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SCIENTIFIC ANALYSIS OF EARLY IRON AGE GLASS BEADS FROM TAIWAN

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Glass beads were luxury items found in funerary and settlement contexts from the Iron Age in Taiwan. This material appears to replace indigenous nephrite which was used for the same decorative and prestige items. The replacement of one material with another has led archaeologists to suggest that the same trade routes used to export nephrite from eastern Taiwan to other areas in Southeast Asia in the late Neolithic were used to import glass beads in the early Iron Age. This movement of materials may be primarily associated with the exchange of objects and the migration of people back and forth between Taiwan and Southeast Asia.

A project to explore the movement of glass beads and to investigate the potential provenance of beads found in Taiwan was initiated in 2012. This research examines beads from a variety of sites in Taiwan dating from the 3rd century BC to the 12th century AD and studies both bead context, typology and chemistry in order provide a more holistic picture of bead provenance and movement. In the field session from March to early June 2015, with the aid of funds from SAS, SEM-EDS and EPMA was conducted on glass beads from four Iron Age sites in Taiwan: Kiwulan (AD700-1200) in northeastern Taiwan, Kueishan (AD400-700) in southern Taiwan and Taoyeh (AD200-600) and Wuchientso (AD600-1000) in southwestern Taiwan (fig. 1). These sites cover a wide geographic range and a continuous chronological sequence in the 1st millennium AD.

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Figure 1. Map showing the location and chronology of Kiwulan, Taoyeh, Wuchientso and Kueishan sites in Taiwan.

Materials and analytical parameters

All of the glass beads analyzed are monochrome beads with a diameter of only a few millimeters; these beads are the most common style recovered in Iron Age Taiwan (fig. 2) and are found in diverse colors. Previous optical microscopic analysis suggested that most of them were made by a drawn method, which is thought to be the predominant manufacturing technique of glass beadmaking in contemporary South and Southeast Asia.

A total of 49 beads were analyzed by SEM-EDS (JEOL JSM-7100F) equipped with Oxford EDS at the Institute of Earth Sciences, Academia Sinica, Taiwan. The beads comprised 25 samples from Kiwulan, 8 samples from Taoyeh, 4 samples from Wuchientso and 12 samples from Kueishan. EPMA (JEOL JXA-8900R) wass also used in order to obtain quantitative chemical data of major and minor elements. However, due to a delay in construction work at the Institute of Earth Sciences, EPMA analysis of Taoyeh, Wuchientso and Kueishan samples have been re-scheduled. Therefore, the EPMA results of Taoyeh, Wuchientso and Kueishan are not included in this report.

Results and Discussion

The results have revealed two main compositional types of

Figure 2. Some examples of glass beads from Kiwulan, Kueishan, Taoyeh and Wuchientso.

glass from the four sites: m-Na-Al glass and plant ash glass (Table 1). I was observed that all the samples generally contain more than 14% soda, which indicates the use of soda as a flux in glass production. Samples with a concentration of MgO higher than 3% are soda plant ash glass, while those with MgO lower than 1% and Al_2O_3 higher than 8% are m-Na-Al glass. The two types of glass composition suggest different sources of soda flux: plant ash glass from vegetal sources and m-Na-Al glass from mineral sources.

In the glass matrix, more mineral traces such as zircon and albite were found in the m-Na-Al glass, which again indicates the use of predominantly mineral raw materials in glass production. In plant ash glass, however, the matrix is more homogeneous in comparison to the m-Na-Al glass.

Generally, a broad linear correlation of Al_2O_3 to CaO was observed in plant ash glass from Kiwulan and Kueishan, but the concentration of Al_2O_3 in Kueishan samples was slightly higher and CaO slightly lower than Kiwulan samples. The typology of glass beads made of plant ash glass in Kiwulan and Kueishan also showed differences. All the plant ash glass from the Kueishan site are dark blue with a diameter larger than 5mm, while all the plant ash glass from Kiwulan is yellow or blue with a diameter of 2-3mm. This evidence, together with the chronology and geographic location of Kiwulan and Kueishan sites, possibly points to different origins of plant ash glasses in Iron Age Taiwan.

In m-Na-Al glass, a linear correlation can be found between MgO and CaO. Upon closer examination of the data it appears that the orange and red glasses generally contain the highest amounts of MgO and CaO, while blue glass contains the lowest concentrations of MgO and CaO. This correlation is also reported in most m-Na-Al glass from around the South China Sea, and it is suggested that the high concentration of MgO and CaO are also associated with higher iron, which may be a reducer for copper red/orange glass (Dussubieux and Gratuze 2010).

The m-Na-Al glass is a predominant type in contemporary Southeast Asia, although the location of primary production sites in Southeast Asia remains unclear (Dussubieux and Gratuze 2010). Increasing amounts of plant ash glass around the South China Sea can be observed from the mid-1st millennium AD, with potential origins in Western Asia (Dussubieux and Allen 2014). The identification of the two types of glass composition in Iron Age Taiwan may suggest the import of glass beads from Southeast Asia. However, the style of some glass beads in Iron Age Taiwan seems to be uncommon in contemporary Southeast Asia. Further analysis is on-going in an attempt to further elucidate their potential provenance.

The proportions of compositions found in the bead assemblages at each site is different. In Kiwulan (AD700-1200) in north-eastern Taiwan, m-Na-Al glass and plant ash glass are similar in proportion. In south-western Taiwan, all the samples in Taoyeh (AD200-600) are m-Na-Al glass, while 1 plant ash glass bead and 3 m-Na-Al beads are identified in Wuchientso (AD600-1000). At the Kueishan site (AD400-700) in southern Taiwan, 2 samples are made of plant ash glass and 10 samples are composed of m-Na-Al glass. Together with material from the previously analyzed site of Chiuhsianglan (300BC-700AD) in south-eastern Taiwan where all the glass beads are m-Na-Al glass, these results probably reveal a chronological distribution of glass compositions through Iron Age Taiwan. This distribution could be further associated with the exchange activities in local areas in Taiwan and between Taiwan and different parts in Southeast Asia, and these patterns are currently being investigated.

The SEM-EDS and EPMA analysis also helps understand the use of colorants. Cuprous oxide was found to contribute to the red and orange color, in different concentrations. Cupric oxide, on the other hand, is the colorant in blue glass. In yellow glass, the use of lead-tin oxide was identified. In green glass, both lead-tin oxide and cupric oxide was used for the production of green. The identification of these colorants is consistent with previous analysis of glass beads around the South China Sea (Dussubieux and Gratuze 2010). However, visible in the BSE image, and through the chemical analysis on local areas within the beads, it could be possible that some yellow glass beads from Kueishan may contain a different opacifier in comparison to other yellow glass in Iron Age Taiwan. This is now under detailed examination in order to understand the potential connection to yellow glass production around the South China Sea.

Summary and Future work

This analytical study identified the major compositional groups, m-Na-Al glass and plant ash glass, of glass beads from several Iron Age sites in Taiwan. This work will

Sample	Composition	Color	n	SiO_2	Al_2O_3	Na_2O	K_2O	MgO	CaO	FeO
Kiwulan										
KWL003	m-Na-Al	orange	5	61.8	12.0	17.9	2.3	0.8	3.4	2.0
KWL011	plant ash	yellow	3	64.8	2.1	17.0	3.8	3.4	7.8	nd
Kueishan										
KS001	m-Na-Al	green	5	66.1	7.5	19.6	1.6	0.5	3.0	1.6
KS004	m-Na-Al	red	5	65.4	10.2	16.4	1.9	0.7	2.8	2.6
KS059	plant ash	dark blue	5	66.6	3.0	17.5	1.7	4.3	6.9	nd
Taoyeh										
TY14	m-Na-Al	yellow	5	63.9	9.4	19.9	2.2	nd	2.5	2.0
TY47	m-Na-Al	red	3	64.4	7.9	18.7	1.6	0.7	4.4	2.3
Wuchientso										
WCT15	m-Na-Al	blue	3	67.9	8.8	16.4	2.2	nd	3.2	1.5
WCT20	plant ash	aqua	3	69.3	3.4	14.0	2.1	3.2	8.0	nd

Table 1: Some examples of different types of glass compositions in Kiwulan, Kueishan, Taoyeh and Wuchientso (wt%).

help to establish the chronological sequence of glass composition in Iron Age Taiwan, and furthermore associate this temporal distribution with exchange activities between Taiwan and Southeast Asia. Although the chemical compositions are all strongly related to Southeast Asia, the style of some glass beads are rare and this may contribute to further discussion of production and consumption of glass beads around the South China Sea.

Detailed investigations are currently being conducted in order to obtain a more comprehensive picture in terms of cultural and economic interactions, reflected by these tiny beads, within Taiwan and between Taiwan and Southeast Asia. Quantitative EPMA results of Taoyeh, Wuchientso and Kueishan samples will be acquired in the near future, and the trace elemental analysis by LA-ICP-MS will also be included for future discussion concerning the grouping and potential provenance of glass beads in Iron Age Taiwan. These compositional data will be combined with stylistic data and the context of each site to understand the differences and similarities of the material culture of glass beads from different regions in Iron Age in Taiwan.

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Dussubieux, L. & Gratuze, B. 2010. Glass in Southeast Asia. In: Bellina, B., Bacus, E. A., Pryce, T. O. & Christie, J. W. (eds.) *50 Years of Archaeology in Southeast Asia: Essays in Honour of Ian Glover*. Bangkok: River Books.

ARCHAEOLOGICAL CERAMICS

Charles C. Kolb, Associate Editor

Book Reviews on Ceramics

Pottery Analysis, Second Edition: A Sourcebook, Prudence M. Rice, Chicago: University of Chicago Press, 2015. xxx + 561 pp., 124 figures, 49 tables, 19 boxes. ISBN: 9780226923208, $150.00 (cloth); ISBN: 9780226923215, $55.00 (paperback); ISBN: 9780226923222, $7.00 to $55.00 (E-book). Most archaeologists, especially those who study ceramic materials, are already familiar with Pru Rice's *Pottery Analysis: A Sourcebook* (1987) an up-to-date and comprehensive synthesis of what was then known about ceramic analysis and it mostly replaced the then "bible" on pottery studies, Anna O. Shepard's *Ceramics for the Archaeologist* (Washington, DC: Carnegie Institution of Washington, 1956, revised 1976). *Pottery Analysis* (1987), hereafter *PA*1, became the "new bible" and the second edition (*PA*2) - a "new testament" - was published on July 10, 2015. Rice herself uses the abbreviations *PA*1 and *PA*2 to distinguish these editions and I shall also employ these designations. *PA*1 received stellar reviews in both the archaeological and ethnographic literature and I had the opportunity to review it shortly after its

publication: *American Scientist* 76(4):408-409 (July-August 1988) and in a "Review Article: Ceramic Studies in Archaeology: *Decoding Prehistoric Ceramics* (edited by Ben A. Nelson. Carbondale and Edwardsville: Southern Illinois University Press, 1985); *Pottery Analysis: A Sourcebook* (Prudence M. Rice. Chicago: University of Chicago Press, 1987)," *Journal of Field Archaeology* 17(1):93-98 (Winter 1990), as well as in a larger perspective: "The Current Status of Ceramic Studies," In *Ceramic Ecology, 1988: Current Research on Ceramic Materials* (1989), edited by Charles C. Kolb, BAR International Series S-513, Oxford, England: British Archaeological Reports, pp. 377-420. Fortunately, I still retain most of my notes on *PA*1and thought that a comparative view of *PA*1 and *PA*2 would be useful.

Rice is Professor Emerita of Anthropology and was distinguished professor, department chair, and associate vice chancellor for research at Southern Illinois University, Carbondale, prior to her retirement in 2011. She earned her doctorate at The Pennsylvania State University where she studied with William T. Sanders and Frederick R. Matson and has conducted extensive research in Mesoamerica and the Andean region, much of which focused on settlement pattern studies, cultural ecology, and ceramic analysis. Note: Your reviewer was also a Penn State undergraduate and graduate student who studied with both Bill and Fred and overlapped chronologically with Pru and her husband Don at PSU while were completing our Ph.Ds.

*PA*1 was published in 1987 initially only in hardcopy (xxiv + 559 pp., 139 figures, and 50 tables) as a reference work (hence the subtle of "sourcebook") and later as a paperback when it also became more commonly used as a textbook. *PA*2 is issued simultaneously in cloth, paperback, and as an e-book (xxx + 561 pp., 124 figures, and 49 tables) plus 19 boxes with explanatory topical information ("Assessing Plasticity: %WP" and "Translating Sherds into Pots," for example). Both editions have prefaces, but *PA*2 has the original *PA*1 preface and the new *PA*2 preface plus an informative "Note to Instructors." The two prefaces should be read as they detail the objectives and goals of both editions as well as the structure and formats of each text. The objectives are different so that the structure of the second edition varies from *PA*1 in that the new edition focuses more on topics and data relating to the indigenous cultures of the Western Hemisphere, notably post-1985 published studies and examples from the Americas and the Caribbean, including historical archaeology (p. xxiv). She comments rightly that she is uncomfortable with her lack of updating the discussions of pottery in Europe, Asia, and Africa – due, in the main, to an inability to read the Francophone literature. In addition, *PA*1 reflected the early interactions between "bumpkin" archaeologists "bedazzled" by first-generation archaeometricians – how things have changed over the past forty years (p. xxiii).

Both editions are structured similarly with the usual front matter (lists of figures and tables, and prefaces incorporating acknowledgments, followed by "Parts" comprised of Chapters (*PA*1had 5 parts with a total of 15 chapters; *PA*2; 6 parts with 26 chapters), and each has a "Glossary" (number of entries: *PA*1: 261 from five sources; *PA*2:271 from six sources – the additions are from the *Clay Minerals Society Glossary* (2012). For *PA*2, the number of "References" has increased to 1,305 from 987 in *PA*1 and includes citations of literature as recent as 2013. The citations are newly revised and the **authors' names** are now in **bold**, hence easier to read; the alphabetized names in the glossary were in **bold** in *PA*1 and that continues in *PA*2 (**absorption**, for example). The double-column "Index" incorporates topical and proper noun entries and decreases from 17 to 15 pages. However, the font size used in these three back matter sections in *PA*2 is one point smaller than in *PA*1 so there is actually more material in the new edition. A notable difference is that *PA*1 used generalized endnotes clustered at the ends of chapter ("Abascal 1975," for example), as well as innotes within the narratives; *PA*2 eliminates the endnotes. In sum, the changes made to the format, structure, and font make *PA*2 readable and easier to use than its predecessor. A summary of the contents (six **Parts** and 26 *Chapters*) and my comments follow. References to my published reviews in the *SAS Bulletin* are, for example, designated as: [Kolb *SASB* 32(2):24-27, 2009].

Part 1 Introduction: one chapter (pp. 1-32): 1 *Pottery and Its History* (pp. 3-32, 11 figures, and 4 tables) is expanded and revised significantly. The topic and definitions of pottery and ceramics are introduced within a historical context beginning with hunting-gathering-forging-collecting, hypotheses and models of earliest production ("software" and pre-ceramic figurines, etc.), and geographical framework. Rice summarizes what is currently known about the origins and history of pottery in the Old World (Eastern Asia, Western Asia/Near East, Africa, and Europe and the Mediterranean) and the New World (South America, Mesoamerica, and North America), and the "Colonial World."

Part 2 The Raw Materials of Pottery Making: Perspectives from Chemistry, Geology, and Engineering: six chapters (pp. 35-125): 2 *Clays: Origins and Definitions* (pp. 35-60, 6 figures, 6 tables, and 1 box) there are major revisions from the *PA*1 edition. Topics

include earth materials, rock-forming minerals, weathering and clay formation, definitions of clays (including for the latter: granulometry, deposition, chemical composition, mineralogy, and planar and non-planar phyllosilicates), and functional definitions. Newly added is an expanded discussion of 3 *Plasticity: The Clay/Water System* (pp. 61-73, 3 figures, 2 tables, and 1 box) focusing on water, dipoles, and ions; plasticity and related factors (particle sizes and shapes, surface tension, adsorption of ions and rigid water, clay minerals, deposit locations, and organic matter); measurements of plasticity, ions, flocculation and organics. 4 *Non-clay Constituents* (pp. 74-88, 4 figures, 1 table, and 2 boxes) documents coarse inclusions, three common minerals (quartz, feldspar, and calcium-bases minerals), triaxial bodies, the definition of temper (kinds and problems in terminology), issues in distinguishing naturally occurring from added substances, inorganic and organic tempers, and temper sizes and shapes. Chapter 5 *Drying and Shrinkage* (pp. 89-98, 4 figures, 2 tables, and 1 box) covers kinds of water, green strength, and drying defection and causes (the latter reviews particle sizes and shapes, shaping methods, preferred orientation, and ambient conditions. 6 *Changes in Clays with Heat* (pp. 99-116, 6 figures, 5 tables, and 1 box) reviews variables such as time, temperature, and atmosphere. Special attention is paid to changes at low temperatures (the loss of volatiles, organics and impurities, shrinkage and changes in clay minerals and inclusions) and high temperature changes (notably, modifications of mineral constituents and sintering and vitrification). Part 2 concludes with a basic chapter on 7 *Glazes* (pp. 117-125, 2 figures and 2 tables) in which Rice reviews briefly the components and kinds of glazes, colorants, and firing.

While Part 2 considered "nature," Part 3 focuses on "nurture."

