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Old Dogs, New Tricks

While most historians of science would characterize the 15th-19th centuries as the "scientific revolution," the much shorter period from the 1940s-1980s might also be called a scientific revolution of sorts. Most of the analytical techniques used today in archaeological science have their origins in this latter post-WWII period, a time in which great investments in scientific training, research, and experimentation were made throughout the world.

Since archaeology is largely concerned with material culture, it is not surprising that applications of a wide range of methods, including INAA, ICP, XRD, XRF, and PIXE, were quick to surface at this time—especially in the 1980s when the expense of purchasing and maintaining instrumentation shrank dramatically. Many of these techniques are capable of high-sensitivity, high-resolution, multi-element characterization of a range of geological materials, including glass, metal, lithics, and ceramics.

Over the past decade, however, there have been many "new tricks," as the saying goes, applied using the "old dogs." That is to say, many of the techniques developed years ago are now being applied in new and exiting ways. For example, in this issue of the *SAS Bulletin*, there are two research articles (by Knudson and Buikstra, and by Slovak) on applying ICP mass spectroscopy to human remains from South America with the goal of using heavy and light stable isotope ratios to document residential mobility among ancient populations. In addition, a new adaptation to ICP, specifically, time-of-flight laser-ablation ICP mass spectroscopy, is used by Hoekman-Sites and associates to study social interaction from the perspective of early Copper Age pottery from eastern Hungary.

Also in this issue, Murakami and colleagues from Arizona State University report on their experiments with thermogravimetric analysis (used to measure weight changes in a substance as a function of time and temperature under controlled gas environments) applied to characterize the composition of lime plaster from Teotihuacan in central Mexico. Lastly, W. James Stemp and colleagues describe how they used a laser profilometer to mathematically characterize the surface microtopography of stone tools for determining differences in function based on use wear.

As you can see, this issue of the *Bulletin* is largely dedicated to showing how archaeological scientists are teaching old dogs new tricks. I hope you enjoy it.

E. Christian Wells

In This Issue

Employment Opportunities

The Center for Excellence in Geospatial Technologies at Statistical Research, Inc., seeks an expert in 3D laser scanning (lidar) responsible for collecting, processing, analyzing, and modeling data from close-range, long-range, and aerial platforms. This position requires a graduate degree in a cultural resources discipline, technical expertise in the scanning of cultural resources, and skills necessary for successful marketing and program development. Please send a letter of application (with salary and employment expectations), curriculum vitae, and references with e-mail addresses to Ms. Trish Craig, Human Resources, Statistical Research, Inc., PO Box 31865, Tucson, AZ 85751-1865.

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 in design and teaching of CMRAE laboratory courses, preparation of protocols for 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. MIT is an affirmative action/equal opportunity employer. This employer does prohibit discrimination based on gender identity/ expression.

The Environmental Studies Program at Denison University invites applications for a tenure-track position beginning in August, 2007. A strong potential for excellence in teaching and a productive research program that may involve undergraduate students are essential. Ph.D. is required; postdoctoral experience and demonstrated teaching ability are assets. The successful candidate will have expertise in geographic information systems (GIS) sufficient to teach Introduction to Environmental Mapping and to manage the GIS lab at Denison. Other teaching responsibilities will include two introductory courses, People and the Environment and Science and the Environment, an advanced course in the area of specialization, and an occasional course for non-majors. All areas involving environmental applications of GIS will be considered; specialties such as cultural geography, environmental history or sociology, ecological anthropology or archaeology, environmental health, or environmental justice would complement the present ENVS faculty. For more information about Denison's Environmental Studies Program visit: http://www.denison.edu/enviro/. Denison offers competitive start-up funds and summer support for student and faculty research. Candidates should send cover letter addressing their interest in liberal arts education, curriculum vitae, statements of teaching philosophy and research interests; copies of transcripts (graduate and undergraduate), and the names, e-mail addresses, and telephone numbers of three references to: Bahram Tavakolian, Director, Environmental Studies Program, Denison University, Granville OH, 43023. Review of applications will begin December 15, 2006.

Awards, Fellowships, and Training

Erasmus Mundus: "Quaternary and Prehistory" is open for the Academic year 2007 - 2008. www.unife.it/progetti/erasmusmundus. Deadline: January 12, 2007. This program, coordinated by Ferrara University (Prof. Carlo Peretto), is financed by the European Commission, in order to promote scientific exchanges and help students from NON EUROPEAN countries to get their degree within a consortium of universities located in France, Italy, Spain and Portugal. Grants are provided for a two year long curriculum. The purpose of the program is to attract and help the best students interested into Quaternary Geology, Human Palaeontology, and Prehistory. Please notice that besides usual grants, an ASIAN WINDOW is open again, in order to provide Asian countries with a specific extra number of grants. Please circulate the attached announcement as widely as possible to the interested students in your university or among your own scientific contacts. Thanking you very much in advance. Sincerely, François Sémah, Christophe Falguères, Professor, Muséum national d'Histoire naturelle, Research Professor, CNRS and Muséum national d'Histoire naturelle Head, Department of Prehistory, Email: falguere@mnhn.fr>falguere@mnhn.fr, Telephone: +33 1 55 43 27 13, +33 1 55 43 27 36.

