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Polar Bears on Thin Ice

In former United States Vice President Al Gore's Oscar-nominated climate change movie, "An Inconvenient Truth," an animated polar bear is depicted swimming for its life after the polar ice cap that forms its habitat melts. The recent calving off of 87 square kilometers of Greenland's ice shelf, as reported in January by the Canadian Ice Service, is dramatic testimony that the fate shown in the film is a real possibility (which is lucky for Gore, given his recent nomination for a Nobel Prize).

While we all love the cute and cuddly polar bear, certainly more than arctic habitats are being affected. According to a new climate change study reported in *Science*, the melting of Greenland's ice sheet would raise the oceans by seven meters, threatening to submerge cities located at sea level, from Los Angeles to London. Even a partial melting of the ice sheet could have catastrophic consequences for low-lying countries like Bangladesh.

As global warming and its effects continue to plague the environment—and engage public audiences, policy makers, and research granting agencies—archaeological science stands to make a significant contribution to understanding the problem. We offer considerable expertise in paleoclimate studies, soil isotope analyses, geoarchaeology, and other research domains aimed at reconstructing ancient landscapes and the climates that shaped them.

In this issue of the *SAS Bulletin*, we feature two research articles that exemplify some of the ways in which archaeological scientists can provide paleoenvironmental data for creating and testing models of long-term climate change and human behavior. In "Late Quaternary Environment in the Teotihuacan Valley, México, Inferred from d13C in Soils," Elena Lounejeva and colleagues from the Institute of Geology of Mexico's National Autonomous University report the results of their analysis of stable carbon isotopes in soil organic matter from highland central Mexico, which allows them to track regional paleoenvironmental changes over the past 13,000 years.

Also in this issue, Craig Fertelmes and C. Michael Barton of Arizona State University's School of Human Evolution and Social Change offer a satellite view of vegetation change in the American Southwest in their contribution on "Using Remote Sensing to Assess the Impact of Prehistoric Agriculture on Modern-Day Vegetation Cover in the U.S. Southwest."

While these kinds of studies can (and often do) create mountains of data as large as the Greenland ice shelf, the trick is orienting the information to the right audiences. So please share this issue of the *Bulletin* with your colleagues in the social and earth sciences who you think would benefit from a dose of archaeological science!

E. Christian Wells

In This Issue

Employment Opportunities

Chair, Department of Material Culture Sciences. The Department of Material Culture Sciences in the College of Liberal Arts at the Rochester Institute of Technology seeks applicants to chair a new and dynamic department in a distinguished technological university. The Department of Material Culture Sciences offers interdisciplinary courses in archaeology/archaeological science and art conservation/conservation science in a liberal arts context, providing an applied approach to the study of material culture. During the current academic year the Department is collaborating on the proposal of a new undergraduate degree program, Cultural Resource Studies, which comprises two tracks: Museum & Information Studies and Art Conservation. A minor in Archaeological Science is being implemented and a degree program in that discipline is being drafted. Academic field of specialization is open, but some scientific background is preferred. Ph.D., administrative experience, a strong record of scholarship, and college level teaching (or equivalent) are required. Candidates will be considered at the Associate Professor or Professor level. Salary is commensurate with qualifications and experience. Candidates must be committed to undergraduate education in a liberal arts environment. The University places a high priority on the creation of an environment supportive of the promotion of ethnic minorities, women, and persons with disabilities. This is an exceptional opportunity for someone interested in taking a leading role in the growth of new disciplines in an innovative department in a rapidly growing and vibrant university. We will begin reviewing applications on January 15, 2007, and will continue the search until the position is filled. Send letter, curriculum vitae, and dossier to Dr. Tina Lent, Department of Material Culture Sciences, College of Liberal Arts, Rochester Institute of Technology, 92 Lomb Memorial Drive, Rochester, NY 14623.

Technical Instructor/Laboratory Supervisor. Massachusetts Institute of Technology. The Center for Materials Research in Archaeology and Ethnology (CMRAE) invites applications for a full-time technical instructor/laboratory supervisor at the CMRAE Graduate Laboratory. The appointment begins January 2007; the position will remain open until filled. The Graduate Laboratory is the primary facility where all CMRAE graduate and undergraduate instruction takes place in the materials science and engineering of archaeological materials. Graduate students carry out their Ph.D. research and undergraduates their senior thesis research in this facility. Applicants must be skilled microscopists with considerable experience in either or both metallography and work with the polarizing microscope. Teaching experience is essential. Expertise in photography of archaeological artifacts and in handling a variety of laboratory computers and computer programs, especially Photoshop, is required. The position includes the opportunity for the laboratory supervisor to conduct independent, ongoing research as well as to interact with engineering faculty and faculty from departments within MIT and at the other CMRAE consortium institutions. Applicants must have the MA/MS degree or equivalent experience. Laboratory supervisor's responsibilities include, Instruction: one-on-one supervision of all users of the laboratory, working closely with CMRAE faculty on design and teaching of CMRAE laboratory courses, preparation of protocols for use of all major pieces of lab equipment, computer-aided documentation of all lab procedures; Research and documentation: work with faculty/staff/students on research projects, develop, maintain, and document reference collections of archaeological materials; Equipment maintenance: purchase of minor pieces of equipment and all lab supplies, maintenance of equipment in all CMRAE facilities, major responsibility for maintaining CMRAE lab computers and installing state-of-the-art software. Please send application letter, including a statement of research interests and details of laboratory experience, CV, and names, electronic and postal addresses, and telephone and fax numbers of three references to: Prof. Heather Lechtman, MIT, Rm. 8-437, Cambridge, MA 02139.

Postdoctoral Research Fellowship. Applications are invited for the position of Postdoctoral Research Fellow, based in the AHRC Centre for the Evolution of Cultural Diversity (www.cecd.ucl.ac.uk), at the Institute of Archaeology, UCL, London. The post-holder will work with Dr James Steele on the European Commission-funded project HANDTOMOUTH, to investigate hard tissue markers of vocal tract form in living primates and extinct hominins. Applicants should have a Ph.D. in a relevant discipline and be experienced in speech physiology and/or comparative skeletal anatomy. The post is funded for a period of 2 years starting 1st March 2007, or as soon as possible thereafter. Salary scale: Grade 7. (from £25,889 to £31,840 plus London Allowance of £2,497, according to previous experience). Informal enquiries may be addressed to Dr James Steele on Tel: +44 (0)20 7679 4773 or by email to j.steele@ucl.ac.uk. For details of how to apply please see the news page on AHRC CECD website and download an application form and job description: www.cecd.ucl.ac.uk. Or contact: HANDTOMOUTH Project Manager, c/o Manu Davies, Administrator, AHRC Centre for the Evolution of Cultural Diversity, Institute of Archaeology, University College London, 31-34 Gordon Square, London WC1H 0PY; Tel: +44 (0)20 7679 4607; Fax: +44 (0)20 7383 2572; Email: manu.davies@ucl.ac.uk. The closing date for applications is 9th February 2007**.** UCL - Taking Action for Equality. Website: http://www.ucl.ac.uk/cecd/home/.

Post-doctoral Scholar. The University at Buffalo, State University of New York, seeks a 2007-2008 Post-doctoral Scholar (PS) for its newly established interdisciplinary Institute for European and Mediterranean Archaeology (IEMA). During a 10 month tenure, the PS teaches one graduate seminar, organizes a symposium, and edits a subsequent volume reflecting IEMA¹s focus on post-Pleistocene European and Mediterranean anthropological and classical archaeology. Symposium focus is open, but should stress contemporary theory and topics of broad current interest. The PS receives stipend, benefits, plus individual research funds. US and international archaeologists with Ph.D. by August, 2007 (but no earlier than 2004), in Anthropology, Classics, Archaeology or related disciplines are encouraged to apply. Application letter, vitae, list of references, and 3-page description of proposed symposium topic, including intended invitees, must be received by March 8, 2007 for August 2007 start, pending final budgetary approval. Email applications will not be accepted. Send application or inquiries to Dr. Tina Thurston, Anthropology Department, SUNY-Buffalo, 380 MFAC, Buffalo NY 14261; 716-645-2414.

Ph.D. Studentship. Interviews to be held end of February. Supervisors: Dr William D. Gosling (W.D.Gosling@open.ac.uk), Dr Angela L. Coe, Dr Vincent Gauci (OU) and Mr. Stephen J. Brooks (Natural History Museum, CASE Partner). Components: 1) Assess climate- versus human-driven environmental change in the tropics; 2) Investigation of various aspects of modern and paleoenvironments using: pollen, charcoal, dung fungus and midges; 3) Field work in eastern cordillera of the Bolivian Andes; and 4) Potential to provide insights valuable to archaeologists, ecologists, climatologists, and policy makers. Unraveling the relative contributions of human activity and climate change is fundamental to any effective conservation strategy, but particularly so in diverse but geographically restricted and isolated ecosystems. The significance of the high Andean woodlands, dominated by the tree genus *Polylepis*, lies in the high biodiversity that is found within the ecosystems that they sustain. The *Polylepis* woodland ecosystems are threatened by increasing human population demand for fuel wood and building materials in an otherwise sparse Andean landscape. Ecologists believe that the current fragmented distribution of these woodlands is a product of the long history of human activity. However, recent fossil pollen data from Lake Titicaca points towards a strong sensitivity to climatic factors over the last >400,000 years. This raises serious concerns about the robustness of this unique ecosystem under future possible climate change. The principal objective of this project is to assess whether the long history of human activity in the Andes is responsible for the fragmented distribution of *Polylepis* woodlands or, alternatively, whether climatic variability is the dominant factor in determining the distribution of *Polylepis* woodlands in the Andes. This will be achieved by obtaining high resolution paleoenvironmental records from four mid-high elevation lakes in the Cochabamba region of Bolivia. Four environmental indicators will be examined: pollen (vegetation), charcoal (fire history), dung fungus (herding activity) and midges (climate). Training will be provided at the supervisor's institutions, the Royal Botanical Gardens Edinburgh and Centro de Biodiversidad y Genética (Cochabamba, Bolivia). Other funding: the sediment cores that will be the basis of this project will be collected in summer 2007 thanks to a National Geographic Research and Exploration Committee grant. The Department has a thriving postgraduate community and the postgraduate training programme provides a full range of courses covering: research techniques, scientific methods, information technology, communication and interpersonal skills, which are tailored to the needs of each student. For questions, please contact the supervisors either by e-mail W.D.Gosling@open.ac.uk or by writing to the address below enclosing a full academic CV and the names and addresses of three academic referees. Full NERC and proposed NERC CASE funding available at http://www.nerc.ac.uk. Alternative sources can be sought for non-UK/EU citizens. For further information see: http://www3.open.ac.uk/earth-sciences/palaeo/ or http://www3.open.ac.uk/Earth-Sciences/opp-studentships.html. Research environment: Department of Earth Sciences (http://www3.open.ac.uk/Earth-Sciences); Centre for Earth, Planetary, Space and Astronomical Research (http://cepsar.open.ac.uk/); The Open University (http://www.open.ac.uk/). Contact: William D. Gosling, RCUK Academic Fellow, Department of Earth Science, CEPSAR, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom; Tel. +44 (0)1908 655147.

Awards, Fellowships, and Training

Palaeoanthropology Field School at Makapansgat. July 1-August 4, 2007. Application deadline: March 16, 2007. The Palaeoanthropology Field School at Makapansgat is designed to provide a holistic approach to palaeoanthropological fieldwork and research. Our program has been running intermittently for almost 10 years, involving a variety of researchers, instructors, postgraduate teaching assistants, and participating students from North America, Europe, Asia and Africa. The field school enrolls a maximum of 15 participants, and runs for five weeks during July and August each year, and includes classroom instruction, demonstrations of original hominid fossils, visits to South African fossil sites, and four weeks of training, fieldwork and educational activities in the Makapansgat Valley. Other trips during the program will include local game parks, historic places, and areas of general interest. For more information, see http://www.shef.ac.uk/archaeology/research/makapansgat.

Geochron Laboratories Annual Research Award. Geochron Laboratories, a division of Krueger Enterprises, Inc., is pleased to announce that it will again award a series of research grants to graduate students in 2007. The awards will consist of analytical services to be performed free of charge for the winner in each category. The deadline for applications is May 1, 2006. The two separate general area awards are offered by Geochron in an attempt to encourage the application of isotopic analysis techniques to solve original and significant problems. The awards consist specifically of the following services: 14C Age Determinations (up to six conventional 14C age determinations), Stable Isotope Ratio Analyses (up to $1,800.00 in stable isotope analyses, of any variety or combination except oxygen SIRA on silicates, based on our published prices). The various categories cannot be combined in the same proposal, although separate proposals by the same applicant are welcome and will be judged independently in their respective categories. Further information about the exact nature of the services available may be obtained by calling 617-876-3691 or sending a fax to 617-661-0148. Please see the website for program rules: http://www.geochronlabs.com/research.html.

Conference News and Announcements

Solar Variability, Climate, and the Paleoenvironmental Record, a proposed session (CL46) at the European Geophysical Union, Vienna, April 15-20, 2007. While the role of Milankovitch scale orbital forcing is well established as the key factor in climate forcing over Quaternary timescale, at shorter timescales there is less consensus. Data from peat bogs, ocean cores and ice core records at times appear to support a strong sun-climate-palaeoenvironment linkage, with global teleconnections. These records include elements of periodicities and changes of a rapid nature, and have potentially profound implications for understanding recent and future climates. However, these records are often inconsistent in space and time, with the changes recorded at some sites not present elsewhere and periodicities sometimes transient. Also, the potential scale of solar changes in recent centuries do not seem large enough to account for the variability seen in some paleoecological records without the operation of amplifying effects, as yet unknown. It is the aim of this meeting to address this important issue by bringing together a range of disciplines and key workers in the field. It is hoped to objectively test the strength of the connection between paleoenvironmental records and solar signals on $10\text{-}10^4$a timescales, to determine where possible the magnitude and patterns within the solar-climate data, and hence investigate the relative importance of solar forcing mechanisms. Atmospheric, solar, and climate scientists will be able to exchange results and views with paleo-environmentalists, and the current state of research determined. Current gaps in the research base will be identified and collaborations for future research programmes established. Papers would therefore be invited from those working in any related field that may help meet the objectives of the meeting, and /or further the progress of long-term solar-climate research. This session is part of an outstanding group of climatic change related meetings at the EGU. It is hoped to publish a special issue of a leading journal following the EGU meeting. Conveners: Jeff Blackford and Gerard J.M. Versteegh. Please reply by mail or e-mail to: Dr. J. J. Blackford, School of Environment and Development, University of Manchester, Oxford Rd., Manchester, M13 9PL, UK., + 44 161 275 3763, Jeff.Blackford@Manchester.ac.uk; or Dr. Gerard J.M. Versteegh, Inst. for Biogeochemistry and Marine Chemistry, Bundesstrasse 55, D-20146 Hamburg, Germany, + 49 40 42838 5167, fgfa008@uni-hamburg.de. For more information please visit: http://www.cosis.net/members/meetings/programme/view.php?m_id=40&p_id=237.

The Human Brain Evolving: Papers in Honor of Ralph L. Holloway, is a symposium taking place April 27-28, 2007 on the Indiana University campus in Bloomington, Indiana. Sponsored by the Stone Age Institute and Indiana University, this symposium will feature two days of presentations by major researchers on aspects of brain evolution in honor of Professor Ralph L. Holloway. Registration for this symposium will be open to the general public, students, and faculty. Registration cost for the two-day symposium is $50 for professionals/general public, and $25 for students registering before April 14th. After April 14, registration is $60 for professionals/general public and $35 for students. There are special events Friday night (dinner and entertainment) and Saturday night (limited-seating, reception and dinner at the Stone Age Institute) for which you can register as well. For more information, please visit the website, http://stoneageinstitute.org and click on "2007 Symposium." This page also has a link to online registration for the symposium.

National Park Service Archeological Prospection Workshop. The workshop, May 14-18, 2007, at the HAMMER Training Facility, in Richland, Washington, is open to all archeologists and students, as well as those interested in forensic studies and cemetery investigations. The National Park Service's 2007 workshop on archaeological prospection techniques is entitled "Current Archaeological Prospection Advances for Non-Destructive Investigations in the 21st Century." Lodging will be at the Guest House, Richland, Washington. This will be the seventeenth year of the workshop dedicated to the use of geophysical, aerial photography, and other remote sensing methods as they apply to the identification, evaluation, conservation, and protection of archaeological resources across this nation. The workshop this year will focus on the theory of operation, methodology, processing, interpretation, and hands-on use of the equipment in the field. There is a tuition charge of $475.00. Application forms are available on the Midwest Archeological Center's web page at: http://www.cr.nps.gov/mwac/. For further information, please contact: Steven L. DeVore, Archeologist, National Park Service, Midwest Archeological Center, Federal Building, Room 474, 100 Centennial Mall, North, Lincoln, Nebraska 68508-3873: tel: (402) 437-5392, ext. 141; fax: (402) 437-5098; email: steve_de_vore@nps.gov.