Part 3 Behavior: Ethnographic Perspectives on Pottery Making: four chapters (pp. 127-224). Chapter 8 *Manufacture* (pp. 129-153, 13 figure and 2 tables) provides a traditional review of pottery production: obtaining and preparing the resources (clay, temper, slip, paint, and fuel) drawing upon Dean Arnold's research (*Ceramic Theory and Cultural Proc*ess, Cambridge: Cambridge University Press, 1985) on distances to resources and; resource modification such as clay mixing, techniques and tools of forming (hand-building, molding, and rotational devices); finishing techniques and tools (secondary forming, beating and scraping, and surface finishing such as smoothing and texturing); and drying and preheating before firing. In Chapter 9 *Surface Enhancement* (pp. 154-165, 3 figures), Rice documents enhancements by penetration or displacement (impressing and cutting), surface additions (appliqués, the application of color and colorants [painting and slipping]), and glazing. In 10 *Firing* (pp. 166-184, 8 figures and 4 tables), basic information is presented on fuel and pottery with regard to kiln firing (kiln types, intermingling wares and fuels, three basic variables [time, temperature, and atmosphere]; and postfired treatments. The author also discusses the economic realities of costs and losses, problems of mixed firing vs. kiln firing, fuel types and costs, and data on comparative firing variables. 11 *Exchange and Household Provisioning* (pp. 186-204, 4 figures and 4 tables) focuses and distribution from producer to consumer (reciprocity, redistribution, exchange, and trade), costs and prices and cautions in data interpretation. Part 3 concludes with salient considerations of consumer issues: ceramic censuses or inventories and household assemblages, quantities and types of vessels, pottery use-life, and recycling/reuse and replacement.

Part 4 Methods and Measures: Analyzing Archaeological Pottery: eight chapters (pp. 205-333). The chapters in Part 4 illustrate how the author has rearranged and expanded sections from *PA*1 which included four chapters: an introduction to characterization, ceramic color, and details physical, mechanical, and thermal properties and their characterization. In *PA*2, Chapter 12 *Methods and Theories* (pp. 209-219, 1 table) begins with Rice's discussion of ceramic analyses and its relationships to the "new" archaeology, processualism, ecology, (including ceramic ecology), post-processual archaeology and the search for "law-like generalizations (e.g., agency theory, practice theory, gender, hermeneutics, phenomenology, social archaeology, etc.) (pp. 209-210). Rice's chapter focuses on experimental archaeology and ethnoarchaeology, technology and choices, and behavioral archaeology and life histories. Ceramics in archaeological site formation, pottery discard and disposal, and site assemblages are detailed, and there is a cautionary message about reconstructing archaeological ceramic assemblages and functions (pp. 218-219). [The Symposium "Technological Choices in Ceramic Production" - Perspectives from Ceramic Ecology, Archaeology and Ethnoarchaeology. *Archaeometry* 43(2):273-277, 2001, by Kolb provides greater context to these topics.] *Classification* in *PA* 1 was within a Part 3 chapter on special topics and is now sensibly separated as Chapter 13 in *PA*2 (pp. 220-245, 12 figures, 1 table and 3 boxes). The major topics reviewed include attributes, a History of Americanist Pottery Classification, definitions of types, kinds of classifications: ethnotaxonomy, devised or formal classifications, and form and form-based categorizations – the latter documents size and proportions, special shape terms, and geometric forms

and contours. The final essay Why Classify Pottery?" is delightful.

14 *Characterization* (pp. 346-358, 2 tables) provides a valuable discussion of historical background, methods, research design, fieldwork and the all-important field sampling (including excavation loci, recovery and processing materials, and resource collecting). The chapter concludes with "Interpretation." I am delighted to see Chapter 15 *Quantification and Sampling Collections* (pp. 259-275, 1 figure, 1 table and 2 boxes), a full treatment focusing on two main topics 1) quantification: counts and measurements, statistical analysis, and the issue of converting "sherds to pots." In 2) sampling is reviewed: sampling from collections, appraising individual sherds, sampling for characterization (dealing notably with research questions and choosing appropriate methods), and selection of specimens for chemical compositional analysis. 16 *Color* (pp. 276-290, 1 figure, 1 table and 2 boxes) deals briefly with a complex topic in which she considers human perceptions of color, the sources of pottery color and its variability (organic matter, iron compounds, and other colorants. Measuring color includes discussions of Ridgway (1912) on "bird colors" – she means bird *feathers*, Maerz and Paul (1950), Munsell (1905), and ASTM (1968). The Munsell system is carefully explained and "Box 16.1 Reporting Color Measurements" (p. 286) contains an extremely useful essay, and she also considers the uses of color measurements. Chapter 17 *Mineral and Chemical Composition* (pp. 291-303, 7 figures) provides a review about the need for quantitative and qualitative descriptions of clay minerals and coarser particles. Petrographic characterization, X-Ray Diffraction (XRD); and chemical analysis (Instrumental Neutron Activation Analysis (INAA), Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS), X-Ray Fluorescence Spectroscopy (XRF), and Proton-Induced X-Ray Emission Spectroscopy (PIXE) are detailed. In 18 *Physical and Mechanical Properties* (pp. 305-322, 3 figures, 2 tables and 2 boxes) the author considers microstructure and physical and mechanical stresses; hardness and strength; permeability, porosity, density, brittleness, fracture, and microcracks. 19 *Thermal Behavior* (pp. 323-333, 1 figure, 1 table and 1 box) begins with a discussion about thermal properties, stresses and shock, resistance to shock (microstructure and shape and design), and modifying thermal behavior such as the potter changing tempers or increasing porosity.

Part 5 Research Questions and Problems: Interpreting Archaeological Pottery: 6 chapters (pp. 335-432) separately review three interrelated topics: location, organization, and products. In 20 *Production I: Location* (pp. 337-349, 2 figures, and 2 boxes) Rice reviews the major topics of physical indicators (artifactual and spatial) and provenience/provenance (compositional analyses and analytic and behavioral confounding factors). A 5,000-word article by Kolb elaborates aspects of this topic: "Provenance Studies in Archaeology," *Encyclopedia of Global Archaeology* (Claire Smith, ed.-in-chief), New York: Springer Publishers, 2014, pp. 6172-6181. 21 *Production II: Organization* (pp. 350-362, 1 figure and 1 table) focuses on production modes, scales, intensity, and complexity as well as specialization types and models, and specific specializations: producer, community, resource, and product. Lastly there is an essay on multicrafting. 22 *Production III: The Products* (pp. 363-375, 2 figures and 1 table) continues the discussion of product attribute variability, standardization, diversity, commodities and commodification, and trade. Manufacture and distribution of pottery is detailed in Dean E. Arnold's *Social Change and the Evolution of Ceramic Production and Distribution in a Maya Community*, Boulder: University Press of Colorado, 2008 [Kolb *SASB* 32(2):24-27, 2009] and a companion volume *The Evolution of Production Organization in a Maya Community*, Boulder: University Press of Colorado, 2014 [Kolb *SASB* 38(1):2-5, 2014]. 23 *Archaeothermometry* (pp. 376-387, 1 figure) dealing with time, temperature, and atmosphere of firing might easily have been included in Part 4. Physical properties and mineralogical and chemical analyses are reviewed: microscopy (petrography and SEM) thermal methods (DT, TG, TG-TTG, and DTA), X-Ray Diffraction (XRD), Mössbauer Spectroscopy, magnetic properties TC, ESR, EPR, and EPR), and Fourier Transform Infrared Spectroscopy (FTIR). There is also an important essay on cautionary uses and data interpretations associated with these procedures. *Thin-Section Petrography of Stone and Ceramic Cultural Materials* by Chandra L. Reedy, London: Archaeopress, 2008 [Kolb *SASB* 31(4):18-20, 2008] and *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section* by Patrick Sean Quinn; Oxford: Archaeopress, 2013 expands the discussion on microscopy in Rice's Chapter 23 [Kolb *SASB* 36(3):7-10, 2013].

24 *Style and Social Interaction* (pp. 388-416, 9 figures) begins with a discussion of "What Is Style?" and "What Does Pottery Style Do?" Another section documents archaeological approaches to pottery style, design elements and their relationships to social interaction, hierarchical design structure analysis, and symmetry analysis. A third section appraises style as communication: information theory, active or passive

communication, learning or transmission, visibility, and meaning. Theoretical issues and style change are also considered. 25 *Functions and Forms* (pp. 411-432, 5 figures and 2 tables) elaborates vessel form, technology, and uses from the perspectives of indirect evidence and inferred functions (physical attributes, and forms and functions: storage cooking, and transfer), and direct evidence of use (residue analysis and the identification of contents, sooting, and surface attrition). "The Hegemony of the Cookpot" is a cautionary tale. Publications by James Skibo have enlightened the pottery form-and-function literature. There is a comparative review of Skibo's *Understanding Pottery Function*, Manuals in Archaeological Method, Theory and Technique, New York: Springer, 2013, and his older *Pottery Function: A Use-alteration Perspective*, New York: Plenum Press, 2002, by Kolb in *Amazon.com*, November 27, 2012. http://www.amazon.com/Understanding-Pottery-Function-Archaeological-Technique/product-reviews/1461441986/ref=cm_cr_dp_text?ie=UTF8&showViewpoints=0#R10H3FS2YU37XH The 2012 volume is separately reviewed in [Kolb *SASB* 35(4):28-30, 2012]. Major publications on archaeological chemistry have been reviewed in the *SAS Bulletin* and these provide somewhat dated but much greater detail than these topics in Rice's compendium: "Comparative review of Three Books on Archaeological Chemistry": *Analytical Chemistry in Archaeology* (A. M. Pollard, C. M. Batt, B. Stern, and S. M. M. Young; Cambridge Manuals in Archaeology, Cambridge and New York: Cambridge University Press, 2007; *Archaeological Chemistry*, 2nd ed. (A. M. Pollard and C. Heron; Cambridge, UK: RSC Publishing (The Royal Society of Chemistry), 2008; and *Archaeological Chemistry*, 2nd ed. (Zvi Goffer, Hoboken, NJ: Wiley-Interscience, Volume 170 in Chemical Analysis: A Series of Monographs in Analytical Chemistry and Its Applications, 2007 [Kolb *SASB* 32(1):22-25, 2009. *An Introduction to Archaeological Chemistry* by T. Douglas Price and James H. Burton, New York: Springer, 2011 [Kolb *SASB* 34(1):2-4, 2011].

Part 6 Then and Now; Now and Then: 1 chapter (pp. 433-449), 26 *The Humility of Things* (pp. 435-449, 3 figures and 1 box) is a fitting conclusion to this volume. Culture change, the loss of traditional potters and their products because of acculturation, status, economic factors, cash economies, convenient substitutes (plastic); changes in decoration and style, form and function, and production and distribution; and conservatism are reviewed briefly.

Presently, there is only one other *current* text dealing with archaeological ceramic analysis -- almost completely Eurocentric: Clive Orton and Michael Hughes (2013*) Pottery in Archaeology*, 2nd ed., Cambridge Manuals in Archaeology, Cambridge: Cambridge University Press, 2013 [Kolb *SASB* 37(1):7-9, 2014]. Hence, Rice's outstanding and most comprehensive second edition (2015) is by far the ceramic "bible" of choice. *PA*2 has a very logical format beginning with a summary of the origins and history of pottery in different parts of the world, and then scrutinizes the physical and chemical properties of the raw materials of pottery. Next it focuses on ethnographic and ethnoarchaeological perspectives on pottery production, and examines the methods of studying pottery's physical, mechanical, thermal, mineralogical, and chemical properties. It would be a useful textbook as was its predecessor, but it is certainly designed as a "sourcebook" or reference work valuable to researchers, academics and students. Mine will certainly get a lot of use – thanks to the University of Chicago Press for producing a well-bound paperback copy.

Three other works related to ceramic studies are in the final publication stage or manuscript stage. Due later this year is *The Oxford Handbook of Archaeological Ceramic Analysis* edited by Alice Hunt, Oxford: Oxford University Press (in press 2015), with seven Parts (41 chapters): Introduction (2 chapters), Research Deign and Data Analysis (4 chapters), Foundational Concepts (8 chapters), Evaluating Ceramic Provenance (13 chapters), Investigating Ceramic Manufacture (9 chapters), Assessing Vessel Function (3 chapters), and Dating Ceramic Assemblages (2 chapters). In the final production stage is *Integrative Approaches in Ceramic Petrography* edited by Mary Ownby, Isabelle Druc, and Maria Masucci, with 14 chapters, being published by the University of Utah Press in late 2016. Close behind is *Approaches to Archaeological Ceramics*, 2nd ed. by Carla Sinopoli and Kostalena Michelaki for Springer Publishers. Also due in 2016 is *The Encyclopedia of Geoarchaeology* (Alan S. Gilbert, ed.), New York: Springer Publishers, which includes a 9,000-word article "Ceramics" by Kolb.

Delightful quotes from literature, science, and anthropology follow each of the titles of Rice's *PA*1 and *PA*2 chapters. I'll end with one from my dissertation: "Ceramic decoration is the 'litmus paper' of history; it results without error to any kind of action from without, but at the same time develops according to fixed internal laws." Igor N. Hlopin "Ancient Farmers of the Tedzen Delta," *East and West* 24(1-2):51-87 (March-June 1974) p. 87.

Craft and Science: International Perspectives on Archaeological Ceramics, Marcos Martinón-Torres (ed.), UCL Qatar Series in Archaeology and Cultural Heritage,

Volume 1. Doha: Bloomsbury Qatar Foundation, 2014. xiv + 279 pp. ISSN: 2312-5004, ISBN: 978-9927-101-75-5. Hardcopies are available and there is an option to print on demand or download for e-readers. There is a gratis PDF (13.5 MB) online at http://www.qscience.com/page/books/uclq-cas The editor, Marcos Martinón-Torres, is Professor of Archaeological Science at the UCL Institute of Archaeology, where he co-ordinates an MSc in the Technology and Analysis of Archaeological Materials and supervises research students working on ancient materials and technologies across the world. The initial idea to publish this volume emerged while preparing the *10th European Meeting on Ancient Ceramics* (EMAC09), co-organized by the University College London (UCL) Institute of Archaeology and the Dept. of Conservation and Scientific Research, British Museum in London. The presentations were given in the Clore Center of the British Museum, 10-13 September 2009. *Most* of the papers were selected from posters and oral presentations originally delivered at that conference, subsequently peer-reviewed and revised by the authors, but a few contributions were invited to "complete the geographic and temporal coverage, or generally to enrich the diversity of approaches represented." The editor points out that the resulting volume, "while far from being comprehensive, offers a rather wide snapshot of current research on archaeological ceramics spanning from Neolithic painted wares to 18th-century porcelain, from the Americas to China." Comparing this published version with 29 contributions to the original abstracts of presentations http://www.ucl.ac.uk/EMAC09/Abstractbook (41 lectures and 47 posters), we find that: Lectures remaining as a chapter (n = 14), posters prepared as a written chapter (n = 10, one with a new title), new chapters (n = 3), and original authors submitting new contributions (n = 2). Geographically, Africa, Southwest Asia, Central Asia and portions of Europe appear to be underrepresented – although two Central Asian papers had originally been presented at the conference.

"Foreword" by editor Marcos Martinón-Torres (pp. xiii-xiv) http://www.qscience.com/userimages/ContentEditor/1417439581043/ucl.2014.ch.foreword.pdf. He comments that ceramics are among the most abundant materials recovered in archaeological sites. Traditionally, they have served as the main staple for archaeologists to establish chronological sequences within sites and cultural affiliations between sites. They are also a primary source for a wealth of information about past economies, social structures and ritual behavior. Inevitably, some research methods are well-established in some regions, whereas they are still emerging in others. He also contends that the integration between science-based approaches and archaeological theory is uneven. However, he states, emerging academic traditions, and those in less-resourced regions, should not be overshadowed by the more established paradigms. Martinón-Torres rightly points out that while it is impossible to keep up with all the work carried out on archaeological ceramics worldwide, it is essential that researchers continue to exchange and compare their methods, results and ideas, and that these are made available to a broader archaeological readership. His edited book aims to facilitate this exchange and update of information on diverse approaches to archaeological ceramics across much of the world. "Pots as signals: Explaining the enigma of long-distance ceramic exchange" by Hector Neff (pp. 1-11), was presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414586624565/ucl.2014.ch1.pdf Ceramic pots do not travel well because they are bulky and fragile. "Further, the raw materials for pottery make up most of the earth's surface, so perfectly adequate pots can be made virtually anywhere on earth." Neff states that there would appear to be "little rational" economic motive for long-distance ceramic exchange. Yet, ceramic provenance investigations consistently demonstrate that pots did travel often over huge distances. In his paper he discusses some striking instances from prehistoric Mesoamerica of long-distance ceramic exchange, considers signaling theory and explains this seemingly irrational human behavior. Costs of transport rise dramatically with distance, especially in the absence of water-borne, animal, or motorized transport, thus, if a pot is recognizably foreign, it is guaranteed to be a high-cost vessel and thus a reliable signal of an individual's control of or access to resources. Comparisons of long-distance ceramic exchange patterns in Early Formative, Classic, and Early Postclassic Mesoamerica appear to accord with this hypothesis, and the hypothesis also serves as a guide for future research. "Lessons from the Elephant's Child: Questioning ancient ceramics," Clive R. Orton (pp. 13-18), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414586763234/ucl.2014.ch2.pdf This paper presents a brief overview of the present state of the scientific study of ancient ceramics, focused through six key questions – what, why, when, how, where and who. The relative importance of each question is assessed by means of a brief literature search. The overview is preceded by a summary account of developments over the last 50 years or so, and is followed by a discussion of the role of sampling in such studies, and of the need for good communication between the field and the laboratory. "Inferring provenance, manufacturing technique, and

firing temperatures of the Monagrillo ware (3520–1300 cal BC), Panama's first pottery," Fumie Iizuka, Richard Cooke, Lesley Frame, and Pamela Vandiver (pp. 19-30), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414586791953/ucl.2014.ch3.pdf Monagrillo (3520-1300 cal BC) is Panama's oldest pottery. Archaeologists assumed it was a low-fired expedient ware made with any available clay. The authors studied 1) clay sources (thin sections; DTA; shrinkage, porosity, and plasticity tests), 2) manufacturing techniques (xeroradiography, thin sections, and by visual inspection), and 3) firing temperature (SEM-EDS; porosity tests). They identified two clay types, one restricted to the Pacific coast, one widely distributed. Vessels were made by layering slabs and occasionally lumps. Rim- and lip-finishing is variable, firing temperature (>800–950°C) is relatively high for open firing, and porosity is quite low. These aspects indicate that Monagrillo was not an experimental or expedient ware.