The Graduate School of Earth Sciences at Potsdam University, Germany (DFG-GRK 1364, entitled "Shaping the

Earth's surface in a variable environment: Interactions between tectonics, climate and biosphere in the African-Asian monsoonal region"), invites applications for nine PhD fellowships, available as of October 1, 2006. The duration of available fellowships is for three years. Stipends of 1200 EUR/month are offered to PhD fellows contingent on successful completion of each academic year. The Graduate School is an integral part of the Department of Geosciences at Potsdam University, co-hosted by the Departments of Biology, Physics, and Geoecology, as well as the Alfred-Wegener-Institute for Polar and Marine Research (Potsdam) and the GeoForschungsZentrum Potsdam. The principal objective of research projects in the Graduate School is the investigation of the interaction between tectonics and climate in shaping the surface of Earth at different length and timescales. In addition, studying the impact of these processes on the biosphere is an integral part of this effort. The regional basis for this research program involves the India-Asia collision zone and the East African Rift System, both characterized by ongoing tectonism and the creation of pronounced relief contrasts during the Cenozoic. Both settings are influenced by the African-Asian Monsoon, which is highly variable on yearly, decadal, millennial, but also on geologic timescales, and has left fundamental imprints in landscape evolution of these regions. We invite applications within the thematic fields of the Graduate School described in detail on the webpage http://www.geo.uni-potsdam.de/graduiertenkolleg. Candidates holding a diploma, MSc or BSc honours degree are invited to submit their applications in PDF format (including cover letter, CV, copies of relevant certificates, contact information of referees, and a three-page research proposal) via email to graduateschool@geo.uni-potsdam.de to the acting representative of the Graduate School: Prof. Manfred Strecker, PhD, Institut für Geowissenschaften, Universität Potsdam, Karl-Liebknecht-Str. 24, D-14476 Golm, Germany. Deadline for submissions is September 1, 2006. Potsdam University is an equal opportunity employer. For additional information please contact Dr. Martin Trauth (Email: trauth@geo.uni-potsdam.de) or Dr. Andreas Bergner (Email: bergner@geo.uni-potsdam.de).

Conference News and Announcements

The Fourth Forbes Symposium on Scientific Research in the Field of Asian Art will be convened by the Freer Gallery of Art, Smithsonian Institution, Washington, D.C. on September 27-29, 2007. Paper proposals are sought that utilize scientific methods of study applied to historic ceramics in Asia (Turkey to Japan, approximately 500 BCE to 1900 CE). Potential topics include technological innovation, common technologies, raw material selection and usage, trade and technology transfer or other questions of a technical, historical, or art historical nature. Papers that explore similarities and differences in ceramic technology, use and distribution intra- and inter-culturally are especially sought. To complement the scientific papers, the symposium committee also welcomes art historical and archaeological papers that concentrate on the historical and cultural context of Asian ceramics. Papers that summarize the current state of knowledge in an area of Asian ceramics and formulate questions where future scientific analysis would be appropriate and necessary are also viable submissions. Those interested in giving a paper are invited to submit an abstract (approximately 200 words) on original, previously unpublished research by 15 February 2007. Notifications of acceptance will be sent by 15 March 2007. Speakers should plan a 25-minute presentation. The symposium will be published. Speakers should plan to submit a publishable manuscript (3000-4000 words) at the time of the symposium. Funding to offset speakers' travel expenses will be available. The language of the symposium is English. Contact: Forbes Symposium 2007/DCSR, Freer Gallery of Art/Arthur M. Sackler Gallery, Smithsonian Institution, MRC 707, P.O. Box 37012, Washington D.C. 20013-7012, U.S.A; Fax: 202-633-9474; email: dcsr@asia.si.edu.

The 33rd International Geological Congress (IGC) in Oslo, Norway in August 2008 will be the official venue for IUGS science and will represent a global forum for geoscientists around the world to share their work. The most recent IGC was held in Florence, Italy in 2004. Submissions may be initiated at http://www.33igc.org/. You may also contact: Science Secretariat: SciComIGC@geo.uu.se; Secretary General of 33rd IGC: as@ngi.no; President of the 33rd IGC: Arne.bjorlykke@ngu.no.

First Latin American Symposium on Physical and Chemical Methods in Archaeology, Art, and Cultural Heritage Conservation. Venue: 11-16 of June, 2007, Museu de Arte de São Paulo (MASP), http://masp.uol.com.br. Languages: Portuguese, Spanish and English. Scientific Topics: Physical and chemical methods applied to the study, characterization, and dating of archaeological, art, and cultural heritage objects. Deadlines: abstract submission: January 31, 2007; information about acceptance: April 30, 2007; preliminary program: March 30, 2007; early registration: April 1, 2007; full paper submission: June 11, 2007; preliminary registration: please visit http://www.dfn.if.usp.br/pesq/faa/simposio06/preinscr.html; contacts: LASMAC 2007, email: acneiva@usp.br, website: http://www.sbf1.sbfisica.org.br/eventos/extras/lasmac.

