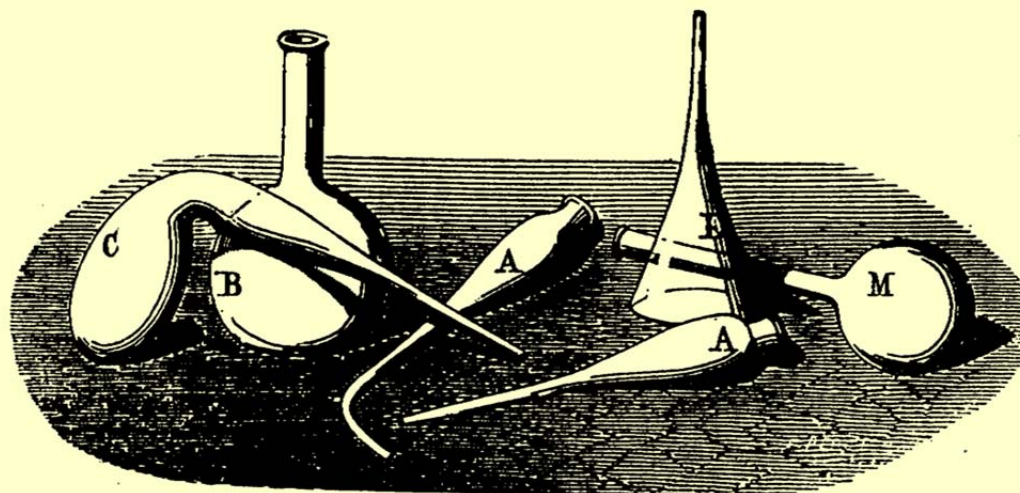




American Chemical Society
**DIVISION OF THE
HISTORY OF CHEMISTRY**



PROGRAM AND ABSTRACTS

245th ACS National Meeting
New Orleans, LA
April 7-11, 2013

S. C. Rasmussen, Program Chair
DIVISION OF THE HISTORY OF CHEMISTRY

Chair: Ned D. Heindel
Lehigh University
Department of Chemistry
Seeley G. Mudd Lab
Bethlehem, PA. 18015
Phone: (610) 758-3464
Fax: (610) 758-3461
Email: ndh0@lehigh.edu

Chair-Elect: Gary Patterson
Department of Chemistry
Carnegie Mellon University
Pittsburgh, PA 15213
Phone: (412) 268-3324
Fax: (412) 268-1061
Email: gp9a@andrew.cmu.edu

Past Chair: E. Thomas Strom
Department of Chemistry and Biochemistry
University of Texas at Arlington
P. O. Box 19065
Arlington, TX 76019-0065
Phone: (817) 272-5441
Fax: (817) 272-3808
Email: tomstrom@juno.com

Secretary-Treasurer: Vera V. Mainz
2709 Holcomb Drive
Urbana, IL 61802
Phone: (217) 328-6158
Email: mainz@illinois.edu

Program Chair: Seth C. Rasmussen
Department of Chemistry and Biochemistry
North Dakota State University
NDSU Dept. 2735, P.O Box 6050
Fargo, ND 58108-6050
Phone: (701) 231-8747
Fax: (701) 231-8831
Email: seth.rasmussen@ndsu.edu

Bulletin Editor: Carmen J. Giunta
Le Moyne College
1419 Salt Springs Rd.
Syracuse, NY 13214-1399
Phone: (315) 445-4128
Fax: (315) 445-4540
Email: giunta@lemoyne.edu

Councilor: Mary Virginia Orna
Department of Chemistry
College of New Rochelle
New Rochelle, NY 10805
Phone: (914) 654-5302
Fax: (914) 654-5387
Email: mvorna@cnr.edu

Councilor: Roger A. Egolf
Pennsylvania State University - Lehigh Valley
Campus, 2809 Saucon Valley Road
Center Valley, PA 18034
Phone: (610) 285-5110
Fax: (610) 285-5220
Email: rae4@psu.edu

Alternate Councilor: Joe Jeffers
Ouachita Baptist University
410 Ouachita Street, Box 3786
Arkadelphia, AR 71998-0001
Phone: (870) 245-5216
Fax: (870) 245-5241
Email: jeffers@obu.edu

Alternate Councilor: Arthur Greenberg
Department of Chemistry
University of New Hampshire
Parsons Hall
Durham, New Hampshire 03824
Phone: 603 862-1180
Fax: 603 862-4278
Email: art.greenberg@unh.edu

Historian: Gary Patterson
Department of Chemistry
Carnegie Mellon University
Pittsburgh, PA 15213
Phone: (412) 268-3324
Fax: (412) 268-1061
Email: gp9a@andrew.cmu.edu

Archivist: John Sharkey
Pace University
Department of Chemistry & Physical Sciences
One Pace Plaza
New York, NY 10038-1502
Phone: (610) 758-3582
Email: jsharkey@pace.edu

Final Program

HIST

DIVISION OF THE HISTORY OF CHEMISTRY

S. C. Rasmussen, *Program Chair*

SUNDAY MORNING

Section A

New Orleans Downtown Marriott at the Convention Center - New Levee

HIST Tutorial and General Papers

S. C. Rasmussen, *Organizer, Presiding*

- 7:30 1.** HIST Tutorial: Early history of alcohol - from food to energy. **S. C. Rasmussen**
- 8:10 2.** Urey, Deuterium, and the Rosenbergs. **D. J. O'Leary**
- 8:40 3.** Chairmen of HIST: 1927-1947. **G. D. Patterson**
- 9:10 4.** Decorating with explosives: Böttger luster on early Meissen porcelain. **N. Zumbulyadis**
- 9:40** Intermission.
- 9:55 5.** What starts in Texas changes the world. **D. Mason**
- 10:25 6.** Edwin Fremont Ladd: Early research and the establishment of North Dakota Agricultural College. **M. Bains, D. J. Mueller, S. C. Rasmussen**
- 10:55 7.** Early (pre-XIXth-century) treatises describing the qualitative and quantitative analysis of mineral water. **N. V. Tsarevsky**
- 11:25 8.** A brief philatelic history of the periodic table. **D. Rabinovich**

SUNDAY AFTERNOON

Section A

New Orleans Downtown Marriott at the Convention Center - New Levee

Mary L. Good: Her Legacy in Science, Policy and Service

Cosponsored by I&EC

M. Cavanaugh, *Organizer*

J. Hayes, *Organizer, Presiding*

- 1:00** Introductory Remarks.
- 1:05 9.** Mary Lowe Good: A Success across Sectors. **M. A. Cavanaugh**
- 1:25 10.** From instructor to icon: Mary Good's academic career in Louisiana. **J. G. Traynham, A. F. Bopp**
- 1:50 11.** Meeting Challenges for the NSF and National Science Board in the 1980's. **E. Bloch, M. Cavanaugh**
- 2:10 12.** Mary Good in Industry - Skillful Leader for R&D. **I. Brubaker**
- 2:35** Intermission.
- 2:50 13.** Service to ACS: Mary L. Good, a member of the ACS presidential succession. **E. Reichmanis**
- 3:10 14.** A Legacy of Leadership and Some 'Good' Stories. **H. Merrell**
- 3:35 15.** "There's Something About Mary.....". **M. Jacobs**
- 4:00 16.** How to retire - not! **C. E. Hathaway**
- 4:20 17.** Remarks, Responses, and Memories. **M. L. Good**

SUNDAY EVENING

New Orleans Downtown Marriott at the Convention Center - TBA

5:00 - 8:00 HIST Executive Committee Meeting

MONDAY MORNING

Section A

New Orleans Downtown Marriott at the Convention Center - New Levee

12th Archaeological Chemistry Symposium

Pigments

Financially supported by Society for Archaeological Sciences

J. Burton, *Organizer*

R. Armitage, *Organizer, Presiding*

9:00 Introductory Remarks.

9:15 18. HyLogger™ near-infrared spectral analysis: A non-destructive mineral analysis for Aboriginal Australian objects. **R. S. Popelka-Filcoff**, A. Mauger, C. E. Lenehan, K. Walshe, A. Pring

9:35 19. Source of red pigments in Lower Pecos pictographs. **K. Bu**, J. Cizdziel, J. Russ

9:55 20. Artists' pigments in illuminated medieval manuscripts: Tracing artistic influences and connections. **M. Orna**

10:15 Intermission.

10:30 21. Characterization of the ink on the Gospel of Judas: A collaborative approach. **J. G. Barabe**, K. A. Martin, E. F. Schumacher, J. R. Swider, A. S. Teetsov

10:50 22. Unprecedented archaeo-chemical discovery of the 2,000-year old "Biblical-Blue" Tekhelet at Masada. **Z. C. Koren**

11:10 23. Characterizing organic colorants in mock-ups of a 15th century Iranian Timurid Qur'an by direct analysis in real time time-of-flight mass spectrometry. **C. Varney**, C. Selvius DeRoo, R. Armitage

MONDAY AFTERNOON

Section A

New Orleans Downtown Marriott Convention Center - New Levee

12th Archaeological Chemistry Symposium

Organic Materials

Financially supported by Society for Archaeological Sciences

J. Burton, *Organizer*

R. Armitage, *Organizer, Presiding*

V. Steele, *Presiding*

1:00 Introductory Remarks.