"The use of andesite temper in Inca and pre-Inca pottery from the region of Cuzco, Peru," Rob Ixer, Sara Lunt, and Bill Sillar (pp. 31-38), new title and presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414586825906/ucl.2014.ch4.pdf Using ceramic petrography, a fabric of Cuzco Inca pottery is compared with those of two pre-Inca wares, Killke and Lucre. Andesite temper is identified in both the Lucre and Cuzco Inca fabrics. This is compared with andesite from the Rumicolca Formation and a match is found for some of the material. Lucre is identified as a technological precursor to Cuzco Inca. The possibility that the temper and Inca building stone came from the same source is mooted but cannot be confirmed based on the present evidence. "50 left feet: The manufacture and meaning of effigy censers from Lamanai, Belize," Linda Howie, James Aimers, and Elizabeth Graham (pp. 39-51), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414586825906/ucl.2014.ch5.pdf Elaborate human effigy censers are widely distributed at sites across the Maya lowlands in the Late Postclassic period (ca. 1250-1540 AD). These censers represent people dressed in costumes, combining martial and supernatural elements. They may have been broken at various sites as part of rituals associated with pilgrimage, but details of their production, movement across the landscape, and meaning remain unclear. A stylistically varied assemblage of fragmented censers of this type has been recovered from Lamanai, Belize, and has been subjected to detailed stylistic, iconographic, and petrographic examination. The results of this study have revealed a higher level of variability in visual and compositional characteristics than has been recognized previously, demonstrating connections to both local and foreign producers, and to several geographically distant production localities. A central focus of the paper is a discussion of methodological issues relating to the integration of extensive data sets characterizing compositional and stylistic/iconographic attributes, including the interplay of variability in technological and provenance characteristics and style. The authors also explore the significance of integrated approaches to understanding Maya interregional interaction just prior to the Spanish conquest. "Molding the 'collapse': Technological analysis of the Terminal Classic molded-carved vases from Altun Ha, Belize," Carmen Ting, Elizabeth Graham and Marcos Martinón-Torres (pp. 53-63), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414586825906/ucl.2014.ch6.pdf Technological analyses by visual examination, thin-section petrography, INAA and SEM-EDS of an assemblage of elite serving vessels from the site of Altun Ha, Belize, provide important data on technology and organization of production. According to the manner in which they were decorated, these vessels are referred to in the literature as 'molded-carved', but prior research has also shown that they share a distinctive iconographic program. Evidence so far indicates that they constitute a ceramic tradition that is reflective of social and political changes that characterized the Terminal Classic period in the Maya lowlands. The results of the technological analyses combined with prior research on contexts, iconography and glyphic texts suggest that alterations in political and social systems during the Terminal Classic stimulated changes not only in the type of elite pottery being produced but also in the manufacturing technology and concomitantly in the organization of production. "Ceramic technology and the global world: First technological assessment of the Romita ware of Colonial Mexico," Javier G. Iñañez (pp. 65-71), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414586825906/ucl.2014.ch7.pdf Romita Ware is a unique ceramic found in Colonial archaeological contexts throughout Mexico. The ceramic features a white slip and a very thin transparent lead-silica glazed outer coating on top. The characterization of the technological choices adopted in the production of Romita ware is assessed by means of SEM. "Pottery production in Santa Ponsa (Majorca, Spain) from the Late Bronze Age to the Late Iron Age (1100–50 BC): Ceramics, technology and society," D. Albero Santacreu, J. García Rosselló, and M. Calvo Trias (pp.73-83), a new contribution. http://www.qscience.com/userimages/ContentEditor/1414586825906/ucl.2014.ch8.pdf The authors represents a

study of hand-made ceramics from different Late Bronze Age to Late Iron Age (1100-50 BC) archaeological sites located in Majorca (Spain), combining petrography, X-ray powder diffraction, X-ray fluorescence, and scanning electron microscopy. The analysis of the ceramic samples focused on the establishment of specific chaînes opératoires. Their analysis is a useful tool for assessing different technological traditions of pottery production throughout prehistory. This theoretical and methodological approach, in agreement with the historical context, permits the interpretation of significant social and technical practices related to pottery production. As the data suggest, the preparation of pottery pastes underwent great changes during the periods under consideration, and especially between the sherds from the different archaeological sites studied. The changes likely occurred in response to new dynamics in the social organization of pottery production, knowledge transmission systems, and learning contexts in the investigated area. "Archaeometric investigation of Punic lamps from Ibiza (Balearic Islands, Spain)," Bruno Fabbri, Sabrina Gualtieri, and Enrico Acquaro (pp. 85-89), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch9.pdf Punic shell-shaped lamps are attested in the Island of Ibiza for a period of almost five centuries (6th-2nd century BC). These two-spouted (Bilicni) lamps gradually evolved from an open to a closed shape, as shown by the six typologies identified on the island. The results of archaeometric investigations indicate that the lamps were locally manufactured using the same type of clays throughout this period; that is calcium-rich fine clay. The absence of specific treatments for the clays and the low firing temperature confirm the scarce quality of the products, as macroscopically ascertained. This may be justified by the possible votive function of the lamps, considering the high number of artifacts without traces of combustion.

"Ceramic technology between the Final Bronze Age and the First Iron Age in NE Italy: The case of Oppeano (Verona)," Massimo Saracino, Lara Maritan, and Claudio Mazzoli (pp. 91-100), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch10.pdf An archaeometric study of pottery from the settlement of Oppeano (Verona, NE Italy) indicates important changes in production technology taking place between the 10^{th} and 5^{th} centuries BC. Ceramic production in the Final Bronze Age was characterised by the use of grog, as in other coeval sites of the southern Adige and eastern Po plains. From the beginning of the Iron Age, the number of recipes increased considerably, the use of grog gradually decreased, and cases of importation are also attested. These changes were probably due to increasing socio-economic complexity and the introduction of new production techniques. "Hispanic *terra sigillata* productions documented on the Catalan coast: Some unexpected results and new issues," Marisol Madrid i Fernández and Jaume Buxeda i Garrigós (pp. 101-108), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch11.pdf Archaeological research has recovered significant amounts of Hispanic terra Sigillata (HTS) dated back to the 1^{st} century AD on the Catalan coast, an area traditionally considered within the influence of Gaulish *sigillata* during that period. Moreover, several new HTS workshops have also been recently discovered in this area. In order to shed light on the provenance and exchange structures of HTS, 86 samples from the sites of Baetulo, Emporiae, and Tarraco were analysed by means of WD X-ray fluorescence (WD-XRF), X-ray diffraction (XRD), and scanning electron microscopy (SEM). The results show that almost no HTS from workshops other than Tricio, located inland, were commercialized on the Catalan coast, in spite of the proximity of other workshops. "The ways of the lustre: Looking for the Tunisian connection," Yona Waksman, Claudio Capelli, Trinitat Pradell, and Judit Molera (pp. 109-116), apparently a different paper. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch12.pdf Recent excavations at the Fatimid and Zirid site of Sabra al-Mansuriya near Kairouan (Tunisia) provide the first evidence of lustreware production in medieval Ifriqiya, in the 10^{th}-11^{th} centuries AD. As the Fatimid dynasty moved from Ifriqiya to Egypt to establish its capital in Fustat (Cairo), technological connections with the Egyptian lustreware could be expected. Tunisian lustreware may also be the link in the transmission of the technique towards Muslim Spain. It represents a new piece of the puzzle of understanding the diffusion of lustre technology from the East to the West of the Mediterranean. The composition and microstructure of the bodies and glazes, and the micro- and nano-structure of the lustre layer are compared in a preliminary approach to the technological relationships between Tunisian, Egyptian, and Spanish lustrewares. "Capodimonte porcelain: A unique manufacture," Bruno Fabbri, Sabrina Gualtieri, and Francesca Amato (pp. 117-124), presented as a lecture in 2009.
http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch13.pdf Established in 1743 in Naples following a commission of Charles of Bourbon, the factory of Capodimonte was dedicated to the production of porcelain. The history of the manufacture and its products are well known, but not the production techniques and the raw materials used. This work presents

the results of the archaeometric characterization of Capodimonte porcelain. Chemical analyses by means of SEM-EDS, observation by optical microscopy in thin section, and crystalline phase composition by X-ray diffraction were carried out in order to investigate the characteristics of the raw materials used for the ceramic body and to establish the firing conditions. The pastes of Capodimonte porcelain are siliceous and show a homogeneous chemical composition, permitting us to infer that the more likely formulation of the starting batch was: 70-75% of quartz rich sand, 15-20% of clay, and 5-10% of soda and may be tartar. In contrast, the pastes show different proportions of crystalline phases (quartz, cristobalite, and tridymite), which allow us to evaluate a firing temperature range of 1050 -1300°C. Capodimonte porcelain is significantly different from all other contemporary European porcelain. It would thus probably be appropriate to design a new category for it, which could be called "siliceous porcelain." "Late Neolithic pottery productions in Syria. Evidence from Tell Halula (Euphrates Valley): A technological approach," Anna Gómez, Walter Cruells, and Miquel Molist (pp. 125-134), apparently a different paper. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch14.pdf The pottery production from Tell Halula, dating from the late Neolithic period, reveals the economic and social complexity of this community in the middle Euphrates valley. Throughout the study of pottery assemblages in the context of field work projects carried out from 1996 to 2007, combined traditional morphostylistic analysis with technological ones. The authors present the current status of research on the final stage of the Halaf culture, commonly known as Late Halaf. The results are focused on manufacturing techniques, with the aim to identify several pottery productions and variability patterns.

"Assyrian palace ware definition and chaîne opératoire: Preliminary results from Nineveh, Nimrud, and Aššur," Alice M. W. Hunt (pp. 135-142), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch15.pdf Palace ware, an 8th-7th century BC drabware, is used as an indicator of Neo-Assyrian imperial elite contact and occupation, despite the lack of an established definition. Definitional criteria must incorporate formal characteristics, such as shape, and manufacture behaviors', such as raw material processing, in order to facilitate the distinction between imported or Assyrian produced vessels and imitations from the imperial provinces. This paper presents eleven preliminary definitional criteria for palace ware based on petrographic analysis and scanning electron microscopy of 24 sherds, radiography of 9 vessels, and typological analysis of 75 vessels from the Neo-Assyrian imperial heartland: Aššur, Nineveh, and Nimrud. "Messages impressed in clay: Scientific study of Iron Age Judahite bullae from Jerusalem," Yuval Goren, Shira Gurwin. and Eran Arie (pp. 143-149), apparently a new contribution. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch16.pdf This study was aimed at providing the opportunity to analyze some as yet undetermined aspects of the Judahite bullae. Since it is widely believed that bullae were used to seal documents or small parcels sent from one authority to another, ensuring the discrete reading of a message or opening of the parcel by the addressee alone, the authors first attempted to disclose the geographical origin of the bullae through the provenance of their clays, in order to map the network of the administrative correspondence of Judah during the middle to the end of the Iron Age. The research project was planned to be made several stages. In the first stage they examined the structural and technical aspects of the bullae based on surface microscopic observations under a stereomicroscope, with magnifications ranging between 10 to 100 times. In the second stage, minute samples were extracted from the bullae by the peeling technique and examined in thin sections under the petrographic microscope. Both the petrographic and the ESEM analyses revealed that the entire two groups of bullae from the City of David in Jerusalem were made of Terra Rossa soil, having the same mineralogical composition of silt and temper inclusions. "The geochemistry and distribution of Archaic, Classical, and Hellenistic wares of the territory of ancient Sagalassos (SW Turkey): A reconnaissance study," Dennis Braekmans, Patrick Degryse, Jeroen Poblome, Bert Neyt. and Marc Waelkens (pp. 151-163), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch17.pdf A reconnaissance survey carried out within the territory of Sagalassos yielded vast amounts of unknown ceramic wares, tentatively dated to the Archaic, Classical, and Hellenistic periods. An archaeometric program including geochemical analysis and applied multivariate statistics was applied in order to grasp the diversity of the wares and consequently identify variability in production. Within the chemical spectrum, it becomes clear that at least two large production groups exist, with a substantial "internal" distribution of wares. Elemental evidence supports the hypothesis of a local production of ceramics related to the geographical situation of the sites. "The colour and golden shine of early silver Islamic lustre," P. C. Gutierrez, T. Pradell, J. Molera, A.D. Smith, A. Climent-Font, and M. S. Tite (pp. 165-171), apparently a new contribution. http://dx.doi.org/10.5339/uclq.2014.cas.ch18 A selection of lustres including 9th century AD polychrome and 10th

century AD monochrome Abbasid lustres from Iraq, and 10th to 12th centuries AD Fatimid lustres from Egypt and Syria are studied in the paper. The selection is based on previous studies that demonstrated that all of them contain metal silver nanoparticles and copper, which, when present, appears either as Cu^{+} or Cu^{2+} dissolved in the glaze. They show different colors, green, yellow, amber, and brown, and may also show or lack a golden-like reflectivity, which results mainly from average size and concentration in the layer of the silver nanoparticles. In this paper, a depth profile composition of the lustre layers is determined using Rutheford Backscattering Spectroscopy (RBS), allowing the determination of the total silver content, concentration of silver, copper to silver ratio, and thickness of the lustre layers. The authors show that the enhanced golden-like reflectivity occurs only for layers with a high concentration of silver, and that the addition of PbO to the alkaline glaze helps the formation of more concentrated layers. The results obtained provide new clues concerning the lead enrichment of the glazes during this period. "Experiments with double chamber sunken up-draught kilns," Dragos Gheorghiu (pp. 173-179), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch19.pdf Sunken up-draught kilns appeared in the 5th millennium BC in the context of the South Eastern European Chalcolithic Cucuteni-Tripolye tradition, as a mechanism for the mass production of ceramics fired at temperatures up to 900°C. Compared with the other pyro-instruments of the respective epoch, the sunken up-draught kiln presented a series of advantages, such as high temperatures, protection of vessels made of fine paste, and a higher output of vessels. Experiments allowed identifying and refining the stages of the chaîne opératoire of this type of kiln, as well as the discovery of new features, such as ergonomics or micro-physical processes, which will help archaeologists understand the complex technology involved in Chalcolithic ceramic making. Petro-mineralogical and geochemical characterization of Middle Neolithic Bükk Culture fine ware from Garadna, NE Hungary," V. Szilágyi, K. T. Biró, P. Csengeri, Gy. Szakmány, H. Taubald, J. Mihály, C. Berthold, J. S. Koós, and J. Zöldföldi (pp. 181-189), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch20.pdf As a continuation of previous research carried out by the authors, further characterization and provenancing of Middle Neolithic Bükk pottery (NE Hungary) were undertaken for the purposes of this study. In the context of the current project, a systematic and representative study of Bükk pottery products was initiated at the core of the tribal area. The basic aim was to compare Bükk fine ware from different sites and to identify local or regional raw materials and production technology. In addition, characteristic incrustation of this fine ware is currently under observation. The current paper summarizes the first results obtained at an important site related to the Bükk Culture in NE Hungary, Garadna - Elkerülo˝ út, Site No. 2, the object of a recent large scale rescue excavation. At this site, material belonging to the typology of Bükk fine ware of consecutive chronological phases showed strong similarities, and indicted that the artifacts might have been made from local raw material. Additional conclusions on the collective features of Bükk fine ware were also added. On the one hand, it was proved once again that raw materials of specific, delimited physical properties were utilized by potters making Bükk fine ware at different sites. This suggests the technological preparedness of craftsmen when selecting raw material. On the other hand, the formerly published hypothesis concerning a restricted chemical composition of this raw material appears controversial.