Time in Karst. We would like to inform you and your colleagues that Karst Research Institute ZRC SAZU from Slovenia and Karst Waters Institute from the United States are organizing a Symposium on Time in Karst, which will be held from March 14 to March 18, 2007 in Postojna, Slovenia. For the participation at the symposium, special opportunity is given to early-stage researchers (with less than 10 years of working experiences since gaining the diploma). They can apply for the Marie Curie Grant covering the living expenses, travel costs and registration fee. The deadline for the application for Grant is November 1, 2006. More details about the Grant and general information about the symposium, Time in Karst, are available at our webpage: http://odmev.zrc-sazu.si/instituti/izrk/index.php?q=en/node/3.

Combining Heavy and Light Stable Isotope Analyses in the Chiribaya Polity of Southern Peru

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Archaeological scientists have long recognized the potential of light stable isotope analysis to elucidate paleodiet. More recently, scholars have begun using heavy and light stable isotopes to examine residential mobility in the past. We have combined both heavy and light stable isotope analysis to examine paleodiet, seasonality, and the movement of people and resources in the Chiribaya polity (c. AD 1000-1300) of southern Peru. Although recent research has demonstrated the complex economic relationships among various Chiribaya-affiliated communities, the movement of people and resources between them is not well understood.

Our research project complemented earlier paleodietary analyses of archaeological human bone from Chiribaya-affiliated sites by incorporating strontium isotope analyses of archaeological human tooth enamel and bone from a subset of the same individuals to examine residential mobility. In addition, because the paleodiet data from archaeological human bone samples provide an average of the last years of an individual's life, we investigate the seasonal variability in resource use through an analysis of carbon and nitrogen isotopes in archaeological human hair.

The Chiribaya Polity of Southern Peru

During the Late Intermediate Period (c. 1000-1300), the Chiribaya were a powerful polity in the Ilo and Moquegua Valleys of southern Peru (e.g. Buikstra 1995; Lozada, Cerna et al. 2005). Previous cranial modification and paleodiet studies of carbon and nitrogen isotopes in archaeological human bone from the Ilo Valley sites of Chiribaya Alta, Chiribaya Baja, and San Gerónimo, as well as the Moquegua Valley site of El Yaral have elucidated complex socioeconomic patterns that support the hypothesis that the Chiribaya polity was a señorío, a confederacy of economically specialized parcialidades (Buikstra et al. 2005; Lozada et al. 2005; Tomczak 2003).

Chiribaya Alta is the largest and most complex of the Chiribaya sites. Because of its large mortuary component, Chiribaya Alta may have been a center of political power and ceremonial activity to which local lords and priests were taken for burial, much like the Peruvian ceremonial centers of Pachacamac and Pacatnamu (Lozada et al. 2002). In contrast, because of the location of the site as well as grave goods, the site of Chiribaya Baja was predominately an agricultural site. At the site of San Gerónimo, burial offerings, which include miniature wooden boats, harpoons, and fishhooks, and bone carbon and nitrogen isotope data imply that the inhabitants subsisted primarily through fishing. Finally, unlike the coastal Chiribaya sites, the site of El Yaral is located in the Moquegua Valley approximately 50 km from the Pacific Ocean at an altitude of 1000 m.a.s.l., where it is surrounded by Tiwanaku-affiliated sites like Chen Chen. El Yaral inhabitants were likely agriculturalists and pastoralists and used Chiribaya-style material culture.

Chiribaya Residential Mobility and Resource Use

To investigate the role of the movement of people and/or resources in the Chiribaya polity, strontium isotope analyses were performed on archaeological human tooth enamel and bone from Chiribaya-affiliated sites (Figure 1). In general, strontium isotope ratios vary according to the age and composition of the bedrock in a given geologic region (Faure and Powell 1972). Since tooth enamel, unlike bone, does not regenerate, differences in strontium isotope ratios in human tooth enamel and bone can be used to identify migration and the geologic origins of immigrants (Ericson 1985). Strontium isotope analysis can test the hypothesis that the inhabitants of Chiribaya-affiliated sites in the Ilo Valley are migrants from the mid-altitude Moquegua Valley and/or the Lake Titicaca Basin.

In addition, we further investigated the role of resource use, and especially of seasonal variability in resource use, through an investigation of carbon and nitrogen isotopes in archaeological human hair from Chiribaya Alta and El Yaral. Briefly, analyses of carbon stable isotopes can determine relative amounts of C4 and C3 plants in an individual's diet from their bone collagen and hydroxyapatite, while nitrogen isotopes can elucidate the role of marine and freshwater food consumption (DeNiro and Epstein 1978, 1981). Although limited to archaeological sites with exceptional preservation, analysis of archaeological human hair can identify seasonal trends in paleodiet. Generally, carbon and nitrogen isotopic analyses of 1-2 cm hair samples can provide dietary information for approximately 1-2 months of food consumption.

Isotope Signatures in the Moquegua and Ilo Valleys

The geologic variability in the Andes means that individuals whose calcium, and hence strontium, comes from different geologic zones can be identified through strontium isotope analysis (Bellido et al. 1956). The Andes themselves are predominately composed of late Cenozoic volcanic rocks, particularly andesites; this geologic zone includes the Moquegua Valley, where El Yaral is located, as well as part of the Ilo Valley, where Chiribaya Alta, Chiribaya Baja, and San Gerónimo are located. The strontium isotope ratios in exposed bedrock and groundwater from this region are similar to strontium isotope ratios in modern and archaeological fauna from the same regions. While the Ilo Valley range as determined by modern fauna encompasses the Moquegua Valley range, complicating the detection of movement between the two valleys using strontium isotope analysis. However, we hypothesized that the large quantities of marine products consumed by inhabitants of Chiribaya-affiliated sites on the coast would raise their strontium isotope signatures to that of seawater (Tomczak 2003; Veizer 1989).