1:05 24. Organic residues in archaeology - the highs and lows of recent research. **V. J. Steele**

1:35 25. Lipid analysis on Mapungubwe ceramics: Determining past function and foodstuffs. **Z. Collins**, C. Z. Ashley, A. Antonites, S. Bauermeister, Y. Naude

1:55 26. Chemical Evidence for the Archaeological Use of Pulque, a Pre-Columbian Fermented Beverage made from Agave. **K. L. Hamilton**, J. E. Bollinger, D. M. Healan, S. M. Grayson, R. Elupula

2:15 27. Identifying Glue Residues on 18th-Century Ceramics from Ferry Farm, George Washington's Boyhood Home. **D. Fraser**, M. Kaktins, R. Armitage

- 2:35 28.** Applications of Direct Analysis in Real Time Mass Spectrometry to Cultural Heritage Materials. **R. Armitage**
- 2:55** Intermission.
- 3:10 29.** Correlating paleoclimate and hominin activity: ESR dating at the Kharga Oasis, Egypt. **A. R. Skinner**, B. A. Blackwell, M. R. Kleindienst, K. V. Spiller, F. Mashriqi, J. I. Blickstein
- 3:30 30.** Preliminary results on biomimetic methods based on soluble ammonium phosphate precursors for the consolidation of archaeological wall paintings. **M. Balonis-Sant**, I. Kakoulli, X. Ma, Z. Yao, B. Wu, G. Sant
- 3:50 31.** Geochemical analysis of occupational surfaces at Augusta, an 18th century English/Miskitu settlement on Roatan Island, Honduras. **P. G. Phillips**, L. D. Mihok, E. C. Wells
- 4:10 32.** Analysis of samples excavated from a royal tomb in El Zotz: Application of materials science characterization techniques in archaeology. **K. A. Cheung**, N. Xie, Z. Yao, S. Newman, S. Houston, S. Prikhodko, I. Kakoulli
- 4:30 33.** Geochemical exploration of pottery and kiln fragments by ICP-OES at Aquabona (Northeast Italy). Identifying Late Republican and Early Imperial Roman amphora production. **D. Braekmans**, P. Monsieur, P. Degryse

MONDAY EVENING

Section A

Location - Hall D

Sci-Mix

S. C. Rasmussen, *Organizer*

8:00 - 10:00

1, 4, 6, 25, 26, 30. See previous listings.

- 34.** Developing direct analysis in real time-time of flight mass spectrometric methods for identification of organic dyes in historic textiles. **C. Day**, C. Selvius DeRoo, R. Armitage
- 35.** Rapid characterization of organic residues on ceramics using direct analysis in real time mass spectrometry. **J. Hopkins**, R. Armitage
- 36.** Biomolecular Evidence from Neanderthal Fireplaces. **A. Sistiaga**, C. Mallol, C. Hernández, B. Galván
- 37.** Laser Ablation – Inductively Coupled Plasma – Mass Spectrometry (LA-ICP-MS) analysis of re-melted glass pendants from the North American Upper Great Lakes. **H. Walder**
- 38.** Baghdad battery. **D. A. Habboush**, **E. J. Caliguri**, J. Audie
- 39.** Source analysis of prehistoric obsidian artifacts in Sicily (Italy) using pXRF. **R. H. Tykot**, K. P. Freund
- 40.** Advantages and disadvantages of pXRF for archaeological ceramic analysis: Prehistoric pottery distribution and trade in northwest Florida. **R. H. Tykot**, N. M. White, J. P. Du Vernay, J. Freeman, M. Koppe, C. N. Hunt, D. S. Woodward
- 41.** Roman rainbow: Investigation of ancient pigments by portable x-ray fluorescence spectroscopy and polarized light microscopy. **R. F. Beeston**, H. W. Becker
- 42.** Assessing pre-Inca subsistence patterns through elemental analysis of human bone using a non-destructive portable X-ray fluorescence spectrometer. **C. L. Bergmann**, R. H. Tykot
- 43.** Lipid residue analysis of pottery at Liangchengzhen, Shandong, China. **R. E. Lanehart**, R. H. Tykot, A. P. Underhill, L. Fengshi, F. Hui, W. Fen - *WITHDRAWN*
- 44.** Metal Plate Connectors of the Tripitaka Koreana Woodblocks. **C. Do**, C. Pyun, J. Bae
- 45.** Chemical analyses of black pigments from Olmec pictographs in southern Mexico. **J. McPeak**, J. Russ, M. D. Pohl, C. L. von Nagy, M. W. Rowe

TUESDAY MORNING

Section A

New Orleans Downtown Marriott Convention Center - New Levee

12th Archaeological Chemistry Symposium

X-ray Fluorescence Spectroscopy in Archaeology and Keynote Address

Financially supported by Society for Archaeological Sciences

R. Armitage, *Organizer*

J. Burton, *Organizer, Presiding*

8:55 Introductory Remarks.

9:00 46. Portable X-ray Fluorescence in Archaeology: Issues related to limitations of instrumentation and suggested methods to achieve desired results. **A. N. Shugar**

9:30 47. Interregional interaction and Dilmun Power in the Bronze Age: A Provenance Study of Ceramics from Bronze Age Sites in Kuwait, Bahrain and the Indus Valley Using non-destructive pXRF Analysis. **H. J. Ashkanani**, R. H. Tykot

9:50 48. Investigating human social dynamics and interaction in Ecuadorian prehistory through obsidian artifact provenience. **E. R. Dyrdaahl**, R. J. Speakman

10:10 49. Energy dispersive X-ray fluorescence analysis of sets of coins of the Kushan Empire, revolutionary France, and the state of Mysore: Three case studies throughout history. N. H. Stroeters, J. L. LaBond, S. D. Maurice, A. Schupbach, A. J. Diefenbach, **M. A. Benvenuto**

10:30 50. pXRF Analysis of Arsenic When Lead Is Present: A Cautionary Tale. **M. W. Rowe**, S. J. Cole, M. Yousuf

10:50 Intermission.

11:05 Introduction of keynote speaker.

11:10 51. Archaeological Chemistry: A Career in Ruins. **M. Pollard**

TUESDAY AFTERNOON

Section A

New Orleans Downtown Marriott Convention Center - New Levee

12th Archaeological Chemistry Symposium

Isotopes in Archaeological Chemistry

Financially supported by Society for Archaeological Sciences

R. Armitage, *Organizer*

J. Burton, *Organizer, Presiding*

A. Thibodeau, *Presiding*

1:30 Introductory Remarks.

1:35 52. Lead and strontium isotopes in archaeology. **A. Thibodeau**

2:05 53. The Use of Isotopes to Determine Geographic Origins of Humans: Cautionary Tales. **J. H. Burton**, T. D. Price

2:25 54. Seasonal reproduction patterns by isotopic signatures ($\delta^{18}\text{O}$) on Early Eneolithic sheep of Cheia (beginning of the 5th mil. cal BC, Romania). **C. Tornero**, A. Balasescu, V. Voinea, M. Balasse

2:45 Intermission.

3:00 55. Stone tools: Stable isotope analysis of organic residues. **K. L. Steelman**, H. Burger

3:20 56. Biogeochemical contributions to our understanding of hominin diet. **M. Sponheimer**

3:50 57. Identifying ancient population movement in Honduras using strontium and oxygen isotopes: New values and interpretations. **K. Miller**, C. Freiwald

4:10 Concluding Remarks.

HIST 1 - HIST tutorial: Early history of alcohol - from food to energy

Seth C. Rasmussen, seth.rasmussen@ndsu.edu. Department of Chemistry and Biochemistry, North Dakota State University, Fargo, ND 58103, United States

The production of alcohol via fermentation is one of the oldest forms of chemical technology and the production of beer predates the smelting of metals. By the 12th century, the ability to isolate alcohol from wine had moved this chemical species from a simple component of alcoholic beverages to both a new medicine and solvent. Of course, this also began the long tradition of production of liqueurs and strong spirits for consumption. The use of alcohol as a fuel, however, did not occur until significantly later periods. A general overview of the early history and chemistry of alcohol and its uses will be presented.

HIST 2 - Urey, deuterium, and the Rosenbergs

Daniel J. O'Leary, doleary@pomona.edu. Department of Chemistry, Pomona College, Claremont, CA 91711, United States

Harold C. Urey discovered the Nobel-worthy mass 2 hydrogen isotope in 1931 and is credited with naming it in June of 1933. Urey's correspondence reveals, however, that his team was struggling to find an acceptable name for 'the hydrogen' as late as May of that year. As documented elsewhere (O'Leary, Nat. Chem. 2012, 4, 236) but expanded upon in this presentation, it was Urey's doctoral advisor G.N. Lewis who decisively influenced him to settle on the name deuterium. Twenty years later, Urey became involved in a profoundly larger controversy when he offered the world a coolly logical and dissenting view of the government's decision to execute Ethel and Julius Rosenberg. The second part of this presentation will briefly discuss Urey's wearying efforts to convince government officials, citizens, and fellow scientists that the US justice system had failed in the Rosenberg case.

HIST 3 - Chairmen of HIST: 1927-1947

Gary D Patterson, gp9a@andrew.cmu.edu. Department of Chemistry, Carnegie Mellon University, Pittsburgh, PA 15213, United States.

The Division of the History of Chemistry achieved full status in 1927. Six people served as Chairman during the formative period from 1927-1947. Biographical material will be presented on Lyman Newell, F.B. Dains, Tenney L. Davis, James Couch, Harrison Hale and Henry M. Leicester. They will also be presented as historians of chemistry and as governors of the HIST Division. The present paper is the first in an annual series of lectures on the Chairmen and Secretaries of HIST.