AGU 2007 Joint Assembly: Special Union Session on Drought and the Americas, Acapulco, Mexico, May 22-25, 2007. Glen MacDonald, Dave Stahle, and Jose Villanueva-Diaz have organized a special Union Session on drought for the 2007 AGU (American Geophysical Union) Joint Assembly. The session will bring together paleoclimatologists, climatologists, oceanographers, and those interested in drought impacts on people and nature to share results on the role of the Pacific Ocean in the genesis of persistent (multi-decadal to longer) arid periods in the Americas and the impacts of such droughts. The convenors invite you to consider submitting an abstract and attending this session. Full details on abstract submission and the conference are available at the AGU website (www.agu.org). We encourage students to attend and they may be able to secure funding for this from the AGU Berkner Travel Fellowships (see below – Feb.15th deadline). Abstracts must be submitted before March 1, 2007. This is the first AGU Joint Assembly in Mexico and offers a unique opportunity for US and Canadian researchers to interact with and share results with Latin American researchers. Union Session 14: Long-term Drought in the Americas and Linkages to Pacific Ocean Variability. Description: Historical and paleoclimatic data provide records of hydrological variability for North and South America that span the Holocene. These records, many of them newly developing, demonstrate the susceptibility of the Pacific margins of the Americas to periods of drought extending from decades to millennia. These past episodes of prolonged and pronounced aridity significantly impacted river flow, vegetation, soil stability, fire-regime, and human populations. New evidence derived from paleoceanography and linked ocean-climatic modeling highlights the critical role of variability in eastern Pacific sea surface temperatures (SST's) – including persistent depression of el Niño occurrence and strength - is producing these prolonged periods of drought. The goal of this session is to bring together researchers from throughout the Americas who are working on paleoclimatology and the impact of past prolonged droughts on natural systems and people with paleoceanographers and ocean-climate modelers. The participants will present their latest findings and work towards a multinational and multidisciplinary synthesis of our current understanding of long-term droughts in the Americas (decadal to millennial) and linkages to long-term Pacific Ocean variability. Invited overview talks will help define major questions. Contributed oral presentations and posters on all aspects of long-term variability in drought in the western Americas and associated long-term variability in the Pacific Ocean are solicited. Submit Abstracts: http://submissions5.agu.org/submission/entrance.asp. Online Submission Deadline: 1 March 2007 at 2359 UT. Abstracts must focus on scientific results or their application. The Program Committee may decline to consider abstracts with other focus. All first authors or sponsors must be AGU members in good standing, or members of one of the sponsoring societies (see list). Invited authors must be approved by the Program Committee. Student Travel Aid: Berkner Travel Fellowship Application: February 15, 2007, see the website, http://www.agu.org/meetings/ja07/?content=berkner&show=travel_elig. Contact Convenors: Glen M MacDonald, Department of Geography, UCLA, 405 Hilgard Ave., Los Angeles, CA 90095-1524, Ph: 310-825-2568, Fax: 310-206-5976, macdonal@geog.ucla.edu; David W Stahle, Department of Geosciences, University of Arkansas, 479-575-3703, dstahle@uark.edu; and Jose Villanueva-Diaz, INIFAP CENID-RASPA, Durango, MEX 35140, +52 (871) 719 1076, villanueva.jose@inifap.gob.mx.

The Canadian Quaternary Association (CANQUA) Conference in 2007 will be hosted at Carleton University, Ottawa, Ontario, Canada, June 4-8, 2007. The conference will provide an invigorating forum for those interested in the interdisciplinary field of Quaternary geoscience, including geologists, geomorphologists, physical geographers, biologists, botanists, oceanographers, archaeologists, environmentalists, and others. The organizing committee extends a warm invitation to all interested persons to attend this conference. The CANQUA Ottawa 2007 meeting is planned to be a five-day conference consisting of four days of technical sessions and an intervening day of mid-conference field trips. The technical sessions will consist of oral and poster presentations organized under six special sessions and one general session. There will also be a pre-conference short course, a conference banquet, and a post-conference field trip. Call for Abstracts: the abstract submission period for oral and poster presentations is now open and extends to March 13, 2007. Details on the submission process and abstract formatting requirements, registration, and other information about the conference can be found at www.canquaottawa2007.ca. Conference Registration: registration for CANQUA Ottawa 2007 is now open. The early registration period extends to March 13, 2007, during which a discounted registration fee is available. Key dates: Tuesday, March 13, 2007 - deadline for submission of oral and poster abstracts. Tuesday, March 13, 2007 - end of early conference registration period. Monday, June 4, 2007 - the first day of technical sessions. For additional information on the conference, please email Greg Brooks gbrooks@nrcan.gc.ca.

Latin American Symposium on Physical and Chemical Methods in Archaeology, Art, and Cultural Heritage Conservation. Pre-Registration: we strongly suggest that all intended participants do the pre-registration through the conference website (http://www.sbf1.sbfisica.org.br/eventos/extras/lasmac). Abstract Submission: the submitted abstracts should strictly follow the format examples in the attached file, which is also available on the conference website, until January 31, 2007. Information about acceptance: April 30, 2007. Preliminary program: March 30, 2007. Early registration: April 11, 2007. Full paper submission: June 11, 2007. Preliminary Registration: please fill out the form available ot the symposium site: http://www.sbf1.sbfisica.org.br/eventos/extras/lasmac/inscricao.htm. Registration fee: until 11/04/2007—$150 (professionals) and $80 (students); after 11/04/2007—$180 (professionals) and $100 (students).

17th INQUA Congress Session: Ecosystem Dynamics and Climate Change in Tropical South America. To be held in Cairns, Australia, July 28-August 3, 2007. Conveners: Francis Mayle, William Gosling, and Simon Haberle. Background and Aim: South America contains the greatest diversity of tropical environments on Earth. Lowland ecosystems range from wet rainforests to arid cactus thorn-scrub, whilst the Andes are home to cloud forest, alpine tundra, and glaciers. This diversity of habitats has attracted a diversity of Quaternary scientists from across the discipline, such as, glacial geomorphologists and ice-core researchers focusing on mountain glaciers, pollen analysts focusing on the plant-rich lower altitudes (e.g., cloud forest and Amazon lowlands), and sedimentologists attracted to barren expanses such as the Atacama desert and Pacific Andean slopes. This multi-disciplinary effort has resulted in a significant increase in research output in recent years; however, the challenge remains to improve dissemination of ideas and findings between these different communities of Quaternary researchers as well as greater cross-disciplinary collaboration. For example, what can be learnt by comparing Andean lake-level changes and glacier fluctuations with ecotonal ecosystem dynamics in the neighboring lowlands? What are the challenges/problems of integrating different lines of paleoclimate evidence, such as lake-level changes, paleo-sand dunes, speleothem deposits, charcoal, stable isotopes, and fossil pollen data? What advances can be made by combining empirical paleodata with vegetation and climate model simulations? The aim of this symposium is therefore to bring together Quaternary scientists, focusing on the South American tropics, with a diversity of backgrounds and approaches in order to stimulate inter-disciplinary discussion and debate, learn from one another's findings, and hopefully better elucidate the linkages between different components of this tropical system. To this end, we encourage participants from a range of Quaternary backgrounds (e.g., ice-core specialists, geomorphologists, palynologists, palaeolimnologists, geochemists, molecular ecologists, and archaeologists). We also welcome paleodata-modeling comparisons, methodological advances, and insights from the study of present-day environments. Please note: 1. We plan to publish papers presented at this session in a special issue of a leading international Quaternary journal, 2. Deadline for abstract submission is January 31, 2007, and 3. Details of the conference and information about abstract submission, registration etc can be found at: http://www.inqua2007.net.au/index.htm. We would also like to draw your attention to the following session at the XVII INQUA Congress (Cairns, Australia, 28 July - 3 August 2007) entitled "High-resolution analysis of catastrophic environmental changes and human response." Conveners: Suzanne Leroy (UK), John Clague (Canada), and Matt McGlone (New Zealand). Abstracts can now be submitted through the following link: http://www.icms.com.au/inqua2007/abstract/. Deadline for submission is 31 January 2007. Session Abstract: Rapid and catastrophic environmental changes have helped shape our civilization. We know that some ancient civilizations have collapsed under their impact, and we wonder if our society is better prepared. In order to improve our preparedness we need to understand what is the full potential of natural hazards (earthquakes, droughts, volcanic eruptions, landslides, hurricanes, meteorites) to wreak damage. Only the analysis of past archives (such as sediment, historical documents, and archaeological remains) can give the total overview of the consequences--physical, biotic, and social. This session explores natural catastrophic impacts that affect people and ecosystems. It is also deals with recovery, either to a new, more resilient status or a return to the previous situation. A multidisciplinary approach is encouraged with geologists and geographers working alongside historians, archaeologists, meteorologists, and physicists in order to create more comprehensive and better understood paleo-reconstructions. The session will also deal with high temporal resolution and robustly calibrated dating. While high resolution will enable us to detect changes at a societal scale, robust chronologies from different archives are essential to be able to establish cause and effect.

21st Conference on Surface Modification Technologies will be held in Paris, September 24-26, 2007 with a session on "Arts and Surfaces." The purpose is to provide an interactive forum for a multidisciplinary discussion on the science and technology of surface-related phenomena for all artistic and archaeological materials. The proceedings of the previous session on "Arts and Surfaces," held in Dijon in 2004, has been published in a double special number of the review "Surface Engineering." For the contents see: www.maney.co.uk/SUR/contents. The session on "Arts and Surfaces" will be scientifically coordinated by Dr Alessandra Giumlia-Mair. Contact for details on this session: giumlia@yahoo.it. For more information on the SMT21 Conference see the website: http://www.c2s-organisation.com. Conference Secretariat: Chantal IANNARELLI, Congrès Scientifiques Services (C2S) SMT 21, c2s@club-internet.fr.

International Aerial Archaeology Conference. September 25-27, 2007, The National Museum, Copenhagen, Denmark. Closing date for abstracts is May 31, 2007. Financial aid for students: aimed at supporting bona fide students who are interested in aerial archaeology and who wish to attend the conference. Anyone wishing to apply should contact Dave Cowley (by letter or email) with information about their interests in archaeology and aerial archaeology, as well as their place of study. Closing date for applications is May 31, 2007. Address for conference correspondence: Dave Cowley, RCAHMS, 16 Bernard Terrace, Edinburgh, EH8 9NX, Scotland, Email dave.cowley@rcahms.gov.uk. Aerial Archaeology Research Group website: http://aarg.univie.ac.at/.

Late Quaternary Environment in the Teotihuacan Valley, México, Inferred from d13C in Soils

E. Lounejeva Baturina, P. Morales Puente, E. Cienfuegos Alvarado, S. Sedov, and E. Solleiro Rebolledo
Instituto de Geología, Universidad Nacional Autónoma de México

As soil pedogenesis is controlled by a set of local soil forming factors, such as climate, hydrological vertical and lateral fluxes, and biota (Targulian and Goriachkin 2004), d13C provides an in situ record for paleoecological reconstruction with high spatial resolution. Archaeological research can use this "soil memory" concept to explore the influence of landscape dynamics on the evolution of early human societies. The stable carbon isotope composition of soil organic matter (SOM), usually expressed as d13C, represents an important element of soil memory, as far as it can be interpreted as a direct indicator of the ratio of C3/C4 plants in the paleovegetation.

The Teotihuacan Valley hosted worldwide known pre-Hispanic civilizations. Through the Classic period, a large urban and ceremonial center developed in the valley. The collapse around A.D. 650 of the state, characterized by stable agriculture and an efficient obsidian and ceramics market over an extensive territory comprising the Mexico and Puebla basins (Millón 1967), is still debated. A possibility of increased aridity, along with human deforestation activity and enhanced soil erosion may have contributed to general agricultural degradation of Classic Mesoamerican cultures (Heine 1987; Pérez 2003). A few centuries later, the Aztecs (or Mexicas) came to the urban center of the valley, which they called Teotihuacan. They continued to rule this territory until European colonization. A period of florescence during the Post Classic period (between A.D. 1350 and 1520) has been established by 14C dating of ceramics (McClung et al. 2005).

Some of the earlier attempts to reconstruct the paleoenvironment in the Teotihuacan Valley were based on paleopedological records (McClung et al. 2003; Gama-Castro et al. 2004; Solleiro-Rebolledo et al. 2006). In this work, we report additional complementary information about the carbon stable isotope composition of organic matter from paleosols in the Teotihuacan Valley (Lounejeva et al. 2006), which supports our interpretation of regional paleoenvironmental changes throughout the past 13,000 years.

Stable Carbon Isotopic Relations in SOM

The d13C, the deviation of any sample isotopic signature from a standard, is expressed in parts per thousand (per mil) (Coplen 1995). The d13C of SOM can be correlated with a relative abundance of buried plant species featured by different photosynthetic pathways. Around 85 percent of plant species generate molecules containing three atoms of carbon using Calvin-type photosynthesis (Boutton 1991; O'Leary 1988). These so called C3 plants are dominant and ubiquitous, and include tall trees, shrubs, a few grasses and some cultivated taxa such as wheat, barley, potato, bean, cotton. They are associated with humid climate and are characterized by relatively low d13C values and a mean of –27 ‰ (Smith and Epstein 1971). About 5 percent of known modern species, refereed to as C4 plants, are highly efficient at assembling four-carbon molecules from atmospheric CO_2 using the Hatch-Slack photosynthetic process. They belong to 18 families, and about half of them are tropical or sub-tropical. The C4 plants cover around 17 percent of the global landscape and are responsible for 20-30 percent of terrestrial photosynthesis (Boutton 1996). These plants discriminate less against the heavy carbon isotope, and are thus characterized by higher d13C values with a mean of -13‰ (O'Leary 1988; Boutton 1991). Many grasses, sedges and herbs, as well as maize, millet, pearl and sugar cane are examples of C4 plants. The C4 plants are generally associated with warm, dry climates.

Finally, CAM plants, known as succulents (i.e., cactus, agave, pineapple, and so on), represents around 10 percent of plant species. At least 30 families of plants belong to this group (Koch, 1998). The CAM plants can have d13C values ranging from –28 to –10 ‰ depending on the particular species, but they are minor components of most ecosystems. The dominance of such kinds of plants, in the absence of the anthropogenic agriculture component, may indicate a very dry climate. The relative contribution from C3 versus C4 plants to the SOM pool markedly influences the d13C value. On the average, d13C of C4 plants is about 14 ‰ higher than d13C of C3 plants. This natural isotopic difference allows interpretations of vegetation changes at a specific site through evaluation of the relative C3-C4 abundance in the SOM. Soil organic matter can be preserved in paleosols for thousands of years enabling the use of carbon stable isotopes as a paleoecological proxy (Heine 1987; Koch 1998). A dramatic shift in C3/C4 ratio over time may be attributed to some changes in climate or other environmental disturbances. The d13C measurement from SOM may be done independently or may be obtained as complementary information from 14C Accelerated Mass Spectrometry (AMS) laboratories. To use the data, one should be sure that during the sample preparation procedure all kinds of carbonates are destroyed in the sample, because carbonates are enriched in heavy 13C isotope (d13C= -7 - +5 ‰), which may alter the signature. The geochemical approach may be accomplished by isotopic study of different SOM fractions, such as humic acid or lignin, but this topic is outside of the objective of this work. Climatic interpretation of any single record can be complicated by factors unrelated to climate that may potentially affect measured proxies. Correlation of different proxy records from several natural records should be helpful for climatic interpretation.

Sites, Samples, and Methods

SOM sampling in the Teotihuacan Valley (Figure 1) included sites at different altitudes: upper parts of volcanic cones (Cerro Gordo), the border of the ancient Texcoco – Xaltocan Lake (Tepexpan), the floodplain in the valley (Otumba, San Pablo) where there is clear evidence of modern human activity and, recently, the valley floor (Rio San Pablo). Cabadas-Báez (2004) and Solleiro-Rebolledo et al. (2006) have described paleopedological features, such as micromorphology, clay mineralogy and phytolits for the paleosols from the referenced profiles. Here we only summarize the main features of profiles, including the age and carbon signature (Table 1). Only humus rich A and AB horizons were sampled for the isotopic study. Samples selected for dating are distributed through the profile to get an idea of the long- term pedogenesis time scale. A few samples were taken directly from two archaeologically

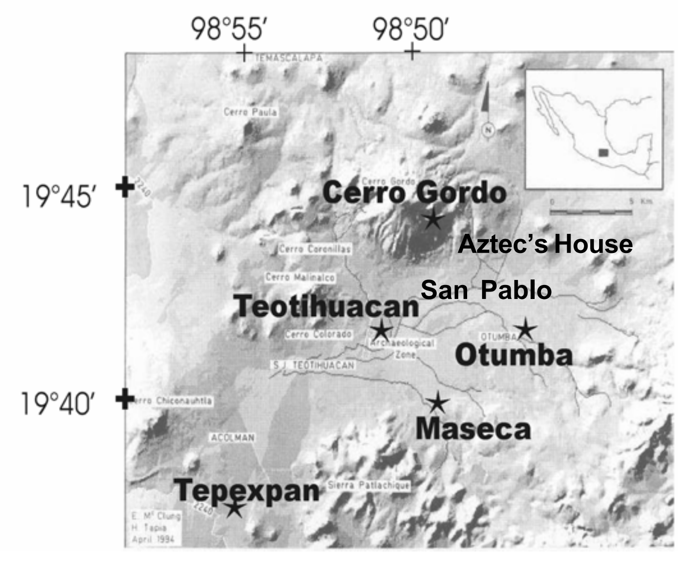

Figure 1. Location and distribution of sites (stars) in the Teotihuacan Valley.

Table 1. Summary of Some Physical and Chemical Characteristics of the Teotihuacan Paleosols and Modern Soils.

Profile	Coordinates H m a.s.l. N altitude W longitude	Horizon	Depth Cm	Age, kyr	Quaternary period	d13C, ‰	* %
Cerro Gordo	2948	Ap	0-15		R	-20.7	46
	19°44'55''	Ah	15-31		late H	-20.2	50
	98°49'24''	AB	31-46	5.6	mid-H	-19.5	55
		2A	71-82	13	late P	-20.9	44
Otumba	2314	Ah	0-22		Late H–R	-18.1	65
	19°41'32''	AB	22-50		Late H–R	-18.6	61
	98°45'49''	2A	50-92	~3*	Late H	-17	73
		2AB	92-122		Late H	-17.2	72
Tepexpan	<2300	Ah modern soil	0-12		late H–R	-16.4	78
	N19°36'52"	2Ah, 1st paleosol	29-38		late H	-16.3	78
	W98°56'47"	3Ah,2nd paleosol	50-60	4	mid H	-15.5	84
		4Ah1,3rdpaleosol	105-115		mid H	-17.2	71
		4Ah2,3rdpaleosol	115-130	5.5	mid H	-17.8	67
		Swamp soil	165-175		early H	-21.9	37
		Swamp soil	180-215	10	late P	-25.7	9
		Swamp soil	215-225		late P	-22.3	34
San Pablo river	2300	2 A, 1st paleosol	27-40		Late H	-22.2	36
		2AC, 1st paleosol	40-62			.18.84	61
	N19°42'30.9"	3A, 2nd paleosol	90-105	0.45		-18.4	64
	W98°49'15.2"	4A, 3rd paleosol	125-175	0.6		-17.3	73
		4AC,3rd paleosol	175-205			-14.7	93
		5 A, 4th paleosol	205-220			-14.9	91
San Pablo terrace	2300	Ap	0-34		R	-18.1	67
	N19°42'25"	Ac	34-40		Late H	-16.6	78
	W98°48'37.2"	2A	52-67		Late H	-16.9	75
Casa Aztecas	N19°42'42.8"	Profile 1 Ah	0-5		R	-17.3	73
	W 98°42'6.9"		15-37		Late H	-15.4	87
			37-62		Late H	-16.8	77
		Profile 2 Ah	0-12		R	-20.5	49
			11658		Late H	-18.9	61
			31-47		Late H	-16.7	77
		Profile 3 Ah				-15.5	87
San Lucas		Ah	0-5		R	-118	45
		AB	21-May		Late H	-20.5	49
Pirámide de la Luna	2000±200	Transported Ah	Younger	<1.8	late H	-17.6	69
		Transported Ah	Younger		late H	-16.2	79
		Transported Ah	Older	>1.8	late H	-16.4	77
		Transported Ah	Older		late H	-16.3	78

R-Recent, H-Holocene, P-Pleistocene

documented monuments, namely from the Pyramid of the Moon, one of the two Classic period pyramids in the central part of the valley, and from the Aztec's House located in the terraces of San Lucas to the northeast of the valley at San Lucas.