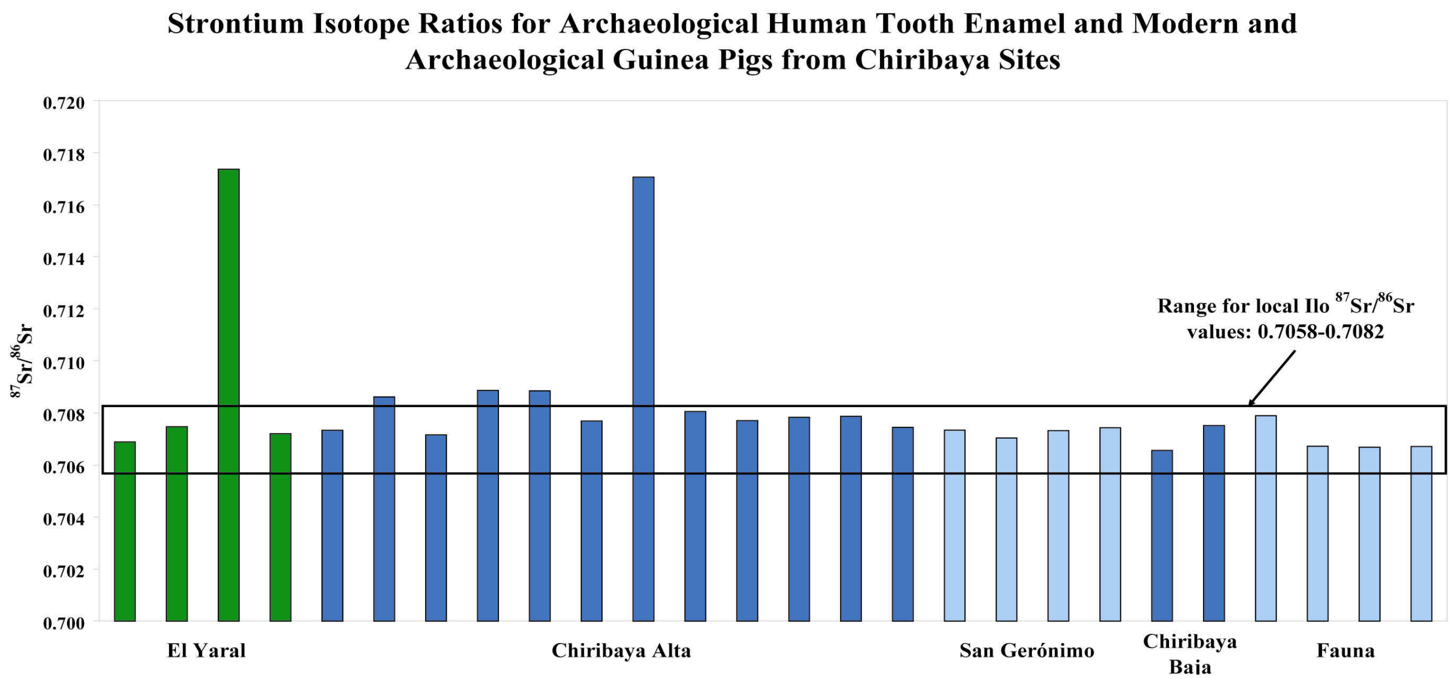

Figure 1. Strontium isotope ratios from human tooth enamel from the cemeteries of El Yaral, Chiribaya Alta, San Gerónimo and Chiribaya Baja, as well as archaeological guinea pig bone from the site of Chiribaya Baja and modern guinea pig bone from Ilo, Peru.

Finally, the Ilo and Moquegua Valleys of southern Peru provide a wide variety of resources that can be identified using carbon and nitrogen isotope analyses. While nitrogen isotopes can distinguish products from the rich marine ecosystem, carbon isotopes can distinguish the utilization of the C4 crop, maize. Tieszen and Chapman (1992) analyzed a variety of terrestrial and marine plants and animals from northern Chile, an area environmentally similar to the Ilo and Moquegua Valleys of southern Peru, and we use their ecosystem data in our interpretations.

Interpretations of Isotope Data

In general, individuals whose tooth enamel strontium isotope signatures appear non-local were buried at El Yaral and Chiribaya Alta, while smaller Ilo Valley sites such as San Gerónimo and Chiribaya Baja show less variability in enamel strontium isotope ratios (Knudson and Buikstra, in press; Knudson and Price, in press). Strontium isotope ratios were most variable at the site of Chiribaya Alta, where mortuary assemblages, cranial modification styles and paleodiet were also highly variable (Tomczak 2003). The high number of non-locals identified at Chiribaya Alta may result from increased access to resources from a variety of different ecological zones, including increased marine consumption. However, it could also support the hypothesis that Chiribaya elites from a variety of sites were buried at Chiribaya Alta, which could have had a function similar to the great ritual and pilgrimage center of Pachacamac on the central Peruvian coast. The fact that two out of four non-locals buried at Chiribaya Alta also had non-local bone strontium isotope ratios further supports this hypothesis, and future analysis of additional bone-tooth pairs from Chiribaya Alta will also test these hypotheses.