HIST 4 - Decorating with explosives: Böttger luster on early Meissen porcelain

Nicholas Zumbulyadis, nickz@frontiernet.net. Unaffiliated, Rochester, NY 14613, United States.

During the early years of its existence, Europe's first porcelain manufactory met with little success in porcelain painting until the arrival of Johann Gregorius Höroldt in 1720. The only exception was a pink gold-based ground color that became known as Böttger luster. Unlike the traditional Purple of Cassius, Böttger luster did not use Sn to stabilize the gold nanoparticles (XRF). Höroldt describes its synthesis in his 1731 hand-written book of recipes as an explosive gold compound. We have recently completed the first transcription and English translation of the entire passage. In the modern context the procedure would not lead to an explosive compound. One must analyze the text in terms of an earlier recipe from "The Last Will and Testament of Basil Valentine." We will compare the synthetic procedures in the two recipes. It is anticipated that the archival documents analyzed in this work will guide future laboratory replication experiments.

HIST 5 - What starts in Texas changes the world

Diana Mason, drdiana@alumni.utexas.net. Chemistry, University of North Texas, Denton, Texas 76203, United States.

If Texas was designated today as its own country, it would be rank as the 40th richest country in the world. But why? This presentation will highlight how the history of Texas has affected the world's stage and how events that have occurred in Texas have made a difference. Discussed will be the advent of the addition of Mercaptans to natural gas, the fluoridation of municipal water supplies, a few special solutions native to Texas, and the birth of nanotechnology.

HIST 6 - Edwin Fremont Ladd: Early research and the establishment of North Dakota Agricultural College

Manpreet Bains, Manpreet.Bains@ndsu.edu, **Dustin J Mueller**, Dustin.J.Mueller@ndsu.edu, **Seth C. Rasmussen**. Department of Chemistry and Biochemistry, North Dakota State University, Fargo, ND 58108, United States.

Leaving the New York State Experiment Station in Geneva, Edwin Fremont Ladd came to the newly founded North Dakota Agricultural College (NDAC) in 1890 to become its second faculty member and the founding father of the chemical sciences in North Dakota. In his first ten years at NDAC, Ladd published papers on topics of soil chemistry, protein isolation, analysis of dairy and beef products, maize storage practices, and chemical composition of feed. This early work advanced the standards and practices that were used in this very agriculturally centered state and started Ladd on the path to become a major crusader of the pure-food movement. This presentation will present Ladd's early time at NDAC and demonstrate its impact had on the state of North Dakota and the shaping of the North Dakota Agricultural College.

HIST 7 - Early (pre-XIXth-century) treatises describing the qualitative and quantitative analysis of mineral water

Nicolay V. Tsarevsky, nvt@smu.edu. Department of Chemistry, Southern Methodist University, Dallas, TX 75275, United States.

The beneficial health effects of mineral springs were recognized at the dawn of human civilization. Although some ancient writers described reactions that can be viewed as “analytical tests”, it was not until the XVIIth century that technical chemists such as Johann Rudolf Glauber (1604-1670) isolated and identified salts present in natural waters. Robert Boyle (1627-1691) described qualitative color tests, and Friedrich Hoffmann (1660-1742) and particularly Torbern Bergman (1735-1784) developed methods for quantitative analysis of complex mixtures. It was their contributions that enabled the compilation of catalogues providing information about both medicinal uses and composition of numerous mineral waters, e.g., Elliot's “Account of the Nature and Medicinal Virtues of the Principal Mineral Waters of Great Britain and Ireland...” (1789). The major discoveries made in the XVIIth and XVIIIth centuries related to the analysis of mineral waters and some early attempts aimed at the preparation of artificial mineral waters will be described.

HIST 8 - Brief philatelic history of the periodic table

Daniel Rabinovich, drabinov@uncc.edu. Department of Chemistry, The University of North Carolina at Charlotte, Charlotte, North Carolina 28223, United States.

Milestones in the history of chemistry, from the notion of the four classical elements in pre-Socratic Greece to the development of the modern periodic table, are described in this presentation and illustrated with postage stamps and other philatelic materials. The discovery of new chemical elements and the contributions of Döbereiner, Gmelin, and Mendeleev to organize them in a rational way will be discussed.



HIST 9 - Mary Lowe Good: A success across sectors

Margaret A. Cavanaugh, mcavanau@nsf.gov. Directorate for Geosciences, National Science Foundation, Arlington, VA 22230, United States.

This overview of Dr. Mary L. Good's career serves as orientation for the symposium. Dr. Good's early years and education will be described and a timeline of her career will be presented. She quickly rose through the ranks in the Louisiana State University system, being named Boyd Professor in 1974. Her success in academia was matched by her prowess as vice president for research at a major oil company in the 1980's and later as Under Secretary of Commerce for Technology in the 1990's. She returned to academe at the University of Arkansas at Little Rock to become the founding dean of the College of Engineering and Information Technology. In 1980, she was appointed to the National Science Board, eventually becoming its chair. She has served as ACS President and been honored by the Priestley Medal. In many cases, Dr. Good has been the first woman to serve in a role or to be so honored.

HIST 10 - From instructor to icon: Mary Good's academic career in Louisiana

James G. Traynham¹, jmtraynham@msn.com, Alvin F. Bopp². (1) Department of Chemistry, Louisiana State University, Baton Rouge, LA 70810-5061, United States. (2) Department of Natural Sciences, Southern University, New Orleans, LA 70126-1009, United States.

Fresh out of graduate school, Mary Lowe Good began her faculty career at Louisiana State University as an instructor in 1954. She initiated a fruitful research career in inorganic chemistry and two years later, with her Ph.D. degree in hand, was promoted to Assistant Professor. In 1958, she and her husband, a physics Ph.D. recipient from LSU, moved to New Orleans, among the original faculty members of the newly-established Louisiana State University in New Orleans. LSUNO subsequently was renamed University of New Orleans but continued as part of the LSU System. Mary was rapidly promoted to professor, and in 1973 she became the first woman to be designated Boyd Professor (most distinguished rank) in the LSU System. In January 1979 she returned to LSU in Baton Rouge to be director of a new materials science program in the College of Engineering. Two years later she retired from LSU, after 26 years of service, to begin an industrial career.

HIST 11 - Meeting challenges for the NSF and National Science Board in the 1980's

Erich Bloch¹, ebloch.ag@huronconsultinggroup.com, Margaret Cavanaugh². (1) The Advisory Group at Huron, Washington, DC 20001, United States. (2) Directorate for Geosciences, National Science Foundation, Arlington, VA 22230, United States.

Concurrent with my term as Director of the National Science Foundation (NSF), Mary L. Good was a member, and later chair and co-chair, of the National Science Board (NSB). She was appointed to the NSB in 1980 by Jimmy Carter and reappointed by Ronald Reagan in 1986. In this presentation, I will describe some of the challenges facing NSF and the NSB during that period and our interaction in meeting them.

HIST 12 - Mary Good in industry: Skillful leader for R&D

Inara Brubaker, inarabrubaker@centurylink.net. UOP/AlliedSignal, United States.

In 1981 Mary Good was selected to be the Vice-President and Director of Research at the UOP Corporate Research Center. Her accomplishments in research and leadership were a good fit to lead the research department. During the 1980s, Mary led the Research Center through several changes in ownership, mergers, acquisitions and divestitures. She made certain that staff understood their role in new technology development, thus she could sell services to the business units.

After Signal merged with Wheelabrator-Frye, Mary convinced the analysts that the Research Center could provide research for the entire Signal conglomerate. When Signal merged with Allied, Mary became the President of Allied-Signal Engineered Materials Research and later the Senior Vice-President, Technology, for AlliedSignal. There she continued development of staffs at three company locations to provide the research support to all units.

Mary's contributions to the Research Centers (1981-1993) are in many expressions of appreciation and gratitude for her strategic and skillful leadership.

HIST 13 - Service to ACS: Mary L. Good, a member of the ACS presidential succession

Elsa Reichmanis, ereichmanis@chbe.gatech.edu. School of Chemical and Biomolecular Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332, United States.

The November 18, 1985 issue of C&EN has as headline news, "Mary Good wins ACS presidential election." Mary Good became just the second woman to be elected as ACS President, winning the election by a little over half the votes cast in the three-way election. The focus of this presentation will be the initiatives, impact and ongoing legacy of 1987 ACS President, Mary L. Good.

HIST 14 - Legacy of leadership and some "Good" stories

Halley Merrell, normam8@yahoo.com. Secretary, Retired, American Chemical Society, United States.

For more than three decades Mary Good has been at the forefront in advancing the Society's policies and programs. Serving in several major leadership positions, Mary was critical to the Society's success at several levels. Her intelligence, critical judgment, and dedication to the Society's goals evidenced at the Board level, in the Council, and with the staff made her the go-to-person for articulation and resolution of numerous major issues. This former president and Board chair was always available with clear advice and counsel on any subject ranging from finance to international relations. Usually, she didn't wait to be asked.

HIST 15 - "There's Something About Mary....."

Madeleine Jacobs, Msj95@acs.org. American Chemical Society, Washington, DC 20036, United States.

"There's Something About Mary" was the title of a 1988 romantic comedy, but it's a fitting title for this talk, in which the presenter will shed some light on aspects of Mary Anne Good's career that may not be as obvious as her manifold contributions to industry, academia, government, and the non-profit world. "What's left?" you may ask. Attend this talk and you'll discover "There's Something About Mary" that you may not have known.

