for the Preservation of Cultural Heritage

CA (cellulose acetate) is a material that was used extensively in the 20th century by the film industry as well as by artists to create fine and decorative art. Compared with traditional material used in cultural heritage, cellulose acetate is a chemically unstable material resulting in shrinkage and deformation even at room temperature. The material may has suffered from severely degradation when visible changes are found. Modern scientific methods such as SEM, FTIR, GPC and XRD are hired to explain degradation makers of cellulose acetate, providing support in the aspect of evaluation of degradation of cellulose acetate. For the first time, a systemic research has been applied to investigate degradation makers, the results offer scientific support for cellulose acetate research as well as related micro-climate design.

8:40 AM
Natural fibers from the Colombian Amazonia as Cultural Materials: *Henry Colorado*[1]; [1]Universidad De Antioquia

This investigation present results about the use of four natural fibers used in the Colombian Amazonia, particularly from the Guainia State. This and other regions have been poorly explored because there was a large scale conflict in the area, which has recently finalized. Indigenous people have been using these fibers for millenniums in many used that includes weapons, food preparation, ornaments, bags, and many others presented here. Particular attention is given to the fibers potentially for engineering applications. These natural materials were studied with scanning electron microscopy and X-ray diffraction techniques. Tensile tests and fiber stability are also presented.

9:00 AM Invited
Archeometallurgy, Heritage and Preservation of Iron Bridge over Mendoza River: *Patricia Carrizo*[1]; [1]Universidad Tecnológica Nacional Regional Mendoza(UTNFRM)

The present work arises from the intention on the part of the Town Hall of Luján de Cuyo, Mendoza, Argentina to preserve the Iron Bridge (1898) previously declared as a cultural heritage, which is in full use being an important means of communication. It consists of seven sections of 40.6 m each and distances of the main

beams is 5.80 m. The metallographic studies confirm that the structure of the bridge is made of forged iron, the chemical composition, thickness measurement, hardness was determined. The corresponding traction and Charpy tests were carried out for the exhaustive characterization of the bridge manufacturing material. His survey allowed to observe the state of conservation, evaluation of the corrosive state. This work deals with the tasks carried out for its Preservation, from the corrosive state to the welding or replacement with similar material and the protocol of surface preparation and painting of the same.

9:20 AM

Moisture Expansion of Porcelain: *William Carty*[1]; Duncan Martin[1]; [1]Alfred University

It is widely accepted that porcelain is unaffected by humidity. This study examines the moisture expansion behavior of four porcelain compositions fired to produce a range of porosities. Samples were evaluated under ambient humidity conditions (50-98% RH for up to 1.5 years) and in accelerated cyclic autoclave tests (275psi for up to 5 hours) with linear expansion measured periodically. Expansion increases linearly with the log of exposure time in both experiments (ambient and autoclave). The results indicate that autoclave conditions appear to approximate 30-100 years in ambient conditions. Porosity and flux level have the greatest contribution to moisture expansion in porcelain bodies.

9:40 AM Keynote

Numbered Jun Ware: Colors and Origins: *Lucy Cooper*[1]; Katherine Eremin[1]; Susan Costello[1]; Jules Gardener[2]; Stephan Kraemer[2]; Marc Walton[3]; Emeline Pouyet[3]; Laure Dussubieux[4]; Andrew Shortland[5]; [1]Harvard Art Museums; [2]Harvard Center for Nanoscale Systems; [3]Northwestern University Art Institute of Chicago Center for Scientific Studies in the Arts; [4]Field Museum; [5]Cranfield Forensic Institute

Numbered Jun is a rare northern Chinese stoneware specially made for the Imperial Court in Beijing, probably in the early Ming period (15th century). Pieces have monochrome blue or purple, derived from blue and red, glazes which have an intriguing chemistry. Analysis was undertaken of examples in the Harvard Art Museums' collection. Following initial non-destructive analysis, several vessels were sampled. A combination of micro- and nano-scale techniques were used to characterize phase morphologies and composition.The red and blue glazes of 'Purple' Numbered Jun are chemically very similar and copper is present in both. The roles of copper and iron species and liquid-liquid phase separation during firing were investigated. The red glaze areas were found to contain nanoparticles of metallic copper which form uniquely in one of the glassy phases.Data was compared with shards excavated from known kiln sites, suggesting the production site for some of the Museums' pieces.