"Archaeometric investigation of Celtic graphitic pottery from two archaeological sites in Hungary," Izabella Havancsák, Bernadett Bajnóczi, Mária Tóth, Attila Kreiter, and Szilvia Szöllo (pp. 191-199), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch21.pdf Graphite-tempered ceramics from two Celtic archaeological sites in South Hungary, Dunaszentgyörgy (Highway No. 6) (LT B2-C1) and Bátaszék (Körtvélyes-du˝lo´´) (LT D), were investigated in the context of the present project. The main aim of the research was to compare the graphitic temper of the vessels found at the archaeological sites and to provide a preliminary outline about the possible provenance of the graphite. Ceramics from both Dunaszentgyörgy and Bátaszék contain similar graphitic temper: graphite fragments and clasts of graphitic paragneiss. Graphitic gneiss contains sillimanite and kyanite. Metamorphic rocks with similar medium- to high-grade minerals cannot be found in outcrops located on the territory of present-day Hungary. Based on the mineralogical composition, the potential source area of the graphitic temper can be restricted to the Variegated Unit of the Moldanubicum zone, in the Czech Republic. In addition to the graphitic rock fragments found as archaeological artifacts at Bátaszék, the comparison of graphite-tempered ceramics to non-graphite-tempered vessels from the same archaeological sites also suggests that graphite was imported as raw material and that ceramics were produced "locally." Firing temperatures for both graphitic and non-graphitic wares were usually below 800°C, and for several non-graphitic vessels below 650°C. "Archaeometric investigation of Buda White

Ware (12th-14th century AD, North Hungary): Initial questions and first results," V. Szilágyi, T. Á. Rácz, V. Gál-Mlakár, E. Simonyi, and I. E. Sajó (pp. 201-211), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch22.pdf The authors summarize the main archaeological questions regarding the medieval (12th-14th century) Buda White Ware (BWW), based on knowledge accumulated from the past 50 years of research. Considering the known facts and contradictions concerning typology, chronology, raw material sources and workshops, and distribution of this peculiar pottery group, the necessity of a scientific characterization of its composition becomes clear. The initial results are based on the investigation of a limited set of archaeological samples, but they confirm that the group of BWW, formerly described as homogenous, can be classified into at least three types based on differences in the raw materials used. In addition, there is evidence of contemporary lower quality imitations. These preliminary results establish the need for further analyses of a larger set of the BWW finds. "The ceramic technology of the architectural glazed tiles of Huangwa Kiln, Liaoning Province, China," Parallel developments in Chinese porcelain technology in the 13th-14th centuries," Baoqiang Kang, Simon Groom, Hongying Duan, Yinzhong Ding, He Li, Jianmin Miao, and Guanglie Lu (pp. 213-223), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch24.pdf An assemblage of architectural glazed tiles from Huangwa Kiln, Haicheng in Liaoning Province, was analyzed using XRF, XRD, and petrography. Microstructure and chemistry indicated the mixing of multiple components. Two potential raw materials for the tile body, a red argillaceous component and a white metamorphic component, were identified and analysed. Experimental replicas were prepared with varying recipes, investigating firing, refinement, and proportions of material, and compared with archaeological compositions. One of the proposed recipes offers a technological justification for the use of two raw materials. This work has clear implications for restoration work on two World Cultural Heritage sites in Liaoning Province. "Parallel developments in Chinese porcelain technology in the 13th-14th centuries AD," Nigel Wood and Sabrina Rastelli (pp. 224-234), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch24.pdf By the 14th century AD, Jingdezhen in Jiangxi province and the Longquan region of Zhejiang province were China's main centers for the manufacture of porcellaneous wares. Jingdezhen specialized in blue and white porcelain, while the Longquan kilns typically used opaque porcellaneous bodies, and smooth and thick, greenish celadon glazes. A pattern of parallel technological development is evident at Jingdezhen and Longquan in the 13th-14th centuries, but probably driven by rather different causes. Jingdezhen is representative of a simpler and more local technological history that seems entirely southern. Longquan however adopted a glaze-type that had already seen many prestigious applications in north China. Unlike the white-bodied Jingdezhen wares, the Longquan bodies were sometimes deliberately discolored with red clays, perhaps to harmonize with their jade-like greenish glazes. "Luminescence dating of ceramic building materials: application to the study of early medieval churches in north-western France and south-eastern England," S. Blain, I. K. Bailiff, P. Guibert, C. Sapin, D. Prigent, and A. Bouvier (pp. 235-242), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch25.pdf This study focuses on early medieval buildings in England and France, specifically on those displaying the presence of brick in their masonry. The purpose was to determine whether medieval builders reused salvaged Roman building materials or if the bricks used were contemporary to the building under construction. Luminescence dating was applied to bricks sampled from 11 standing Anglo-Saxon or Carolingian churches. The luminescence dates show that the two types of practice were in use in both countries. Where contemporary brickmaking appears to be the case, the study also provided a more precise chronology of the buildings.

"Computerized documentation of painted decoration on pottery vessels using 3D scanning," David Ben-Shlomo, Avshalom Karasik, and Uzy Smilansky (pp. 243-252), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch26.pdf The authors examine the possibility of the incorporation of painted decoration on pottery into the computerized documentation of ceramics, using 3D scanning. A new method is described for the recording of standard decorations painted on the surfaces of pottery vessels as 2D images, viewed in various projections. The diverse images are captured directly from the 3D model after it was accurately positioned. The output is automatically incorporated in the final publication together with the final drawing of the vessel. Several archaeological examples are presented and discussed. Insights into manufacturing techniques of archaeological pottery: Industrial X-ray computed tomography as a tool in the examination of cultural material," Stephan Karl, Daniel Jungblut, Hubert Mara, Gabriel Wittum, and Susanne Krömker (pp. 253-261), presented as a poster in 2009. http://www.qscience.com/userimages/ContentEditor/1414

588802444/ucl.2014.ch27.pdf The application of x-radiography in ceramic studies is becoming an increasingly valued method. Using the potential of industrial x-ray computed tomography (CT) for non-destructive testing as an archaeometric or archaeological method in pottery studies, especially regarding aspects such as manufacturing techniques or pottery fabrics, requires controlled data-acquisition and post-processing by scientific computing adjusted to archaeological issues. The first results of this evaluation project show that, despite the difficulties inherent in CT technology, considerable information can be extracted for pottery analysis. The application of surface morphology reconstructions and volumetric measurements based on CT data will open a new field in future non-invasive archaeology. "Thermal shock resistance of tempered archaeological ceramics," Noémi S. Müller, Vassilis Kilikoglou, Peter M. Day, and George Vekinis (pp. 263-270), presented as a lecture in 2009. http://www.qscience.com/userimages/ContentEditor/1414588802444/ucl.2014.ch28.pdf The principles governing thermal shock resistance are introduced briefly, followed by the presentation of an experimental study conducted to assess the influence of temper and firing temperature on the thermal shock resistance of clay-based ceramics. Focusing on the assessment of a material's capability to resist thermal stresses, difficulties which arise when interpreting experimental results are discussed. The authors report that thermal shocking may induce a change in fracture mode in the ceramics, a finding which has important implications for the interpretation of experimental results and the assessment of the performance of ceramic vessels when exposed to sudden thermal stresses. In the main, it appears that for coarse cooking ware pottery, thermal shock resistance might not play such an important role as frequently has been assumed. Limited thermal shocking might even be beneficial for a ceramic's subsequent exposure to thermal stresses, as it can result in a change in fracture mode and may increase the toughness of the material. "The second life of ceramics: a new home in a lime environment," Ioannis Karatasios, Konstantinos Alexiou, Noémi S. Müller, Peter M. Day, and Vassilis Kilikoglou (pp. 271-279), presented as a lecture in 2009. http://dx.doi.org/10.5339/uclq.2014.cas.ch29 This paper presents the results of a systematic investigation of the pozzolanic activity of different types of ceramic admixtures, as a function of their chemical composition (calcareous, noncalcareous) and vitrification state. The study was carried out on experimental ceramic-lime mixtures. The evaluation of the reactivity of the different ceramic admixtures includes conductivity measurements of the saturated calcium hydroxide solutions to which they were added, assessment of the amount of hydrated calcium alumino-silicate phases formed, and determination of the microstructure of the resulting solid material. The experimental results of this study provide a baseline against which the performance of different archaeological mortars can be discussed. Low-fired calcareous ceramics with no or limited vitrification have been found to exhibit good reactivity with slaked lime, while high- fired non-calcareous ceramics present no reactivity.

ARCHAEOLOGICAL CHEMISTRY

Ruth Ann Armitage, Associate Editor

Rather than summarize all recent developments in archaeological chemistry, I'll focus here on bringing your attention to a few archaeologically-relevant papers in the chemistry literature and the upcoming American Chemical Society (ACS) national meeting in Boston. As always, if anyone has chemistry-related topics or news to include in future columns, never hesitate to contact me.

A relatively recent review (Nigra, et al. 2015) describes some of the pitfalls associated with applying analytical chemistry to archaeological materials. The review provides a historical overview of the discipline, starting with Alfred Lucas, the chemist recruited by Howard Carter to study the Tutankhamun tomb materials. Brief overviews of the most widely used archaeological chemistry methods are presented. While there are textbooks that obviously go into much greater detail in all of these methods, the review is a short introduction to archaeological chemistry that, being published in an ACS journal, should reach an audience of chemists unfamiliar with our discipline.

Applications of nuclear magnetic resonance (NMR), either for imaging or chemical characterization, are not commonly encountered in archaeological chemistry, but Zhu, et al. (2015) describe a unique approach to using magnetic resonance imaging and proton NMR to understanding the tanning process used in the Arctic to preserve reindeer skins. Of particular note is the application of the "NMR MOUSE", a non-invasive method for depth profiling the composition of organic materials. The NMR results helped to clarify how different tanning methods – the application of cod-liver oil compared to tannins derived from willow bark – affect the cross-linking of the collagen in the animal skins.

The determination of collagen and its preservation in bone is extremely important in archaeological studies. An upcoming poster presentation in the Environmental

Chemistry sessions at the ACS National Meeting in Boston by Vesper, et al. (2015) describes the use of portable hand-held Raman spectroscopy for non-destructive quantitative analysis of collagen in bone. The authors claim that the method has great potential for field use in screening collections for further analysis of paleodiet, radiocarbon dating, and ancient DNA. Be on the lookout for a future paper from these authors on the topic.

The recent release of mining waste into the Animas River in the western United States is a reminder that the acquisition and processing of metals leaves a mark on the environment. How long the legacy of such activities is preserved in environmental records is the focus of a paper in *Environmental Science and Technology* by Hillman, et al. (2015). *ES&T* is not a journal in which one expects to find a paper of interest to those studying the last 5000 years of copper and silver metallurgy in the Yunnan Province of China. The paper uses the analysis of well-dated cores from Erhai Lake to make inferences about land use and metals processing in the area over a period spanning from the Han Dynasty to the present.

Of course there are many more papers showcasing applications of chemistry in archaeology, and this is merely a small sampling from the ACS journals published in 2015. ACS has, within the Division of the History of Chemistry, a "subdivision" of Archaeological Chemistry. In 2012, when organizing the most recent Archaeological Chemistry Symposium for ACS, the membership roster for the subdivision consisted of 118 people (myself and a few other SAS members included). This is a very small segment of ACS (0.07%), a 158,000-member organization. If any SAS members are also ACS members, please consider joining HIST and the ARCH subdivision when you renew your ACS membership. The time is rapidly approaching for the next Symposium (ideally in 2018 or so), and the sooner someone steps up to organize it, the better!

References cited

Hillman, A. L., M. B. Abbott, J. Q. Yu, D. J. Bain and T. Chiou-Peng. 2015 Environmental Legacy of Copper Metallurgy and Mongol Silver Smelting Recorded in Yunnan Lake Sediments. *Environmental Science & Technology* 49(6):3349-3357.

Nigra, B. T., K. F. Faull and H. Barnard. 2015. Analytical Chemistry in Archaeological Research. *Analytical Chemistry* 87(1):3-18.

Vesper, B., M. Colvard, G. Cordell and W. Pestle. 2015 ENVR 481: Non-destructive screening of collagen content in archaeological bone samples using hand-held Raman spectroscopy. Paper presented at the 250th ACS National Meeting and Exposition, Boston, MA.

Zhu, L., E. Del Federico, A. J. Ilott, T. Klokkernes, C. Kehlet and A. Jerschow. 2015 MRI and Unilateral NMR Study of Reindeer Skin Tanning Processes. *Analytical Chemistry* 87(7):3820-3825.

ARCHAEOMETALLURGY

Thomas R. Fenn, Associate Editor

The column in this issue includes the following categories of information on archaeometallurgy: 1) New Books; 2) New Book Chapters/Articles; 3) Doctoral and Master Theses; 4) Forthcoming Meetings; 5) Previous Meetings; 6) Research and Education Opportunities; and 7) Web-based Resources.

New Books

Metals in Past Societies: A Global Perspective on Indigenous African Metallurgy, by Shadreck Chirikure, 2015, Springer Briefs in Archaeology: Contributions from Africa, Springer International Publishing, xxi+166 pgs, 63 figs, 3 tabs, ISBN: 978-3-319-11640-2; (pbk.); 978-3-319-11641-9 (ebk.), Softcover 51.99 €, eBook 41.64 €. This book seeks to communicate to both a global and local audience, the key attributes of pre-industrial African metallurgy such as technological variation across space and time, methods of mining and extractive metallurgy and the fabrication of metal objects. These processes were transformative in a physical and metaphoric sense, which made them total social facts. Because the production and use of metals was an accretion of various categories of practice, a *chaîne opératoire* conceptual and theoretical framework that simultaneously considers the embedded technological and anthropological factors was used.

The book focuses on Africa's different regions as roughly defined by cultural geography. On the one hand there is North Africa, Egypt, the Egyptian Sudan, and the Horn of Africa which share cultural inheritances with the Middle East and on the other is Africa south of the Sahara and the Sudan which despite interacting with the former is remarkably different in terms of technological practice. For example, not only is the timing of metallurgy different but so is the infrastructure for working metals and the associated symbolic and sociological factors. The cultural valuation of metals and the social positions of metal workers were different too, although there is evidence of some values transfer and multi-directional technological cross borrowing. The multitude of permutations associated with metals production and use amply demonstrates that metals participated in the production and reproduction of society.

Despite huge temporal and spatial differences there are so many common factors between African metallurgy and that of other regions of the world. For example, the role of magic and ritual in metal working is almost universal be it in Bolivia, Nepal, Malawi, Timna, Togo or Zimbabwe. Similarly, techniques of mining were constrained by the underlying geology but this should not in any way suggest that Africa's metallurgy was derivative or that the continent had no initiative. Rather it demonstrates that when confronted with similar challenges, humanity in different regions of the world responded to identical challenges in predictable ways as mediated by the prevailing cultural context.

The success of the use of historical and ethnographic data in understanding variation and improvisation in African metallurgical practices flags the potential utility of these sources in Asia, Latin America and Europe. Some nuance is however needed because it is simply naïve to assume that everything depicted in the history or ethnography has a parallel in the past and vice versa. Rather, the confluence of archaeology, history and ethnography becomes a pedestal for dialogue between different sources, subjects and ideas that is important for broadening our knowledge of global categories of metallurgical practice.

The book is divided into seven chapters and includes references at the end of each chapter and a final general index. The chapters comprise: 1) Metals and the Production and Reproduction of Society; 2) Origins and Development of Africa's Preindustrial Mining and Metallurgy; 3) Mother Earth Provides: Mining and Crossing the Boundary Between Nature and Culture; 4) Domesticating Nature; 5) Socializing Metals; 6) The Social Role of Metals; and, 7) Bridging Conceptual Boundaries, A Global Perspective. PDFs of the table of contents and a sample of the text, as well as more information about purchasing this volume can be found at the publisher's website: http://www.springer.com/us/book/9783319116402.

Metallurgy in Ancient Ecuador: A Study of the Collection of Archaeological Metallurgy of the Ministry of Culture, Ecuador, by Roberto Lleras Pérez, 2015, Archaeopress Precolumbian Archaeology No. 5, Archaeopress Publishing Ltd, Oxford, UK, 210 pages, full color throughout, 25cm, ISBN: 9781784911607; e-ISBN: 9781784911614 (e-book, PDF), £28.00. Metallurgical activity was present in Ecuador from at least 1500 BC; by around the beginning of the Common Era metallurgical manufacture and use had extended to most of the Costa and Sierra. Regional styles soon evolved giving rise to high levels of technical craftsmanship and to shaping particular iconographic and decorative patterns. Copper, gold, silver and platinum were mined, processed and converted into thousands of ornaments, offerings, tools and weapons extensively used both by elites and by the common people. By 1450, the Incas had invaded most of the Ecuadorian Sierra and eventually they integrated the diverse metallurgical traditions into their state-managed metallurgical industry. The European conquest in the sixteenth century deeply affected the native metallurgical activities, even though in some regions copper continued to be worked throughout the colonial period. The reconstruction of the general outlines of this fascinating historical process was made possible through the study of the collection of archaeological metal objects of the Ministry of Culture and Heritage of Ecuador, the compilation of previous archaeological references, laboratory analyses and C14 dating of museum objects. This work is the first one of its kind to be published on the ancient metallurgy of Ecuador.

The book is divided into seventeen parts and includes references at the end. The chapters comprise: Introduction; The collection of the Ministry of Culture; Previous studies on the pre-Hispanic metallurgy of Ecuador; Metallogenesis and metal resources in Ecuador; Early finds and the Initial Period; Great Regional Groups: La Tolita – Tumaco; Great Regional Groups: Jama – Coaque; Great Regional Groups: Bahia; Great Regional Groups: Milagro – Quevedo; Great Regional Groups: Manteño – Huancavilca; Great Regional Groups: Puruha; Great Regional Groups: Cañari; Great Regional Groups: Carchi – Nariño; Isolated finds and problematic Groups; The Inca metallurgical integration; Iconography and symbolism in metallurgy; Synthesis; and An interpretative proposal for the development of metallurgy in Ecuador. More information on purchasing this book can be found at the publisher's website: http://archaeopress.com/ArchaeopressShop/Public/displayProductDetail.asp?id={1C1AEAE6-A149-4B7D-AAC5-FE82DD01A3B1}.