HIST 16 - How to retire - not!

Charles E. Hathaway, cehathaway@gmail.com. University of Arkansas at Little Rock, Little Rock, AK 72204, United States

This presentation will address what it is like to work FOR Mary Good as the founding Dean of the College of Engineering at UALR and as an economic driver in Arkansas.

HIST 17 - Remarks, responses, and memories

Mary L. Good, mlgood@ualr.edu. Donaghey College of Information Science, University of Arkansas at Little Rock, Little Rock, AR 72204, United States

Remarks, responses, and memories of the life and career of Mary L. Good.

HIST 18 - HyLogger™ near-infrared spectral analysis: A non-destructive mineral analysis for Aboriginal Australian objects

Rachel S Popelka-Filcoff¹: rachel.popelkafilcoff@flinders.edu.au, Alan Mauge², Claire E Lenehan¹, Keryn Walshe³, Allan Pring⁴. (1) School of Chemical and Physical Sciences, Flinders University, Adelaide, SA 5001, Australia (2) Department of Manufacturing Innovation Trade Resources and Energy (DMITRE), South Australian Government, Adelaide, SA 5000, Australia (3) Department of Anthropology, South Australian Museum, Adelaide, SA 5000, Australia (4) Department of Mineralogy, South Australian Museum, Adelaide, SA 5000, Australia

The CSIRO Australia HyLogger™ technology has been adapted from mineral exploration and mining applications to the high-resolution non-destructive infrared and visible light spectroscopic mineral analysis of Aboriginal Australian objects. Aboriginal Australian people primarily applied mineral pigments to wood, fiber, bark, resin or other organic substrates, making non-destructive in-situ scientific analyses of cultural objects challenging. This proof of concept study demonstrated the utility of the near-IR technology for the visual and

mineralogical analysis of Aboriginal Australian objects, as case studies for the development of methods to identify and differentiate types of mineral pigments regardless of substrate or binder. While many identified pigments such as hematite and goethite were expected for the red, orange and yellow pigments, Hylogger™ in combination with The Spectral Geologist™ software identified additional mixtures of previously unknown mineral components.

HIST 19 - Source of red pigments in Lower Pecos pictographs

Kaixuan Bu¹, kbu@go.olemiss.edu, James Cizdziel¹, Jon Russ². (1) Department of Chemistry and Biochemistry, University of Mississippi, University, MS 38677, United States (2) Department of Chemistry, Rhodes College, Memphis, TN 38112, United States

Laser ablation – inductively coupled plasma – mass spectrometry (LA-ICP-MS) was used to characterize the chemical composition of red pictograph pigments from the Lower Pecos Archaeological Region with the goal of identifying the source of the iron-based pigments. Thirteen paint specimen collected from two southwest Texas rock art sites were compared with three potential source materials (ochre, yellow siltstone and rhyolite), and two pigment cakes (crayons) that were excavated near the sampling sites. The chemical signature of the pictograph paints was strikingly similar to that of the yellow siltstone. If this material was the primary source for red pigments then we could conclude that the hunter-gatherers in the region 3000-4000 years ago had the technology to isolate the iron-oxide from the quartz matrix and convert the yellow goethite into red hematite.

HIST 20 - Artists' pigments in illuminated medieval manuscripts: Tracing artistic influences and connections

Mary Virginia Orna, mvorna@cnr.edu. Department of Chemistry, The College of New Rochelle, New Rochelle, NY 10805, United States

For the art historian, chemical analysis of pigments serves two main purposes. It can confirm or deny the alleged attribution or dating of a painting based on comparison with the known painting practices of the artist or period. In addition, the analysis of pigments can have a broader, and perhaps a more profound, importance to the historian as a tool for understanding more about the artistic process itself. Thus, in collaboration with several art historians and chemists, a lengthy project studying medieval illuminated manuscripts through the application of small particle analysis techniques was undertaken. Several dozen manuscripts from various museums and centers have been sampled and analyzed. Results to be discussed are the building of a pigment database, tracing lines of influence and interconnection between medieval centers of manuscript production, clarifying periods of known usage of several important artists' pigments, the difference in pigment usage between Armenian and Byzantine artists, the problems involved with handling manuscripts directly, and anachronistic pigment usage.

HIST 21 - Characterization of the ink on the Gospel of Judas: A collaborative approach

Joseph G. Barabe, jbarabe@mccrone.com, Kathleen A. Martin, Elaine F. Schumacher, Joseph R. Swider, Anna S. Teetsov. McCrone Associates, Inc., Westmont, Illinois 60559, United States

In 2006, the National Geographic Society (NGS) contracted with McCrone Associates to characterize the ink in a purportedly 3rd century document, the Gospel of Judas, in order to determine whether the ink was consistent with materials and manufacturing methods of 3rd century Egypt. McCrone's approach was to assemble a group of scientists with expertise in different aspects of microanalysis: The project required taking the initial ink samples in Geneva, Switzerland, specimen preparation for each of the instruments, and analysis by polarized light microscopy, scanning electron microscopy with high-resolution imaging and energy dispersive X-ray spectrometry (EDS), X-ray diffraction, transmission microscopy with EDS, and infrared and Raman spectroscopy. The ink turned out to be an unexpected mix of a traditional carbon black ink in a gum binder with an iron gall component which lacked the expected sulfur. Altogether, our findings are not inconsistent with 3rd century Egyptian ink.

HIST 22 - Unprecedented archaeo-chemical discovery of the 2,000-year old “Biblical-Blue” Tekhelet at Masada

Zvi C. Koren, zvi@shenkar.ac.il, *The Edelstein Center for the Analysis of Ancient Artifacts, Department of Chemical Engineering, Shenkar College of Engineering and Design, Ramat-Gan, Israel 52526, Israel*

There has been much confusion as to the malacological provenance, color, and chemical constitution of Tekhelet – the most sacred of the three Biblical dyes. For the first time, a two-millennia archaeological dyeing from the famous Judean palatial fortress of King Herod at Masada has been unambiguously identified as Biblical Tekhelet based on archaeo-chemical and physical evidence. Multicomponent HPLC analyses on purple archaeological dyeings and pigments produced from the most important Muricidae mollusk, Hexaplex (= Murex) trunculus, have shown that they consist mostly of three indigoidal colorants: red-purple 6,6'-dibromoindigo (“DBI”), violet 6-monobromoindigo (“MBI”), and dark-blue indigo (“IND”) [Koren ZC, *Microchim. acta* 2008, 162, 381-392]. Two chromatic sub-species of *H. trunculus* were used in antiquity, one that produced reddish-purple dyeings and hence richer in DBI, while the other produced bluish-purple dyeings richer in IND. This talk will discuss this unprecedented find, which may alter many people's perception of the color of “Biblical-Blue”.

HIST 23 - Characterizing organic colorants in mock-ups of a 15th century Iranian Timurid Qur'an by direct analysis in real time time-of-flight mass spectrometry

Christina Varney¹, rarmitage@emich.edu, *Cathy Selvius DeRoo*², *Ruth Ann Armitage*¹. (1) *Department of Chemistry, Eastern Michigan University, Ypsilanti, MI 48197, United States* (2) *Department of Conservation, Detroit Institute of Arts, Detroit, MI 48202, United States*

The Detroit Institute of Arts has in its Islamic collection a unique 15th century Timurid Qur'an. The Qur'an contains brilliantly-colored painted and polished paper with the calligraphy text inked onto the pages. The Qur'an is currently undergoing a multidisciplinary study to identify the inks, pigments, binders, dyes, gold alloys, and fibers used to construct the manuscript. X-ray fluorescence has shown that the colored pages contain primarily lead, suggesting that most of the colors are due to organic colorants. Raman microscopy indicated the presence of indigo in the blue pages, but fluorescence from organics, thought to be binder, was significant. We report here results from direct analysis in real time mass spectrometry (DART-MS) identifying organic dyes in mock-ups with a matrix that mimics that of the DIA Qur'an. These results will provide optimized methods for future work with authentic microsamples.

HIST 24 - Organic residues in archaeology: The highs and lows of recent research

Valerie J Steele, vsteele@thebritishmuseum.ac.uk, *Department of Conservation and Scientific Research, The British Museum, London, United Kingdom*

The analysis of organic residues from archaeological materials has become increasingly important to our understanding of ancient diet, trade and technology. Residues from many diverse contexts have been retrieved and analysed from the remains of food, medicine and cosmetics to hafting material on stone arrow heads, pitch and tar from shipwrecks, even ancient manure from soils. There have been many advances in our understanding of this kind of research over the past two decades. Some have led to the ability to give very specific and detailed interpretations of the materials preserved in the archaeological record. However there are still areas where we know very little, like the mechanisms at work during the formation and preservation of residues, and areas where each advance produces more questions rather than answers, as in the identification of degraded fats. This talk will discuss some of the most significant achievements in the field to date and the ongoing challenges for research in this area.

HIST 25 - Lipid analysis on Mapungubwe ceramics: Determining past function and foodstuffs

Zurethe Collins¹, zcollins9@gmail.com, *Ceri Z Ashley*¹, *Alexander Antonites*¹, *Sieglinde Bauermeister*², *Yvette Naude*². (1) *Department of Archaeology and Anthropology, University of Pretoria, Pretoria, Gauteng 0014, South Africa* (2) *Department of Chemistry, University of Pretoria, Hatfield, Gauteng 0028, South Africa*

Lipid analysis has been used in archaeology to analyse the residues left in ceramics, ranging from ancient Rome amphorae to the ceramics used during ancient Greek times. The use of lipids in other areas of the world

has shown the potential of this method to explore the actual use of ceramics. A single study using lipid analysis through GC/MS on Iron Age ceramics in southern Africa showed that lipids were present in a sample of ceramics, due to lipids seeping into the ceramics as a result of cooking activities. The present study will elaborate on this previous research through the examination of ceramics from the archaeological settlement of Mapungubwe. Previous ceramic studies have focused mainly on the stylistic characteristics instead of their function. This study will aim to determine the past use of ceramics and whether this is linked to form/decoration.