Four samples come from a gallery, dug in 2002 for archaeological research just inside the Pyramid of the Moon. The gallery walls display interfaces between seven constructions built one over the other at different times between 1800 and 1500 years ago (100-450 A.C.) (Sugiyama and Cabrera 2003). The interface fill has a stratified structure (Figure 2), and it seems to be a re-deposited soil rich in organic matter. We assume that each fill layer represents the surface soil from the surrounding ground at the time the pyramid was

Figure 2. Wall fragment from the artificial gallery in the Pyramid of the Moon: general view (left); close-up of marked area where the Ah horizons of the superimposed fills can be seen (right).

Figure 3. Aztec's House living rooms.

constructed. Consequently its carbon isotopic composition should reflect the vegetation in Teotihuacan at that time. We sampled humus-rich fills from the 2nd and 4th horizons, according to the numeration of the superimposed buildings. The San Lucas area was widely settled during the Postclassic period. Unfortunately, during the last several years, the terraces have been strongly affected by modern cultivation. The Aztec's House is a rectangular shape with walls of 13 m x 7 m and is composed of three rooms: a food preparation area, a storage room, and living areas (Figure 3). Seven humus rich samples from different sides of the living room were selected for the isotopic study.

We used the routine sample preparation and instrumental analysis reported by Lounejeva and colleagues (2006). The proportion x of carbon derived from C4 (+CAM) plants in soil samples was calculated from the mass balance equation (Boutton 1996) reduced to: x = (d13C + d13CC3) /(d13CC4), where d13C is the isotopic ratio of the sample; d13CC4 = -13.67 and d13CC3 = -26.96 ‰ are the means of the present day respective plant species in the area (Lounejeva et al. 2006). The equation implies a positive linear dependence between d13C of SOM and the proportion of organic carbon derived from C4 plants.

Results and Discussion

The d13C obtained from the soils in Teotihuacan Valley, as well as the calculated fraction of C4-derived SOM, are presented in Table 1. These values are are displayed in Figure 4. Along the vertical chronological axis, we use the values based on a mixture of 14C dating, pedological studies, and archaeological correlations. Radiocarbon dates from such alluvial soils are controversial, because intensive soil erosion affected the valley by about A.D. 1100-1550 (McClung et al. 2005). The obtained set of isotopic data constitutes a good illustration of the high spatial resolution of the SOM carbon isotopic record. Weak chronological support for the samples studied here only allows for general interpretations to be made. The increase of d13C from the late Pleistocene to the middle Holocene can be more clearly observed in those profiles that span longer periods, such as the Tepexpan profile from the valley floor and the Cerro Gordo profile higher up in the valley.

The late Pleistocene-early Holocene swamp paleosols dated around 10,000 B.P. have the more depleted isotopic relations (d13C less than -21‰,), dominated by C3 aquatic vegetation derived carbon. We infer a high wetness availability for the end of Pleistocene in the valley from the presence of swamp soils and its low d13C (Lounejeva et al. 2006). The middle Holocene paleosols (6,000-4,000 B.P.), on the contrary, in both profiles have relatively enriched signatures (d13C = -15.54 and –19.5 ‰, respectively). Post-burial pedogenic processes should not affect the SOM isotopic signature more than 2 ‰, so we infer an environment dominated by C4 plants due to the arid climate of the middle Holocene.

The late Holocene and modern soils younger than 2,000 B.P., including those from the archaeological objects, display d13C spreading between –14.65 and – 22 ‰. This could be due to their geomorphic position, however, these values are still high enough to infer a dominant component of carbon derived from C4 and CAM plants. However, the same tendency may be traced in each profile: the younger the soil, the lower its isotopic signature; especially notable in the San Pablo profile, where d13C drops more than 6‰. We correlate these data with a slight increase of C3 species buried in the soils and infer a slight increase of wetness availability over the last 2,000 years. Such a general natural tendency seems to be affected by anthropogenic C4 components, for example, by maize cultivated in Otumba or Aztec's House through the last centuries.

Our interpretation of the isotopic data from the soils of the Teotihuacan Valley agrees in general with other

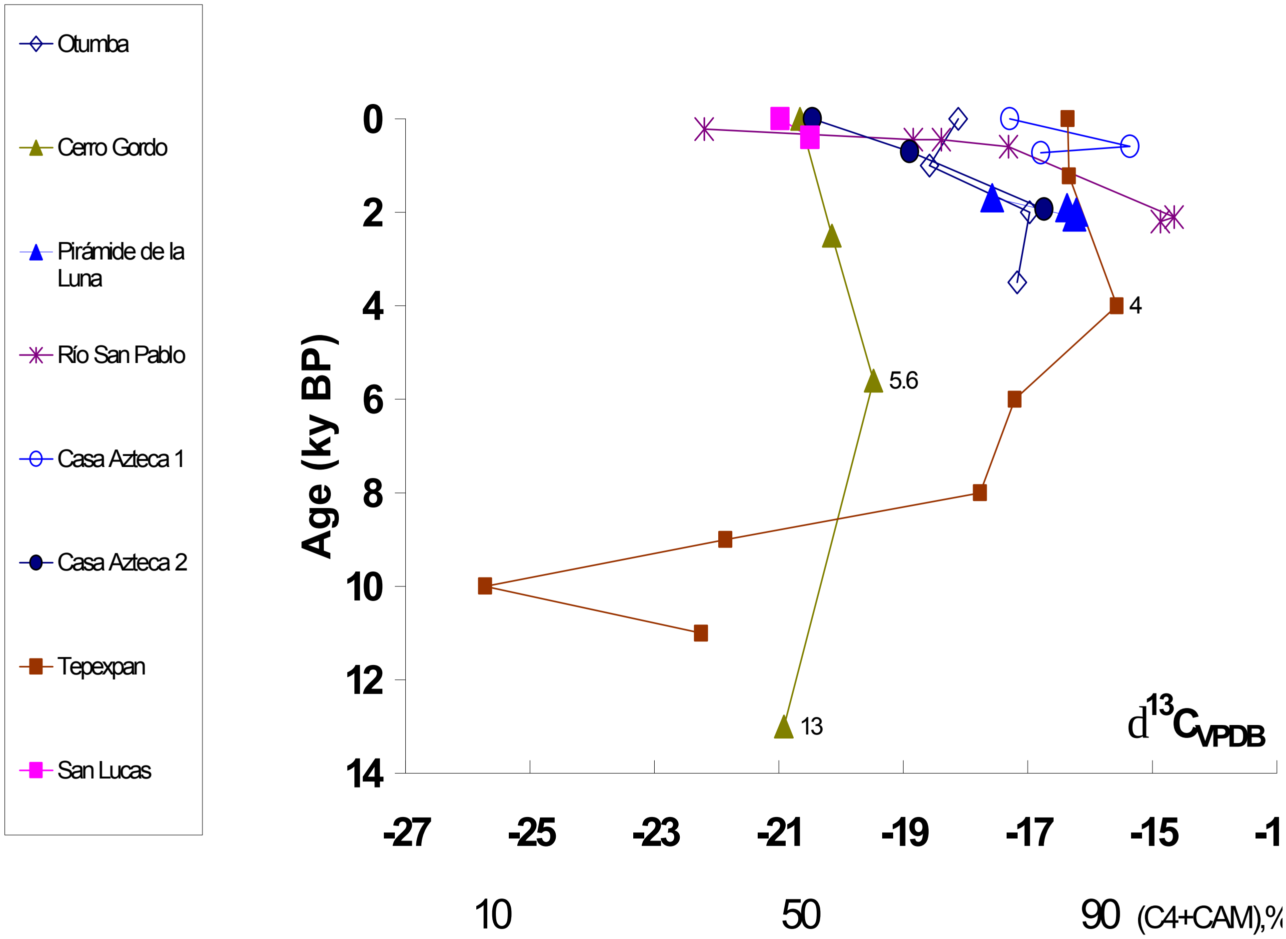

Figure 4. Stable carbon isotopic signature and corresponding contribution of C4 and CAM plants to the SOM of paleosols and modern soils from the Teotihuacan Valley.

paleoenvironmental studies of lacustrine sediments, based on diatom and pollen records and supported by some AMS radiocarbon dating from the neighboring areas of the Central Mexico Basin (Caballero-Miranda et al. 1998, 1999, 2001, 2002; Lozano-García et al. 1998; Metcalfe et al. 2000; Sedov et al. 2003; Urrutia-Fucugauchi et al. 1994, 1995).

Conclusions

The carbon isotopic values in paleosols and modern soils from the Teotihuacan Valley region suggest the following natural environmental fluctuations: 1) natural substantial increase of C4 vegetation and corresponding shift from a relatively wet climate through the late Pleistocene (13,000-10,000 B.P.) to a relatively dry climate in the middle Holocene (6,000-4,000 B.P.), and 2) a relative increase of C3 plants demanding more humidity for at least the past 2,000 years and the establishment of the present climate characterized by still dominant CAM and C4 vegetation in the valley. The isotopic data obtained in the Teotihuacan Valley reflect the anthropogenic effects of cultivation on the vegetation component to the SOM. Rigorous research based on advanced sampling plans and supported by geochemical (chronological and isotopic) data may shed light on this question.

Acknowledgments

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Using Remote Sensing to Assess the Impact of Prehistoric Agriculture on Modern-Day Vegetation Cover in the U.S. Southwest

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Archaeological and historical research is paying increasing attention to human-induced environmental change spanning temporal ranges of hundreds and even thousands of years (i.e., Foster et al. 2003; Hardesty and Fowler 2000; Peeples et al. n.d). These studies are becoming important to present day resource and land use management because they can elicit information concerning the long-term effects of human activity on the natural landscape. Remote sensing applications provide an efficient method to evaluate the impacts of recent anthropogenic activities on the modern natural landscape at regional scales (i.e., Camacho-de Coca et al. 2004; Tateishi et al. 2004; Tobler et al. 2003). This study uses remote sensing to examine the effects that prehistoric agricultural practices may have had on shaping modern vegetation cover in the middle Chevelon Creek Drainage, east-central Arizona. The findings of this study offer a new application of spatial technology and imaging for better understanding the long-term impacts of small-scale agriculture and other landuse practices on modern landscapes. Furthermore, the findings of this study may have important implications for the archaeological assessment of prehistoric agriculture in the American Southwest.

Study Area

The primary study area is confined to the boundaries of the Mogollon Rim Small-Site Survey (MRSS) conducted by a team from Arizona State University and University of Valencia, Spain (1997-1999) in the middle reaches of Chevelon Canyon (Figure 1). This survey recorded high-resolution, patch-based data on prehistoric agricultural and pre-agricultural settlements in a GIS-defined catchment around the Late Archaic Chevelon Crossing site (Peoples et al. n.d.). Chevelon Creek begins at the escarpment of the Mogollon Rim in the south and flows northward through diverse geographical and ecological zones of the southwestern edge of the Colorado Plateau. The terrain nearer to the Mogollon Rim in the south is higher in elevation and more rugged, but becomes gentler as elevation decreases toward the northern reaches of the creek. The variation in the region's plant communities is for the most part dependent on elevation. In total, five different vegetation communities were defined and used in the study (Plog et al. 1976): 1) desert-short grassland, 2) open woodland, 3) Pinyon-Juniper woodland, 4) Douglas-fir/Ponderosa-pine Forest, and 5) a riparian zone. It is important to note that although these ecological boundaries are not explicitly abrupt as the elevation gradually changes, the vegetation communities are for the most part uniform in internal composition across the study area landscape (Plog et al. 1976:17).

Research Question

The variation in the ecological communities of the Chevelon drainage presented the earliest inhabitants of the region (c. 9000 BC) with a variety of plant and animal species that supported their subsistence strategy for millennia. Around A.D. 400, however, the inhabitants of the Chevelon drainage shifted their strategy away from foraging in the canyons to a lifestyle based on agriculture. They moved their settlements to the ecologically stable uplands where they took advantage of a more predictable ecosystem for maize cultivation (Peeples et al. n.d.). These uplands were attractive for maize agriculture because of their initially fertile soils and the relatively low labor costs of clearing the land with fire (Matson et al. 1988). Pinyon-Juniper woodlands that dominated these areas subsequently were transformed by swidden agriculture (i.e., shifting cultivation) (Kohler and Matthews 1988).

While conducting the patch-based survey, the MRSS crew recorded that pockets of open woodland were often present within the larger Pinyon-Juniper cover in close proximity to ancient habitation sites. This suggests a possible link between the agricultural practices of the ancient inhabitants and the modern "natural" landscape. In other studies it has been estimated that following clearance for agriculture, it can take

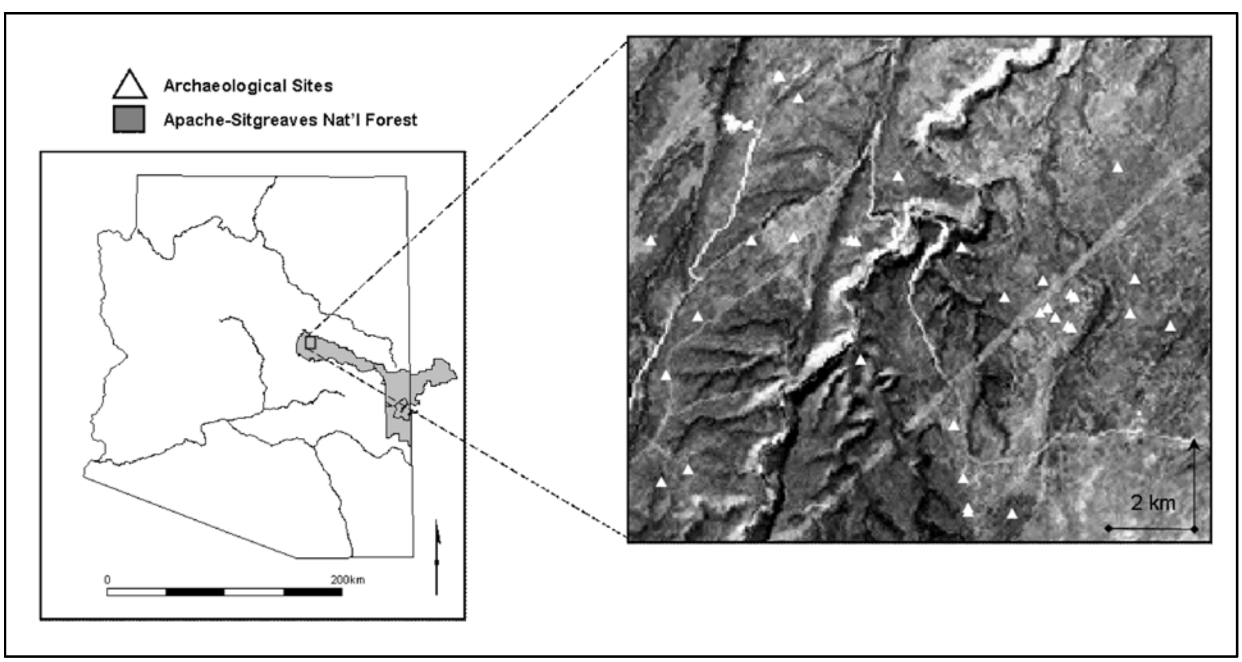

Figure 1. Study Location: A projection of Chevelon Creek in East-Central Arizona, focusing on Chevelon Canyon with archaeological sites as white triangles.

100-350 years for soils of the Colorado Plateau to regain sufficient fertility to allow the Pinyon-Juniper woodland to reach previous levels of maturity and coverage (Stiger 1979:136). A systematic association between prehistoric farming settlements and clearings in the modern forest, however, may indicate that the impacts of prehistoric agricultural practices on the Southwestern landscape do not just last for a few decades or centuries, but can persist for nearly a millennium. Therefore, the primary aim of this study is to evaluate the significance of any spatial association between the open vegetation and archaeological sites in the Pinyon-Juniper woodland.

Methods

A two step process was used to assess the spatial association between open-woodland vegetation and known archaeological sites. First, a discriminant analysis was performed to differentiate areas around sites from non-site locales in terms of land cover. Analysis was carried out in Multispec (3.2), multispectral image software, developed by Purdue University and NASA available at no cost (http://cobweb.ecn.purdue.edu/~biehl/MultiSpec/). A Landsat-7 ETM+ image from 2 June 2001 was overlain by a georeferenced shape file of the known archaeological sites in order to identify the Landsat pixels (28.5 m x 28.5 m in size) surrounding sites. These sites were extracted from the MRSS and the U.S. Forest Service, Apache-Sitgreaves Forest archaeological site databases, and included only those sites that have visible above ground room blocks or agricultural features such as check dams. In total, 35 sites met these criteria; the locations of which can be seen in Figure 1. A quarter kilometer (9 x 9 pixels) grid was placed around each of the 35 sites (2907 pixels total). A similar number of pixels (3000) were randomly selected from areas of land not near the habitation sites. Areas where vegetation differences were clearly due to reasons other than landuse—riparian zones or recently burned areas—were excluded from the non-site pixel selection. The site and non-site areas were then compared with respect to reflectance values in the visible light and non-thermal infrared bands (1-5 and 7). These bands are sensitive to variations in the amount and type of vegetation cover (Lillesand et al. 2004:433).

For the second procedure, a supervised classification analysis was conducted to indicate the distribution of open vegetation and its proximity to the archaeological sites (Figure 2). The supervised classification was performed in Multispec (3.2) using Landsat-7 ETM+ bands 3, 4, and 5 because these three bands are considered especially useful for differentiating among vegetation species and the quantity of land cover (Lillesand et al. 2004:422; Camacho-De Coca et al. 2004:3458). To assist in the supervised classification, two 1 m resolution B&W digital orthoquad images of the study area were employed to help define ten training fields for each of the five plant communities listed above. Information from the training fields was used to classify the entire image into the five plant communities. Using the Maximum Likelihood method, the pixels in the training fields were classified with a 93.3 percent accuracy, suggesting the overall classification to be robust. To better visualize the distribution of the open woodland cover, the resultant classification was transformed into a binary image with black pixels representing the open woodland and white pixels representing all other vegetation classes (Figure 3).