The Metallurgy of Roman Silver Coinage: From the Reform of Nero to the Reform of Trajan, by Kevin Butcher and Matthew Ponting, with contributions by Jane Evans, Vanessa Pashley and Christopher Somerfield, 2014, Cambridge University Press, Cambridge, UK, xxxii+797 pages, 227 b/w illus., 24 col., 118 tabs., 5 append., bibliography and index, ISBN: 978-1-107-02712-1 (hbk.), $170.00.The fineness of Roman imperial and provincial coinage has been regarded as an indicator of the broader fiscal health of the Roman Empire, with the apparent gradual decline of the silver content being

treated as evidence for worsening deficits and the contraction of the supply of natural resources from which the coins were made. This book explores the composition of Roman silver coinage of the first century AD, re-examining traditional interpretations in the light of an entirely new program of analyses of the coins, which illustrates the inadequacy of many earlier analytical projects. In addition, minor and trace elements, and lead isotopes, provide evidence for the supply of materials and refining and minting technology. Sometimes this allows us to determine the origin of the metal, whether freshly mined, or recycled. It can even pinpoint likely episodes of recycling old coins and, when combined with the study of hoards, hint at possible strategies of stockpiling of metal. The creation of reserves has a direct bearing on the question of the adequacy of revenues and fiscal health.

The organization of the book comprises twenty-two chapters divided between three main parts: Part I-General Introduction; 1) Roman silver coinage and monetary history; 2) Roman silver coinage and monetary stability; 3) A science on the margins of numismatics: a history of metrological and metallurgical studies; 4) Metrology and hoard analysis; 5) The issue of 'fineness', of instrumental analysis and of data quality; 6) Metallography and the production of denarius blanks; 7) The material sampled; Part II-The Denarius; 8) The Julio-Claudian background, 2 BC to AD 64; 9) The reforms of Nero, AD 64–68; 10) The Civil Wars, AD 68–69: Rome; 11) The western denarii of the Civil Wars; 12) From Vespasian to the reform of Domitian, AD 69–82; 13) The reforms of Domitian; 14) From Nerva to the reform of Trajan, AD 96–99; 15) The denarius: summary and conclusions; Part III provincial silver coinages; Introduction to Part III; 16) Cistophori of Asia; 17) Other provincial silver of Asia Minor; 18) Caesarea in Cappadocia; 19) Syria; 20) Egypt; 21) Provincial silver coinages: summary and conclusions; and 22) Summary of conclusions. Appendices consist of: Appendix 1 Silver content of imperial denarii; Appendix 2 Gold to silver ratio; Appendix 3 Coins of unusual or irregular composition; Appendix 4 Denarius hoards of the period from Caligula to Trajan's reform (AD 37–99); and Appendix 5 Key to figs. 15.1–15.4. More information on purchasing this book can be found at the publisher's website: http://www.cambridge.org/US/academic/subjects/classical-studies/ancient-history/metallurgy-roman-silver-coinage-reform-nero-reform-trajan.

New Book Chapters/Articles

The NARNIA Project: Integrating Approaches to Ancient Material Studies, edited by Vasiliki Kassianidou and Maria Dikomitou-Eliadou, 2014, The NARNIA Project and the Archaeological Research Unit, University of Cyprus, Nicosia, 272 pgs, col/b&w illus., ISBN: 9789963700875 (e-book). This book culminates much of the research undertaken as part of the NARNIA project. Divided into seven sections, or "work packages", "[t]he fourth work package of the NARNIA project is dedicated to the study of copper metallurgy. The production and trade of copper was decisive for the formation of the Bronze Age and was one of the guiding forces behind the establishment and transformation of trading networks in the eastern Mediterranean, throughout the long history of the region; the significance of copper and its alloys remained undiminished until Late Antiquity" (p. 107).

Contributions to the work package "Copper metallurgy in the eastern Mediterranean" consist of an "Introduction" (Vasiliki Kassianidou; pp. 107-109), "The production and trade of Cypriot copper in the Late Bronze Age" (Lente Van Brempt; pp. 110-121), "Unravelling technological issues of metallurgical ceramics from Cyprus: The case of Kition" (Demetrios Ioannides; pp. 122-133), "pXRF analysis of Cypriot copper alloy artefacts dating to the Late Bronze and the Iron Age" (Andreas Charalambous; pp. 134-145), "Into the crucible. Methodological approaches to reconstructing ancient crucible metallurgy, from New Kingdom Egypt to Late Roman Bulgaria" (Frederik Rademakers; pp. 146-155), and "Copper alloy production and consumption in the Tuscia region during the Middle Ages" (Mainardo Gaudenzi Asinelli; pp. 156-167). The e-book can be downloaded as a PDF at the following link: https://lekythos.library.ucy.ac.cy/bitstream/handle/10797/14341/The-Narnia-Project-EBOOK-%20low%20res.pdf?sequence=1.

Settlement and Metalworking in the Middle Bronze Age and Beyond: New Evidence from Tremough, Cornwall, edited by Andy M. Jones, James Gossip and Henrietta Quinnell, 2015, Sidestone Press, Leiden, 250 pgs, 93 illus. (b&w), 7 illus. (col.), ISBN: 9789088902932 (print), 9789088902949 (e-book PDF), 34.95 € (printed), 6.50 € (e-book PDF). Between 2008 and 2011 excavations were undertaken by the Cornwall Archaeological Unit at Tremough, near Penryn, Cornwall. The site is situated on a plateau overlooking the Carrick Roads, historically one of the busiest waterways in Cornwall. The excavations led to a large number of significant archaeological features being uncovered ranging from Neolithic pits to Bronze Age structures and late prehistoric enclosures. Foremost of these sites were a Middle Bronze Age roundhouse (circa 1500-1300 cal BC) and a large circular Late Bronze Age enclosure (circa 1000-800 cal BC). Importantly, the roundhouse was found to contain stone moulds associated with the production of socketed tools and pins, and traces of

metalworking were found inside the building. As such, the excavations have provided the first evidence for metalworking inside a Middle Bronze Age roundhouse in southern England, as well as radiocarbon dating for a range of metalwork forms. As part of the project, finds of metalwork from other roundhouses in the southwest region have been reassessed. The Late Bronze Age enclosure is the first of its type to be found in the southwest of Britain. It encircled a large number of pits and postholes, some of which were associated with rectangular postbuilt structures. A carefully made cairn of burnt stone beside a large pit and a second large pit containing burnt stone and pottery were also investigated. These may have been associated with cooking or perhaps with a small-scale episode of metalworking, as the tip of a sword mold was found in one of the pits. The significance of the investigated sites is fully discussed with regard to their relationships with other prehistoric sites on the plateau and in terms of their wider context with other sites in the Southwest and beyond. Of particular interest to the archaeometallurgists are Chapters 5 (The moulds and metalwork), 6 (Geochemical analysis of samples from Tremough) and 11 (Discussion: pits, deposition metalworking and circularity). Information about purchasing this book can be found at the publisher's website: www.sidestone.com.

From the book ***Pyla-Kokkinokremos: A Late 13th Century BC Fortified Settlement in Cyprus, Excavations 2010-2011***, by Vasos Karageorghis and Athanasia Kanta, 2014, *Studies in Mediterranean Archaeology*, Vol. CXLI, Åströms Förlag, Uppsala, comes "Appendix V. Chemical analyses of copper alloy artefacts from Pyla-Kokkinokremos using portable X-Ray Fluorescence" (A. Charalambous, Vasiliki Kassianidou; pp. 197-204).

Two new issues of ***The Crucible*** (Issue 88, Spring 2015 and Issue 89, Summer 2015) are available from ***The Historical Metallurgy Society (HMS)***. Issue 88 includes 12 pages of news, a Council-person introduction, reviews, interviews, and more. A PDF version of the issue is at: http://hist-met.org/images/hmsnews.88.pdf. Issue 89 includes 20 pages, with an Editorial, news, correspondence, interview, a Council-person introduction, reviews, and more. A PDF version of this will be available soon online and I will include the link in the next SAS Bulletin.

From the ***Journal of Archaeological Science*** (2015, Vol. 63) comes "3D numerical simulation on the flow field of single tuyere blast furnaces: A case study of the Shuiquangou iron smelting site dated from the 9th to 13th century in China" (Xing Huang, Wei Qian, Wei Wei, Jingning Guo, Naitao Liu; pp. 44-58), "The implication of varying ^{14}C concentrations in carbon samples extracted from Mongolian iron objects of the Mongol period" (Jang-Sik Park; pp. 59-64), and "Eneolithic copper smelting slags in the Eastern Alps: Local patterns of metallurgical exploitation in the Copper Age" (G. Artioli, I. Angelini, U. Tecchiati, A. Pedrotti; pp. 78-83), and from (2015, Vol. 62) comes "Eiland crucibles and the earliest relative dating for tin and bronze working in southern Africa" **(**Foreman Bandama, Simon Hall, Shadreck Chirikure; pp. 82-91), and from (2015, Vol. 61) comes "Crucible technologies in the Late Bronze—Early Iron Age South Caucasus: copper processing, tin bronze production, and the possibility of local tin ores" (Nathaniel L. Erb-Satullo, Brian J.J. Gilmour, Nana Khakhutaishvili; pp. 260-276), and from (2015, Vol. 59) comes "Identifying American native and European smelted coppers with pXRF: a case study of artifacts from the Upper Great Lakes region" (Laure Dussubieux, Heather Walder; pp. 169-178).

From ***Journal of Archaeological Science: Reports*** (2015, Vol. 3) comes "Archeometallurgical and technical characterization of 7th century AD Iron fishing-spear and fire basket found in the Dor lagoon, Israel" (A. Stern, D. Ashkenazi, D. Cvikel, B. Rosen, E. Galil; pp. 132-143), and from (2015, Vol. 2) comes "An insight into the organisation of metal production in the Argaric society" (Mercedes Murillo-Barroso, Ignacio Montero Ruiz, Gonzalo Aranda Jiménez; pp. 141-155), and "Archaeometallurgical analysis of metal remains from the Dor 2006 shipwreck: A clue to the understanding of the transition in ship construction" (Y. Kahanov, D. Ashkenazi, D. Cvikel, S. Klein, R. Navri, A. Stern; pp. 321-332).

From ***Archaeometry*** (2015, Vol. 57, No. 4) comes "The Composition and Microstructural Variation of the Bronze Age Metal Ornaments from Lower Silesia (South-West Poland): Chemical Analytical and Archaeological Aspects" (J. Puziewicz, J. Baron, Th. Ntaflos and B. Miazga: pp. 653-676), "Comparison of analytical techniques for analysis of archaeological bronze" (V. Lyubomirova, R. Djingova and I. Kuleff; pp. 677-686), "Metal Use and Production among Coastal Societies of the Atacama Desert" (V. Figueroa, D. Salazar, B. Mille and G. Manríquez; pp. 687-703), "Mineralogical and Chemical Characterization of Roman Slag from the Archaeological Site of *Castra* (Ajdovščina, Slovenia)" (S. Kramar, V. Tratnik, I. M. Hrovatin, A. Mladenović, H. Pristacz and N. Rogan Šmuc; pp. 704-719), and "The Role of Pattern-Welding in Historical Swords—Mechanical Testing of Materials Used in Their Manufacture (A. Thiele, J. Hošek, P. Kucypera and L. Dévényi; pp. 720-739), while from (2015, Vol. 57,

Supplement S1) comes "An Egyptian Partially Gilded Bronze Group Statue: Examination and Analysis (M. Ghoneim; pp. 130-146), and from (2015, Vol. 57, No. 3) comes "Evidence of Metallic Plating on Archaeological Artefacts by Voltammetry of Microparticles (E. Ottenwelter, V. Costa; pp. 497-504), and "Cargoes of Iron Semi-Products Recovered from Shipwrecks off the Carmel Coast, Israel (E. Galili, S. Bauvais, B. Rosen, P. Dillmann; pp. 505-535).

From ***American Journal of Numismatics***, (Second Series, 2014, Vol. 26), comes "pXRF Analysis of Cypriot Gold Coins of the Classical Period" (E. Markou, A. Charalambous, V. Kassianidou; pp. 33-60). From ***Palestine Exploration Quarterly*** (2015, Vo. 147, No. 3) comes "Solomonic Phobia or 10th Century BCE Phobia? Reponse to Zeidan A. Kafafi, "New insights on the Copper Mines of Wadi Faynan/Jordan", *PEQ* 146.4 (2014), 263-80" (Mohammad Najjar; pp. 247-253). From ***Southeastern Archaeology*** (2015, Vol. 34, No. 2) comes "A Fresh Look at a Little-Known Southeastern Copper Plate" (Amanda D. Roberts Thompson, Mark Williams; pp. 149-163). From ***Industrial Archaeology Review*** (2015, Vol. 37, No. 1), comes "Roşia Montană, Romani: Industrial Heritage *in situ*, between Preservation, Controversy and Cultural Recognition" (Florentina-Cristina Merciu, Andreea-Loreta Cercleux, Daniel Peptenatu; pp. 5-19).

Doctoral & Master Theses

Into the Crucible: Methodological approaches to reconstructing crucible metallurgy, from New Kingdom Egypt to Late Roman Thrace, by Frederik W. A. Rademakers (Doctoral thesis, Institute of Archaeology, University College London), 2015, 684 pages, 293 figures, 56 tables, 16 appendices, and bibliographical references.

The subject of this PhD thesis is the study of ancient metallurgical crucible assemblages, with a particular focus on the methodological framework for such studies. This is approached through three case studies from the eastern Mediterranean: Qantir–Pi-Ramesse (Ramesside Egypt, 13th century BC), Gordion (Late Phrygian/Achaemenid Anatolia, 6th-4th century BC) and Nicopolis/Philippopolis/Serdica/Stara Zagora (Roman Thrace, 2nd-5th century AD).

For each of these three case studies, the metallurgical activities are reconstructed and contextualized. This involves determining the technical processes, material use and organization of metal production both on the site and regional scale. No relation exists between these sites and each case study stands on its own: results from the technological reconstruction are interpreted within their particular archaeological and regional/historical context, to which they offer novel contributions.

The main research material consists of crucible remains, and to a lesser extent metal remains, which are investigated using optical microscopy and SEM-EDS to establish the technological processes and material use. The applicability of handheld XRF for such reconstructions is evaluated as well. Finally, lead isotope analysis (using MC-ICP-MS) of metal remains (scrap, spills, ingots, objects and prills extracted from crucible slag) and crucible ceramic and slag is performed.

The overarching goal of this research is to evaluate methodological approaches to the study of crucibles and crucible assemblages by comparing the results for these three examples, not in terms of technology, but by evaluating the influence of varying crucible typology, preservation, abundance, contextual information, and sample availability, as well as the use of various analytical techniques. These considerations are then combined to formulate more general recommendations for the sampling, examination and interpretation of ancient crucible assemblages.

Ironworking in late medieval Ireland,* c. *AD. 1200 to 1600, by Paul Rondelez (Doctoral thesis, Department of Archaeology, University College Cork, National University of Ireland), 2014, xvi+ pages, 100 figures, 47 tables, 7 appendices. Includes bibliographical references.

The landscape of late medieval Ireland, like most places in Europe, was characterized by intensified agricultural exploitation, the growth and founding of towns and cities and the construction of large stone edifices, such as castles and monasteries. None of these could have taken place without iron. Axes were needed for clearing woodland, ploughs for turning the soil, saws for wooden buildings and hammers and chisels for the stone ones, all of which could not realistically have been made from any other material. The many battles, waged with ever increasingly sophisticated weaponry, needed a steady supply of iron and steel. During the same period, the European iron industry itself underwent its most fundamental transformation since its inception; at the beginning of the period it was almost exclusively based on small furnaces producing solid blooms and by the turn of the seventeenth century it was largely based on liquid-iron production in blast-furnaces the size of a house. One of the great advantages of studying the archaeology of ironworking is that its main residue, slag, is often produced in copious amounts both during smelting and smithing, is virtually indestructible and has very little

secondary use. This means that most sites where ironworking was carried out are readily recognizable as such by the occurrence of this slag. Moreover, visual examination can distinguish between various types of slag, which are often characteristic for the activity from which they derive. The ubiquity of ironworking in the period under study further means that we have large amounts of residues available for study, allowing us to distinguish patterns both inside assemblages and between sites. Disadvantages of the nature of the remains related to ironworking include the poor preservation of the installations used, especially the furnaces, which were often built out of clay and located above ground. Added to this are the many parameters contributing to the formation of the above-mentioned slag, making its composition difficult to connect to a certain technology or activity. Ironworking technology in late medieval Ireland has thus far not been studied in detail. Much of the archaeological literature on the subject is still tainted by the erroneous attribution of the main type of slag, bun-shaped cakes, to smelting activities. The large-scale infrastructure works of the first decade of the twenty-first century have led to an exponential increase in the amount of sites available for study. At the same time, much of the material related to metalworking recovered during these boom-years was subjected to specialist analysis. This has led to a near-complete overhaul of our knowledge of early ironworking in Ireland. Although many of these new insights are quickly seeping into the general literature, no concise overviews on the current understanding of the early Irish ironworking technology have been published to date. The above then presented a unique opportunity to apply these new insights to the extensive body of archaeological data we now possess. The resulting archaeological information was supplemented with, and compared to, that contained in the historical sources relating to Ireland for the same period. This added insights into aspects of the industry often difficult to grasp solely through the archaeological sources, such as the people involved and the trade in iron. Additionally, overviews on several other topics, such as a new distribution map of Irish iron ores and a first analysis of the information on iron smelting and smithing in late medieval western Europe, were compiled to allow this new knowledge on late medieval Irish ironworking to be put into a wider context. Contrary to current views, it appears that it is not smelting technology which differentiates Irish ironworking from the rest of Europe in the late medieval period, but its smithing technology and organization. The Irish iron-smelting furnaces are generally of the slag-tapping variety, like their other European counterparts. Smithing, on the other hand, is carried out at ground-level until at least the sixteenth century in Ireland, whereas waist-level hearths become the norm further afield from the fourteenth century onwards. Ceramic tuyeres continue to be used as bellows protectors, whereas these are unknown elsewhere on the continent. Moreover, the lack of market centers at different times in late medieval Ireland, led to the appearance of isolated rural forges, a type of site unencountered in other European countries during that period. When these market centers are present, they appear to be the settings where bloom smithing is carried out. In summary, the research not only offered the opportunity to give late medieval ironworking the place it deserves in the broader knowledge of Ireland's past, but it also provided both a base for future research within the discipline, as well as a research model applicable to different time periods, geographical areas and, perhaps, different industries.