HIST 26 - Chemical evidence for the archaeological use of pulque, a pre-Columbian fermented beverage made from agave

Kasey L Hamilton¹, khamilto@tulane.edu, **James E Bollinger**¹, **Dan M Healan**², **Scott M Grayson**¹, **Ravinder Elupula**¹. (1) Department of Chemistry, Tulane University, New Orleans, LA 70118, United States (2) Department of Anthropology, Tulane University, New Orleans, LA 70118, United States

Despite ethnographic, visual artistic, and early historical evidence for the consumption of pulque in Mesoamerica, no direct chemical evidence for the fermented agave beverage pulque has been reported within these archeological contexts. An organic residue study was conducted on ancient ceramic samples from the site of Tula, Hidalgo, Mexico. These samples associated with the Toltec site (c. 900 CE) were compared to lipid extracts from modern samples of pulque in order to establish the possibility of determining a chemical biomarker for its pre-historic consumption. Gas chromatography-mass spectrometry (GC-MS) analysis was used to identify surviving lipid contents embedded within thirteen different sherds, as well as to analyze the components of five different modern pulque samples. A terpenoid compound was found in each of the modern pulque samples, as well as many of the ancient ceramic sherds analyzed. The correlation of this compound, combined with characteristic fatty acids, provide strong evidence for the storage of this fermented beverage within the archaeological ceramics tested. The identification of these compounds as biomarkers for pulque consumption offers a valuable tool for identifying the use and trade of this important resource throughout prehistoric Mesoamerica.

HIST 27 - Identifying glue residues on 18th-century ceramics from Ferry Farm, George Washington's boyhood home

Daniel Fraser¹, dfraser@lourdes.edu, **Mara Kaktins**³, **Ruth Ann Armitage**². (1) Department of Chemistry and Physical Science, Lourdes University, Sylvania, OH 43560, United States (2) Department of Chemistry, Eastern Michigan University, Ypsilanti, MI 48197, United States (3) The George Washington Foundation, Fredericksburg, VA 22405, United States

Archaeological investigations at Ferry Farm, home to the Washington family from 1738-1772, have yielded numerous ceramic artifacts associated with Mary Washington, George Washington's mother. Several of these bear residues of historic mending. The nature of the glues, and the relationship between these various artifacts, remains poorly understood. We are using direct analysis in real time mass spectrometry to investigate the composition of replica glues made from historic recipes. The adhesives fall into three classes: hide glues, resin glues, and casein-based "cheese" glues. While there is some overlap in recipes, marker compounds like abietic acid derivatives from pine resins and hydroxyproline from hide can help to rule determine which, if any, class was used on the excavated ceramics. Understanding the composition of the glues provides insight into Mary Washington's relationship to her ceramics and their uses, as well as information about the practice of china mending in the 18th century.

HIST 28 - Applications of direct analysis in real time mass spectrometry to cultural heritage materials

Ruth Ann Armitage, ramitage@emich.edu. Department of Chemistry, Eastern Michigan University, Ypsilanti, MI 48197, United States

Direct analysis in real time (DART) is an ambient ionization method for mass spectrometric identification of small molecules (less than 1000 Daltons) that requires little or no sample preparation. This nondestructive technique has been widely used for forensic science and pharmaceutical applications since its introduction in 2005. We are developing methods for characterizing art and archaeological materials by use of DART with high resolution mass spectrometry. Ongoing projects involve identification of organic colorants in textiles and painted

surfaces with complex matrices, screening ceramic artifacts for the presence of biomarker compounds characteristic of various organic residues, and differentiation of proteinaceous binders in glues and paints. Simple in-source derivatization or adduct formation, with or without additional sample preparation, can provide information about a wide range of materials of interest in cultural heritage studies without the need for chromatographic separation.

HIST 29 - Correlating paleoclimate and hominin activity: ESR dating at the Kharga Oasis, Egypt

Anne R Skinner¹, anne.r.skinner@williams.edu, **Bonnie AB Blackwell**^{1,2}, **Maxine R Kleindienst**³, **Kassandra V Spiller**¹, **Faizullah Mashriq**², **Joel I Blickstein**². (1) Department of Chemistry, Williams College, Williamstown, MA 01267, United States (2) RFK Science Institute, Glenwood Landing, NY 11547, United States (3) Department of Anthropology, University of Toronto, Mississauga, Mississauga, Ontario L5L 1C6, Canada

At Kharga Oasis in Egypt's hyperarid Western Desert, carbonate spring deposits and lacustrine sediment record several humid intervals during the Pleistocene, when wetlands, ponds, and small freshwater lakes provided water, thus permitting herbivore and human habitation. Finds include artifacts from Early Stone Age, Middle Stone Age, and later cultures. Standard ESR analysis was used to date freshwater mollusc shells (*Melanoides tuberculata*) found in tufas and lake silts at Wadi Miduawara. Dates suggest that freshwater existed at Miduawara at least during four different periods: at 13-20 ka, 31-40 ka, and 50-51 ka in Oxygen Isotope Stage (OIS) 2, 72-86 ka and 105 ka in OIS 5, 152-177 ka and 187 ka in OIS 6, and 198-208 ka and 229 ka in OIS 7. Moreover, snails and freshwater existed during the earliest Pleistocene, at ~ 2 Ma, which could have enabled the first hominin migration out of Africa via the Western Desert.

HIST 30 - Preliminary results on biomimetic methods based on soluble ammonium phosphate precursors for the consolidation of archaeological wall paintings

Magdalena Balonis-Sant², mbalonis@ucla.edu, **Ioanna Kakoulli**¹, **Xiao Ma**², **Zhaoying Yao**², **Benjamin Wu**³, **Gaurav Sant**⁴. (1) Materials Science and Engineering/Cotsen Institute of Archaeology, University of California, Los Angeles, Los Angeles, CA 90024, United States (2) Materials Science and Engineering, University of California, Los Angeles, Los Angeles, CA 90024, United States (3) Bioengineering, University of California, Los Angeles, Los Angeles, CA 90024, United States (4) Civil and Environmental Engineering, University of California, Los Angeles, Los Angeles, CA 90024, United States

This research develops hydroxyapatite (HAP)-based, inorganic mineral systems with improved properties for the consolidation of powdery wall paintings of archaeological significance. The scientific approach exploits biomimetic (biologically inspired design) principles to induce the formation of protective HAP crystals by triggering reactions between the calcium carbonate-rich layers in wall paintings and ammonium phosphate precursors. The high solubility and absence of toxicity of ammonium phosphates (precursors) and the stability of the calcium hydroxyapatite (reaction product) at varying pH, renders this treatment extremely promising for consolidation and protection of weathered wall paintings. Tests were carried out on experimental wall painting panels (representing the most common typologies across space and time) applying cellulose compresses of 1M and 2M solutions of diammonium hydrogen phosphate for 3 to 6 hours contact time. The consolidating effect, influence of the solution and conditions (composition, pH, contact time, application method) on hydroxyapatite formation (rate, extent) was evaluated through a series of structurally and compositionally sensitive analytics including: VPSEM-EDS, 3D-microstructure reconstructions, optical and mechanical analyses. Preliminary results indicated the formation of a porous hydroxyapatite network at the subsurface of the wall painting test panels, reduction of water absorption and dissolution at low pH and insignificant color change. These data show the potential of this treatment for the consolidation of powdery multi-layered wall paintings and their protection from weathering and deterioration induced by passage-of-time and environmental action linked effects.

HIST 31 - Geochemical analysis of occupational surfaces at Augusta, an 18th century English/Miskitu settlement on Roatan Island, Honduras

Paige G Phillips, pgphillips@mail.usf.edu, Lorena D. Mihok, E. Christian Wells. Department of Anthropology, The University of South Florida, Tampa, Florida 33620, United States

Geochemical analyses of archaeological soils have been used in a variety of contexts to prospect for activity loci, with the greater goal of identifying the nature and extent of past human behaviors. However, much of this work has focused on prehistoric settlements, leaving gaps in our understanding about the fate and transport of chemical residues in historical settings. This paper reports the results of our ICP and colorimetric analyses of a range of earthen substances—soil, sediment, clay, plaster, and daub—from Augusta, Honduras. Now a major heritage site, Augusta was founded as an English stronghold on Roatan Island from 1742-1748 and hosted a mix of English militia and indigenous Miskitu. While historical documents provide details on the intentions of English settlers, we know very little about how English and Miskitu interacted on a daily basis. Here we discuss our research that integrates the geochemical and archaeological records to better understand the community.