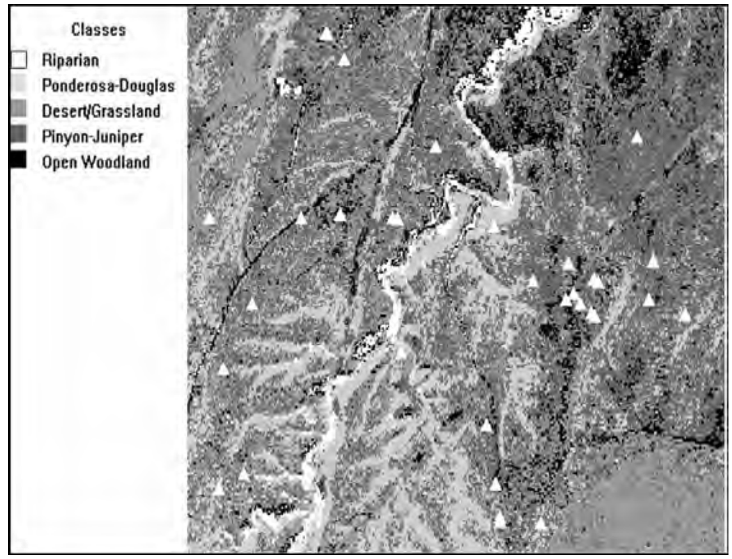

Figure 2. Supervised Classification for Middle Chevelon Creek Drainage with archaeological sites as white triangles.

It should be noted that desert-short grassland was initially considered to be part of the open vegetation category. However, most desert-short grassland pixels were found to be representative of either burn areas or Forest Service roads and, therefore, were removed from inclusion into the open vegetation category. Lastly, one-quarter kilometer catchment rings were placed around each site. For each catchment zone, the distance to the nearest open woodland pixel (if present) as well as the total area of open woodland pixels (if present) was recorded.

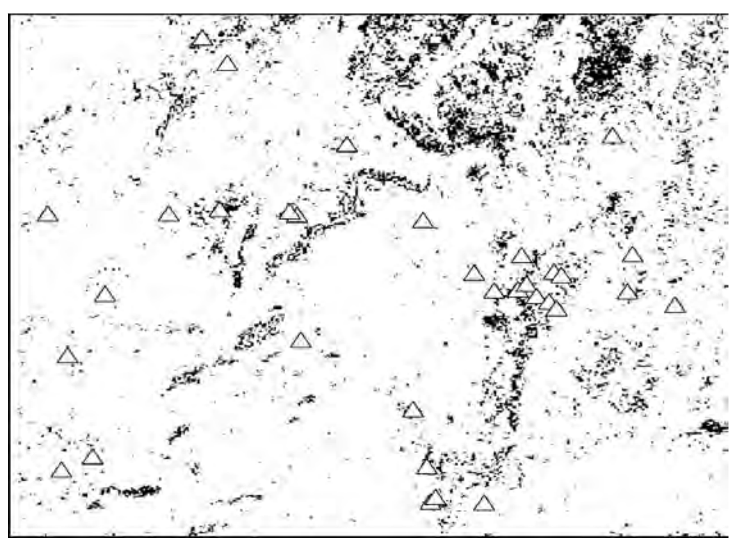

Figure 3. Binary image of study area revealing areas of open woodland (black pixels) and location of prehistoric agricultural sites (white triangles).

Results

The discriminant analysis showed clear differences between band values for pixels associated with sites and those that were not (Table 1). More importantly, Table 2 shows that 71 percent of the pixels around sites and non-site cases were classified differently. This is an especially high value considering that the areas around sites are not completely devoid of trees and sites and non-site areas all fall broadly within the Pinyon-Juniper woodland zone. Furthermore, a Wilk's Lambda test indicated that the probability that sites and non-sites shared the same distribution of band value was 0.00, offering statistical support for a significant difference in the vegetation cover for areas of land near and distant from archaeological sites.

The results of the supervised classification analysis further support the presence of open vegetation in the proximity of archaeological sites. The analysis revealed that 27 of the 35 (77 percent) habitation sites contained areas of open woodland within their catchment zone. Interestingly, areas of open woodland only account for 6.28 percent of the vegetation cover for the entire study area. A Chi-squared test shows that the distribution of open woodland around prehistoric agricultural settlements is significantly different from that of the region as a whole (a = .001). This lends further support for an association between areas of open woodland and archaeological sites, and strongly implies that the prehistoric agriculture in the Chevelon Drainage sufficiently altered the conditions for Pinyon-Juniper woodland growth that it has influenced modern vegetation cover.

Conclusion

The above analyses produced two closely related findings. First, there is a notable difference in vegetation cover for land near archaeological sites and the land that is not and, second, these same sites are strongly associated with open woodland. It is possible that prehistoric people situated their farms in openings in the Pinyon-Juniper. However, this does not explain why open vegetation persists so consistently around such sites almost a millennium later. A more likely explanation is that the distinctive vegetation around these sites is a long-term result of human activity, and may represent prehistoric agricultural fields.

Table 1. Discriminant Coefficients (Landsat ETM+ Band Values) Distinguishing Site and Non-site Regions.

Group Means		
Band	Sites	Non-sites
1	121.5	123.439
2	82.481	85.113
3	100.84	105.411
4	73.774	74.175
5	147.51	147.686
7	147.51	147.686

Table 2. Classification Matrix Revealing the Percentage of Cases that Were Classified Correctly.

Classification Matrix			
	Sites	Non-Sites	% Correct
Sites	2006	901	69
Non-Sites	841	2159	72
Total	2847	3060	71

It is clear that the agricultural potential around each of these prehistoric settlements warranted the investment of labor needed to clear and cultivate fields, and to construct permanent facilities for habitation and storage. However, if the natural vegetation remains impoverished centuries later, then these landscapes probably could not have continued to support human occupation either. In this sense, agriculture in this region was initially productive but ultimately unsustainable. Short-term landuse practices destroyed the long-term productivity of this region for maize horticulture. This study suggests that even small-scale human activities can leave an imprint on the landscape that lasts for centuries.

This research also offers a potentially valuable method for investigating prehistoric agriculture in the semiarid Southwest and environmentally similar areas. Remote sensing has proven useful for identifying agricultural features in the neotropics (Pope and Dahlin 1989; Heckenberger et al. 2003; Sever and Irwin 2003). The strong association of open woodland areas with prehistoric habitation sites documented in this study suggests the possibility of identifying prehistoric agricultural fields using remote sensing analysis of modern vegetation in semiarid woodlands. Additional work is needed to ground truth the associations proposed here between modern vegetation and prehistoric agriculture. But similar work currently in progress shows considerable promise in this regard (Briggs et al. 2006).

Finally, this work further demonstrates the importance of augmenting traditional archaeological fieldwork with geospatial methods like remote sensing to better understand the role of humans in transforming landscapes.

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FTIR-ATR Studies of Plasma-Oxidized Materials: Implications for "Nondestructive" Radiocarbon Dating

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In the early 1990s, plasma chemical oxidation (PCO) was first implemented at Texas A&M University for selective oxidation of organic matter in rock paintings for radiocarbon dating. This technique utilizes low-temperature and -pressure oxygen plasma to oxidize the organic carbon present on the surface of the material of interest, producing CO_2, which can be subsequently dated by accelerator mass spectrometry (AMS). Recently, Steelman et al. (2004) proposed using the PCO method as a "non-destructive" technique for radiocarbon dating fragile materials (Steelman and Rowe 2002). They report that little or no *visible* change occurs when fragile materials are plasma-oxidized for AMS dating. Plasma reacts only with the exposed surfaces, removing a minute amount of material from those surfaces. Reliable AMS dates have routinely been obtained on less than 100 µg of carbon as CO_2 generated by the PCO method. The surface composition, and how representative it is of the whole object, is of particular interest.

Contamination is always of great concern in the dating of small samples. The contamination may be isolated at the surface, as in residues from handling or from conservation treatments, or may permeate the object, as is the case with humic substances from groundwater. Surface contamination is particularly important in the case of PCO-AMS: to obtain a valid radiocarbon date, such contamination must be removed prior to plasma treatment. Depending on the type of artifact, surface contamination can generally be removed with a soft brush or by immersion in water. Pervasive contamination, however, is typically removed through harsh chemical pretreatments with strong acid or base solutions, which tend to be destructive. For PCO to be considered truly nondestructive, a minimal – yet effective – pretreatment method must be developed and utilized.

The *chemical* changes induced in plasma-oxidized archaeological materials have not been examined previously in this context. Low temperature plasma is used in the textile industry to modify the surfaces of fabrics while maintaining the general bulk properties of the materials. Plasma treatment has the advantage of being environmentally friendly compared to wet chemical modification methods such as bleaching. Linen exposed to oxygen and argon plasma treatments shows significant surface morphological and chemical change, while oxygen plasma is effective for surface scouring of cotton (Rashidi et al. 2004; Wong et al. 1999). Plasma treatments have also been used in conservation applications to remove smoke and fungal contamination on paintings and paper (Laguardia et al. 2005; Rutledge et al. 2000).

Because plasma interactions occur at the surface, analytical methodologies specific to that region are required.

One such method is attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR). FTIR is widely used in conservation science because it is nondestructive and is applicable to both organic and inorganic materials. ATR is a specialized sampling technique whereby samples to be studied are pressed against a highly refractive optical crystal of zinc selenide or diamond. The infrared light is then directed onto the crystal, where some of the radiation bleeds into the surface of the sample and is absorbed. The radiation that is not absorbed by the sample is passed back through the crystal to the detector. The resulting spectrum is obtained from the ratio of total light reflected by the crystal alone and with a sample present.

This work specifically aims to measure the chemical effects of the plasma treatment on archaeologically-relevant materials by using infrared spectroscopy. Comparison of the functional groups present on the surface of the sample before and after being subjected to oxygen plasma treatment will aid in understanding the effects of the plasma and thereby improvements in the "non-destructive" process. In this study, cotton, linen, silk, and wool samples that were free of sizing, dyes and unbleached were characterized along with leather, grass, wood, and charcoal using ATR-FTIR, both before and after being subjected to plasma chemical oxidation. The measurements for characterization were completed on a Shimadzu FTIR-8400S (32 scans, 4.0 cm^{-1} resolution, 4700-500 cm^{-1} range) with a Pike MIRacle ATR containing a single-bounce zinc selenide crystal. The samples were subjected to 100 watt oxygen plasmas (1 torr) for 60 minutes.

Results and Discussion

During plasma oxidation, yellowing of the wool, silk, and cotton samples was observed. Some discoloration of the leather, cotton, and linen samples was also observed as well, but to a lesser extent. The FTIR spectra obtained indicate that leather, wool, and silk samples were all affected during plasma oxidation, while cotton, linen, and charcoal were unaffected by this process. The functional groups that seem to be the most affected include amines (-NH) and carbonyls (-C=O), both of which show strong peaks around 3300 cm^{-1}. Stretching of the C-H bond, observed at 2900 cm^{-1}, also appears to decrease after plasma treatment. The decrease in these two bands most likely results from removal of an outer layer of the material by the plasma. Some variation in pre- and post-plasma spectra may result from differences in the orientation of the samples on the ATR crystal. The wood and grass samples were affected significantly more than the textile samples. Mold, probably *Apergillus* sp., which was observed on the grass sample, was visibly removed by the plasma (Figure 1), but only on the exposed surface. The wood, which had been buried in soil, was not washed prior to oxidation. A significant decrease in the C-H stretch band was observed in the infrared spectra of both of these samples. It is possible that the plasma removed some of the surface contaminants on the wood and grass samples, which were "dirty" prior to oxidation. These observations are consistent with those reported by Rutledge et al. (2000) and Laguardia et al. (2005). This is an important observation, as the selective removal of surface contamination may be particularly useful for using the plasma method for preparing materials for radiocarbon dating.

The relatively large 1 μm sampling depth of FTIR-ATR may have obscured changes that occurred at the outermost surfaces of the materials, yielding spectra that show little or no difference before and after plasma-chemical oxidation. FTIR-ATR is often used in conjunction with other, more surface selective methods, such as x-ray photoelectron spectroscopy (XPS), which is limited to the outermost 10 nm (0.00001 μm). Further work will utilize other ATR crystals that yield a smaller penetration depth and higher signal-to-noise. This should yield more surface-selective and higher quality spectra to further elucidate the effect of plasmas on these materials.

Conclusions

Even under harsh conditions (100 W plasma for 60 min), there did not appear to be many significant chemical changes made to the surface of the textile samples. Even materials such as wool and silk, which showed significant yellowing, did not appear to have changed significantly based on the IR spectra. For the other materials–especially the grass and wood– a decrease in the surface contaminants due to removal of the outer surface layers was observed by FTIR-ATR. Further

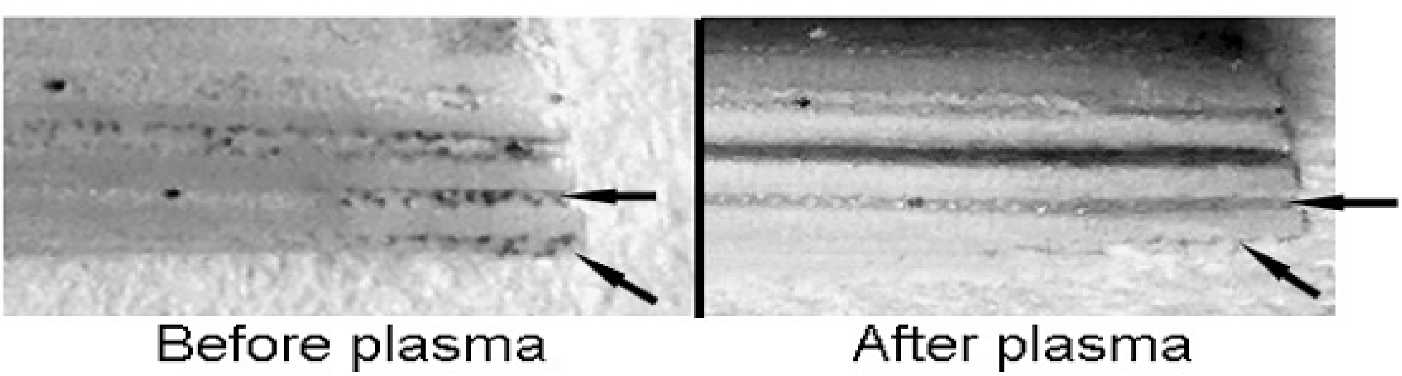

Figure 1. Photo showing the effect of oxygen plasma treatment on molded areas on a sample of grass. Note that the bottom right corner of the sample has been destroyed by the plasma.

studies, particularly those utilizing x-ray photoelectron spectroscopy (XPS) and ATR crystals yielding more sensitivity and selectivity, will aid in maximizing the potential of plasma-chemical oxidation for removal of surface contaminants prior to radiocarbon analysis of fragile materials.

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Thermogravimetric Analysis (TGA) of Archaeological Materials, Part II: Ceramics

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In the previous issue of the SAS Bulletin (Murakami et al. 2006), we introduced thermogravimetric analysis (TGA) and presented a case study highlighting technological changes in lime plaster production at Teotihuacan, Mexico. In this paper, we demonstrate how TGA can be used to estimate the original firing temperatures for archaeological ceramics. We first present the results of experimental TGA on clay test tiles from different geological contexts. We then discuss pilot studies of two archaeological datasets. For the first study, we interpret TGA results in conjunction with X-ray diffraction (XRD) to estimate original heating temperatures for Hohokam buff ware sherds from the Southwest United States. For the second study, we estimate firing temperatures for Aztec plainwares from highland central Mexico based on a comparison of TGA results from the archaeological samples with results obtained from clay test tiles heated to different temperatures.

Ceramic Firing Temperatures and TGA

When clays are subject to intense heat, they undergo a series of predictable physical and chemical changes. Generally, ceramic materials exhibit weight loss peaks as a result of dehydration up to 200°C, due to dehydroxylation at ca. 200-600°C, and due to carbonate decomposition at ca. 600-900°C. TGA is used to measure weight changes in a substance as a function of time and temperature under controlled gas environments (Earnest 1988) and, thus, provides a useful analytical tool for determining the rate and intensity of weight changes in ceramic samples.

Thermal analysis of ceramics for the purpose of interpreting original firing temperatures is predicated on simple premises: 1) clay minerals and other elements of ceramic pastes (e.g., quartz) will exhibit predictable changes in weight at specific temperature ranges as a result of dehydration, dehydroxylation, and decomposition/combustion of organic and mineral inclusions; 2) the weight loss that occurred during the original firing presumably will not reoccur during reheating of the ceramic specimen (but see below); and 3) when subject to controlled reheating, ceramics originally fired at higher temperatures will exhibit less weight loss than those originally fired at lower temperatures, assuming roughly comparable mineralogical, organic, and petrographic compositions (e.g., Papadopoulou et al. 2006:44).

However, a number of important factors influence the rates and intensity of weight changes in ceramics, including the type of clay mineral, clay particle size, and the presence/absence of non-plastic inclusions. For example, rates of weight loss will vary for different clay minerals and inclusions. The duration and atmosphere of the original firing will also affect rates of weight loss. Moreover, some weight loss processes are reversible, especially for ceramics fired below 800°C. Campanella et al. (2003:136) and Drebushchak et al. (2005:624) explain that low-fired ceramics may eventually recover part of the interleaf water (rehydration) as well as, although more slowly, the water of constitution (rehydroxylation). Despite these complications, TGA has proven successful in reconstructing original firing temperatures, especially when combined with other analytical techniques (Bayer and

Wiedemann 1983; Campanella et al. 2003; Drebushchak et al. 2005; Edwards and Segnit 1984; Moropoulou et al. 1995; Papadopoulu et al. 2006; Schomberg 1991) or experimental studies (see below).

Sample Preparations and Analytical Procedures

All ceramic samples were crushed into a fine powder (ca. 100 mg) and analyzed using a furnace-equipped electrobalance with microgram sensitivity to measure minute weight changes during the heating process. Each sample was heated to 1,200°C at a rate of 4°C per minute. Weight measurements are recorded every six seconds, which facilitates measurement of the rate of weight changes during the heating process. Various gas environments can be chosen for the TGA assays; in this case, dry air was used to simulate the original kiln-firing atmosphere. TGA data are best analyzed through inspection of the rate and intensity of weight changes as the temperature varies. The line graphs show both weight loss with increasing temperature (TGA curve) and the differential weight loss per ten-second interval (DTG curve). The latter curves help identify temperature ranges for the peak episodes of weight change during the heating process.