However, at Chiribaya Alta, identifying the locals is also informative. One of the richest tombs excavated at Chiribaya Alta was tomb number 419 (Figure 2), which contained one male and two females (Buikstra 1995). The rectangular tomb had been closed by large rocks and mortar laying over three cane litters, and contained numerous grave goods placed near the feet of the three individuals, included 32 ceramic vessels, 20 baskets, and 25 textiles (Buikstra 1995). According to cranial modification styles and the presence of San Gerónimo ceramics, the women were more likely to be *pescadores*, while the man was more closely linked to the *labradores*. The adult male had a local Ilo Valley signature in his first molar tooth enamel (CHA-3704, 87Sr/86Sr=0.707693) and femur (CHA-3704, 87Sr/86Sr=0.707469). In addition, one of the women buried in the same tomb also had a local signature (CHA-3610, 87Sr/86Sr=0.70783) in her first molar tooth enamel. The adult male in tomb 419 has been identified as a paramount lord of the Chiribaya polity, yet both this man and the women who were buried with him clearly lived in the Ilo Valley during the first few years and the last decade of their lives. This lends support to the hypothesis that the Chiribaya polity was predominately a coastal society with coastal, not *altiplano*, origins.

Analysis of carbon and nitrogen isotopes in hair samples from individuals buried at Chiribaya Alta (Figure 3) shows values similar to those published in previous paleodietary studies (Tomczak 2003). However, our work has demonstrated that some individuals at Chiribaya Alta had quite variable d13C-keratin and d15N values in hair segments that formed over approximately the last 2 years of life (Knudson et al., in press). The most dramatic changes are seen in 26 cm of hair from CHA-2059, an adult female. The highest values are seen in the hair segments within 6 cm of her scalp and the hair segments

Figure 2. Tomb 419 from the site of Chiribaya Alta.

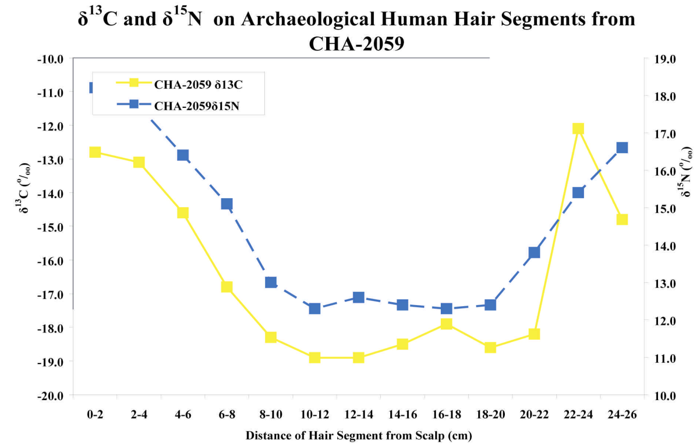

Figure 3. Carbon and nitrogen isotope data from CHA-2059 from the site of Chiribaya Alta.

within 22-24 cm from her scalp; these values are d13C-keratin = -12.1o/oo – -13.1o/oo. This implies that the protein sources in this woman's diet in approximately the last six months and approximately 22-26 months before death were dominated by C4 plants, presumably maize (Tieszen and Chapman 1992). However, the intervening months show a gradual decrease and then increase in d13C-keratin values. These values imply that C4 plants were less important sources of protein during these periods of hair growth, and that protein sources at this time were instead C3 plants and terrestrial animals. In addition, this woman consumed the greatest amount of marine animals in approximately the last two months of her life, and again in the period of approximately 20 through 26 months before death.

The observed intra- and inter-individual variability in d13C-keratin and d15N values in hair from Chiribaya Alta could be explained by a number of different environmental, social, and political factors. There are no clear sex differences in these variable patterns of seasonal differences in d13C-keratin and d15N values, and adult females and males exhibit both low and high variability in their d13C-keratin and d15N values in hair. If the variability seen in seasonal paleodietary trends is due to temporal factors, it could be the result of poor harvests caused by El Niño events, or less trade due to changes in economic and social relationships. It may also be the case that variability in Chiribaya Alta hair samples reflects residential mobility and movement between different environmental and/or geologic zones.

Acknowledgements

This paper would not have been possible without the generous assistance of a number of scholars. The following individuals or institutions helpfully provided laboratory access, logistical support, or sample analysis: Arthur Aufderheide, James H. Burton, Michael Chapman, Paul D. Fullagar, Geochron Laboratories, Larry Tieszen, and T. Douglas Price. In addition, Deborah E. Blom, María Cecilia Lozada Cerna, and Paula Tomczak kindly provided access to valuable contextual information and their cranial modification and paleodiet data for the individuals included in this study, which vastly improved our ability to contextualize our interpretations. Finally, we would like to acknowledge the following funding sources: the National Science Foundation (BCS-0202329, SBR-9708001, BNS-8920769), Geological Society of America (6833-01), the University of Wisconsin at Madison, and the Southern Peru Copper Company.