HIST 32 - Analysis of samples excavated from a royal tomb in El Zotz: Application of materials science characterization techniques in archaeology

Kristina A. Cheung¹, kristinacheung@gmail.com, Nuoya Xie², Zhaoying Yao¹, Sarah Newman³, Stephen Houston³, Sergey Prikhodko¹, Ioanna Kakoulli^{1,4}. (1) Department of Materials Science and Engineering, University of California, Los Angeles, Los Angeles, California 90024, United States (2) Department of Chemical Engineering, University of California, Los Angeles, Los Angeles, California 90024, United States (3) Department of Anthropology, Brown University, Providence, Rhode Island 02912, United States (4) Cotsen Institute of Archaeology, University of California, Los Angeles, Los Angeles, California 90024, United States

This project focuses on the characterization of materials from burial offerings and painted decoration in a royal Maya tomb at El Zotz, Guatemala and their association to mortuary rituals. Archaeological findings included vessels, jade masks, organic materials (wood, cord, and textiles), specular hematite cubes, shells with powdered cinnabar, green (malachite) painted stucco assumed to have decorated the wooden bier where the king was resting, and caches of lip-to-lip orange bowls containing human phalanges. This paper describes preliminary findings from non-invasive and non-destructive analysis techniques including XRF, VPSEM-EDS, XRD, and Raman spectroscopy, emphasizing the potential of these combined technologies in the identification of organic and inorganic markers to infer burial customs. The nature and location of the findings, the evidence of pigment coloration on the bones employing hematite and cinnabar, and the indication of exposure of the bones to high temperatures suggest highly complex mortuary practices of Maya elite.

HIST 33 - Geochemical exploration of pottery and kiln fragments by ICP-OES at Aquabona (northeast Italy): Identifying late Republican and early Imperial Roman amphora production

Dennis Braekmans^{1,2}, d.j.g.braekmans@arch.leidenuniv.nl, Patrick Monsieur⁴, Patrick Degryse³. (1) Department of Materials Science, Delft University of Technology, Delft, The Netherlands (2) Department of Archaeology, Leiden University, Leiden, The Netherlands (3) Department of Geology, KU Leuven, Leuven, Belgium (4) Department of Archaeology, Ghent University, Ghent, Belgium

Major and trace-element concentrations determined by inductively coupled plasma-optical emission spectrometry (ICP-OES) show that three pottery groups can be distinguished involving the characterization of new amphora production sites at the Adriatic coast. This paper focuses on three different research questions: (1) characterize the amphora production at Acquabona, (2) identify possible chronological differences in raw material use, (3) define the relation of the ceramics with the excavated kilns and samples clay and soil material. The selection of raw materials is chronologically diversified and corresponds with the local production of amphora (175-25 BC). Groups are distinguished using SiO₂, CaO, Sr and Zr data combined with statistical factor and cluster analysis. Using geochemical analysis in determining pottery production proved to be successful in determining local signatures of ceramics and clays. In this study alkaline earth minerals (e.g. Ba and Sr) and high field strength elements (e.g. Zr) are considered useful for provenance studies taking into account the variety of clays and non-plastic materials used in manufacturing ceramics.

HIST 34 - Developing direct analysis in real time-time of flight mass spectrometric methods for identification of organic dyes in historic textiles

Calvin Day¹, rarmitage@emich.edu, **Cathy Selvius DeRoo**², **Ruth Ann Armitage**¹. (1) Department of Chemistry, Eastern Michigan University, Ypsilanti, MI 48197, United States (2) Department of Conservation, Detroit Institute of Arts, Detroit, MI 48202, United States

Identifying organic dye compounds in textiles is a significant challenge in conservation science. Existing methods, such as liquid chromatography, require lengthy sample preparation procedures or relatively large amounts of sample. Direct analysis in real time mass spectrometry is a simple method for identifying a number of classes of dye compounds in single fibers. Blue and red fibers from historic tapestries from the Detroit Institute of Arts collections yielded clear spectra for indigotin and several anthraquinones including alizarin and purpurin, indicating the use of indigo and madder or Lady's bedstraw as sources of the colors. Yellows and greens have many possible botanical sources, and many of the colorant compounds are structural isomers. Flavones like luteolin and apigenin were readily observed in wool, silk, and cotton dyed with the most common natural yellow dyes. Ionization conditions that induce fragmentation may prove useful in differentiating some isomeric colorants.

HIST 35 - Rapid characterization of organic residues on ceramics using direct analysis in real time mass spectrometry

John Hopkins, rarmitage@emich.edu, **Ruth Ann Armitage**. Department of Chemistry, Eastern Michigan University, Ypsilanti, MI 48197, United States

Chemical analysis of adsorbed organic residues on ceramics is an established method for identifying food and trade items from the ancient world. Such characterization involves a variety of methods often requiring lengthy preparation steps. A large proportion of samples chosen for residue characterization yield no identifiable compounds of interest. DART-MS has potential for use as a high throughput method for screening samples for further study, as it requires little sample preparation and short run times. Our research is aimed at evaluating DART-MS as a biomarker screening tool prior to use on genuine archeological samples. Simulated archeological ceramics were prepared in the laboratory and evaluated using DART-MS. Mass spectra for wine residues showed significant quantities of tartaric acid even lengthy burial and intensive cleaning. Fatty acids in olive oil and dairy residues are not qualitatively diagnostic, but in-source doping to enhance triglyceride signals may differentiate these two materials.

HIST 36 - Biomolecular evidence from Neanderthal fireplaces

Ainara Sistiaga^{1,2}, sistiaga@mit.edu, **Carolina Mallo**¹, **Cristo Hernández**¹, **Bertila Galván**¹. (1) Department of Prehistory, Anthropology and Classics, Paleolithic Hunter-Gatherer Research Group, Universidad de La Laguna, La Laguna, Tenerife 38071, Spain (2) Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, United States

The biomarker approach has been shown to be a powerful tool in archaeological research. Nevertheless, its application in prehistoric contexts is practically unknown. Here, we present results from a microstratigraphic study of three Neanderthal fireplaces from the Middle Paleolithic site of El Salt (Alicante, Spain) from this perspective. In this study, we identified the nature and preservation state of organic substances present in archaeological combusted sediment through coupled GC/MS and soil micromorphology. We found that the black layers of the fireplaces comprise a suit of organic substances possibly representative of a pre-combustion, pre-human occupation soil substrate, while human occupation and burning is associated with the white layers, which comprise pine wood ash, and in one case with a greenish layer beneath the ash containing coprostanol, a human faecal biomarker. Our study shows the potential of the biomarker approach in archaeological microstratigraphy, in this case, to identify periods of site abandonment.

HIST 37 - Laser ablation: Inductively coupled plasma, mass spectrometry (LA-ICP-MS) analysis of re-melted glass pendants from the North American upper Great Lakes

Heather Walder, hwald@wisc.edu. Department of Anthropology, University of Wisconsin - Madison, Madison, WI 53706, United States

In the Upper Great Lakes region of North America, Indigenous people crushed and re-melted glass trade beads to produce new adornment forms during the late 17th and 18th centuries. Laser Ablation – Inductively Coupled Plasma – Mass Spectrometry (LA-ICP-MS) was used to assess the chemical composition of re-melted glass pendants and re-melted fragments from four archaeological sites, as well as glass beads from these and other sites in the region, in order to investigate pendant production and trade. The data reflect both glass recipes used in Old World glass manufacturing processes and Indigenous raw material choices for re-melted glass pendant production. Glass of similar chemical composition recovered from different places may demonstrate trading relationships among archaeological sites. Chemical matches between beads and pendants from the same archaeological site may indicate that people were producing pendants on-site using available beads as raw material, rather than receiving beads and pendants from separate trade sources.

HIST 38 - Baghdad battery

Dhia A. Habboush, HabboushD@sacredheart.edu, **Edward J. Caliguri**, caligurie@sacredheart.edu, Joseph Audie. Chemistry, Sacred Heart University, Fairfield, CT 06825-1000, United States

Beth Nahrain, Aramaic for the land of two rivers (Mesopotamia) is credited as the cradle of western civilization with history going back over 7000 years. This is the site of the first cities, first written letters, and earliest works and developments of arts, literature, libraries, laws, philosophy, mathematics, medicine, astronomy, and time.

In technology and science, this was the site of the invention of the wheel, glass, work with copper, iron and glass and chemistry. A less known discovery is believed to be a Galvanic cell, a clay jar housing an iron rod surrounded by a copper cylinder. The original, over 2000 years old, was discovered near Baghdad (ca 1936) and today is in the Berlin Museum, Germany. A replica of the device made at General Electric (ca 1939) is in the Berkshire Museum, Massachusetts. An updated review of the history of the Baghdad battery is presented here as part of the human chemical heritage.

HIST 39 - Source analysis of prehistoric obsidian artifacts in Sicily (Italy) using pXRF

Robert H Tykot¹, rtkot@usf.edu, Kyle P Freund². (1) Anthropology, University of South Florida, Tampa, FL 33620, United States (2) Anthropology, McMaster University, Hamilton, Ontario L8S4L8, Canada

While obsidian artifacts have been found at many prehistoric archaeological sites in Sicily, only a few studies have been done to determine the specific geological sources used. In 2012, nearly 600 artifacts from 25 archaeological sites dating from the Neolithic, Copper, and Bronze Ages were analyzed non-destructively using a portable X-ray fluorescence spectrometer. A Bruker III-SD was equipped with a special filter (76 µm Cu, 25 µm Ti, 305 µm Al) to maximize trace element analysis. The resulting data for rubidium, strontium, yttrium, zirconium, and niobium were calibrated against international obsidian standards, and compared with results obtained with the same instrument on geological sources and subsources in the Mediterranean region. All artifacts tested came either from Lipari or Pantelleria, confirming visually-based predictions but also demonstrating that multiple subsources were used on each island. These results are used to assess variation based on site location, time period, and lithic typology.