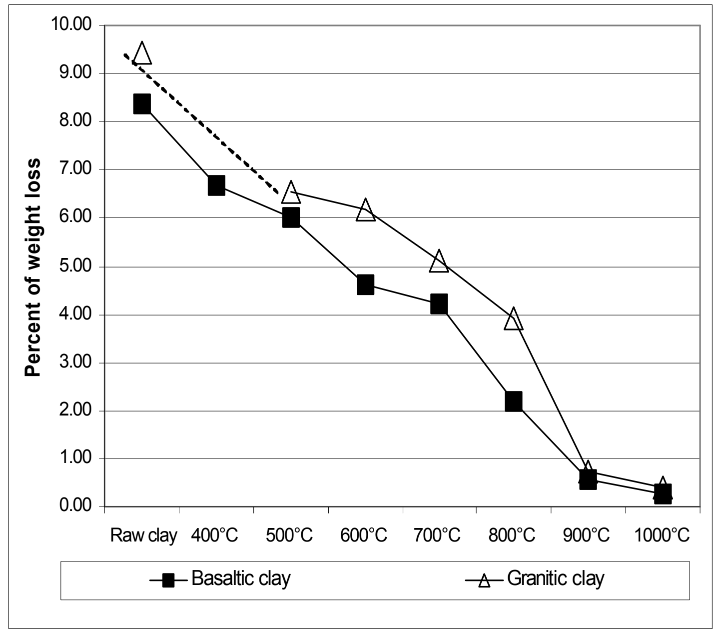

Figure 1. Weight loss percents of test tiles made of basaltic and granitic clays collected near Payson, Arizona. The temperatures shown are the test tile firing temperatures.

Experimental TGA on Clay Test Tiles

To establish an empirical framework for interpreting the TGA results for ceramics, we conducted thermogravimetric analysis on a series of prepared test tiles made of clays from different geological sources. The test tiles were formed from basaltic and granitic clays collected near Payson, Arizona (Simon 1988). The test tiles were heated in an electric kiln from 400°C to 1000°C at 100°C intervals. The kiln was immediately turned off once target temperatures were reached so that the test tiles experienced furnace cooling and were not left to soak at the target temperatures. TGA was conducted on the raw clay tiles as well as the test tiles heated to the target temperatures. Unsurprisingly, weight loss is inversely related to original firing temperature for both the basaltic and granitic clays (Figure 1). Both clay types reveal comparable trajectories of weight loss, although the "shapes" of the lines vary between the two clays. The results show characteristic trends in weight loss for different firing temperatures for clays from two different geological contexts and provide valuable reference data for approximating original firing temperatures for archaeological ceramics.

Case Study 1: Hohokam Buff Wares

Four buff ware specimens were selected for this pilot study (Samples 29, 38, 50, and 83) from collections excavated at the Cashion site in Phoenix, Arizona. Prior to the study, Murakami (2004) undertook a temper study of the Cashion buff wares and grouped them into four temper groups. We selected one sherd from each group.

We also conducted XRD on the isolated clay-size fractions (<2 μm). Clay minerals typically exhibit small XRD peaks, making it extremely difficult to identify them when non-clay minerals are present in the bulk sample (Moore and Reynolds 1997). To isolate the clay fraction, the pieces were crushed into a fine powder, and particles less than 2 μm were separated using a centrifuge. Wet samples were mounted on slides and dried in a glycol chamber placed in an oven at 60°C over night. We used a Siemens D-5000 to scan the slides at 2*è* = 5°C to 30°C with steps of 0.02°C per second. We also conducted acid tests to test for carbonate content. XRD results show that all the samples contain illite, quartz, feldspar, and calcite (Figure 2). Kaolinite was also detected for Samples 38 (muscovite/mica schist group) and 50 (granitic sand group). Also, an acid test showed that all but Sample 29 contained carbonate, which is consistent with the very low calcite intensity observed for this sample using XRD.

TGA results reveal variability among the four samples in total weight loss percents and weight loss percents in various temperature ranges (Figure 3). Sample 29 lost only 0.8% of its total weight, suggesting it was fired at a higher temperature than the other samples. Sample 83 lost 2.3%; Sample 50 lost 4.2%; and Sample 38 lost 6.2%. Given their lower weight loss percents, Samples 29 and 83 probably were originally fired at higher temperatures than Samples 38 and 50. Comparing these results with the test tiles, particularly granitic clay, suggests original firing temperatures between 600°C (Sample 38) and 900°C (Sample 29). However, because illites were detected in all four samples, they were probably heated below 850°C. The dehydroxylation of illites is reversible when heated lower than this temperature, but when heated above 850°C, illites form spinels, at which point dehydroxylation is no longer reversible (Todor 1976:227-228).

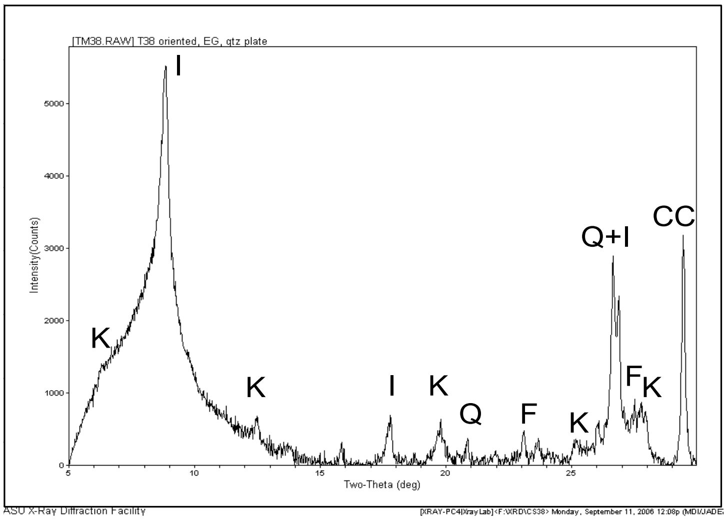

Figure 2. XRD patterns of sub 2μ particles from Sample 38 (muscovite/mica schist group) from the Cashion site (K= kaolinite; I= illite; Q= quartz; F= feldspar; CC= calcite).

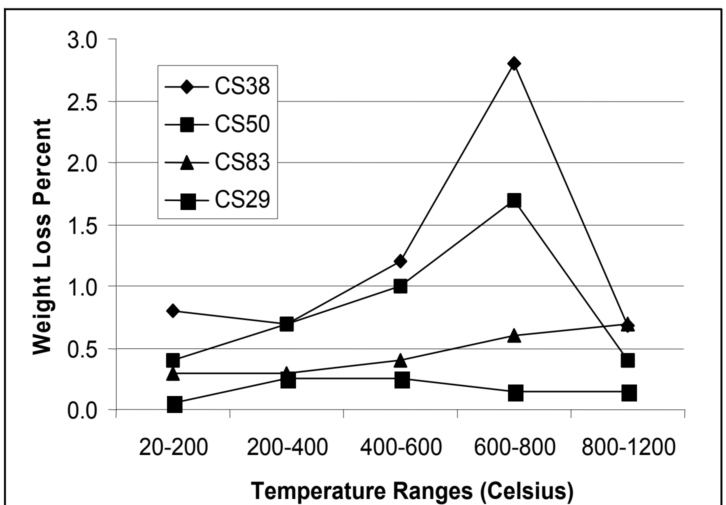

Figure 3. Weight loss percents observed at 200°C temperature ranges during TGA for four buff ware samples from the Cashion site, Phoenix, Arizona.

One notable difference among the samples is the relatively low but continuous weight loss between 200°C and 1200°C for the higher-fired samples and the pronounced weight loss between 600°C to 800°C for the lower-fired samples. It is likely that enhanced weight loss between 200 and 600°C for the lower-fired samples is associated with dehydroxylation of kaolinite, which occurs from 450 to 700°C (Todor 1976:215). Previous XRD studies of clay minerals show that, when heated at 550°C for one hour, kaolinite becomes amorphous to X-rays (Moore and Reynolds 1997). Thus, it is possible that the lower-fired samples were fired at temperatures below 550°C. However, it is not clear that the amorphous phase of kaolinite is stable in the ambient atmosphere for a long time; these amorphous materials also might reform their parent hydroxide-containing phases as a result of prolonged atmospheric exposure. If so, then the lower-fired samples were probably fired above 550°C.

The pronounced weight loss between 600°C and 800°C for the lower-fired samples is likely associated with the decomposition of calcite. It is not clear, however, whether calcite represents an original component of the ceramic that failed to decompose during original firing (due to insufficient heating temperatures) or whether it results from recrystallized calcite (Drebushchak et al. 2005). If the former is the case, then the samples were likely fired at temperatures below 750/800°C. Also evident are differences in carbonate decomposition between the lower- and higher-fired samples. For the lower-fired samples, the decomposition of $CaCO_3$ begins at around 600°C and completes at 750°C. For the higher-fired samples, decomposition begins at ca. 500°C. Given the lower temperature of calcite decomposition in the higher-fired samples, it is possible that calcite is poorly crystallized and could have been re-carbonated remnants of decomposed calcite or accumulated in post-depositional contexts. If so, the higher-fired samples could have been fired at or above 750°C. Moreover, the paste of the highest-fired sample is reddish in color and may have been iron-rich (from diorite). This is consistent with it having been fired at higher temperatures, as iron compounds develop a more pronounced reddish color when exposed to higher temperatures (Matson 1971).

Case Study 2: Aztec Plain Wares

TGA was conducted on a sample of 27 plainware specimens from Aztec and Early Colonial period sites (A.D. 1200-1650) in the Basin of Mexico (Garraty 2006). Unlike the Cashion samples, we did not conduct XRD on these samples. We compare the TGA results from the archaeological specimens with the results derived from the experimental test tile study. This case study thus employs a very different approach to interpreting TGA results from the previous study of Hohokam buff wares.

We use the test tile results to *roughly* bracket original firing temperatures. Most of the clays used to produce Aztec pottery are probably from andesitic clay deposits in the Basin (de Terra et al. 1948; Slayton 1985:22-23). We did not conduct experimental tests on andesitic clay test tiles; however, andesite is geologically closely related to basalt. We assume that the weight changes for andesitic and basaltic clays will be similar. TGA results reveal that the mean total weight loss percent is 2.4% with a range from 1.1% to 4.9%. Using the weight loss percents for the basaltic clay as a comparative baseline, we conclude that most of Aztec plainwares were probably fired between about 600°C and 900°C. The weight loss percent for the basaltic clay at 600°C is ca. 4.6%, suggesting most specimens were fired above ca. 600°C. The percents at 900°C are well below 1%, suggesting the original heating temperatures probably did not exceed 900°C. Nearly half (12 of 27, 44%) of these specimens lost less than 2% of their original weight during re-heating, and only four specimens revealed weight loss percents above 3%. For the basaltic clay, weight loss percent is above 2% at 800°C (2.2%). Hence, most Aztec plainwares were likely fired above about 800°C but below 900°C. The weight loss percents for the basaltic test tiles between 600°C and 800°C range from 2.2% to 4.6%. Thus, we conclude that the lower-fired Aztec plainwares with weight loss percent in the range of 2.5% to 5% were likely originally heated between 600°C and 800°C.

Conclusion

TGA is a useful tool for interpreting original firing temperatures for archaeological ceramics, especially when combined with experimental studies or other materials science analyses, such as XRD. TGA also holds promise in defining and understanding firing technology in prehistoric pottery production, a key topic that is generally absent from ceramic studies. TGA provides insights into craft specialization and technology.

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Understanding Chronology in Historic Period Navajo Textiles: Red Dye Analysis

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Chemical identification of the red dyes used in historic textiles in the southwestern United States can aid in determining the production age of the handwoven textiles. In the mid-nineteenth century Navajo weavers unraveled yarn from cloth (bayeta) that was brought via government annuities and trading into the Southwest to use in their own handwoven blankets and garments (Wheat and Hedlund 2003). These raveled yarns came from a variety of sources and may contain imported red insect dyes—lac, cochineal, and kermes. Along with fabric texture, yarn spin direction and ply numbers, and stylistic features, dye testing may add to information used to determine the chronology of a textile. The presently accepted chronology shows that prior to 1860, commercial red yarn that was imported into the Southwest was primarily dyed with lac. Between 1860 and 1865, a mixture of lac and cochineal was common, and by 1865 pure cochineal dominated until the synthetic dyes were introduced in the late 1870s and 1880s (Wheat and Hedlund 2003).

The lac insect (*Laccifer lacca*) is native to India and Southeast Asia (Wheat and Hedlund 2003). The lac dyestuff was imported into England by the late eighteenth century. There are four chemical species within the lac beetle that produce the red dye: laccaic acid A, B, C and D, with A being most abundant. The cochineal insect (*Dactylopius coccus*) is native to the Americas, where the insects live on prickly pear cactus (*Opuntia*) pads (Hogue 1993). Kermes (*Kermes vermilio*) is a parasite that feeds on Mediterranean oak (Cardon 1990), found in the Mediterranean region of southern Europe and Turkey. Kermesic acid (kermes) is the aglycone of carminic acid (cochineal), and both acids are responsible for producing the red color of the dyes (Bingham and Tyman 2000). Figure 1 shows the chemical structures of these red dyes. Due to the importation of commercial cloth into the Southwest from eastern American as well as European woolen mills, there is the possibility that each of these dyes may have been incorporated into Navajo textiles.

Extensive analysis has been previously done on Navajo textiles and, more specifically, on red dyes in these textiles. Anthropologist Joe Ben Wheat (Wheat and Hedlund 2003) devoted considerable effort to working on this topic and collaborated with biochemist David Wenger (2003) for the dye analysis. An extensive database was compiled from their results, focusing on lac, cochineal, and the synthetic dyes. The goal of the present project is to enhance and perhaps add another level of sensitivity to the established chronology by probing for the insect dye kermes, which was not previously sought.

Materials and Methods

The dyed fiber standards in this study were created directly using the dried insects. Lac (*Coccus lacca*) and cochineal (*Dactylopius coccus*) were obtained from Maiwa Craft Supply (Vancouver, BC, Canada), and kermes (*Kermes vermilio*) was obtained from German dye chemist Harold Böhmer. The wool (carded and spun Churro wool from Howard's Handwerk Haus, Tucson, AZ) was mordanted and dyed using standard methods (Fereday 2003). Both alum (potassium aluminum sulfate) and tin (stannous chloride) mordants were used (obtained from Aurora Silk). After samples were dyed, two extraction methods were carried out. The EDTA extraction method used a 1:1 mixture of DMF with 0.1% aqueous H_2EDTA with heat (100°C water bath, 30min) to extract the dye from the fiber (Tiedemann and Yang 1995; Zhang and Laursen 2005). The sulfuric acid extraction method utilized concentrated sulfuric acid (1hr) to extract the dye (Wenger 2003). The UV-Visible spectrophotometry analysis was performed using an Agilent 8453 spectrophotometer. A Hewlett Packard/Agilent 1100 series HPLC was used with an Agilent Zorbax RX-C8 4.6 x 150mm, 5µm analytical column. The initial solvent system was on a gradient: 0 min- 80%A 20%B, 20 min - 5%A 95%B (A: H_2O with 0.1%TFA, B: MeOH) (Hayashi and Saito 2001). The chromatographic data was taken with the detector set at both 254nm and 495nm. Raw data are reported in Table 1.

Results and Discussion

Wenger's (2003) previous analysis of Navajo textiles utilized strong acidic conditions to extract the dyes from the wool fibers, followed by analysis and identification using UV-Visible spectrophotometry. Previously it was thought that by reacting cochineal with strong acid, complete cleavage of the glucose ring would occur and thus cochineal and kermes would not be identifiable, since cochineal and kermes are chemically distinguishable only by the presence or absence of a glucose sugar (Wenger, personal communication 2005). However, since the glucose ring is attached to the base structure via a C-C bond, not a C-O bond, it is more resistant to cleavage. It is true the acid will hydrolyze part of the glucose ring, but it is not cleaved all the way to the base structure (Allevi et al. 1987). Nevertheless, chemical species that are very similar in structure, such as the incomplete cleavage product of cochineal and kermes, are very difficult to identify in a UV-visible spectrum. Therefore, two changes were made to the dye extraction and analysis procedure. This study uses a metal chelating compound

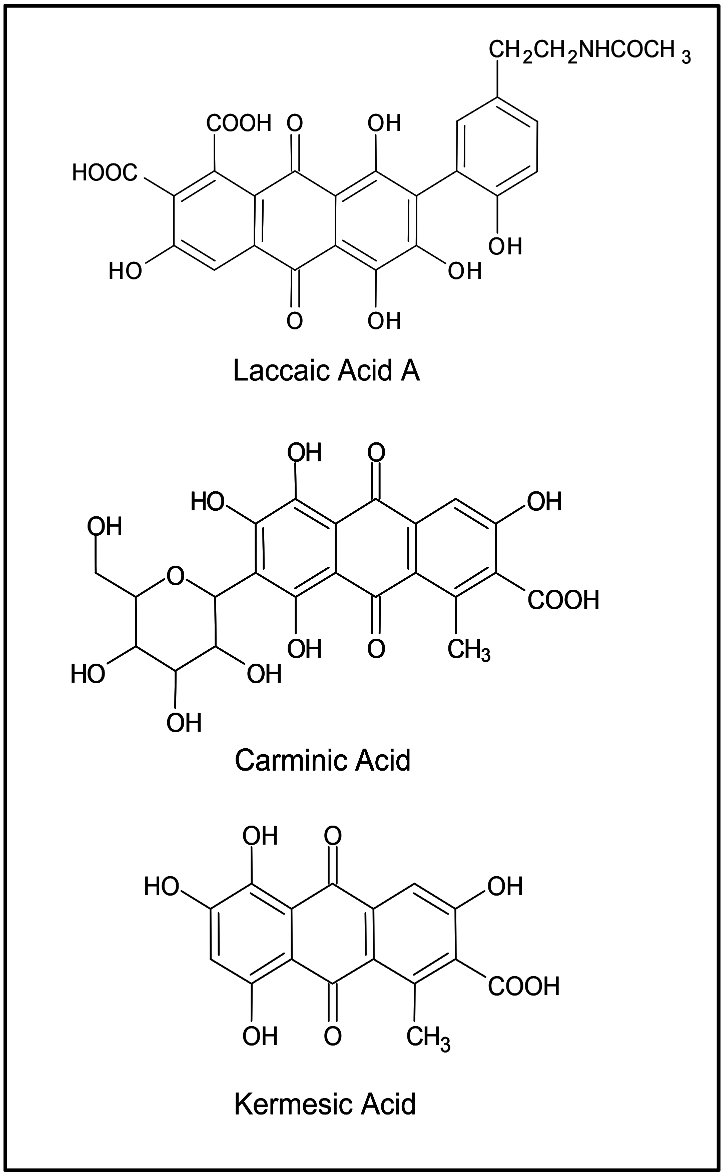


Figure 1. The chemical structures of the red anthroquinone insect dyes: lac (laccaic acid A), cochineal (carminic acid) and kermes (kermesic acid).