10:20 AM Break

10:40 AM Invited

Viscous Flow of Medieval Cathedral Glass: *John Mauro*[1]; Ozgur Gulbiten[2]; Xiaoju Guo[2]; Olus Boratav[2]; [1]The Pennsylvania State University; [2]Corning Incorporated

A popular urban legend concerns the apparent flow of stained glass windows in medieval cathedrals, where the glass windows are commonly observed to be thicker at the bottom than they are at the top. Advances in glass transition theory and experimental characterization techniques now allow for us to address this urban legend directly. In this work, we investigate the dynamics of a typical medieval glass composition used in Westminster Abbey. Despite a significantly lower value of the room temperature viscosity found compared to previous studies, the viscosity of the glass is much too high to observe measurable viscous flow on a human time scale. We also use analytical expressions to describe the glass flow over a wall, calculating a maximum flow of ~1 nm over a billion years.

11:20 AM

The Lost Craftsmanship of the Cheapside Hoard: *Ann-Marie Carey*[1]; Keith Adcock[1]; [1]School of Jewellery

The Cheapside Hoard is a fragile collection of over 500 precious artefacts, an incredible time capsule of 17th century craftsmanship. The Museum of London sought to answer a simple but reoccurring question – How were they made? Deciphering the craftsmanship hidden within was fundamental to the research. A team of curators,

historians, conservators, metallurgist, CAD technologist and jewellers were brought together in a collaborative project between the Museum of London and the School of Jewellery Birmingham City University.Data collection required a non-invasive approach, combining craftsmanship enquiry, laser scanning, endoscope and digital photos. Artefacts were read by craftspeople not as finished objects, but a schedule of manufacture. Each layer of construction interrogated for witness marks of manufacture alluding to fabrication techniques hidden beneath the surface. CAD provided the virtual framework to analysis the scan data, interpret the findings, and allow for further downstream activities combining 3D printing and current craftsmanship.

Art and Cultural Heritage: Reverse Engineering: Art and Cultural Heritage: Reverse Engineering II
Program Organizers: Glenn Gates, Walters Art Museum; John McCloy, Washington State University

Wednesday 2:00 PM
October 17, 2018
Room: B232
Location: Greater Columbus Convention Center

Session Chair: Glenn Gates, Walters Art Museum

2:00 PM Invited

Experimental Confirmation of Rock Melting in Iron Age Swedish Vitrified Hillfort: *John McCloy*[1]; Jose Marcial[1]; Mahmood Abusamha[1]; Carolyn Pearce[2]; Michael Schweiger[2]; Jarrod Crum[2]; Connor Appel[2]; Jack Clare[3]; Jamie Weaver[4]; Rolf Sjöblom[5]; Erik Ogenhall[6]; Eva Hjärthner-Holdar[6]; Mia Englund[6]; Albert Kruger[7]; [1]Washington State Univ; [2]Pacific Northwest National Laboratory; [3]University of Sheffield; [4]National Institute of Standards & Technology; [5]Luleå University of Technology; [6]Arkeologerna; [7]Department of Energy - Office of River Protection

In Pre-Viking Iron Age Sweden, ancient materials engineers consolidated fort walls by melting metamorphic amphibolite rock along with locally available granitic gneiss rocks. This practice may have been carried out by placing wood and charcoal in "firing holes" on opposite sides of ~3 x 1 meter "boxes" which are still visible today. This talk will describe the 2017 archaeological excavations at Broborg hillfort and recent experimental work to replicate the rock melting practices. The unique geology of Broborg is discussed compared to geologies where other vitrified hillforts are found. The important archaeological significance of the high temperatures required to vitrify the Broborg amphibolite is noted, in reference to additional experimental work on granite and basalt melting and phase evolution as a function of temperature. Other ongoing work to understand the environmental impacts on the Hillfort glass and the implications for nuclear waste glass long term stability are also briefly discussed.

2:40 PM Invited

Sifting the Past From Over a 1000 Years of Alteration: *Jamie Weaver*[1]; Rolf Sjöblom[2]; Carolyn Pearce[3]; Joseph Ryan[3]; Edgar Buck[3]; John McCloy[4]; David Peeler[3]; [1]National Institute of Standards and Technology; [2]Luleå University of Technology; [3]Pacific Northwest National Laboratory; [4]Washington State University

A challenge to historical reconstruction science is the separation of original construction materials from materials created due to alteration. However, it is both necessary and important to develop an accurate hypothesis of what materials were used to construct a site. The identification of alteration products and their sources can also be beneficial as they are signatures of environmental and anthropogenic changes to a site. This presentation will provide a brief overview of biotic and abiotic alteration processes that can occur on silicate glasses that have been naturally altered, and how the identified products can be key to developing a better understanding of the history of an archaeological site. Case studies of altered glasses collected from an ancient Roman shipwreck and a pre-Viking hillfort will be discussed. Analysis of both glasses required consilience between scientific and humanistic fields, and the development of interdisciplinary methods that have been underused in durability science.