A PDF copy of Volume 1 can be accessed at: http://cora.ucc.ie/bitstream/handle/10468/1944/Volume1.pdf?sequence=2, while Volume 2 can be accessed at: http://cora.ucc.ie/bitstream/handle/10468/1944/Volume2.pdf?sequence=3.

Forthcoming Meetings and Conferences

The **Historical Metallurgy Society (HMS)** will have an "Archives and Slag Collection – Study/Work Day", Saturday September 26, 2015, at the Lon Warehouse, Ironbridge Gorge Museum Trust, Coalbrookdale, UK. After coffee, registration and introduction, the program includes a few short presentations, such as "Cataloguing the Tylecote metallographic collection" by Aurélie Cuénod, and "Care of Slag Collections" by David Dungworth, and several workshop sessions including "Workshop Sessions: archives and slag", "Workshop: What do you think it is? Discovering slag", and "Workshop: This is what it is. Interpreting slag" (by David Dungworth and Aurélie Cuénod). A Q&A session and feedback opportunities also are built into the schedule. A booking form can be found at: http://hist-met.org/images/Other_event_files/ACC_Studyday_Bookingform.docx, and more information can be found at: http://hist-met.org/meetings/archive-and-study-day.html.

The **Historical Metallurgy Society (HMS)** Annual "Research in Progress Meeting" will be held Friday, November 13, 2015, at the Experimental Techniques Centre, Brunel University, UK. This meeting is aimed at a wide variety of contributors, from historical and archaeological metallurgists to excavators, historians and economists. The organizers are particularly interested in bringing together contract and public sector archaeologists with academic researchers, and in fostering links between the different disciplines studying

metallurgy and related activities. General enquiries can be directed to hmsRinPconf@hist-met.org.

The ***41st International Symposium on Archaeometry (ISA)***, will be held May 15-20, 2016, in Kalamata, Greece. This conference is a most welcome forum to present the latest data and updates of archaeometric research and archaeological science, covering the full spectrum of topics, materials, techniques, time span and global applications. As always, the conference will have a major thematic session, for both oral and poster presentations, on ***Metals and Metallurgical Ceramics.*** Additionally, the ***41st ISA*** will host two special sessions: ***Environmental Remote Monitoring for Archaeology and Cultural Heritage*; and, *The Beginning of the Bronze Age in Eastern Mediterranean***. They also will run a panel discussion on ***History, Archaeology and Archaeometry: Defining a Relationship*** aiming at drawing extra attention to new research and application challenges for scholars from both the humanities and science.

Some key deadlines include:

- Abstract Submission: August 15 – December 15 2015
- Applications for Awards/Grants: August 15– December 15, 2015
- Applications for Hosting Next ISA (2018): August 15–December 15, 2015
- Early Registration: August 15, 2015–February 15, 2016 (Normal 170€, Student 90€)
- Late Registration: February 16–May 15, 2016 (normal 200€, student 100€)

Additional information about the conference, venue, abstract and registration submission, travel and accommodations can be found at the conference website: http://isa2016.uop.gr/index.html.

Previous Meetings and Conferences

The international conference ***Archaeometallurgy in Europe IV*** was held in Madrid, Spain, from June 1-3, 2015. General presentations were thematically grouped and divided into one, two or three concurrent sessions spread throughout the three days. The conference also included a visit to and presentations at the *Museo Arqueológico Nacional* (*National Archaeological Museum*) on the afternoon of the 2nd and a wonderful conference dinner that same evening. On June 4, after the conference conclusion, a limited number of attendees were also treated to a visit to the ancient copper mining and metallurgical production site of Cerro de los Almadenes (Otero). This site includes a Roman period occupation, slag heaps, furnaces, and ancient mines, as well as evidence for later exploitations as well. Subsequent to visiting that site, the attendees visited the *Fundación Centro Nacional del Vidrio*, near Segovia, where attendees had the opportunity to see the history of glass production in the region and witness modern craftsmen producing beautiful objects for purchase.

A program of the oral presentations can be found at: http://www.congresos.cchs.csic.es/aie4/sites/default/files/official_programme.pdf, while a list posters is at: http://www.congresos.cchs.csic.es/aie4/sites/default/files/poster_presentations.pdf. Proceedings of the conference are currently being organized for submission, and should be available in the next year or two.

The ***15th International Conference of the European Association of Southeast Asian Archaeologists***, was held 6 -10 July 2015, at the Université Paris Ouest Nanterre la Défense. A session at this conference entitled "Metallurgy and mankind in Southeast Asia's past", convened by Oliver Pryce and Stéphanie Leroy, included the following presentations: "Decorated Indian bronze bowls found in Thailand: a re-evaluation" (Ian Glover), "Implementation of the new archaeometallurgy paradigm in Southeast Asia" (Joyce White, Elizabeth Hamilton), "How much is enough and what to do with it: which direction Southeast Asian lead isotope archaeology?" (Oliver Pryce), "Metal artifacts from Gua Harimau (Harimau Cave) South Sumatera, Indonesia: composition and structure analysis" (Harry Octavianus Sofian, Oliver Pryce), "Comparisons between megalithic and early historic Indian vessels & high-tin bronzes with early examples found in Thailand" (Sharada Srinivasan), "Late prehistoric metal exchange networks in the Thai-Malay Peninsula: matches, fakes and a chronological shift" (Bérénice Bellina-Pryce, Oliver Pryce), "Technical investigations of a Khmer bronze male deity from the Metropolitan Museum: Angkorian foundry practices and 11th century innovations" (Brice Vincent, Federico Caro, Donna Strahan), "A late prehistoric iron smithing workshop and associated iron industry at the port settlement of Khao Sek, Thai-Malay Peninsula" (Peter Petchey, Bérénice Bellina-Pryce, Oliver Pryce), "Casting for the king: the royal palace bronze workshop of Angkor Thom" (Martin Polkinghorne, Brice Vincent, Nicolas Thomas), "Elemental analysis and provenance study on metal artefacts from the 12-13th century's Java Sea wreck" (Jun Kimura, Laure Dussubieux, Saito Tsutomu), and "Iron and the Khmer empire (9th to 15th c.): a multidisciplinary (sourcing and dating) approach to evaluate the iron procurement during the Angkorian period" (Stéphanie Leroy, Mitch Hendrickson, Philippe DIllmann, Emmanuelle Delque-Kolic, Enrique Vega). Short and long abstracts can be found at:

http://www.nomadit.co.uk/euraseaa/euraseaa15/panels.php5?PanelID=3531.

Research and Education Opportunities

A masterclass in **tatara and crucible steel making** will be held September 5-11, 2015, in Antwerp, Belgium. This masterclass will be given by Niko Heyninnen (Fi) and Klaas Remmen (B). The masterclass will cover both the tatara steel making process (used to make tamahagane) and the crucible steel refinery process to learn everything there is to know about the Japanese tatara process. The instructors and participants will also build up a tatara shaft furnace to reduce iron ore to steel. One aim is to send every participant home with at least 5kg of high-quality steel (tamahagane) from this process. Participants will also make crucible steel out of low carbon iron and practice forging this magnificent ancient steel. Both the theoretical background and hands-on practice will be covered. Participants can choose to come later than the designated dates and only attend the firing and forging of the furnaces and steel. The masterclass will be held in Hoboken (Antwerp, Belgium) at 'The Wolkammerij', next to the Umicore plant. The organizers aim for 10 participants, and the primary language will be English. People interested in participating can contact Klaas Remmen (Klaasremmen@gmail.com) for further details.

Web-Based Resources

Donald Wagner has provided an internet link to a translation by Brian Awty of Otto Johannsen's article, "Eine Einleitung zum Eisenguss vom Jahre 1454" [A guide to the casting of iron dated 1454], originally published in *Stahl und Eisen*, 1910, 30.32: 1373–1376. The link to the translation can be be found at: http://www.scribd.com/doc/271022557/Brian-Awty-A-guide-to-the-casting-of-iron-dated-1454.

BOOK REVIEWS

David Hill, Associate Editor

Caithness Archaeology: Aspects of Prehistory, **by** A. Heald and J. Barber. 2015. Whittles Publishing, Dunbeath, ISBN 978-184995-151-7

Reviewed by Steve Dockrill, University of Bradford, School of Archaeological Sciences

This is a very readable volume written by two well-known professional archaeologists. Both have extensive interests in Caithness, Andy Heald representing the science-based archaeology of today whose interest is centered on the Iron Age of Caithness and John Barber providing a questioning approach to both chambered cairn and broch construction.

The key to the success of this book is that the authors achieve within the book's narrative an instant connection with the reader. The text is written in a unique style, which almost instantly involves the reader in a dialogue. The reader is taken on a journey through time and is provided with a discussion of the rich heritage of monuments and archaeological landscapes. The warmth of the text is enhanced by the detailed introduction to the principal "personalities who excavated the sites" (Heald and Barber 2015, 11). The inclusion of personalities both antiquarian and recent provides an important context to the monuments in terms of what survives today and to the development of our understanding of the various groups of sites. These groups provide the chapters, which extend from the Neolithic into the Viking middens and the Medieval period. The books chapters are clearly structured with each focusing on one of these themes (e.g. Chapter 6 - Brochs, Chapter 11- Settlement and Middens).

Another aspect of this is book is that it helps to fill a gap in the archaeological literature and provides an introduction to the archaeology of Caithness, something which its authors state was missing. The authors contrast this with numerous guides and texts written for Orkney and hope that their volume goes some way to readdress the importance of the county's archaeology and the 5,000 known sites (Heald and Barber 2015, 7). To do this, the authors take the reader on a journey through time, selecting key sites that illustrate periods of significant cultural change, whether this is represented by changes in domestic or funerary architecture or changes in cultural practice. The archaeological narrative is a cleverly woven mix of historical investigation, description and explanation. The result is the generation of very readable chapters, achieved by integrating the key sites that represent the chapter themes into the narrative.

The archaeology is described in a clear and thoughtful way and uses relevant illustrations from these early publications throughout. The photographs are black and white and the printed version has a hint of sepia, giving a uniformity to the photographic images which fits well with the antiquarian plans. These are supplemented where necessary by clean diagrams such as fig. 3.5 or new 3D laser scan imagery (fig 3.4 and aerial (Lidar) scans such fig. 3.6). The book is a combination of description and authoritative explanation. Key to its readability is its warmth of dialogue, feeding the interest of the reader. Many books of this nature lack references, but this volume is extremely well researched and importantly

includes referenced sources. Much of the Scottish material published in the *Proceedings of the Society of Antiquaries of Scotland* is now available on the internet and available to the lay reader.

This book can be read at many different levels; as a layman's introduction to the archaeology of Caithness, while the use of references provides the reader with the ability to examine source material and it is a useful starting point for the student of archaeology or heritage. The main examples are taken from that great period of antiquarian and early archaeological investigation from the mid-19th to mid-20th centuries.

This book also recognizes the present custodians of Caithness' rich prehistoric heritage. It contains passages of heartfelt warmth for these often-unidentified volunteers. An example is the authors' genuine admiration for local enthusiast Alistair Sutherland.

> "He is one of the most inspiring people we have met on our journey and is one of the reasons – or perhaps the sole reason - why we continue to work in the area." (Heald and Barber 2015, 94).

The book is a well-produced authoritive text on Caithness prehistory, that is well illustrated and provides an important insight not only to the excavators but to those present day unpaid custodians of the past such as Alistair Sutherland and Meg Sinclair and her passion for the county's archaeology (Heald and Barber 2015, 124).

The book is good value at £20 in hardcover and I would strongly recommend it not only to the visitor but also to the resident. For those interested in the prehistory of Caithness, this book is for you.

Nature and Antiquities: The Making of Archaeology in the America edited by Philip L. Kohl, Irina Podgorny, and Stefanie Gänger. 2014. University of Arizona Press, Tucson, AZ.

Reviewed by Margaret E. Beck, University of Iowa

How did European and Euroamerican scholars come to understand ancient America? The modern inhabitants of the Americas were unfamiliar enough when first encountered in the sixteenth century; their past could not be accommodated within anything scholars understood as "history." Papers in this edited volume grapple with the nineteenth-century construction of Native American pasts, heavily influenced by the natural sciences. They document the shift in collection and display from broad and general-in which modern material culture and antiquities were lumped with fossils, rocks, and plants-to specific, in which artifacts were classified and systematically studied. In the introduction, the editors note "this book is not so much a history of archaeology as a history of the sometimes divergent practices and discourses that emerged in relation to the collection, sale, consumption, and study of American antiquities over the nineteenth century" (p. 8).

The discussion in these pages will certainly be fascinating to anyone interested in material culture, antiquarian collections, popular conceptions of Native Americans, and the history of archaeology. The pages abound with con men "scientists," the eccentric wealthy, outrageously improbable nineteenth century interpretations, and compelling insights into the construction of our historical consciousness. Chapters are grouped into three sections, each of which addresses a particular aspect of constructing the past. In "Part 1. Interplays," authors consider how multiple fields were blended in studying the past, such as the creation of archaeological atlases modeled after those from other disciplines. "Part II. Settings" presents different collectors, describing their collecting strategy and how they understood their own collections. One particularly striking example is a Peruvian society woman's cabinet of curiosities, with a mind-blowing array of pickled biological specimens presented alongside the artifacts. Chapters in "Part III. Narratives" focus on specific attempts to write the past, such as the attempts in nineteenth-century Brazil to conceptualize indigenous history. Notably, this volume takes a transcontinental approach, with cases from all over North, Central, and South America.

Nature and Antiquities is a compelling read with invaluable insights into the growth of our discipline. Authors consider not only the early contributions of the natural sciences to archaeology but also the political implications of this for indigenous peoples-all of which should be of special interest to members of the Society of Archaeological Sciences. Historians, museum curators, and scholars in native studies will also find much in these pages of interest. Selected chapters should intrigue and inspire students in a variety of courses although, given the sophistication of the writing and ideas, these might be better suited to graduate students rather than undergraduates.

The Tomb of Li Chui: Interdisciplinary Studies into a Tang Period Finds Assemblage edited by Susanne Greiff, Romina Schiavone, Zhang Jianlin, Hou Gailing, and Yang Junchang. 2014. Monographien des Romisch-Germanischen Zentralmuseums, Band 117: Verlag des Romisch-Germanischen Zentralmuseums, Mainz, 387 pp.

Reviewed by Prof. David A. Scott, Department of Art History and Inter-Departmental Program in Archaeological and Ethnographic Conservation, UCLA

This impressive volume, partially funded by the German Federal Ministry of Education and Research, is a salutary reminder of the failings of the British and American economic models in which funding from a Ministry itself is not available for domestic/foreign-based projects of this sort and for support of the resulting publication. The German Ministry even provided funds for the workshops in Xi'an which has been a continual and on-going expense since 1989. This impressive German commitment to archaeological research and publication over a period of 25 years is in stark contrast to the meager offerings of the British and American funding agencies and their lack of any coherent long-term vision of the kind displayed here.

The volume records the details of the excavation of the tomb of the noblewoman Li Chui who died at the age of 25, as related by the interpretation of her epitaph discovered in the tomb. Li was buried in an earth-chambered tomb outside of the Tang period capital Chang'an, which is the present-day Xi'an. Due to a rare combination of circumstances, the tomb was never pillaged and all of the grave goods survived. In 2001, an unusually rich and filigree assemblage of jewelry was retrieved together with the deceased's skeleton in two separate blocks by a team of Chinese archaeologists and stored in the archaeological laboratory in Xi'an. During the laboratory studies, specialists of the Germanic-Sino co-operation project of the Romisch-Germanisches Zentralmuseum in Mainz, and the Shaanxi Provincial Institute of Archaeology worked collaboratively on the conservation, documentation and presentation of the finds and the contexts in which they were discovered. The study allowed the fine jewelry of the tomb to be studied in detail, a rare and significant moment in the study of the antiquities of the Tang dynasty. The larger goal of the project was to convey a unique and detailed insight into the Tang world of Li Chui and the cultural milieu in which she lived.

The present volume comprises eighteen contributions, including the introduction and greetings section and is informatively illustrated with numerous color plates and black-and-white drawings. The first substantive chapter begins with a report on the excavation and documentation of the site by Ma Zhijun. During the construction of an extension of Xi'an University of Technology, some 200 tombs were found of which an impressive number, 186, were excavated, Li Chui's tomb being one of them. During the removal of the backfill, artifacts of lacquerware, silver, bronze and iron objects were discovered as well as an elaborate headdress, the skeleton itself, and several layers of finely woven textile, gold threads, gold and bronze decorative elements, jade pendants, lead ornaments, pearls and beads and different types of ceramics. The range and types are illustrated and are informative in terms of the amulets and animals represented in small clay figures. Two block lifting strategies were employed to remove the surrounding material to the laboratory intact. The bronze objects included two interesting bronze mirrors, one eightfold lobate and the other six, both with exceptionally well-preserved mother-of-pearl inlay, an octagonal mirror with concave borders which is described as being silver-plated on the reverse, but this looks from the photograph as if it is not plated but inlaid in a silver foil technique seen in other examples of the type. Fine examples of silver are included in the tomb including a rare silver lock in an excellent state of preservation. The iron scissors are heavily corroded and are presumably illustrated before conservation treatment, as their condition looks precarious, although the treatment of the iron finds is not mentioned in the text. It is pleasing to see the small lead dishes and lobate plates illustrated in color, as these are often simply shown as drawings. A variety of jade pendants were found, as well as fragments of lacquer objects and gold and silver cloisonné work. The magnificent reconstructed headdress with peacock designs is one of the wonders of this book and the work carried out. This report consumes the first 97 pages of the text, which does not really mention any of the possible organic materials such as seeds, pollen, skeletal material, etc., but perhaps these are destined to be published elsewhere.