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An Examination of Prehistoric Residence Change in Middle Horizon, Peru Using Multiple Isotopic Analyses

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The archaeological site of Ancón, located 40 km north of Lima on Peru's Central Coast (Figure 1), has been the object of intense archaeological inquiry for the last century (see Kaulicke 1997 for a general synopsis). The majority of research at Ancón has focused on changes in mortuary practices, as thousands of burials have been encountered at the site. During the Andean Middle Horizon (AD 550-1000), radical changes in funerary customs and the presence of foreign style objects at the site have led some scholars to speculate that Ancón functioned as an imperial colony, occupied partially by settlers from the highland Wari Empire (Uhle 1968[1912]; Menzel 1977). In order to evaluate this hypothesis, strontium isotope analysis, which potentially can distinguish between individuals of local and non-local origin, has been used to determine the degree of residential mobility at Ancón in the Middle Horizon.

The principles of strontium isotope analysis in archaeology are relatively straightforward and have been used by scholars to monitor residence change in the archaeological record (e.g., Grupe et al. 1997; Price et al. 1998; Bentley et al. 2003; Schweissing and Grupe 2003; Knudson et al. 2004; Wright 2005). Strontium isotope ratios in a geological zone are determined by the age of the mineral and the Rb/Sr ratio of the parent rock (Faure and Mensing 2005). 87Sr/86Sr ratios in bedrock are transferred through the food chain such that strontium ratios in soil, plants and animals in a given geological zone should reflect underlying 87Sr/86Sr ratios in the parent rock (Blum et al. 2000). Assuming humans were eating only locally grown foods, 87Sr/86Sr ratios in human hard tissue should reflect the strontium composition of an individual's diet, which in turn mirrors the geological environment (Ericson 1985; Sealy et al. 1991; Grupe et al. 1997; Price et al. 1998).

Tooth enamel of the permanent dentition forms in early childhood, and once formed undergoes little change during an individual's lifetime (Hillson 1996). Human bone, on the other hand, undergoes complete replacement of its chemical constituents every six to ten years. Measurements of strontium in human tooth enamel, therefore, reflect the first years of an individual's life while measurements of strontium in human bone reflect the isotopic composition of the geological region in which a person lived before death (Ericson 1985, 1989; Sealy et al. 1991). Differences in strontium isotope ratios between human bone and teeth from the same individual indicate change in geological environment, and thus residence change (Ericson 1985; Price et al. 1998).

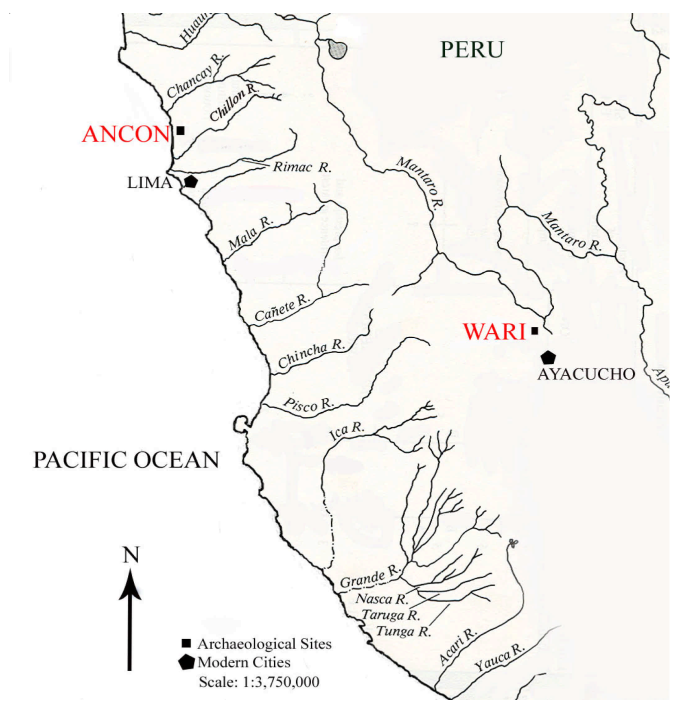

Figure 1. Partial map of Peru indicating sites mentioned in text. Redrawn from Isbell and McEwan (1991).

Materials and Methods

Strontium isotope ratios were determined for bone-tooth pairs from thirty-five Middle Horizon Ancón individuals. All enamel samples were taken from maxillary or mandibular molars. Bone samples were taken from cortical bone and came from the diaphyseal mid-shaft of long bones.

Strontium ratios for the Ancón region were unknown prior to the current research. Geological characterizations of the area indicate that the site of Ancón is situated in an alluvial floodplain formed from numerous deposition events throughout the Pleistocene (Moncayo et al. 1992). The alluvial deposit is composed of a heterogeneous mix of materials, including tertiary rock, Mesozoic volcanics, and coastal batholiths that date to the Cretaceous period (Moncayo et al. 1992). Baseline exchangeable soil (i.e., plant-available) strontium isotope values for the Ancón region were determined using two archaeological soil samples and are reported here. Biologically available strontium ratios for the Ancón region during the Middle Horizon currently are being determined by the author using the remains of 4 archaeological guinea pig, or *cuyes*, from Ancón.