Table 1**:** The dye analysis results for the Southwest textiles from the Arizona State Museum. All the analyzed textiles were Navajo, except for E-9990 which was Acoma.

Sample	Previous Analysis	Results
8407-light	never tested	cochineal 41: lac 52
8407-dark	never tested	cochineal 15: lac 85
8418-red	cochineal 45: lac 55	cochineal 60: lac 40
8418-dark	cochineal 30: lac 70	cochineal 52: lac 48
8420-rose	never tested	synthetic
8420-maroon	never tested	cochineal
22077-bright	cochineal 90: lac 10	cochineal
22077-dark	cochineal	cochineal
22078-tassel	never tested	cochineal
22078-red	never tested	cochineal 85: lac 15
E-1201	cochineal	cochineal
E-2167	never tested	cochineal
E-2211-pink	never tested	cochineal 41: lac 17: syn 42
E-2211-maroon	never tested	cochineal 37: lac 63
E-2270	never tested	cochineal 7: lac 93
E-2853-red	cochineal	cochineal
E-2853-maroon	cochineal	cochineal
E-2856	cochineal 95: lac 5	cochineal 68: synthetic 32
E-2859-red	cochineal 55: lac 45	cochineal 54: lac 46
E-2859-pink	synthetic	synthetic
E-2867(pink)	cochineal	cochineal
E-3266-orange	synthetic	synthetic 95: cochineal 5
E-3266-maroon	cochineal	cochineal
E-9990-red*	never tested	cochineal 80: lac 20

to extract the dyes instead of the concentrated acid, followed by High Performance Liquid Chromatography (HPLC) analysis instead of UV-Visible spectrophotometry.

The insect dyes lac, cochineal and kermes are mordant dyes, which utilize a metal ion to form a chemical complex between the dye and the desired fiber, which may be cotton or wool (Figure 2) (Timar-Balazsy and Eastop 1998). Because the dye is only held onto the fiber by binding to the metal ions,

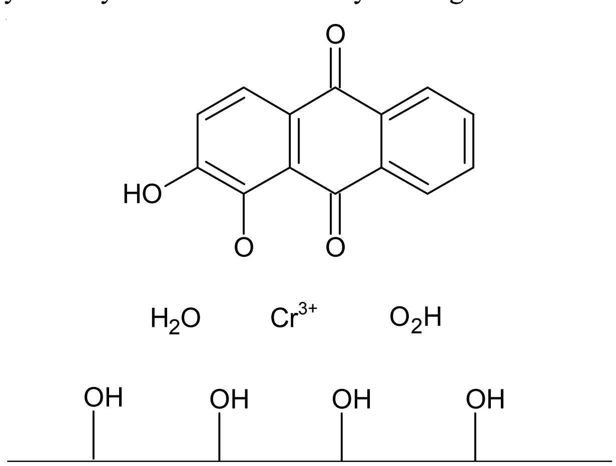


Figure 2. In mordant dyes metal ions are used to bind the dye to the fiber. In this example, chromium (III) is bound to cotton, the anthroquinone dye and two water molecules are the other chelating agents.

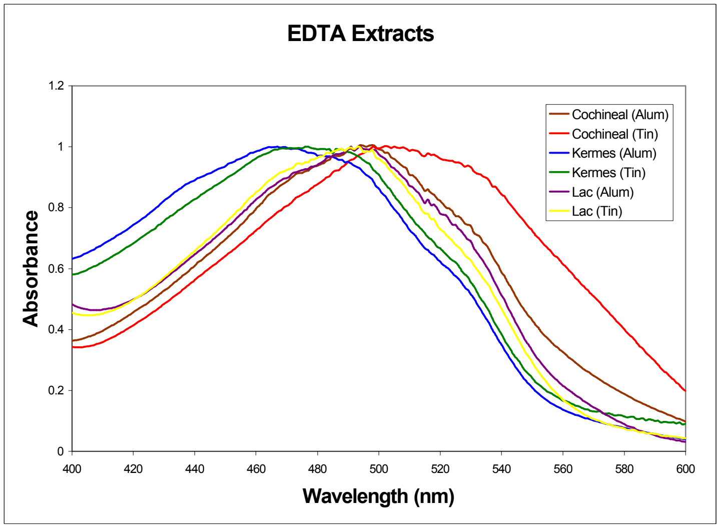
there is an alternative way to extract the dye from the fiber without the use of strong acid. Using a metal chelator instead of a strong acid to cleave the dye/metal/fiber bonds should leave the dye molecules intact and lead to better chemical analysis. Ethylenediaminetetraacetic acid (EDTA) is a hexadentate ligand chelator that will bind to the metal ion with a stronger affinity than the anthroquinone dye, which will cause the dye to be released from the fiber. This extraction method does not chemically alter the glucose ring on cochineal, and so allows the chemical structure to be analyzed more accurately.

HPLC analysis of the extracted dye adds a further level of sensitivity to the analysis of the dyes. HPLC utilizes a separation step prior to the absorbance detection of the analyte, which allows base-line resolution of the analyte peaks that is unachievable with UV-Visible spectrophotometry. Figure 3 shows the UV-Visible spectra for both the sulfuric acid and EDTA extracts, as well as the chromatogram of the EDTA dye extracts. The sulfuric acid extracts could not be analyzed with HPLC due to the inability of the stationary phase in the HPLC column to withstand the low pH of the sulfuric acid. However, the results show that baseline resolution and reproducibility are achieved with HPLC, and the UV-Visible spectrophotometry results are not as diagnostic.

A diverse range of Navajo textiles was sampled in order to encompass the time span, designs, and yarn types that might involve kermes as a contributing dye source. The textile samples from the Arizona State Museum were extracted using the EDTA method and analyzed by HPLC. The most significant finding was that kermes was not found in any of the textiles sampled. However, this conclusion is logical because by this time cochineal was abundant in Europe and had mostly replaced kermes as the dyestuff of choice due to its higher dye content (Wheat and Hedlund 2003). The dye compositions (percentages) were compiled for the textiles tested by integrating the analyte peaks on the HPLC chromatograms. A subset of the samples tested were textiles previously analyzed by Wenger. Comparing the results from this study with previous findings showed a strong positive correlation. Only two samples' results differed enough to require further investigation. The first anomaly was a two-piece Navajo dress (E-2856) for which the estimated chronology was 1850-1865. However, results from this study showed the presence of synthetic dye, thus suggesting a later estimated date range. The other interesting piece was a Navajo chief's blanket which was found to contain lac and cochineal, as well as synthetic dye. It seems unlikely that all three dyes were used on the same fibers. More work needs to be done, but the probable explanation for this was the use of yarns from different sources in the same blanket, and a procedural error in sampling. Overall, the present study strongly supports Wenger's previous analysis, as well as adds to the database of dye testing for Southwestern textiles.

Conclusions

No source of kermes was found in the Navajo textiles tested, although it was important to make the analyses with the



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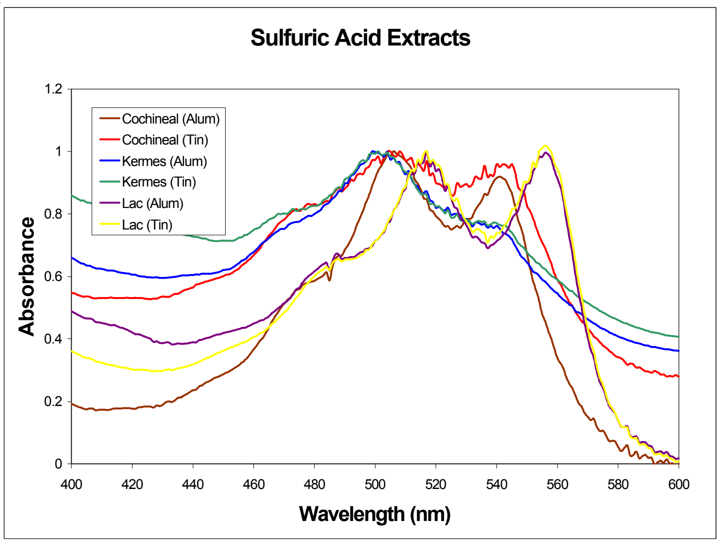

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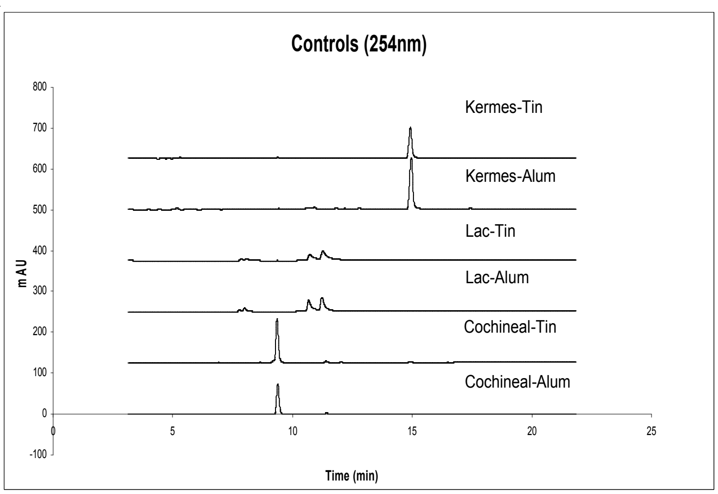

C

Figure 3. A and B show the UV-Visible spectra of the EDTA and sulfuric acid extracts, respectively; C shows the HPLC chromatogram of the dye standards at 254 nm.

revised method in order to distinguish between kermes and cochineal. Although not every textile can be sampled, it seems unlikely that kermes entered the Southwest on fabrics that were subsequently raveled and rewoven, since the sample set used in this study was derived from a broad set of characteristics. Testing for kermes has applications beyond textiles from the Southwest. For example, it has potential applications in the study of Middle Eastern carpets and textiles. Cochineal was not always available in Europe, and kermes was the red insect dye used prior to European contact with the New World. Expanding this type of testing may help to establish the period during which each dye was used. Given an improved chronology, this testing could refine certain dating techniques based on the presence or absence of kermes versus cochineal.

Acknowledgments

National Science Foundation IGERT Fellowship and the University of Arizona Program for Archaeological Sciences, Dr. Harold Böhmer for the dried kermes beetles, and the Arizona State Museum, Tucson, AZ, for permission to sample the Navajo textiles.

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Archaeological Ceramics

Charles C. Kolb, Associate Editor

The column in this issue includes six topics: 1) Reviews of Books on Archaeological Ceramics, 2) New British Archaeological Reports-International Series, 3) Previous Meetings, 4) Forthcoming Meetings, and 5) Internet Resources.

Reviews of Books on Archaeological Ceramics

Springer Handbook of Materials Measurement Methods, Horst Czichos, Tetsuya Saito, and Leslie Smith, Leslie (eds.). New York: Springer, 2006, xxvi + 1208 pp., 970 illustrations in color, plus a CD-ROM; ISBN-10: 3-540-20785-6, ISBN-13: 978-3-540-20785-6 (hardcover) 249 €. This weighty "handbook" is written for materials scientists, materials engineers, physicists, chemists, and mechanical engineers, but has content applicable to archaeometry. Therefore, this handbook is of some interest to all facets of the archaeological sciences. The term "materials measurement" denotes operations to distinguish qualitatively and to determine quantitatively characteristics of materials. The contributors have compiled advanced methods for materials measurement and characterization from the macroscopic to the nano-scale. Materials science and its industrial applications require the highest level of accuracy and reliability in the measurement of the properties of materials and the assessment of their safety and reliability. The volume provides clear guidelines and standards on how to measure the full spectrum of materials characteristics of new materials and systems. Since materials science forms a bridge between the more traditional fields of physics, engineering, and chemistry, unifying the varying perspectives and covering the full gamut of properties also serves a useful purpose. The publisher claims that this handbook is the first dedicated to these practical and important considerations. The book is divided into four parts encompassing 22 chapters. Part A: "The Materials Measurement System" details the basic elements of metrology, the system which allows measurements made in different laboratories to be confidently compared. The process of making reliable measurements is analyzed along with methods for estimating the uncertainty of measurements. Finally, the various ways of organizing materials are presented and the materials measurement system is outlined. There are three chapters: 1. "Measurement Principles and Structures"; 2. "Measurement Strategy and Quality"; and 3 "Materials and their Characteristics: Overview." Part B: "Measurement Methods for Composition and Structure" considers methods for the analysis of material composition and structure. Structure is defined to include both atomic and molecular arrangements and also microstructure and defect structures over larger scales. There are three chapters: 4. "Chemical Composition"; 5. "Nanoscopic Architecture and Microstructure"; and 6. "Surface and Interface Characterisation." Part C: "Measurement Methods for Materials Properties" has five chapters that focus on the evaluation of the methods of measuring the fundamental properties of materials. In addition to aspects of mechanical properties, the methods of characterizing the thermal, electrical, magnetic and optical properties of materials important to their practical applications are described. The chapters include: 7. "Mechanical Properties"; 8. "Thermal Properties"; 9. "Electrical Properties"; 10. "Magnetic Properties"; and 11. "Optical Properties." Part D: "Measurement Methods for Materials Performance" contains five contributions on the testing of material performance in application conditions. Included are the measurement of corrosion, friction and wear as well as biogenic impact on materials and more specific materials environment interactions. The evaluation of material performance and condition monitoring by nondestructive techniques and embedded sensors is also considered, and experimental, deterministic and probabilistic methods for the characterization of safety and reliability are outlined. The contributions include: 12. "Corrosion"; 13. "Friction and Wear"; 14. "Biogenic Impact on Materials"; 15. "Materials–Environment Interactions"; and 16. "Performance Control and Condition Monitoring." Part E: "Modelling and Simulation Methods" focuses on five significant modeling and simulation methods that underline measurement procedures that rely on mathematical models to interpret complex experiments or to estimate properties that cannot be measured directly. The chapters are: 17. "Molecular Dynamics"; 18. "Continuum Constitutive Modelling"; 19. "Finite Element and Finite Difference Methods"; 20. "CALPHAD Methods"; 21. "Phase Field": and 22. "Monte Carlo Simulation." A useful appendix provides current, relevant "International Standards of Materials Measurement Methods." The volume also has a detailed subject index. University and laboratory libraries should have this volume in their collections. The searchable CD-ROM requires a 150 Mb drive space; it loads quickly and navigates easily in a Windows environment. However, the 249 € price for this volume (ca. $324.00 US/£168.00) will preclude it from most personal libraries.

Ceramics in America 2006, Robert Hunter (ed.), Hanover and London: Published by the Chipstone Foundation. Distributed by University Press of New England. Chipstone Foundation distributed by University Press of New England, 2006. xiii + 336 pp., ISBN 0-9724353-7-9, ISSN 1533-7154, $60.00 (paper). *Ceramics in America* is an interdisciplinary annual journal that examines the role of historical ceramics in the American context. The intended audience includes collectors, historical archaeologists, curators, decorative arts students, social historians and contemporary potters. Its editor, Rob Hunter, has again shepherded the publication of another outstanding volume in this annual. Hunter is a specialist in American and English ceramics with twenty years of professional experience in historical archaeology having excavated Colonial British sites throughout Virginia and North Carolina. He is a partner in Period Designs, a firm specializing in the reproduction of seventeenth- and eighteenth-century decorative arts.

Hunter has assembled a splendid collection of significant articles dealing with an array of topics from the excavation of important pottery production sites (primarily factories and kilns), to research on particular ceramics. The 2006 issue provides evidence of Dutch and English delft tiles used in seventeenth- and eighteenth-century American fireplaces, and features new information about American stoneware and the archaeological recovery of commemorative wares related to George Washington in Alexandria, Virginia. A highlight of the journal is the second part of John Austin's examination of potter Palin Thorely's career and production in Williamsburg, Virginia. There are nine major articles (pp. 1-238) and nine reports (pp. 240-

272), 12 book reviews (pp. 273-310), and the continuing annual "Checklist of Recent Articles and Books on Ceramics in America" prepared by Amy C. Earls, this year with 349 entries (pp. 311-321), plus a 13-page double-column index of conflated topics and proper nouns. The articles are accompanied by splendid color photographs created by Gavin Ashworth.

The major contributions include: Barbara H. Magid's "Commemorative Wares in George Washington's Hometown" (pp. 2-39, 49 figures, 74 endnotes) in which she considers broken commemorative objects that were recovered from archaeological excavations in Alexandria, Virginia. Jill Weitzman Fenichell's "Fragile Lessons: Ceramic and Porcelain Representations of Uncle Tom's Cabin" (pp. 40-57, 26 figures, 20 endnotes) focuses on ceramics related to Harriet Beecher Stowe's novel and imagery taken from the book that was used in the cause for the abolition of slavery. Arthur F. Goldberg and James P. Witkowski's "Beneath His Magic Touch: The Dated Vessels of the Enslaved African American Potter, Dave" (pp. 58-92, 36 figures, 4 tables, 60 endnotes) document the life of the Southern master potter David Drake, who made large alkaline-glazed stoneware in the Edgefield District of South Carolina in the 19th century. John A. Burrison's "Fluid Vessel: Journey of the Jug" (pp. 93-121, 47 figures, 57 endnotes) in which he traces the history of the jug from its beginnings in Southwest Asia through Europe and the evolution of the form in North America. Mark M. Newell with Peter Lenzo in "Making Faces: Archaeological Evidence or African-American Face Jug Production" (pp. 122-138, 35 figures, 21 endnotes) report the excavation of an archaeological site in Edgefield District of South Carolina where African-American "face" vessels were made. In an effort to understand the manufacturing processes, Newell had Lenzo, a contemporary potter, study and replicate the vessels. Diana Edwards and Lynne Dakin Hastings' "Ceramics at Hampton Mansion, Baltimore County, Maryland" (pp. 139-159, 38 figures, 22 endnotes) examines the acquisition of household ceramics in a prominent Baltimore family during the 18th and 19th centuries. Their assessment provides important evidence regarding changing styles, household economies, and familial connections. Al Luckenbach and Taft Kiser in "Seventeenth-Century Tobacco Pipe Manufacturing in the Chesapeake Region: A Preliminary Delineation of Makers and their Styles" (pp. 160-177, 24 figures, 23 endnotes) report the results of their study of the manufacture and distribution of locally-made terracotta tobacco pipes from the 17th century. John C. Austin's "J. Palin Thorely (1892-1987), Potter and Designer: Part 2, Williamsburg" (pp. 178-216, 91 figures, 2 appendices, 6 endnotes) completes an analysis begun in Ceramics in America 2005, and documents Thorley's work for Colonial Williamsburg's Craft House and sheds light on the colonial revival movement. Ivor Noël Hume's contribution, "Neither 'Landskip' nor 'Scripture': Collecting Dutch Maritime Tiles" (pp. 217-238, 35 figures, 18 endnotes), focuses on maritime mythology represented in Dutch delft wall and fireplace tiles.