Sonia Filip then provides a cultural and historical analysis of the features and finds of Li Chui's tomb which discusses the dress accessories, jade perforated pendants, waistband, hairstyles and headdresses, which illustrates the reconstruction of the headdress again, together with the fine craftsmanship of the pendants shaped in the style of peacock feathers from the headdress itself. The chapter also discusses the find of the inlaid mirrors, and the two mirrors with silver inlay. The front of the mirrors are not illustrated, only the reverse sides, which is a pity in an archaeological report, since the corrosion or lack of it on the front surfaces is often indicative of burial conditions and the context in which the mirror has been kept.

The next chapter is some thoughts on the grave goods by Zhang Jianlin which concentrates on the headdress and the jewelry items. Zhang notes that miniature household items made of lead for the tomb are artifacts which have

been discovered in several tombs of the early to middle Tang. He concludes that the lead objects are imitating grave goods of gold and silverware, often called "spirit vessels"

Annette Kieser then discusses the silver vessels, including a magnificent silver tripod vessel and two silver bowls. The writer concludes that the quality and range of silver found in the tomb suggests only moderate status and wealth of the owner compared with what is known from other Tang burials.

Annegret Gerick then discusses the headdress, its exposure, restoration and reconstruction. This is an excellent piece of work which deals with a variety of finds, again leading to the illustration of the reconstructed headdress. In this chapter it is fully justified by the fine quality of the conservation work carried out in the block lifting and excavation in the laboratory of the small finds. Stephan Ritter then continues the account of the block lifting work, concentrating on the torso of Li Chiu. This is a well-illustrated account of the revelation of the fine jewelry, literally being slowly removed from its original burial context. The organic remains are not discussed here, and the inorganic materials take precedence. Friederike Moll-Dau further contributes to the itemization of the jewelry and the exposure, conservation and museum presentation of the block-lifted finds. This is another excellent chapter, detailed, well-illustrated and informative. The skeletal material is shown in diagrammatic form but is not illustrated or further discussed here. Huang Xiaojuan presents a chapter on the reconstruction and presentation of the artifacts form the torso of Li Chui discussing briefly the numerous decorative elements. A conservation section is then presented by Eva Ritz concerning the wet Qi-lacquerware from the tomb, together with associated material including textile imprints: another high-class chapter in this book. Yang Junchang and Huang Xiaojuan next discuss the gold and silver threads from the block lifting of Li Chui's body, which is useful but seems to lack any reference to the work of Márta Járó, Andrew Oddy, Jack Ogden or other well-known names in the field of metal thread examination in terms of jewelry.

Susanne Greiff presents her work using micro-Raman and micro-XRF on the mineral pigments and inlays. It is a pity here that x-ray diffraction by Debye-Scherrer technique was not employed, since the method remains the most definitive analytical methodology for the examination of mineral species. For example, Greiff writes that micro-XRF showed the presence in one sample of copper, phosphorus and aluminum. It is indeed probable that this is turquoise, but an x-ray diffraction study of a microgram would have been able to positively identify exactly which variety of turquoise is represented by the data. The problem with the study gradually becomes clear: the inability to actually take any samples for analyses results in the problem of minimal information which can sometimes be a consequence of minimal intervention, but that is as far as the investigators were probably allowed to go.

The next chapter by Florian Ströbele and Liang Jiafang, considers the tool marks and the XRF analysis of the silverware from the tomb. Again, there were limitations in what was possible in terms of the equipment and techniques employed. The results from the tool marks study was especially interesting and has not been employed enough since the pioneering work of E. Benner Larsen in Denmark in the 1970's. Once again, the references are perhaps not doing justice to the subject. The authors do not really discuss the gold content of the silver objects and whether this could lead to evidence of cupellation of lead ores, which must remain a subject here for further research. The next chapter deals with the non-destructive analysis of the components of the headdress, which, given the complexity of the headdress should probably have been greatly expanded by the authors in view of the complexity and variety of materials and techniques. The final chapter discusses the facial reconstruction following digitization of the skull and virtual replacement of missing parts to create a restored version of the face of the deceased.

In summary, this is a useful addition to the technical and conservation literature in terms of the study of this unique tomb. What would have been beneficial would have been a greater ability to examine the construction, solder, composition, joining techniques, isotope studies and more sophisticated analytical work to complement the excellent conservation work carried out. Clearly some of this work would have required the removal of small samples for analytical study, which was probably beyond the scope of the agreement of work. If this is the case, the authors should have clearly stated this at the beginning of the book, since XRF can only go so far in attempting to answer more probing questions concerning technology and composition. That may represent a missed opportunity or may present the possibility that further work on the tomb materials can and will be carried out in the future, to match the excellent standard of the conservation work and the published reports provided here. A well-produced and informative volume which is recommended for library purchase.

MARITIME ARCHAEOLOGY

Nicolás Ciarlo, Associate Editor

This section includes a note about the conservation and digital documentation of the *H.L. Hunley* submarine (M. P. Scafuri). It also contains a list of recent articles and books which cover different archaeometric investigations related to underwater and coastal sites. In addition relevant past conferences, presentations and proceeding papers, as well as upcoming meetings, are mentioned. Last but not least, data about upcoming courses and seminars is provided.

Current Research

Deconcretion and 3D Documentation of the Hull of the *H.L. Hunley* submarine

Beginning in 2014, the conservation staff at Clemson University's Warren Lasch Conservation Center (WLCC) in Charleston, South Carolina have been removing the marine concretion and actively treating the hull of the American Civil War submarine *H. L Hunley*. As the conservation of this historic artifact proceeds, the archaeological team is documenting many features of the 19th-century vessel as they are revealed. In addition, the concretion itself is being studied to understand the details of the conditions that developed around the submarine as it lay buried for 136 years several miles offshore Charleston. The documentation has proceeded along several avenues: observation and photography, direct measurements, and 3D scanning.

The removal of marine concretion from the exterior of the *H.L. Hunley* has provided an opportunity to analyze the nature of the concretion and given the WLCC scientific team their first glimpse of the structure of the riveted iron hull. As part of the deconcretion plan, the exterior concretion was removed first along the seams between the 80 cm long, semi-cylindrical hull plates. This allowed the archaeological team to collect concretion thickness data in a grid pattern over the length of the hull. Approximately 1.200 thickness measurements were recorded from the exterior concretion, spaced roughly 10-20 cm along each edge. This data enabled archaeologists to develop a comprehensive database of information about the concretion, as well as a visual representation in Adobe Illustrator® of its thickness over the hull. The data collected is being used to better understand the variable environmental conditions and possible burial sequences of the submarine over time.

3D documentation has also played a significant part in the overall documentation strategy of the project since the recovery of the submarine in 2000. Over the years, various technologies have been employed to collect detailed surface and feature data from the hull, operational components, and artifacts of the vessel. The recent deconcretion process exposed many previously obscured characteristics of the hull and has allowed for a new high-resolution scanning survey to document much of the submarine. In March of 2015, with assistance from Boeing South Carolina, a survey was conducted using the Surphaser® 100HSX laser scanning system. This system collects data in a 360 degree area above and around the scanner to a range of approximately 100m. By setting up the unit in specific positions around the submarine, the archaeological team was able to collect millions of points from both the interior and exterior of the hull. The data was then processed using the PolyWorks® software platform developed by InnovMetric Software, Inc (Figure 1).

The 3D documentation of the hull of the *H.L. Hunley* submarine will be used to complement and expand the project's overall 3D site plan. As the deconcretion, treatment, and conservation of the *H.L. Hunley* submarine continues, this and future documentation will aid the archaeological team at the WLCC in their investigation of this enigmatic vessel. For more information about the project, see: http://www.clemson.edu/restoration/wlcc

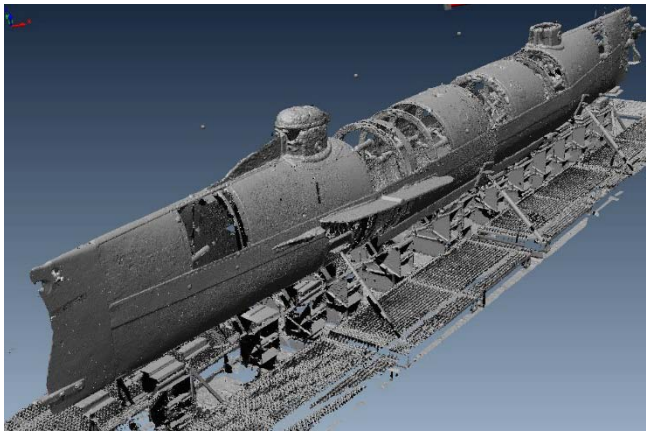

Figure 1. 3D point cloud of the H.L. Hunley collected using the Surphaser® 100HSX laser scanner. Courtesy: Friends of the Hunley.

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Recent Publications

International Journal of Nautical Archaeology. From *IJNA* year 2015, Vol. 44, No. 1: "Construction Features of Doel 1, a 14th-Century Cog found in Flanders" (J. Vermeersch & K. Haneca); and "A Chain Pump

Recovered from the Wreck of the Warship Northumberland (1703)" (D. Pascoe et al.).

Journal of Archaeological Sciences. From the first semester of 2015, the following papers are highlighted: *JAS*, Vol. 53: "Demise of a harbor: a geochemical chronicle from Ephesus" (H. Delile et al.); and "Use of Zanzibar copal (*Hymenaea verrucosa* Gaertn.) as incense at Unguja Ukuu, Tanzania in the 7–8th century CE: chemical insights into trade and Indian Ocean interactions" (Alison Crowther et al.); Vol. 54: "Chronology and palaeoenvironmental reconstruction in the sub-tidal zone: a case study from Hinkley Point" (Seren Griffiths et al.); "Ostracodological studies in archaeological settings: a review" (Ilaria Mazzini et al.); "The environs of Elaia's ancient open harbour – a reconstruction based on microfaunal evidence" (Anna Pint et al.); "Palaeoenvironmental evolution of the ancient lagoon of Ostia Antica (Tiber delta, Italy)" (Cecile Vittori et al.); and other research on different sites based on ostracode analyses; Vol. 55: "Selective attack of waterlogged archaeological wood by the shipworm, *Teredo navalis* and its implications for *in-situ* preservation" (A. M. Eriksen et al.); and "Archaeology, taphonomy, and historical ecology of Chesapeake Bay blue crabs (*Callinectes sapidus*)" (T. C. Rick et al.); Vol. 56: "Molluscs emergent, Part II: themes and trends in the scientific investigation of molluscs and their shells as past human resources" (K. D. Thomas); Vol. 57: "Sclerochronology of *Busycon sinistrum*: late prehistoric seasonality determination at St. Joseph Bay, Florida, USA" (R. M. Harke et al.); and "Middle and Later Stone Age shellfish exploitation strategies and coastal foraging at Hoedjiespunt and Lynch Point, Saldanha Bay, South Africa" (K. Kyriacou); and Vol. 58: "Estimating California mussel (*Mytilus californianus*) size from hinge fragments: a methodological application in historical ecology" (B. Campbell & T. J. Braje); and "Making the most of fragments: a method for estimating shell length from fragmentary mussels (*Mytilus californianus* and *Mytilus trossulus*) on the Pacific Coast of North America" (G. G. Singha & I. McKechnie).

Journal of Archaeological Sciences: Reports. This year, the new *JAS Reports* published the following articles: Vol. 1: "Tracing historical animal husbandry, meat trade, and food provisioning: A multi-isotopic approach to the analysis of shipwreck faunal remains from the *William Salthouse*, Port Phillip, Australia" (E. J. Guiry et al.); "Integrated geophysical research of Bourbonic shipwrecks sunk in the Gulf of Naples in 1799" (G. Mattei & F. Giordano); and "Paleo-environmental evolution of the Larnaca Salt Lakes (Cyprus) and the relationship to second millennium BC settlement" (B. Devillers et al.); Vol. 2: "Provenance materials for Vitruvius' *harenae fossiciae* and *pulvis puteolanis*: Geochemical signature and historical–archaeological implications" (E. D'Ambrosio et al.); "Archaeometallurgical analysis of metal remains from the Dor 2006 shipwreck: A clue to the understanding of the transition in ship construction" (Y. Kahanov et al.); and "3D solid modeling and the naval architecture of *Vasa*" (Kelby Rose); and Vol. 3: "Archeometallurgical and technical characterization of 7th century AD iron fishing-spear and fire basket found in the Dor lagoon, Israel" (A. Stern et al.).

Geoarchaeology. From 2014, Vol. 29, No. 6: "Geophysical and Geoarchaeological Investigations at Aganoa Beach, American Samoa: An Early Archaeological Site in Western Polynesia" (F. B. Pearl et al.); and 2015, Vol. 30, No. 1: "A New Model for Coastal Resource Productivity and Sea-Level Change: The Role of Physical Sedimentary Processes in Assessing the Archaeological Potential of Submerged Landscapes from the Northwest Australian Continental Shelf" (I. Ward et al.); Vol. 30, No. 2: "A Predictive Model for Locating Early Holocene Archaeological Sites Based on Raised Shell-Bearing Strata in Southeast Alaska, USA" (R. J. Carlson & J. F. Baichtal); and Vol. 30, No. 3: "Radiocarbon and Luminescence Age Determinations on Mounds at Crystal River and Roberts Island, Florida, USA" (T. J. Pluckhahn et al.).

The following articles published during the first half of 2015 present archaeometric results that could be of interest for maritime archaeologists: ***Anthropocene***, in press (available online): "Responses of the Roanoke Bayhead Delta to variations in sea level rise and sediment supply during the Holocene and Anthropocene" (A. M. Jalowska et al.); ***Continental Shelf Research***, Vol. 98: "Benthic conditions around a historic shipwreck: *Vrouw Maria* (1771) in the northern Baltic proper" (A. T. Ruuskanen et al.); ***Dendrochronologia***, Vol. 33: Dendrochronological evaluation of ship timber from Charlestown Navy Yard (Boston, MA)" (P. P. Creasman et al.); ***International Biodeterioration & Biodegradation***, Vol. 98: "Marine bivalves colonizing Roman artefacts recovered in the Gulf of Pozzuoli and in the Blue Grotto in Capri (Naples, Italy): Boring and nestling species" (S. Ricci et al.); ***Intersecciones en Antropología***, No.16: "Arqueometalurgia de naufragios históricos en Argentina: estado de la cuestión y perspectivas futuras" (N. C. Ciarlo); ***Journal of Anthropological Archaeology***, Vol. 37: "The Paleo-Aleut to Neo-Aleut transition revisited" (N. Misartia & H. D. G. Maschnerc); ***Journal of Visual Communication and Image Representation***, Vol. 26: "Automatic Red-Channel underwater image restoration"

(A. Galdran et al.); ***Mediterranean Archaeology & Archaeometry***, Vol. 15, No. 2: "Characterization and Provenance of Building Materials from the Roman Pier at San Cataldo (Lecce, Southern Apulia, Italy): A Lithostratigraphical and Micropaleonthological Approach (M. Sammarco et al.); ***Metallography, Microstructure, and Analysis***, Vol. 4, No. 3: "The Brass Nails of the Akko Tower Wreck (Israel): Archaeometallurgical Analyses" (M. Cohen et al.); ***Ocean & Coastal Management***, Vol. 113: "The role of underwater cultural heritage on dark matter searches: Ancient lead, a dual perspective" (E. Perez-Alvaro & M. F. Gonzalez-Zalba); ***Procedia Materials Science***; Vol. 8: "Naval Crossfire: A Comparative Analysis of Iron Projectiles from Mid-18th to Early 19th Centuries European Warships" (N. C. Ciarlo et al.); and "Coppers from the Battle of Trafalgar: Metallurgical Analysis of Structural Fastenings from the French ships *Fougueux* (1785-1805) and *Bucentaure* (1804-1805)" (H. De Rosa et al.); and Vol. 9: "19th Century Wooden Ship Sheathing. A Case of Study: The Materials of Puerto Pirámides 1, Península Valdés" (H. De Rosa et al.); ***Proceedings of the Geologists' Association***, Vol. 126, No.1: "The evolution of Palaeolake Flixton and the environmental context of Star Carr: an oxygen and carbon isotopic record of environmental change for the early Holocene" (I. Candy et al.); ***Quaternary International***, Vol. 367: "A staged geogenetic approach to underwater archaeological prospection in the Port of Rotterdam (Yangtzehaven, Maasvlakte, The Netherlands): A geological and palaeoenvironmental case study for local mapping of Mesolithic lowland landscapes" (P. C. Vos, et al.); and "The late Nordic Iron Age and Viking Age royal burial site of Borre in Norway: ALS- and GPR-based landscape reconstruction and harbour location at an uplifting coastal area" (E. Draganits, et al.); ***Quaternary Research***, Vol. 83, No. 2: "Sea level, paleogeography, and archeology on California's Northern Channel Islands" (L. Reeder-Myers et al.); and "Historic and Holocene environmental change in the San Antonio Creek Basin, mid-coastal California" (R. Scott Anderson, et al.); and "Seawater temperature seasonality in the South China Sea during the late Holocene derived from high-resolution Sr/Ca ratios of *Tridacna gigas*" (H. Yan, et al.); as well as other papers about coastal and sea-level reconstructions (see Vol. 83, No.1 & No.3); and ***Talanta***, Vol. 137: "Elemental analysis of materials in an underwater archeological shipwreck using a novel remote laser-induced breakdown spectroscopy system" (Guirado, et al.). See also papers published on a special issue of ***Robotics and Autonomous Systems***, Vol. 67 (Advances in Autonomous Underwater Robotics), edited by Ch. Ament, T. Pfuetzenreuter & T. Rauschenbach.