Diagenesis, or post-mortem alteration of human bone and teeth, is a fundamental problem in the use of archaeological skeletal material for dietary reconstruction (Nelson et al. 1986; Sillen 1986; Price et al. 1992; Sillen and Sealy 1995; Hoppe et al. 2003). Diagenetic processes and rate of alteration differ depending on the materials (e.g., bone verses teeth), the elements (strontium vs. carbon) involved (Schoeninger 1995) and climatic conditions (Price et al. 1992; Nielsen-Marsh and Hedges 2000). Thus, the integrity of each specimen and element must be assessed prior to analysis (Hoppe et al. 2003). Five bone samples were selected from my sample randomly for X-Ray diffraction and FTIR analyses. The samples were run at the analytical facility in the GES department at Stanford University. The results from both tests indicate that the apatite composition among the five Ancón samples had not been diagenetically altered and that biogenic strontium signatures in the bone, and subsequently tooth enamel, should be preserved.

All Ancón enamel, bone and soil samples were further prepped for Sr analysis by the author at the Paytan Chemical Oceanography Lab at Stanford. Enamel and bone samples were mechanically cleaned using a Dremel Multipro drill outfitted with a 0.5 mm inverted cone tip and subjected to a series of acid rinses in order to remove organics and diagenetic carbonates.

Approximately 25 mL of 0.25 ammonium acetate was added to each 2 g soil sample. The samples were shaken for 1 hour after which the samples were centrifuged for 10 minutes at 10,000rpm. Approximately 7 mL from each sample was then dried down and 5 ml of 2.5 HCL were added to each sample. Strontium in the bone, enamel and soil samples was separated using standard cation exchange procedures. Fifty-six of the samples were analyzed by Dr. Bettina Weigund and the author at the Stanford-USGS Micro-Isotopic Analytical Center (SUMAC) on a Finnigan MAT 262 thermal ionization mass spectrometer (TIMS). The remaining human samples and soil samples were analyzed by Tom Bullen at the US Geological Society in Menlo Park, CA, on a Finnigan MAT 261 TIMS.

Results and Discussion

Figure 2 illustrates the results from the soil analysis. The range of strontium isotope values for the Ancón region is 87Sr/86Sr = 0.7075-0.7080. This estimate is based on 2 standard deviations from the soil sample mean of 87Sr/86Sr = 0.7077. Admittedly strontium values in soil can vary widely. Price et al. (2002) noted that alluvial soils in particular tend to produce 87Sr/86Sr values that represent an average of their overall source materials. As a result, the range of strontium values for Ancón presented here should be viewed as a preliminary indicator of strontium values for the region. The inclusion of strontium isotope data from archaeological fauna, which is currently underway, and additional soil and plant samples should help to refine these preliminary values.

For the present study, I use the range of strontium values as determined from the soil samples to distinguish between individuals with local and non-local strontium signatures. Individuals whose Sr ratios fell within the mean of the two soil samples ±2 standard deviations were considered local. Conversely, individuals with strontium ratios higher or lower than that range are considered potentially non-local.

Figure 3 shows strontium isotope ratios for archaeological tooth enamel from thirty-five individuals buried at Ancón. Several of the individuals in my sample had higher or lower strontium isotope ratios than the established range for the site. One of the individuals, P8247 - a female - had a strontium signature much lower than the established range (87Sr/86Sr=0.70555) indicating that she was an immigrant to the community. Interestingly, her Sr signature is well within the range of strontium isotope values established for the Ayacucho

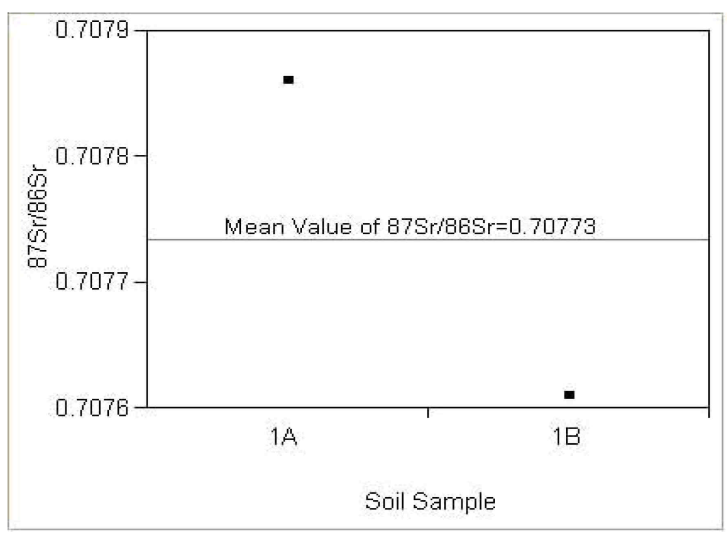

Figure 2. Strontium isotope ratios from two archaeological soil samples from the Ancón region.