HIST 40 - Advantages and disadvantages of pXRF for archaeological ceramic analysis: Prehistoric pottery distribution and trade in northwest Florida

Robert H Tykot¹, rtkot@usf.edu, Nancy Marie White¹, Jeffrey P Du Vernay², John Freeman¹, Martin Koppe³, Christopher N Hunt¹, Deena S Woodward⁴. (1) Anthropology, University of South Florida, Tampa, FL 33620, United States (2) Alliance for Integrated Spatial Technologies, University of South Florida, Tampa, FL 33620, United States (3) Université Bordeaux III, France (4) Florida Department of State, Division of Historical Resources, Tallahassee, FL, United States

Ceramic artifacts from northwest Florida were tested non-destructively with a portable X-ray fluorescence spectrometer to study production and trade during the late prehistoric and protohistoric periods. Analyses using

a Bruker III-V were conducted on 500 ceramic samples from 8 archaeological sites, for 180 seconds and using a filter that provides highly precise data for trace elements Rb, Sr, Y, Zr, and Nb. While these ceramics were not painted or glazed, analyses were done on both inside and outside surfaces, and on broken edges. Quantitative values in ppm were produced using widely shared calibration software for these elements, and principal components analysis of the data show that the ceramics fall into distinguishable site groups, with most of the artifacts tested most likely coming from clay sources near each site. Further investigation assesses whether there are patterns based on object type and decoration, and the advantages and disadvantages of using this method.

HIST 41 - Roman rainbow: Investigation of ancient pigments by portable X-ray fluorescence spectroscopy and polarized light microscopy

Ruth F Beeston¹, rubeeston@davidson.edu, Hilary W Becker². (1) Department of Chemistry, Davidson College, Davidson, North Carolina 28035, United States (2) Department of Classics, University of Mississippi, Oxford, Mississippi, United States

The subject of this study is a collection of raw pigments from a 2nd-3rd century C.E. pigment shop located in the Area Sacra di S. Omobono, in the Forum Boarium of Rome. The shop was excavated during the 1970's, yielding over fifteen containers of blue, light blue, green, yellow, orange, red, pink, and white pigments. A Bruker Tracer III-SD portable x-ray fluorescence spectrometer was used on-site to determine major, minor and trace elements, allowing us to identify the types of pigments present and to distinguish unique elemental profiles. Additional characterization was conducted using polarized light microscopy. Pigments were examined with transmitted and reflected light and between crossed polars, and particle characteristics were compared to those of reference samples of historical pigments. The pigments identified include two preparations of Egyptian blue, green earth, at least five distinct iron earth pigments (red, yellow, and orange ochre) and calcium carbonate.

HIST 42 - Assessing pre-Inca subsistence patterns through elemental analysis of human bone using a non-destructive portable X-ray fluorescence spectrometer

Christine L. Bergmann, clbergma@mail.usf.edu, Robert H. Tykot. Department of Anthropology, University of South Florida, Tampa, Florida 33620, United States

Peru is commonly known for having the largest empire in pre-Columbian America but relatively little is known about the subsistence patterns of the pre-Inca communities that existed during the Initial Period. Our research tests the hypothesis that there was a difference in food consumption and acquisition practices between coastal and inland communities, using a portable X-ray fluorescence spectrometer to measure strontium, barium, calcium, and other elements in human bone. The use of a non-destructive pXRF has become a very beneficial tool for the analysis of archaeological materials especially human remains. The pXRF analysis of fifty-three bone samples from the sites of Pacopampa and Cardal suggest that, although the pXRF produces precise results, there are outliers in the data that could only be explained by contamination or degradation of the bone after deposition into the earth. This may be corrected by thorough cleaning, multiple spot analyses, and selecting well-preserved samples.

HIST 43 - Lipid residue analysis of pottery at Liangchengzhen, Shandong, China

Rheta E Lanehart¹, rlanehar@usf.edu, Robert H Tykot¹, Anne P Underhill², Luan Fengshi³, Fang Hui³, Wang Fen³. (1) Department of Anthropology, University of South Florida, Tampa, Florida 33620, United States (2) Department of Anthropology, Yale University, New Haven, Connecticut 06511, United States (3) School of History and Culture, Shandong University, Jinan, Shandong, China

A lipid residue analysis of 18 pottery sherds excavated at Liangchengzhen, a Longshan site (2600-1900 B.C.) was undertaken to compare the chemical compositions of pottery forms with the actual food residues contained in the vessels and to identify trace biomarkers for food sources. The total lipid was extracted from pottery samples using a Soxhlet extraction device. Modern reference samples of dried fish, rice, millet, and pig bone were extracted using a Dionex 200 accelerated solvent extractor. The alkane lipid fraction was separated by column chromatography. Samples were run on a Varian 320 gas chromatograph/mass spectrometer equipped with a Varian Factor 4 VF-5MS fused silica capillary column. Biomarker peaks for marine samples were the ratio of the

C15 and C17 alkane peaks and the ratio of the C25 to C27 alkane peaks for terrestrial samples. The results of the residue analysis supported the hypothesized pottery use and function during the Longshan.

HIST 44 - Metal plate connectors of the Tripitaka Koreana woodblocks

Choon Ho Do¹, choondo@sunchon.ac.kr, Chong Hong Pyun², Jung Hyun Bae³. (1) Div. of Fisheries System Engineering, National Fisheries R & D Institute, Kijang-gun, Busan 619-705, Republic of Korea (2) KIST, Seoul, Republic of Korea (3) Daon Culture, Gyungju, Republic of Korea

Composition of the metal plate connectors on the corners of the Korean Buddhist Tripitaka (Canon) Printing woodblocks was analyzed using X-ray fluorescence spectroscopy (XRF). The Buddhist Canon Printing Woodblocks were carved during AD 1236-1251. The woodblocks are one of Korean Treasures and enlisted as a World Cultural heritage in 1995 and documentary heritage in 2007 by UNESCO. Copper was the main component according to XRF analysis. Shapes and composition of the iron nails used for metal plate connectors connecting end pieces and main printing wooden plate were also examined using XRF. Period of attaching the metal plate connectors to the woodblocks were examined with other related documents. It is believed that the copper plates in addition to Japanese lacquer coatings helped the conservation of the woodblocks from fungi digestion because copper metal exhibits antimicrobial properties and copper compounds are actually used as wood preservative to prevent dry rot.

HIST 45 - Chemical analyses of black pigments from Olmec pictographs in southern Mexico

Joseph McPeak¹, russj@rhodes.edu, Jon Russ¹, Mary D. Pohl², Christopher L. von Nagy³, Marvin W. Rowe⁴. (1) Chemistry, Rhodes College, Memphis, TN 38112, United States (2) Department of Anthropology, Florida State University, Tallahassee, FL 32306, United States (3) Independent Scholar / Urban Origins Project, 2897 Cadence Court, Reno, NV 89523, United States (4) Chemistry, Texas A&M University - Qatar, 1630 Villa Strada, Santa Fe, NM 87506, United States

Pictographs in the Middle Formative site of Oxtotitlán were systematically analyzed using a portable XRF system determine the primary pigment materials. We also collected small paint chips from selected artifacts under a National Geographic /Waitt research grant for additional analyses in the laboratory. Of particular importance was selecting paints that could be radiocarbon dated. Several black paints at the site were considered viable for C-14 dating because the lack of Mn suggested that charcoal was used to make the paint. Additional analysis of the pigments indicated that charcoal is not the pigment, but bitumen is more likely the substance used to make the paint. If bitumen is the pigment, then this is the first evidence that it was used in the production of ancient parietal rock art. Moreover, since bitumen can be provenanced based on organic composition, it might be feasible to ultimately determine the source of the pigment material.

HIST 46 - Portable X-ray fluorescence in archaeology: Issues related to limitations of instrumentation and suggested methods to achieve desired results

Aaron N. Shugar, shugaran@buffalostate.edu. Department of Art Conservation, Buffalo State University of New York, Buffalo, NY 14222, United States

This is an exciting time for archaeology. The ongoing miniaturization of analytical instrumentation has advanced to a state where traditional lab based analysis can now be performed in the field (i.e. XRF, Raman, FTIR etc...). This in situ analysis can be enormously advantageous for archaeologists providing identification of artifacts on the spot and even helping guide excavation to be more beneficial. But what seems advantageous can also be detrimental if not fully understood. pXRF offers a utopian view of this on site elemental analysis, but what is often offered and promoted by manufacturers rarely will produce viable results when investigating the material types we encounter. The underlying physics of XRF limit what we should consider acceptable data, yet we can extract exceptionally useful information when this instrument is used responsibly. Several examples will be given to emphasize this position and methods of analysis will be recommended to aid in proper interpretation of raw data.

HIST 47 - Interregional interaction and Dilmun power in the Bronze Age: A provenance study of ceramics from Bronze Age sites in Kuwait, Bahrain, and the Indus Valley using non-destructive pXRF analysis

Hasan J. Ashkanani, hasan@mail.usf.edu, Robert H. Tykot. Anthropology, University of South Florida, Tampa, FL 33612, United States

Known as the most interactive period of trade and interregional interaction, socio-political regions in the Bronze Age were highly involved in the Near Eastern economy. Dilmun was in charge to control the commodities and transshipment between Gulf political entities such as Mesopotamia as well as Eastern Arabia and far-distance ones such as the Indus Valley. This paper seeks to launch the first scientific provenance study on a regional scale for 2nd millennium Dilmun pottery in the Persian-Arabian Gulf, particularly Kuwait and Bahrain. Going beyond typological technique, our aim is to reconstruct a chemical database of Bronze Age ceramics and fingerprint the production centers in the Persian-Arabian Gulf using trace elements Rb, Sr, Y, Zr, and Nb obtained with a non-destructive portable X-ray fluorescence spectrometer. Multiple spots on artifact surfaces were tested to inspect the quantitative precision of the technique and the homogeneity of ceramics analyzed non-destructively.