3:20 PM Break

3:40 PM Invited

Principles of Roman Cementitious Systems in Architectural and Marine Concretes: *Marie Jackson*[1]; Juhyuk Moon[2]; Heng Chen[3]; Yi Zhang[4]; [1]University of Utah; [2]Seoul National University; [3]Southeast University; [4]National University of Singapore

In late 1st century BCE, Roman engineers defined foundational principles and installation procedures for high

performance architectural and marine concretes. Reverse engineering of the mortars of these materials indicate that reaction of glassy, alkali-rich volcanic tephra with high calcium quicklime created resilient calcium-aluminum-silicate-hydrate (C-A-S-H) cementing binder, through hydration with fresh water and Alban Hills scoriae in architectural concretes, or seawater and Gulf of Naples pumice in marine concretes. Portlandite (Ca(OH)2) was rapidly consumed in mortar reproductions, within about 90 days in the architectural mortar and 6 months in the marine mortar. Studies of ancient mortars indicate that strätlingite, zeolite, and Al-tobermorite cements then crystallized in vesicles, interfacial zones, and pores in the cementing matrix. The mineral cements apparently precipitated from supersaturated fluids derived from floods, ground water, and seawater that percolated through the porous structures and dissolved glass and crystals, becoming progressively more alkaline. Later alteration of cementitious phases then produced calcite and vaterite. Initial pozzolanic cementitious processes requiring high energy input transformed to energetically self-sustaining post-pozzolanic cementitious processes involving authigenic mineral cycling in chemically dynamic microenvironments. Roman natural scientists described these energetic processes.

4:20 PM

Using Trace Element Ratios to Establish Provenance of Brick and Terra Cotta: *Emily Steiner*[1]; Pippa Merrick[2]; Susan Tunick[3]; Kathryn Tierney[4]; Hyojin Lee[1]; William Carty[1]; [1]New York State College of Ceramics at Alfred University; [2]Historical Hillsborough Research Group; [3]Friends of Terra Cotta; [4]Boston Valley Terra Cotta

Determining the provenance of manufactured ceramics is of considerable interest. It is proposed that the ratios of trace elements correlate between fired and source/green samples of similar provenance. Trace element selection is based on three criteria: detection resolution, limited solubility of the oxide in water, and limited isomorphic substitution. Four elements meet these criteria: La, Ce, Sm and Gd. Green and unfired terra cotta samples established statistical reliability. The elemental ratios of brick (31 brick, 10 raw clay) and historical terra cotta (11 samples) were evaluated. Of the 11 terra cotta samples, eight were grouped tightly indicating they were likely manufactured by the same company. Of the brick samples, they fell into broader groups with less distinct correlations likely due to variations in the raw clay deposit. This technique has potential for development as an analytical tool to evaluate provenance of historical samples.

4:40 PM Invited

Deriving History from Isolated Late Classic Maya Ceramic Vessels: *Ronald Bishop*[1]; [1]NMNH-Smithsonian Institution

Late Classic (ca 600-850 AD) Maya ceramic vessels occupy prominent displays in many local, national and international museums. They are resplendent as representatives of ancient artistic excellence with their elaborate elite polychrome imagery of palace scenes, dancers, rulers, and hieroglyphic texts. For 40 years an intensive program of neutron activation analysis has focused on the development and circulation of pottery for the investigation of social, economic and political relationships among Maya polities. The accumulated analytical data base provides a compositional background onto which the chemical patterns of the museum vessels can be projected that allows vessel to vessel relationships to be gleaned relative to a geographical perspective. When attributed to a variably delimited area of the Maya lowlands, the visual informational context of the vessels can be used to evolve an objectively-based Maya history.

5:20 PM Invited

Analysis of Inorganic Pigments in Unknown Paintings by Painter Fernando Fader through X-ray Fluorescence (XRF): *Patricia Carrizo*[1]; Cristian Aguilera[1]; Julio Ortigala[1]; [1]Universidad Tecnológica Nacional Regional Mendoza(UTNFRM)

Since the last decades of the last century, non-invasive and portable analytical techniques have been developed for the study of patrimonial works. One of the techniques that have evolved is the fluorescence of x-rays. It is a procedure to be carried out at the moment of carrying out a study prior to an intervention or an authentication of a work of art. It was possible to identify the pigments used in pictorial works known by the Argentine painter Fernando Fader and which served to make the corresponding contrast of a variety of unknown works recently found on the walls of the Museum Fader's House. The test study of hypothesis of difference of means between the different chemical elements read by XRF showed for reds and blues there is no significant difference with a

level of significance of 0.05 and a value of p greater than 0.2