The nine reports, "New Discoveries," are preceded by a one page "Introduction" (p. 239) by Merry Abbitt Outlaw. The reports are: Robert Hunter and Hank D. Lutton, "A Yankee Jug in Dixie" (pp. 240-243, 7 figures, 3 endnotes); John E. Kille, "Mixing Religion and Drink: Personified Expressions in Rockingham Glaze" (pp.243-246, 5 figures, 5 endnotes); Al Luckenbach, "Painted Tiles from Tulip Hill, Anne Arundel County, Maryland" (pp. 246-251, 8 figures, 6 endnotes); Ronald L. Napier, "Peter Bell Jar" (pp. 251-252, 3 figures, 5 endnotes); Beverly A. Straube, "A Wretched Tile from Jamestown" (pp.252-253, 5 endnotes); Gerald L. Thiebolt, "Creating Architectural elements in Clay" (pp. 254-259, 9 figures); Warren Bakley, "A Designer Touches Clay" (pp. 259-262, 7 figures); Susan Tunick and Jay Shockley, Early Examples of American Architectural Terracotta in Charlestown, South Carolina" (pp. 263-268, 11 figures, 9 endnotes); and Kathryn Boxhorn, "A Pot for Abby Cross off Westerly, Rhode Islands, and Stonington, Connecticut" (pp. 268-272, 3 figures, 10 endnotes).

Listed in an online "Table of Contents" but not published in this annual is an article entitled "New Insights into Nineteenth-Century Eastern Virginia Stoneware" by Kurt C. Russ and Robert Hunter. Nonetheless, the editor has again presented the reader with a valuable compendium about ongoing research into ceramics made in America.

New British Archaeological Reports, International Series

Roman Military Brick Stamps, by Renate Kurtzmann. BAR S-1543, ISBN 1841719757 (2006). vii + 298 pages; 209 figures, tables, plans, drawings and photographs; glossary of terms. £43.00. The purpose of this work is to determine the most informative articles and the most effective methods and research approaches to the study of Roman brick stamps covering the former Roman Empire. The different research methods used in different areas are compared. This study attempts to give an overall view of research methods, approaches and categories of studies used in all schools of brick stamp research and poses the question whether brick stamps can contribute to our understanding of military history. Regional and local differences of both stamps and modern schools of research are highlighted and their importance in terms of Roman history is discussed. This volume concentrates directly on a series of related questions such as: what are the different research methods used in dealing with military brick stamps, and who uses them? What are the different results represented by the different research approaches? Which results are best achieved by what methods? What can Roman military brick stamps contribute to an understanding of Roman history and can they be used as documents of military history, as other military inscriptions are? Or could they, instead, be helpful in reconstructing other historical aspects of Roman provinces? Are military brick stamps uniform documents which can be used equally in all former Roman provinces? The work concentrates on legionary rather than all military stamps. This study is intended to serve as a representative sample of the research methodologies for each province. Therefore, the focus lies on legionary stamps (but occasionally also includes auxiliary stamps where no other evidence exists). The author critically reviews a selection of articles, focusing primarily on the methodologies employed by certain scholars. The reviewed articles contain a selection of brick stamps. A catalogue of the works reviewed is included and the publications listed there form the background for this present analysis. The bibliography contains a list of all other works cited and consulted. Chapter 1 includes an introduction to the methodologies of studying brick stamps, concentrating on research methods and approaches. It also contains a discussion of the methodology used in this thesis, and also introductions to Roman bricks, and stamps on bricks, respectively. Chapters 2-9 analyze the different groups of research schools and the methodologies they employ in studying military brick stamps. Chapters 10-13 consider more general problems and questions which arise during the study of provincial military brick stamps, such as the phenomenon of name stamps, the question of when the habit of stamping bricks was started by the Roman army, the relationship between brick stamps and military territories or the so-called prata legionis and the problem of brick reuse. Chapter 14 summarizes the answers to the research questions posed in the course of the previous chapters and offers a conclusion.

David Ben-Shlomo, *Decorated Philistine Pottery: An Archaeological and Archaeometric Study*. BAR S-1541, ISBN 1841719730 (2006). vi + 194 pages; 114 figures, maps, plans, drawings and illustrations; 5 data appendices. £42.00. This study concentrates on Philistine decorated pottery, its production centres and trade patterns. These issues are examined by both archaeological and archaeometric approaches. In recent years, a considerable amount of data has been accumulated on Philistine sites, especially from the excavations at Tel Miqne-Ekron, and the new excavations at Ashkelon and Tell es-Safi. Therefore, although a vast literature already exists on the Philistines, their material culture and related issues, there has been very little study that systematically combines all this data. This work examines the Iron Age Philistine material culture in general and the Philistine pottery in particular, from a holistic approach. The Philistine phenomenon is defined and described in Part 1 from its various aspects: the historical background, the archaeological evidence and its social and ethnic aspects. Part 2 describes and discusses the updated archaeological evidence of pottery production and workshops in the southern Levant during the end of the Late Bronze Age and the Iron Age. Ethnographic research is utilized to describe the pottery production sequence, technological aspects and modes of production and distribution of pottery. As this work is a provenance study of a geographically and geologically limited area a methodological discussion was called for presented in Part 3. In Part 4, the archaeometric results are presented. Part 5 combines the archaeological and archaeometric results and evaluates them from broader cultural, technological and historical perspectives.

Previous Meetings

The American Schools of Oriental Research annual meeting was held in Washington, DC, 15-19 November 2006. The Plenary Session features a talk by Colonel Matthew Bogdanos (USMCR) entitled "Thieves of Baghdad: One Marine's Passion to Recover the World's Greatest Treasures." Among the over 290 papers presented were six on ceramic materials: Eric Lapp (Independent Researcher), "Sepphoris Lamps with Menorah Images and other Clay Lynchnoi Unearthed at the 'City of Peace' from Near and Far"; Michael Zimmerman (Brown University), "Establishing Continuity in Ceramic Material Culture across the Jordan in the Classical Periods: The Assemblages from 'Araq el-Emir, Herodian Jericho, and Khirbet Qumran"; Eric Lapp (Independent Researcher), "The Importation of Ceramic Lamps to Aila"; Catherine Duff (University of Toronto), "The Nature of Egyptian Imperialism in the Late Bronze Age Palestine: Evidence from Ceramics"; Hamed Salem (Bizeit University), "Historical Comparison of Two Palestinian Traditional Crafts Reflected on Pottery and Embroidery Designs"; and Cigdem Toskay-Evrin (Vienna University), "Late Antique Early Islamic Cooking Wares from the Republic Square Excavations, Tarsus-Cilicia: Transition and Change."

The II Congreso Nacional de Arqueológica Histórica was held at the Museo Nacional de Antropología, México, DF, México, from 21-24 November 2006. Six of the 73 presentations concerned ceramics. These included: Sorocco C. de la Vega Doria and Noe Alejandro Rivera Arzate, "Las mayólicas del siglo XIX de los muestrarios de la ENEH"; Alicia Zapatas, "Trabajos preliminaries sobre azulejos de la ciudad de México"; Marísol Sala Díaz and Angélica Oviedo Herrerías, "Propuesto tipológia de la cerámica historica de la Cuenca de México"; and Eduardo Ambrosio Lima, "La cerámica histórica del Palacio Nacional." Roberto E. Junco presented "Periplo de la porcelana China en Nueva España: Arqueometría y Arqueología Histórica en la Costa Grande de Guerrero"; Thomas Charlton and Cynthia L. Otis Charlton gave a paper entitled "Patrones de asentamiento: arqueología de ranchos y haciendas" ; and Thomas Charlton and Patricia Fournier presented "El ser y hacer se la Arqueología Histórica en México: tendencias y perspectivas de investigación."

The Eighteenth John A. Pope Memorial Lecture: "First in the Realm: Ranking Raku Ceramics in Japanese Culture," by Morgan Pitelka, was presented in the Meyer Auditorium at the Freer and Sackler Galleries, Washington, DC on 9 December 2006. The author received his M.A. and Ph.D. degrees in East Asian Studies from Princeton University and is currently Luce Assistant Professor of Asian Studies at Occidental College, Los Angeles. He is the son of a potter and has been a potter "all of his life." Pitelka discussed the mid-day tea event (sometimes, erroneously, called the "tea ceremony"), emphasizing the social practices and vessel types and uses, as well as the archaeology of the ceremony and raku bowl-making, which dates to the late 16th century CE. Raku involves carving the vessel from a slab of clay (raku is not wheel-made), glazing, and firing. He also discussed the Kyoto "school" of raku producers, the ranking of raku vessels, and the 1736 publication in woodblock printing in Japanese of Collected Raku Ceramic Secrets, which includes clay and glaze formulae. The creation of vessels that imitate bowls produced decades and centuries earlier is, he noted, a sincere form of flattery. More information can be found in Pitelka's book, *Handmade Culture: Raku Potters, Patrons, and Tea Practitioners in Japan*, Honolulu: University of Hawai'i Press, 2005, xii + 236 pp.; hardback, ISBN 13-978-0-8248-2885-1; paperback, ISBN 13-978-0-8248-2970-4.

The Second Annual Braunstein Symposium, "Figurines of Ancient Mesoamerica: Power and Guidance, 2007," was held 12-14 January 2007 at the University of Nevada Los Vegas Marjorie Barrick Museum, and included the presentation of nine papers and several roundtable discussions. The Opening Address by Violeta Vázquez Campa (Centro INAH [Instituto Nacional de Antropologia e Historia] Oaxaca) was entitled "Understanding the Use of Preclassic Articulated Pottery Figurines from the Southern Isthmus of Tehuantepec." Subsequent papers included: Jeffrey P. Blomster (George Washington University), "Sex in the First Mesoamerican City: A Re-examination of Olmec Sex and Gender and Early Formative Figurines"; Glenna Nielsen (Brigham Young University), Mary E. Pye (New World Archaeological Foundation), and Gerardo Gutierrez (Centro de Investigaciones y Estudios Superiores en Antropología Social), "Pots with Faces: A Comparative Analysis of Ceramic Vessels with Human Faces from Eastern Guerrero"; David Cheetham (Arizona State University and New World Archaeological Foundation, BYU), "Formative Period Pottery Figurines of the Southern Maya Lowlands"; Christina Halperin (University of California, Riverside), "Setting the Tone: Classic Maya Figurines in Performance and Music-making"; Matilde Ivic de Monterroso (Universidad del Valle de Guatemala) "With Hands and Molds: An Analysis of the Technology of Figurines"; Kata Faust (University of California, Riverside), "To Drill, Pierce, and Bind: New Fire Figurines and the Huastec Aesthetic of the Penitent Body"; Erin Sears (University of Kentucky, Lexington and Smithsonian Institution), "Along the Rivers and through the Woods: Cancuén's Figural Contacts"; and Mary E. Pye (New World Archaeological Foundation) and Gerardo Gutierrez (Centro de Investigaciones y Estudios Superiores en Antropología Social), "Teotihuacán Style Censers from Eastern Guerrero."

The Society for Historical Archaeology 2007 Conference on Historical and Underwater Archaeology was held in Williamsburg, Virginia, 10-14 January 2007. "Old World/New World: Culture in Transformation" was the conference theme and reflected that 2007 is the 400th anniversary of the founding of Jamestown, Virginia and is also the 40th anniversary of the SHA. The meeting attracted nearly 1,600 participants. Twenty-five of the approximately 400 papers and posters were on ceramics. The paper included: Anna Agbe-Davis, "Who's in the Pipe Line?" [ceramic pipes]; Todd M. Allman et al., "A Study on Production and Exchange among Enslaved Africans on St. Kitts, west Indies using Macroscopic Analysis and Chemical Composition" [INAA of sherds and clay sources]; Anthony Belz, "Who Smoked these Pipes: An Investigation into Historic Farmstead sites on the Mashantucket Pequot Reservation"; Ronald Bishop, M. James Blackman, and Patricia Fournier, "Once Upon a Time in Michoacán: Reevaluating the Role of Indigenous Potters in the Production of European-style Incised Lead Glazed Ceramics"; Eleanor Breen, "Mending the Pat: Reconstructing Virginia's History through Ceramic Analysis"; Edward E. Chaney, "'Earthen vessels...so large and fine': Colonial English Use of Native American Material. Culture in the Middle Atlantic Region"; Ronald Coleman, "The Tuscan Olive Jar: A Biography of An Artifact in British, British Colonial, and Royal Navy Contexts on the 17th and 18th Centuries"; Robert Cromwell, "'Where Ornament and Function are so Agreeably Combined': A New Look at Consumer Choice studies Using English Ceramic Wares at Hudson's Bay Company Fort Vancouver"; Marie-Hélène Daviau, "'Micmac' Tobacco Pipes Found in Quebéc: Typology, Provenance, and Social Meaning"; Laura Galke, "Colonowhere, Colonowhen, Colonowho: Exploring the Dimensions of Space, Time, and Meaning of Colonoware Ceramics at Manassas, Virginia"; Heather Gibbson, "French Ceramics from LA Mahaudière Plantation: Understanding Foodways and Consumption in Guadeloupe"; Mark W. Hauser and Kenneth Kelly, "Cabotage in the Eastern Caribbean: Analysis of regional Trade through INAA of Island-made Ceramics"; David Higgins, "Into the Melting Pot: British Clay Tobacco Pipes as Evidence for Ingredients"; Charles C. Kolb, "White Clay smoking Pipes from Barcelona, New York: problems of Chronology and Provenance"; Brad Loewen and Pierre Régaldo, "French Green-glazed Coarse earthenware and the Pottery Centre of Sadirac in the Bordeaux Hinterland"; George Miller and Amy Earls, "War and Pots" The Impact of Economics and Politics on Ceramic Consumption Patterns"; Merry A. Outlaw, "North Devon Sgraffito-decorated slipware at Jamestown"; Luke Pecoraro, "'Pipes, Pots, or the Like of': Patterns of Trade and the Rise of Local elites in Seventeenth Century Virginia"; Linda Shulsky, "16th Century Porcelain Gold Brocade Wares"; Tara Tetrault, "Considering the Changes in the Virginia Pottery Industry"; Ronald Tremblay, "'Micmac' Pipes of the St. Lawrence Valley: Imports, Regionalisms and Exports"; Jennifer Trunzo, "Patriotic Wares: Ceramic Consumer Patterns on the Home Front During the American Revolution in Rural Connecticut"; and Susie White, "An Old world Model for a New World Problem? The Use of Tobacco Pipes in Establishing Regional Identity." Posterns on ceramics included: Leila Joyce, "A Ceramic History of the Dunn Tavern Site"; Shawn Carlson, Ronald Bishop, and M. James Blackman, "Compositional Analysis of Spanish Colonial Ceramics from Texas"; and Sarah M. Ginn, "Gender and Pottery Production in the California Missions: Pathway for Male Social Mobility or Maintenance of Indigenous Gender Ideology?" Ceramics in America editor, Robert Hunter, was the recipient of an SHA Award of Merit for 2007.

Forthcoming Meetings

The Symposium on Chinese Export Trade Ceramics in Southeast Asia will be held at the National Library, 100 Victoria Street, Singapore, 12-14 March 2007. This meeting will bring together archaeologists and ceramic scholars from China, Southeast Asia, and the western hemisphere, highlighting recent advances in archaeological, maritime, and ceramic research on the ceramic export trade. The three main themes for the symposium are: 1) Maritime Archaeology: Shipwrecks and port sites are important sources of information regarding the transport and exchange of ceramics. Important new discoveries in this field are revolutionizing our knowledge of early Southeast Asian commerce, both within the region and with China; 2) Production Centers of Ceramics: In the past few years, Chinese archaeologists have conducted work at kiln complexes in southern and eastern China which produced many of the wares which are found in Southeast Asian archaeological sites. This burst of activity is rectifying a long period of relative neglect of this subject. Though much remains to be accomplished, preliminary results have already begun to create a much clearer picture of the ebb and flow of production in different parts of China; 3) Consumers of Trade Ceramics: This subject has received the most attention in the past. Much of our early knowledge of Chinese ceramic trade with Southeast Asia was derived from burial sites, often looted, where intact items were found. The archaeology of settlements began later, but has also yielded significant insight into the role of imported ceramics in the economy and belief systems of Southeast Asia. The importance of the export ceramic industry for China's economy in the period from the 9th to the 15th centuries is another subject which new research is beginning to clarify.

The symposium will be conducted in English and Chinese. The conference fees (includes all lunches, tea/coffee, and conference package) are as follows: standard fee: SGD 250; early bird fee: SGD 200 (by 31 January 2007); student fee: SGD 60 (lunch will be on your own). To receive the student rate, please attach a copy of your current student card, or any proof of student status. Applicants should send in their bank drafts or cheques made payable to the "National University of Singapore," together with a completed registration form to the conference secretariat by 3 March 2007. For additional information, please contact the conference Secretariat: Ms. Valerie Yeo (Asia Research Institute, National University of Singapore, AS7, Shaw Foundation Building; Level 4, 5 Arts Link; Singapore 117570. Telephone: (65) 6516 5279, Fax: (65) 6779 1428; e-mail: ariyeov@nus.edu.sg).