HIST 48 - Investigating human social dynamics and interaction in Ecuadorian prehistory through obsidian artifact provenience

Eric R Dyrda¹, erd142@psu.edu, Robert J Speakman². (1) Department of Anthropology, The Pennsylvania State University, University Park, PA 16802, United States (2) Center for Applied Isotope Studies, University of Georgia, Athens, GA 30602, United States

The exchange of non-local goods has long been considered an important component of life throughout much of Ecuadorian prehistory. While a large portion of our understanding of exchange in this region comes from ethnohistoric records, archaeologists primarily have contributed to the study of exchange by sourcing obsidian. We present the results of recent geochemical sourcing research with portable X-Ray Fluorescence (pXRF) instrumentation that analyzed more than 2500 obsidian artifacts from more than 60 archaeological sites, quadrupling the number of sourced obsidian artifacts from Ecuador. In addition to providing new insights on the relevant geochemical signatures for the region, this robust dataset allows for the opportunity to go beyond documenting the presence of various raw material sources at particular sites and begin to consider the potential processes that could have produced the wide distribution of non-local goods in Ecuadorian prehistory.

HIST 49 - Energy dispersive X-ray fluorescence analysis of sets of coins of the Kushan Empire, revolutionary France, and the state of Mysore: Three case studies throughout history

*Nicholas H Stroeters, Jessica L LaBond, Shelby D Maurice, Andrew Schupbach, Andrew J Diefenbach, **Mark A Benvenuto**, benvenma@udmercy.edu. Chemistry & Biochemistry, University of Detroit Mercy, Detroit, MI 48221-3038, United States*

Three series of copper coins have been analyzed by energy dispersive X-ray fluorescence spectrometry for elements including copper, zinc, tin, lead, silver, gold, and several other, possibly trace, elements. The coin sets are from the ancient Kushan Empire, from France during the revolutionary government of the late 1790's, and from the Indian state of Mysore. The elemental, compositional make up of each set, as well as the implications of the findings, will be presented and discussed.

HIST 50 - pXRF analysis of arsenic when lead is present: A cautionary tale

Marvin W Rowe^{1,2}, marvinrowe@gmail.com, Sally J. Cole³, Mohammed Yousuf⁴. (1) Department of Chemistry, Texas A&M University - Qatar, Doha, Qatar (2) Conservation Laboratory, Museum of New Mexico, Santa Fe, NM 87506, United States (3) Department of Archaeology, Ft. Lewis College, Durango, CO 81301, United States (4) Department of Mechanical Engineering, Texas A&M University - Qatar, Doha, Qatar

Although the InnovXAlpha Series portable X-ray fluorescence device we used to qualitatively analyze ceramics pigments and Lowry Pueblo Kiva white paint repeatedly reported As (in hundreds of measurements), there was

no significant amounts of As present in those samples. Obviously, care must be taken when using that device to determine As when there are significant amounts of Pb present in the samples.

HIST 51 - Archaeological chemistry: A career in ruins

Mark Pollard, mark.pollard@rlaha.ox.ac.uk. *Research Laboratory for Archaeology and the History of Art, University of Oxford, Oxford, OX1 3QY, United Kingdom*

This paper will give a brief review of the history of the applications of chemistry to archaeology, highlight a few modern examples, and discuss the challenges presented by the need to integrate research from two very different cultural traditions, straddling the science/humanities 'divide'.

HIST 52 - Lead and strontium isotopes in archaeology

Alyson Thibodeau, alyson.thibodeau@gmail.com. *Department of Earth Sciences, University of Toronto, Toronto, Ontario M5S 3B1, Canada*

Lead and strontium isotopes are among the most powerful and widely applied tracers in archaeometry. Both together and separately, they are used to determine the provenance of many archaeological materials, including metals, glasses, glazes, minerals, ceramics, bone, teeth, and wood. Advances in the past decade have made these isotopic measurements more precise, rapid, and affordable than ever, creating opportunities to both re-examine older studies of provenance and initiate new ones. This talk describes recent applications of lead and strontium isotopes to materials preserved in the archaeological record of the American Southwest and Mexico (e.g. turquoise, metals, glazes). These new isotopic data revise our knowledge of artifact provenance across these regions and challenge long-held ideas about the nature of long-distance exchange networks in Prehispanic North America. The novel insights gained through these studies highlight the continuing power and potential of lead and strontium isotopes as tracers of archaeological materials.

HIST 53 - Use of isotopes to determine geographic origins of humans: Cautionary tales

James H Burton, jhburton@wisc.edu, *T. Douglas Price*. *Department of Anthropology, University of Wisconsin, Madison, Wisconsin 53706, United States*

After decades of measuring various isotope ratios to determine geographic origins of humans, we have progressed beyond necessarily simplistic concepts to uncover dietary, ontogenetic, and methodological effects that create both problems and opportunities for a richer understanding of past human behavior. Illustrative case studies will be presented.

HIST 54 - Seasonal reproduction patterns by isotopic signatures ($\delta^{18}\text{O}$) on early Eneolithic sheep of Cheia (beginning of the 5th mil. cal BC, Romania)

Carlos Tornero¹, ctornero@mnhn.fr, *Adrian Balasescu*², *Valentina Voinea*³, *Marie Balasse*¹. (1) *"Archéozoologie, Archéobotanique: Sociétés, Pratiques et Environnements", UMR 7209 CNRS/MNHN, Paris, France 75005, France* (2) *Musée national d'Histoire de la Roumanie, Bucarest, R, Romania* (3) *Musée d'Histoire Nationale et Archéologie, Constanta, Romania, Romania*

Cheia is an Early Eneolithic site (beginning of the Vth mill. BC; Hamangia culture) settled in the central hills of the Dobrogea province in south-eastern Romania. The site delivered an exceptional collection of faunal remains. Although the economy relied heavily on cattle husbandry, an important secondary role was given to domestic caprines. The recovered assemblage includes an important number of sheep tooth rows. We performed stable isotope analyses in tooth enamel from the second and third molars of different individuals. Variations in the sequential analyses of carbonate $\delta^{18}\text{O}$ values in both molars are used to investigate seasonal reproduction patterns. The results obtained are compared with recently available data from modern referential breed sheep populations in Europe with known birth dates. High seasonal resolution is finally obtained and the distribution of sheep births throughout the year is represented, adding significance information to the study of sheep management.

HIST 55 - Stone tools: Stable isotope analysis of organic residues

Karen L Steelman, ksteel@uca.edu, Hayden Burger. Department of Chemistry, University of Central Arkansas, Conway, AR 72035, United States

We utilized plasma oxidation and stable isotope mass spectrometry to study organic residues on stone tools. Corn, a C4 plant, was processed using modern tools. Two different washing techniques were performed to remove surface contamination from handling prior to placing stone tools in an oxygen glow discharge. Organic residues trapped in stone tool micro-fracture cracks were oxidized to carbon dioxide for stable isotope mass spectrometry. This preliminary study demonstrates proof of concept for stable isotope analysis and radiocarbon dating of organic residues on stone tools using plasma oxidation.

HIST 56 - Biogeochemical contributions to our understanding of hominin diet

Matt Sponheimer, matt.sponheimer@colorado.edu. Department of Anthropology, University of Colorado Boulder, Boulder, CO 80309-0233, United States

Biogeochemical approaches have provided insights into the diets of early hominins and more recent humans. Revelations in the past few years, in particular, have fundamentally changed our understanding of the diets of several hominin taxa, and in so doing, are shaping the dialogue about the selective pressures faced by our ancestors. Moreover, data have recently been generated for nearly the entire suite of African hominins, which allows us to address questions about regional and temporal differences, as well as about the relationship between diet and morphology in new ways. Here, I discuss these data, how they are shaping our thinking about human evolution, and try to draw some general conclusions about the contributions of biogeochemistry to our understanding of the past.

HIST 57 - Identifying ancient population movement in Honduras using strontium and oxygen isotopes: New values and interpretations

Katherine Miller¹, katie.miller@asu.edu, Carolyn Freiwald². (1) Center for Bioarchaeological Research, Arizona State University, Tempe, AZ 85287-2402, United States (2) Department of Sociology and Anthropology, University of Mississippi, Oxford, MS 38655, United States

Strontium isotope ratios in human tooth enamel show widespread population movement among the Classic period Maya, including in-migration to both large centers and rural communities. Our ability to identify potential homelands for migrants is based on (1) understanding the relationship between geologic variability and $87\text{Sr}/86\text{Sr}$ values, and (2) obtaining values for all likely homelands in each study. This is particularly important for studies of sites like Copan, which is the major urban center located at the periphery of the Maya region. Thirty-four modern plant and animal samples from western Honduras show that the area's geologic regions have distinct average strontium isotope values. These data elucidate additional potential homelands for non-local individuals buried at Copan and other Maya sites, which we demonstrate by re-interpreting conclusions in previously published studies. Equally important is the potential for exploring migration patterns among diverse indigenous populations in Honduras, like the Maya, Jicaque, and Lenca.