Art and Cultural Heritage: Discoveries and Education: Art and Cultural Heritage: Discoveries and Education

Sponsored by: ACerS Art, Archaeology, and Conservation Science Division
Program Organizers: Glenn Gates, Walters Art Museum; Marie Jackson, University of Utah

Wednesday 2:00 PM
November 4, 2020
Room: Virtual Meeting Room 10
Location: MS&T Virtual

Session Chair: Glenn Gates, Walters Art Museum

2:00 PM

Introductory Comments: Art and Cultural Heritage: *Glenn Gates*[1]; [1]Walters Art Museum
Introductory Comments

2:05 PM Invited

ACerS-AACS Shepard Award: Small Steps, Occasional Leaps, Significant Backslides: Ceramic Compositional Analysis in an Americanist Archaeological Perspective: *Ronald Bishop*[1]; [1]Smithsonian Institution; NIST National Center for Neutron Research

Archaeology is exploratory discipline in which contributions by the physical and chemical sciences have provided data that allows inferences to be made regarding the stability, change, and circulation of ceramic materials, leading to new understandings of past societal interactions. This presentation highlights developmental stages in the use of compositional analysis. I explore the role of Anna O. Shepard as a leading voice calling for the acquisition of petrographic data and how that data should be used. In particular, I underscore her importance in my ongoing research at the Maya site of Palenque, Chiapas, Mexico. Beyond Shepard, I consider the contributions of neutron activation analysis, an investigatory tool the emerged of importance second only to that of radiocarbon dating. Shepard's approach, neutron activation, and advances in data mining techniques informed by geochemical understanding are illustrated in the exploration of ceramic development in the volcanic landscape of prehistoric Nicaragua. I conclude with an idiosyncratic perspective on the development of ceramic compositional analysis and what I see as hindrances to that development.

2:45 PM

Adsorption on Kaolinite Surfaces: A Density Functional Theory (DFT) Approach to Quantifying Interactions Between a Clay Mineral and Small Molecules: *Jessica Heimann*[1]; Joseph Bennett[1]; Zeev Rosenzweig[1]; [1]University of Maryland, Baltimore County

Kaolinite [$Al_2Si_2O_5(OH)_4$] is a mineral formed from repeating layers of tetrahedral silica linked to octahedral alumina. Throughout history, this clay mineral has been used in a wide range of applications including cosmetics, ceramics, and as a constituent in fuller's earth. The duality of kaolinite as the main component in porcelain vs. as an absorbent for oils and fatty acids leads to an interesting question: "How does one clean a material (in, for example, an unfired porcelain object) that removes oil and grease from other materials?" In this work, we aim to address this question by using density functional theory (DFT) to probe pH-dependent interactions between native or dehydrated kaolinite and a series of small molecules and organics. The results of this study provide insight into not only the mechanism of detergent adsorption, but also the effects of adsorption on surface properties (e.g. a change in susceptibility to further adsorbate binding).

3:25 PM

An Unusual Green Pigment in a Korean Temple Banner: *Christina Bisulca*[1]; Christopher Foster[1]; Katherine Kasdorf[1]; Zhongrui (Jerry) Li[2]; [1]Detroit Institute of Arts; [2]University of Michigan

The Detroit Institute of Arts is undertaking a technical analysis of a large Korean temple banner, Ksitigarbha

as Supreme Lord of the Underworld, dated to the early 18th century. The silk support is deteriorated, and appears embrittled with large fractures which in some areas has led to total loss. Silk damage occurs in specific motifs, all of which are associated with green pigment. Based on analysis, areas with severe silk deterioration are associated with a green copper chloride pigment whereas stable green areas are painted with malachite. This green copper chloride contained primarily atacamite, botallackite, and copper oxalate based on x-ray diffraction. Botallackite, an unstable copper chloride, is not commonly used as a pigment but has been found in other Asian paintings and polychromy. It is believed to be synthetic based on morphology in scanning electron microscopy. The deterioration of silk caused by this pigment mixture is under ongoing investigation.

4:05 PM

Naturally Altered Glass: Methods and Challenges of Modeling Long-term Glass Alteration Environments: *Jamie Weaver*[1]; [1]National Institute of Standards and Technology

Glass artifacts can be exposed to natural environments for extended periods of time before being accessioned into a collection. This exposure can alter a glass surface and near-surface volume, a feature which can make the development of a long-term storage and stabilization plan challenging. Gaining an understanding of what could have contributed to the alteration layers' formation (i.e. agents of change) as well as both the resulting structure and chemistry of the layer(s) may help streamline this planning process. In this presentation, a reverse engineering approach for natural glass alteration environments that accounts for biotic and abiotic alteration agents will be outlined. Current models of glass alteration will be discussed and placed in the context of cultural property risk assessment methods. Challenges and successes of applying these methods will be presented along with examples of execution as relating to two case studies: ancient Roman and pre-Viking hillfort glasses.

4:45 PM

Compositional and Structural Analysis of Early Chinese Currencies: Michael Wall[1]; Joseph McCool[1]; Caroline White[1]; Yuheng Wang[1]; *Marcus Young*[1]; [1]University of North Texas

Non-destructive analysis using synchrotron radiation X-ray diffraction and scanning electron microscopy with energy dispersive spectroscopy was performed to determine the composition and structure of various ancient Chinese currencies, including one Knife Money coin from the Zhou Dynasty and twelve square-holed coins from the Tang and Song Dynasties, is presented. The currency was generally found to be composed of primarily a Cu-based alloy with small amounts of Pb and Sn and trace amounts of other elements and oxides. The main phase present in all the coins is an FCC Cu-based alloy along with FCC reflections from the traces of Pb. The immiscible Pb within these Cu-based alloys was found to be distributed as small globules or islands ranging between 10-80 ìm and scattered throughout the Cu-based matrix. Results from this study are compared with results on similar coins in the same Dynasty periods.

5:25 PM

Cementitious Systems in Roman Reactive Glass Marine Concretes: *Marie Jackson*[1]; Cory Trivelpiece[2]; Nanfei Cheng[1]; Barbara Nash[1]; Nobumichi Tamura[3]; [1]University of Utah; [2]Savannah River National Laboratory; [3]Advanced Light Source

The beneficial corrosion of reactive volcanic glass in the pumiceous pozzolan of ancient Roman marine concretes produces cementitious systems that have maintained cohesion and resilience for two millennia. Long after hydrated lime ($Ca(OH)_2$) was fully consumed through pozzolanic reaction, fluids percolating through the concrete structures dissolved residual alkali-rich volcanic glass and crystals in the pumice. Post-pozzolanic mineral cements, mainly phillipsite and Al-tobermorite, crystallized from these fluids -- refining pore space, repairing fracture surfaces, and preserving chemical resilience by incorporating cations and anions in their crystal lattices. Micrometer-scale maps of pumice clasts from the *Portus Cosanus* (1st C BCE), *Baianus Sinus* (ca. 55 BCE), *Caesarea* (30 BCE), and *Portus Neronis* (60 CE) concretes with synchrotron X-ray microdiffraction and microfluorescence experiments describe these post-pozzolanic cementitious fabrics. Results of parallel dissolution experiments with Campi Flegrei pumice in diverse solutions provide a geochemical framework for understanding hydrological processes in the ancient maritime concrete structures.