The conference organizers are: Prof. John N. Miksic; Dr. Edwards E. McKinnon; Prof. Qin Dashu; Prof. Li Jian An; Ms. Chong Yuan Jian; Ms. Tan Teng Teng; Ms. Chen Jiaz; and Mr. Lim Chen Sian. Scheduled presenters include: Prof. Chen Kuo-Tung (Institute of History and Philosophy, Academia Sinica, Taiwan); Dr. Edwards E. McKinnon (United Nations Development Programme Banda Aceh); Mr. John Guy (Victoria & Albert Museum); Dr. Marie France Dupoizat (France); Ms. Ke Fengmei (Centre for the Management and Preservation of Artefacts, Putian); Prof. Li Jian An (Archaeological Institute, Fujian Museum); Mr. Lou Jianlong (Archaeological Institute, Fujian Museum); Dr. Michael Flecker (Maritime Explorations, Singapore); Prof. Morimoto Asako (Japan); Prof. Qin Dashu (Peiking University); Prof. John N. Miksic (National University of Singapore); Prof. Qi Dongfang (Peking University); Prof. Robert E. Murowchick (Boston University, USA); Ms. Rita Tan (KAISA Heritage Centre, Manila); Dr. Roxanna M. Brown (Southeast Asian Ceramics Museum, Bangkok University); Mr. Shen Yuemin (Archaeological Institute, Zhejiang Museum); Prof. Wang Xiaoyun (The Academy of Science of Chinese Literature); Prof. Yang Zhishui (The Academy of Science of Chinese Literature); and Dr. Zhao Bing (College de France).

The Colloquia Anatolica et Aegaea Antiqua II International Conference on the topic "Terracotta Figurines in the Greek and Roman Eastern Mediterranean: Production and Diffusion, Iconography and Function" is scheduled for 2-6 June 2007 in Izmir, Turkey. The chronological focus of the meeting will be the century BCE to the 4th century CE. Abstracts were due in June 2006 and there is an Internet site under construction at http://web.deu.edu.tr/terracottas/ that provides information on registration and accommodations. No abstracts have been posted as of January 2007. For additional information, contact the Chief Organizer, Dr. Ergun Lafli (Dokuz Eylul Universitesi, Izmir Turkey); e-mail: elafti@yahoo.ca.

The 44th Annual Meeting of The Clay Minerals Society (CMS) will be held 2-7 June 2007 in Santa Fe, New Mexico, see http://www.sandia.gov/clay. This CMS meeting will include a session on "Clays and Archeology." Anyone interested in presenting a paper in this session should contact Eric Blinman, Office of Archaeological Studies, P.O. Box 2087, Santa Fe, NM 87504-2087; e-mail: eric.blinman@state.nm.us; telephone: 505/827-6470.

Internet Resources

Greek, Roman, and Byzantine Pottery at Ilion (Troia): The Study Collection and Cataloged Pottery (a public draft of work in progress), edited by Sebastian Heath and Billur Tekkök, http://classics.uc.edu/troy/GRBPottery/. The post-Bronze Age team at Troia has assembled a substantial study collection of Greek, Roman and Byzantine pottery. Over the course of more than a decade of publication, a large number of sherds were cataloged, and the project maintains an extensive archive of sherd descriptions, profile drawings and photographs. This digital publication contains an assemblage of primary information with the purpose of making it more widely accessible. Currently, only a small fraction of the total material is presented on the website. A majority of the sherds now available come from the study collection, which was assembled under the impetus and direction of Billur Tekkök. Many project members have contributed brief descriptions of the sherds in the collection and some of those appear here with only minor editing. When descriptions closely quote already published articles, this is indicated by the phrase "First published as..." with a linked reference to the printed work. In these instances, the original articles remain the primary publication and should be cited directly. Some sherd descriptions being published here are drawn from works-in-progress and full bibliographic information will be added in the future. The editors have chosen to release this document as a public draft because they believe its content is already useful and because they wish to receive feedback on the content. The main problem is that many of the catalog entries are in the process of being edited. This is balanced by the decision to work towards making available the same quality of information for each entry as has been recorded by the project. Currently, it is the color photography that best shows the benefits of this approach. When detailed digital images exist, these can be viewed at their original resolution, as well as at a smaller size for faster downloading. High quality profile drawings are also included where possible.

The Beazley Archive is a research unit of the Faculty of Classics at Oxford University and maintains the original archive of Sir John Beazley, Lincoln Professor of Classical Archaeology and Art from 1925 until 1956. This resource is available on the Internet at http://www.beazley.ox.ac.uk/BeazleyAdmin/Script2/default.htm. The archive is currently located in the Ashmolean Museum and consists of 500,000 notes, 250,000 black and white photographs, 33,000 negatives, 7,000 color prints, 2,000 books and catalogs, and 50,000 gem impressions. The corpus of photographs of Athenian vases is the largest archive of this class in the world and was the basis of Beazley's life's work. Other scholars, most recently Llewelyn Brown's photographs (about 10,000 from the German Committee for Corpus Vasorum Antiquorum), have contributed resources; see http://www.beazley.ox.ac.uk/BeazleyAdmin/Script2/Pottery.htm on Greek Painted Pottery. This URL leads to an introduction to the Beazley Archive Pottery Programs; an overview of styles and periods (illustrated discussions of the major styles and periods of Greek painted pottery, with links to objects held in the Ashmolean Museum); a history of collecting and scholarship (illustrated discussions of early collecting and study, listing ancient authors and modern archaeologists and showing examples of classical antiquities and fine art); and an introduction to Sir John Beazley's drawings from Athenian pottery. There is also an advanced database search capability for scholars as well as a general database search capacity (designed for general use, for students and the wider public. Search options are presented in an easily accessible format, and guidance is provided for those unfamiliar with the subject and/or with using databases. Satellite maps and timelines show the centers of production and the distribution of Greek painted pottery. Other links take the user to pottery shapes and color images with examples from the Ashmolean's collections. "Greek Painted Pottery I: Overview of Styles and Periods" contains information on timescales, chronology , the Orientalizing tradition, fifth-century Athens, techniques of decoration, painting on pottery, vase-painting and the history of art, pottery shapes, and the identification of painters. "Greek Painted Pottery II: History of Collecting and Scholarship" provides additional materials, including ancient authors and "modern archaeologists."

The Archaeological Ceramic Building Material Listserv, acbmg@yahoogroups.com for 29 October 2006 carried a post by Sandra G-Noble sgnuk@yahoo.co.uk about Roman ceramic portable ovens (clibani pl., cilbanus sing.). Fragments of this rare find were recovered from the Chester Amphitheater excavations and reported in Chester Amphitheater Project Newsletter 9: (December 8, 2006), pp. 6-7 (with an image of three sherds; researchers should also consult http://www.chester.gov.uk/amphitheatre/files/amph_issue9_colour.pdf (Adobe Acrobat required). She reports that a nearly complete oven from Grimes' Holt excavations is illustrated as a drawing in the journal Y Cymmrodor Vol. XLI: 212 (1930).

Book Reviews

Stacey N. Lengyel, Associate Editor

Recreating Hopewell. Douglas K. Charles and Jane E. Buikstra, editors, University Press of Florida: Gainesville, USA, 2006. xix + 657 pp., 155 figures, 37 tables, index. Price: $75.00 (cloth). ISBN: 0-8130-2898-1.

Reviewed by Amy L. Ollendorf, ALO Environmental Associates LLC, 111 Pratt Street, Minneapolis, MN 55419-1304, USA

The 2000 conference, "Perspectives on Middle Woodland at the Millennium" (Center for American Archaeology in Kampsville, Illinois), inspired this book. Conference participants who have their work in this book should be commended for contributing to an extensive collection that has earned its place among other volumes about Hopewell archaeology. The publication of this book follows closely behind two other major books on Hopewell archaeology – Carr and Case (2005) and Byers (2004). In his recent review of those two books, Anderson (2006) acknowledges that broad syntheses are critical to understanding the state of contemporary knowledge. This book is divided into four major sections, and the editors provide a useful introduction to each. The first section, entitled "Hopewell in Ohio," includes nine chapters. Many chapters in this section deal with settlement and mobility with examples from diverse parts of Ohio, but a single model is by no means presented for the Ohio Hopewell. For example, Pacheco and Dancey (ch. 1) propose a model in which Ohio Hopewell communities are composed of dispersed sedentary households that cluster near sacred precincts that include earthworks. However, the chapters by Cowan (ch. 2), Yerkes (ch. 3), and Byers (ch. 4) offer an alternative that involves higher levels of residential mobility in subsistence-settlement systems than in the Pacheco-Dancey model. The last five chapters in this section primarily focus on Ohio Hopewell earthworks. Greber (ch. 5) says that in general it appears that Ohio Hopewellians "lived lightly on the land" (p. 104) and that many, but not necessarily all, of the earthworks were likely used for many generations. Seeman and Branch (ch. 6) pick up on this latter theme with their thesis that decreased frequency of mound building at the drainage-scale in comparison to earlier periods "marked a shift away from a mounded landscape composed of many places where history took place…" (p.121). Lepper (ch. 7) discusses evidence for "The Great Hopewell Road;" he posits that generations of Ohio Hopewellians would have traveled in pilgrimages along this "conduit of unifying ritual" (p. 130). Because gleyed soils originated in waterlogged conditions, Sunderhaus and Blosser (ch. 8) interpret the presence of such soils in earthworks as symbolic of a water association; thus, Hopewellian builders were performing a world recreation ceremony as they erected the earthworks. The final chapter in Section One (Riordan, ch. 9) focuses on the discovery of a specially constructed gate that "…appears to be the first discovery of such a feature at a Hopewell earthwork" (p. 156). With the close of this chapter, the editors have opened a figurative door to the topics in the next section – "Hopewell/ Middle Woodland Outside Ohio."

The chapters in Section Two are arranged geographically, starting in Georgia (Jefferies, ch. 10; Steinen, ch. 11), then moving to Indiana (Ruby, ch. 12; Mangold and Schurr, ch. 13), turning northward through Michigan (Garland and DesJardins, ch. 14; Brashler et al., ch. 15), then turning westward to Wisconsin (Jeske, ch. 16; Stoltman, ch. 17) and Illinois (Fortier, ch. 18), and ending to the south and west in Kansas (Logan, ch. 19). Taken collectively, these ten chapters provide a stunning array of primary data. Many of the chapters in this section grapple with the extent and/or nature of regional participation in the "Hopewell Interaction Sphere" (Caldwell 1964). Patterns that emerge through these chapters indicate variability in subsistence and participation in the Hopewell Interaction Sphere. As the editors point out in their introduction, "neither of these conclusions is new, but the increasing amount of relevant information available allows more sophisticated modeling of the social and economic processes involved (for example, chapters by Fortier, Jeske, and Ruby)" (p. 159).

Section Three groups chapters along the theme, "New Approaches to Hopewell Material Culture." The chapters in this section will likely resonate most with SAS members. Hughes (ch. 20) uses non-destructive, energy dispersive x-ray fluorescence (EDXRF) spectrometry to explore the sources of Hopewell obsidian; Yellowstone National Park was not the only source for obsidian at Ohio Hopewell and other Middle Woodland sites. Burks and Pederson (ch. 21) report the results of their analyses of deposits from outside of and between mounds in an effort to learn about the daily lives of Hopewell people; their samples were from major excavation projects at the Hopewell Mound Group and Hopewell Culture National Historical Park near Chillicothe, Ohio. They conclude that much of the debris from these contexts represents "the remains of small, short-term camps inhabited by groups visiting the earthworks to participate in the varied social and ceremonial events that took place there throughout the year" (p. 401). Van Nest (ch. 22) blends geoarchaeological techniques and ethnographic information into an "ethnogeological approach." She discusses the mounds in their landscape contexts as physical manifestations of Hopewell belief systems - "…some mound groups were built on the edge of truncated alluvial fans or terraces…some groups…were situated in the floodplain such that…they became islands at high river stages…[other mound groups] are [in] bluff-top settings that command spectacular river valley vistas... Thus the river-edge fan and terrace sites…occupy an intermediary position, one that possibly allowed simultaneous access to both the upper and the underworld…" (p. 425). Fie (ch. 23) focuses on the theme of "visiting" with her compositional and stylistic study of ceramics. Fie's characterizations were completed with instrumental neutron activation analysis (INAA); the differences among ceramics leads Fie to suggest a network of exchange in the lower Illinois Valley that is "a more inclusive model of Middle Woodland interaction…" (p. 445). Holt (ch. 24) compares animal use at mound centers and so-called hamlets in the Illinois Valley. She reports almost year-round, self-sufficient occupation of both types of Havana Hopewell settlements, a pattern that continued into the early Late Woodland. The final two chapters in Section Two (Hall, ch. 25 and Brown, ch. 16) make use of ethnohistoric information in their interpretations of Hopewell material culture. Hall's study utilizes ethnohistoric descriptions to interpret a copper cutout excavated from Bedford Mound 8 in Illinois, whereas Brown's work focuses on "…the material expression of persons actively engaged in altered states of consciousness [i.e., shamans]" (p. 488).

Entitled, "Recreating Hopewell: Commentaries," Section Four contains two chapters that provide critiques of the previous chapters. Smith (ch. 27) "writes from the perspective of one who has a long history of looking at aspects of Hopewell across the Eastern Woodlands…" (p. 489). Chapman (ch. 28) "provides a view from outside North America, bringing to bear his experience with similar issues in European Neolithic archaeology."

This book will appeal to scholars of the North American Eastern Woodlands, and it will undoubtedly go through a second printing. A comprehensive map should be added to show the locations of all of the Ohio sites discussed in the various chapters, and another should be added to illustrate the locations of all the sites outside of Ohio. The index is thorough, and one complete bibliography serves the entire book. However, the list of contributors is difficult to locate while in the midst of reading; it takes an archaeologist to find the list sandwiched between the bibliography and index.

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The Native American World beyond Apalachee: West Florida and the Chattahoochee Valley, by John H. Hann. University Press of Florida, Gainesville. 250 pages, 5 tables, 2 maps.

Reviewed by Thomas J. Pluckhahn, Department of Anthropology, University of South Florida, Tampa, FL 33620-8100, USA

Archaeologists and ethnohistorians who work in the southeastern United States need no introduction to the prolific career of John Hann, research historian at the San Luis Archaeological and Historic Site in Tallahassee, Florida. For those unfamiliar with Hann's research, however, it is worth a brief introduction. Over the course of the past 20 years, Hann has authored or co-authored more than six major books on the ethnohistory and archaeology of the native peoples of Florida. Much of this scholarship has focused on the three most populous of Florida's Indian groups in the early historic era—the Timucua, Calusa, and Apalachee—as reflected in the records of Spanish missionaries, bureaucrats, and conquistadors. Hann has mined these records to produce a series of detailed social histories that have greatly illuminated an era previously known almost exclusively through archaeology.

With his latest book, Hann turns his attention to the hinterland of Spanish Florida, specifically the native peoples to the west and north of the Apalachee province, in what is now northwestern Florida, southern Georgia, and southeastern Alabama. The documentation for these groups—many of whom would later form the Creek Confederacy—is often sparse. Most were mentioned only in passing in Spanish and British historical records, and moved frequently in the 1600s and 1700s.

After an introduction that provides the general context for the early history of the region, Hann examines the historical documentation for each of the towns, polities, and ethnic groups that are known to have resided in this frontier—from those closest to the Apalachee (the Amano, Chine, Chacato, and Pacara) to those further removed (the Chisca, Chichimeco, Pansacola, and Apalachicoli). The group-by-group approach taken here is reminiscent of pioneering ethnohistorian John Swanton (although Hann draws on a far wider range of sources and uses them more judiciously). This is difficult reading, and often made more taxing by Hahn's tendency toward extensive quotation. Moreover, although a few maps are provided, I found myself wishing for more and more-detailed maps to track the sometimes bewildering movements of people through time. In later chapters, Hann returns to a narrative thread, examining the hostilities that lead to the destruction of the Spanish missions, as well as the Yamasee War and its aftermath. These sections make for more engaging reading, and should be more accessible for non-specialists.

The Native American World beyond Apalachee fills a serious void in the scholarship of the early historic Southeast. Those of us who work in the region owe Hann a debt of gratitude for tackling a synthesis of an area with far less historical documentation than his previous subjects. If this makes for a somewhat less compelling narrative than some of Hann's earlier works, it is nevertheless a necessary synthesis of the historical data, and one that will become an invaluable aid to researchers who work in the area.

Upcoming Conferences

Rachel S. Popelka-Filcoff, Associate Editor

9-10 March. Disease in Global Environmental History. Toronto, Ontario, Canada. Relationships among diseases, human societies, and environments. Contact: Carolyn Podruchny, History Department, York University, 2140 Vari Hall, 4700 Keele Street, Toronto, ON M3J 1P3 carolynp@yorku.ca.

23-25 March. 24th Annual Visiting Scholar Conference: The Archaeology of Anthropogenic Environments. Carbondale, IL, U.S.A. The conference will consider the archaeological evidence for human manipulation of the environment, both as a context for modern environments, and as a source of data about past societies. General information: www.siu.edu/~cai/vsconference2007.html. Contact: Rebecca Dean, (618) 453-5032, rdean@siu.edu.

25-29 March. 233rd National Meeting and Exposition, American Chemical Society, Chicago, IL, USA. General information: http://www.acs.org.

2-6 April. Layers of Perception: Advanced Technologies Means to Illuminate the Past CAA 2007, Berlin, Germany. Contact: izaw@zedat.fu-berlin.de. General information: http://www.caaconference.org/.

10-13 April. XVII SASQUA Biennial Congress, Council of the Southern African Society for Quaternary Research (SASQUA), Howick, KwaZulu-Natal, South Africa. Understanding environmental change: The contribution of Quaternary hindsight to future sustainability. Contact: Dr Greg Botha gabotha@mweb.co.za and Rebekah Grow rgrow@mweb.co.za. Organizing Committee; SASQUA 2007, c/o Council for Geoscience, P.O. Box 900, Pietermaritzburg, 3200, South Africa.

18-21 April. GMPCA colloquium, Archéométrie´07. Maison Méditerranéenne des Sciences de l´Homme, Aix-en-Provence, France. XVIth colloquium has the theme of "Diffusions, Migrations, Exchanges : The Mediterranean Basin Influence." Contact: archeometrie07@mmsh.univ-aix.fr.

19-21 April. Developing International Geoarchaeology, University of New Brunswick, Saint John, NB, Canada. Contact: Pam Dickinson, Dept. of Geology, University of New Brunswick, PO Box 4400, Fredericton, New Brunswick, E3B 5A3, Canada. Phone: 001 (506) 453-4804, fax: 001 (506) 453-5055, email: diskinson@dig2005.com. General information: http://www.dig2007.com/.

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