British Archaeological Reports (BAR). The following books recently published by Archaeopress are of particular interest to nautical archaeologists, especially for those involved with the study of post-depositional processes and conservation of wooden shipwrecks: "Shipwrecks and Global 'Worming'" (P. Palma & L. N. Santhakumaran), Archaeopress (Open Access), ii + 62 pages; illustrated in full color throughout, ISBN 978 1 78491 (e-PDF). This book provides an account of marine wood-boring organisms, as well as a historical review of their action on wooden ships and the methods implemented since Antiquity to protect them from their detrimental effects. One can find very interesting information about the taxonomy of various marine wood-borers, and the appearance of the different timbers attacked by them, which were examined under the microscope. This contribution can be downloaded from www.archaeopress.com.

Another noteworthy monograph is: "WreckProtect: Decay and protection of archaeological wooden shipwrecks" (Ch. Gjelstrup Björdal & D. Gregory, eds., with assistance from A. Trakadas), viii + 154 pages; illustrated throughout in color, ISBN 9781905739486. It shows the results of the WreckProtect, an interdisciplinary research project supported by the European Union, focused on the decay and preservation of wooden shipwrecks located in the Baltic Sea. Together with data about the anatomy and structure of wood, and the physical and biological decay of shipwrecks underwater, this work has very useful information on how to identify the remains in both sediments and the water column. A third publication, related to the analysis of two post medieval shipwrecks, is worth mentioning: "The Maritime Archaeology of Alum Bay" (J. Satchell & J. Whitewright), x + 168 pages; illustrated throughout in color and black & white, BAR No. 608 Maritime Archaeology Trust Monograph Series (formerly Hampshire and Wight Trust for Maritime Archaeology Monograph Series) No. 2, ISBN 9781407313368. Two English ships from late 18th to early 19th century, one of them identified as the 38-gun frigate HMS *Pomone*, sunk nearby Needles in 1811, were analyzed. The results of the dendrochronological and metallurgical examination of the remains are noteworthy.

Cultural Heritage and Archaeological Issues in Materials Science II, edited in 2014 by J. L. Ruvalcaba Sil, J. Reyes Trujeque, A. Velazquez Castro & M. Espinosa Pesqueira, compiles the papers from Symposium 8A, 'Cultural Heritage and Archaeological Issues in Materials Science (CHARIMSc)', of the *XXII International Materials Research Congress (IMRC)* held in Cancun, Mexico. *MRS Proceedings*, Vol. 1618:

"Characterization and evaluation of salty cleaning compounds study in historic objects made of copper alloys from the 'El Tejas' shipwreck" (D. A. Arano et al.).

Shipwrecks around the World: Revelations of the Past, edited in 2015 by S. Tripati, xx + 827 pages, has two book chapters that underwater archaeologists and conservation scientists will find very useful: "The conservation of waterlogged wood – An overview of developments" (I. Godfrey); and "The conservation of iron artefacts recovered from the marine environment (J. Carpenter).

Arqueometría argentina, metodologías científicas aplicadas al estudio de los bienes culturales: datación, caracterización, prospección y conservación, compiled in 2015 by A. Pifferetti & I. Dosztal, 300 pages; includes several works presented at the *5° Congreso Argentino de Arqueometría y Primer Encuentro Latinoamericano de Tecnologías Históricas* (Rosario, Santa Fe, Argentina, October 23th to 25th, 2013). Among other compelling contents, specific chapters about dendrochronolgy and petrography of materials from an 18th century Spanish merchant ship found in Puerto Madero, City of Buenos Aires, as well as archaeometric studies related to a mid-19th century coastal battle at Vuelta de Obligado, San Pedro, Province of Buenos Aires, are worth mentioning.

Previous Meetings and Conferences

48th Annual Conference on Historical and Underwater Archaeology. *Peripheries and Boundaries*. The Society for Historical Archaeology Annual Conference was held from 6th to 11th January 2015, at the Sheraton Hotel in Seattle, Washington, USA. Among the many interesting symposiums and sessions, those related to geophysics and materials characterization are worth mentioning: "Deepwater Shipwrecks and Oil Spill Impacts: A Multidisciplinary Approach to Understanding Site Formation Processes... and in 3-D!" (M. Damour); "Recent Developments in the Study of Hull Construction" (F. Castro); and "The Digital Age: Advances to Underwater Archaeological Survey Techniques" (L. G. Colombo). Several presentations dealt with methodological concerns and analysis of materials from different ships: "The Australian Historic Shipwreck Preservation Project: *in-situ* preservation techniques for wooden shipwrecks" (C. M. Philippou et al.); "New Technologies": Remote Sensing Tools and Techniques in Italian Underwater Archaeology" (M. Secci); "Emerald Bay Project: Digital Monitoring of the Two 19th-century Submerged Barges" (P. Bojakowski et al.); "Underwater 3D Imaging with Structured Light: Implications for Ethics and Economics" (Ch. T. Begley & A. E. Wright); "Recording Historic Shipwrecks at the Speed of Light: An Archaeological Analysis of the ULS-200 Underwater Laser Scanner to Sonar, Video, and Photographic Recording Methodologies" (M. C. Murray); "Recent Advances in Marine Magnetic Survey: Case Studies from the Application of the *Magnetometer Survey Python Toolbox V 1.0*" (Brandi Carrier et al.); "Sandalwood and Starfish: A Study of the Shipwreck *Brunswick* (1805) and Site Formation Processes in Simons Bay" (N. R King & I. R. Mollema); "A Model And Tools For Investigating The Monterrey Shipwrecks" (F. Cantelas et al.); "The Conservation of the *Monterrey A* Artifacts" (Ch. Dostal & A. Borgens); "Geomorphology and Site Formation Processes of Three 19th Century Shipwrecks in the Gulf of Mexico" (M. L. Brennan et al.); "Reconstructing Holocene Wetlands of Northern England: New Paleographic Models in the Humber Estuary" (E. A. Rodriguez); "Archaeology and the Battle of the Atlantic: Approaches, Methods and Results of Studying an Underwater Battlefield" (J. C Hoyt); "Naval Battlefield Reconstruction as a Predictive Model for Deep Water Remote Sensing: Search for Bluefields and U-576" (J. Bright); "The Hull Recording in the 2014 Field Season at Gnalic" (S. Govorcin et al.); "Infrared Imaging and Artifacts: Attempting to See Beyond the Human Eye" (S. M. Cuellar); "*In situ* Site Stabilization of HMS *Fowey*" (J. A. Keller et al.); "Gulf of Mexico Shipwrecks, Corrosion, Hydrocarbon Exposure, Microbiology, and Archaeology (GOM-SCHEMA): Studying the Effects of a Major Oil Spill on Submerged Cultural Resources" (M. Damour et al.); "The Degradation of Wooden- and Steel-Hulled Shipwrecks in the Marine Environment" (J. D. Moore III & B. A. Jordan); "Microbial Ecology of Gulf of Mexico Shipwrecks" (P. M. Gillevet et al.); "Morphology and Mineralogy of Consolidated Iron Corrosion Products from Historic Shipwrecks in the Gulf of Mexico" (B. J. Little et al.); "Corrosion and Microbiological Evaluation of a Recovered Experimental Platform from the site of DKM U166" (L. Johnston & R. Cullimore); "Deep Wrecks in 3D: AUV and ROV Laser and Sonar Scans of Deepwater Shipwrecks in the Gulf of Mexico" (R. Church et al.); and "Gulf of Mexico SCHEMA: Studying the Effects of a Major Oil Spill on Submerged Cultural Resources. Where do we go from Here?" (L. Hamdan et al.).

Underwater 3D Recording and Modeling (TC V, CIPA). The works presented at this workshop, held on April 16th and 17th, 2015, at Piano di Sorrento, Italy, were published as part of *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* (ISPRS Archives). This special issue (Vol. XL-5/W5) was edited by F. Menna, E. Nocerino, S. Del Pizzo, F. Bruno & F. Remondino, and is

currently available at http://www.int-arch-photogramm-remote-sens-spatial-inf-sci.net/XL-5-W5/index.html. The following papers can be highlighted: "Underwater Photogrammetry and 3D Reconstruction of Marble Cargos Shipwreck" (C. Balletti et al.); "Active and Passive 3D Imaging Technologies Applied to Waterlogged Wooden Artifacts from Shipwrecks" (A. Bandiera et al.); "Laser Scanner Reliefs of Selected Archeological Structures in the Submerged Baiae (Naples)" (B. Davidde Petriaggi & G. Gomez de Ayala); "Airborne Laser Bathymetry for Documentation of Submerged Archaeological Sites in Shallow Water" (M. Doneus et al.); "A Multidisciplinary Approach to the Coastal Protection of Two Archaeological Sites in Lybia" (I. D'Urso et al.); "Study of a Wreck in Foreshore Context" (O. Hulot et al.); "Aspects of Biodeterioration of Lapideous Submerged Artefacts: 3D Methodologies Application" (S. Ricci et al.); and "Computer Vision Photogrammetry for Underwater Archaeological Site Recording in a Low-Visibility Environment" (T. Van Damme); among other.

Upcoming Conferences

Roman Amphora Contents International Interactive Conference (RACIIC). *Reflecting on Maritime Trade in foodstuffs in Antiquity*. The Universidad de Cádiz – CEI MAR, Centre Camille Jullian (Aix Marseille Université / CNRS / MCC / INRAP), and Università della Calabria/ERAAUB - Universidad de Barcelona, are organizing a meeting focused on the analysis of organic residues that are often preserved in Roman amphorae, found in large quantities in underwater and land sites of Atlantic and Mediterranean contexts. In particular, the Conference will include two special sessions about 'Archaeometric indicators', which are useful means to deepen the knowledge about sea trade of foodstuffs during Antiquity. Further information about this meeting can be found in the official website at www.amphoraecontentsconference.es, or by emailing Max Luaces to amphorae.contents@uca.es. Oficina de coordinación del CEIMAR, Edificio Hospital Real, Plaza de Falla, 8 (11002), Cádiz, Spain.

Courses and Seminars

Archaeometry in Maritime Archaeology (La Arqueometría en la Arqueología Marítima). This 50 hour degree course will be held at the University of Cadiz (UCA), Andalusia, Spain, and is framed in the Doctoral School Program of Maritime History and Archaeology belonging to the EIDEMAR International Program. It will be under the direction of Dr. Salvador Domínguez-Bella (Earth Sciences, UCA) & Dr. José Ramos Muñoz (History, Geography and Philosophy, UCA). Academic Course: 2014/2015. Language: Spanish / French.

For additional information about this degree course, contact Dr. Salvador Domínguez-Bella to: salvador.dominguez@uca.es. See other EIDEMAR programs at: http://www.campusdelmar.es/en/eidemar-doctoral-school-education

Photogrammetry applied to documentation in Underwater Archaeology (Fotogrametría aplicada a la documentación arqueológica subacuática). The Cadiz University (*Universidad de Cádiz*), in partnership with the Centre of International Excellence of the Sea (*Centro de Excelencia Internacional del Mar, CEIMAR*) and the Underwater Archaeology Centre of Andalusia (*Centro de Arqueología Subacuática de Andalucía, CAS-IAPH*) will host a series of courses that deal with methodologies and techniques applied to underwater archaeological work.

The first in the cycle, directed by Xavier Nieto Prieto (Cadiz University), will refer to photogrammetry applied to underwater survey. Degree students and other technicians with experience in Underwater Archaeology will be taught how to deal with different cases according to their specific features and how to use software to process the pictures into 3D models. It will take place from October 5th to October 8th, 2015, at the School of Philosophy and Letters, Cadiz University, Andalusia, Spain.
For registration and further information about the course, please visit the Arts & Humanities section: www.fueca.uca.es:8080/web/fueca/cursos-de-formacion-continua, or contact Dr. Nieto at: Avenida Doctor Gómez Ulla, s/n (11003), Cadiz, Spain. Tel.: +34 956015591. xavier.nieto@uca.es

Advanced Practicum in Maritime Archaeology. Flinders University will host a field school practicum between 16th and 28th November 2015. This course will focus on Marine Geophysics for Archaeology, providing students with opportunities to participate in the workplace environment. This course will allow students to put their theoretical learning into practice, develop a sense of the workplace, enhance their employment prospects through additional training, build a network of contacts, and develop a range of personal and professional work skills.

The program will comprise taught course work on the principles, theory and method of marine geophysics for archaeology. One day will be spent in the field, to acquire data, while another will be devoted to interpretation and reporting as would be expected in a professional environment. Theory and taught coursework will cover an introduction to sidescan, marine magnetometer, sub-bottom and multi-beam. Field data will be gathered and interpreted using sidescan data only.

If you need further information about the course please contact Dr Jonathan Benjamin to jonathan.benjamin@flinders.edu.au, GPO Box 2100, Adelaide 5001, South Australia, Tel: +61 8 8201 5875. The Department of Archaeology at Flinders University regularly offers a range of field schools and other intensive topics in locations around Australia. See www.flinders.edu.au/ehl/archaeology/fieldwork/field-schools

UPCOMING CONFERENCES

Rachel S. Popelka-Filcoff, Associate Editor

2015

21-23 October. 5th Latin-American Symposium On Physical And Chemical Methods In Archaeology, Art And Cultural Heritage Conservation - LASMAC 2015
Quito, Ecuador. http://www.lasmac2015.com

21-23 October. Metrology For Archaeology, Benevento, Italy. General information: http://www.metroarcheo.com/index.php

1-4 November. The Geological Society of America National Meeting. Baltimore MD USA. General information: http://www.geosociety.org/meetings/

5-7 November. Society for American Archaeology (SAA) and the European Association of Archaeologists (EAA): *Connecting Continents: Archaeological Perspectives on Slavery, Trade, and Colonialism*. Curacao. General information: http://www.saa.org/Portals/0/SAA/Meetings/Connecting%20Continents%20updated%201.pdf

6-8 November. From Anthrosphere to Lithosphere (and back again): A Celebration of the Career and Research of Terry O'Connor. The 36th Annual Association for Environmental Archaeology Conference, 2015. York, UK. General information: https://www.york.ac.uk/archaeology/news-and-events/events/conferences/aea/#tab-4

18-21 November. American Schools of Oriental Research Annual Meeting. Atlanta GA USA. General information: http://www.asor.org/am/index.html

18-22 November. American Anthropological Association 114th Annual Meeting. "Familiar Strange" Denver, CO USA. General information: http://www.aaanet.org/meetings/

2-4 December AAA Australian Archaeological Association Conference: "On the Edge: The Archaeology of Adaptation and Transition", Fremantle, WA Australia General information: https://www.conferenceonline.com/abstract/alogin/?clear=1&warehouse_id=1342

11-12 December. Middle Palaeolithic in the Desert II. Bordeaux, France. General information: https://sites.google.com/site/middlepalaeolithicdesert/home

14-18 December. American Geophysical Union Fall Meeting, San Francisco, CA USA. General information: http://fallmeeting.agu.org/2014/2015-fall-meeting/

2016

6-9 January. Society for Historical Archaeology Conference, Washington D.C. USA. General information: http://www.sha.org/index.php/view/page/annual_meetings

8-11 January. Archaeological Institute of America Annual Meeting, San Francisco, CA USA. General information: http://www.archaeological.org/annualmeeting

3-5 February. International Conference of Aerial Archaeology, titled "From Aerostats to Drones: aerial imagery in Archaeology" Rome, Italy. General information: labtaf@unisalento.it

13-17 March. 249th National Meeting and Exposition, American Chemical Society. Denver, CO USA. General information: http://www.acs.org.

18-19 February. "Evaluating the Early Anthropocene Hypothesis: The Impact of Early Farming Economies on the Environment in East and West Asia" Copenhagen, Denmark. Abstract deadline 1 December. General information: http://eeah.ku.dk/

29 March - 2 April. 44th International Conference on Computer Applications and Quantitative Methods in Archaeology (CAA). Oslo, Norway. Abstract deadline: 18 October 2015. General information: http://caaconference.org

6-10 April. Society for American Archaeology. 81st Annual Meeting, Orlando, FL USA. Abstract deadline September 10 2015. General information: http://www.saa.org/Default.aspx?TabId=1419

12-16 April. American Association of Physical Anthropologists Annual Meeting. Atlanta, GA. General information: http://physanth.org/annual-meeting

15-20 May. International Symposium on Archaeometry, Kalamata, Greece. Abstract deadline December 15 2015. General information: http://isa2016.uop.gr

31 July-5 August. Gordon Research Conference: Scientific Methods in Cultural Heritage Research, Newry, ME USA. General information: http://www.grc.org/grc/programs.aspx?id=15101

28 August-2 September. World Archaeological Congress, Kyoto, Japan. http://wac8.org/

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