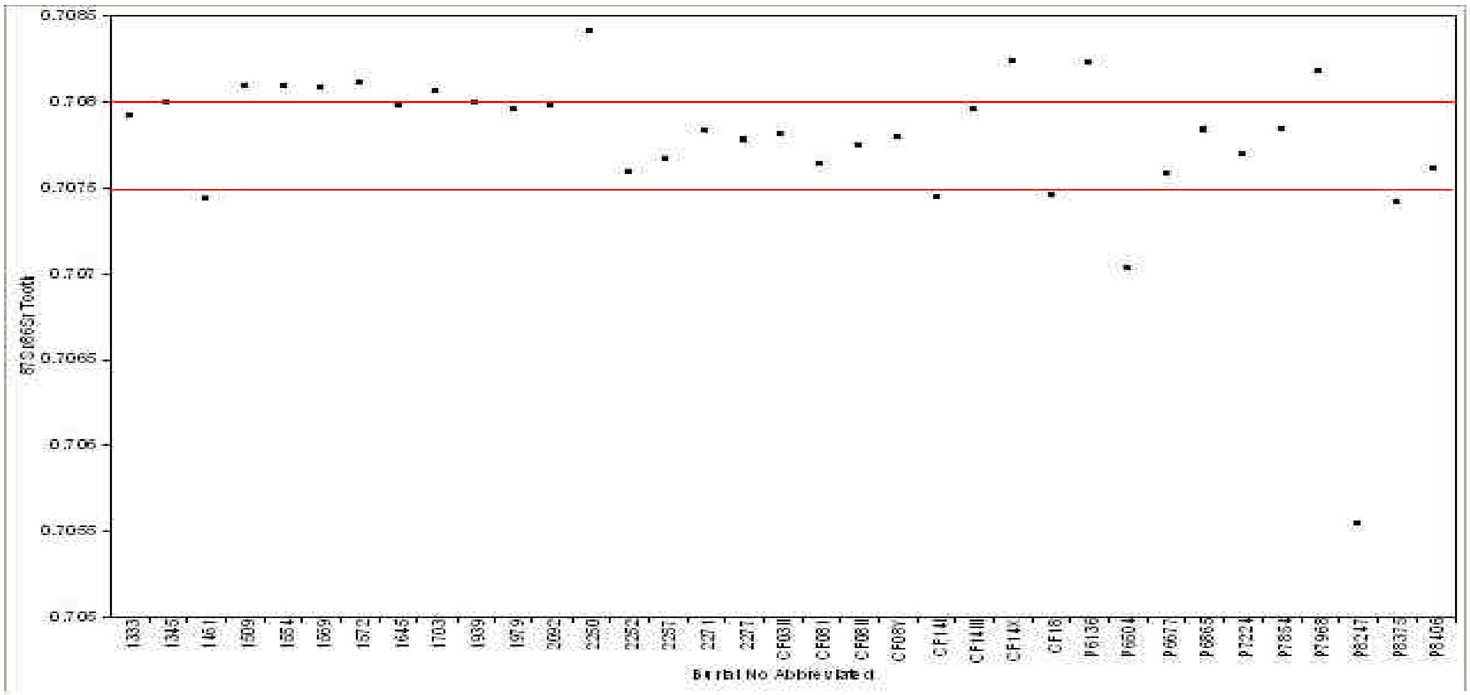

Figure 3. Strontium isotope ratios for archaeological tooth enamel from individuals buried at the site of Ancón. The area within the two red lines indicate the range of strontium isotope values for the Ancón region based on two soil samples (±2 s.d.). Individuals with values above or below this range potentially can be categorized as non-local.

region (Knudson and Tung, in press)—heartland of the Wari polity. She was buried with Wari style artifacts, raising interesting questions about her cultural and political affiliation.

A closer examination of strontium isotope ratios from Ancón bone samples also indicate that some members of Ancón's population may have been moving around later in life (Figure 4). One individual, CF-14-X, had a lower bone strontium isotope value than the remainder of the sample population while six of Ancón's inhabitants displayed higher strontium isotope bone values. All but one of these individuals had corresponding enamel Sr values within Ancón's range, indicating that they were born and raised locally but likely lived elsewhere during the last 7-10 years of their life. Their presence at Ancón implies that they either moved back to Ancón shortly before death or that their bodies were brought back to the site for burial.

Two other factors might explain the high number of individuals with aberrant enamel or bone strontium signatures in my sample. First, the range of strontium values for the site of Ancón given here is based on limited data (i.e., two soil samples). It is possible that data from on-going strontium isotope analysis of archaeological fauna will broaden the strontium isotope range for the Ancón region. If this proves to be the case, some of the individuals categorized as non-local here may be reclassified as local.

Secondly, anomalous Sr values among members of Ancón's population may be related to dietary bias. A diet rich in marine resources, for example, would shift 87Sr/86Sr ratios towards the modern seawater signature - 87Sr/86Sr=0.7092 (Vezier 1989). This would potentially obscure local and non-local geological Sr values (Knudson 2004). At Ancón, there is ample archaeological and osteological evidence that suggests inhabitants were regularly consuming marine foods in addition to terrestrial-based resources. The high Sr ratios among some of Ancón's inhabitants, thus, might be related to the heavier consumption of marine resources among this segment of the site's population. Dietary bias also might explain lower strontium values among some Ancón inhabitants. Given the stratified nature of resource zones in the Andes (Murra 1975; Tomczak 2003), it would not be unlikely that some individuals consumed foods grown in other locales with different strontium values.

In order to distinguish among these potentially ambiguous outcomes, I have integrated multiple isotopic tracers into my analysis. Currently I am conducting C and N isotope analyses of bone collagen, C isotope analysis of enamel and bone carbonate and O isotope analysis of enamel for the 35 Ancón skeletons. Carbon and N isotope values have been used to distinguish among C3, C4, and marine-based diets and to differentiate between protein and non-protein resources (DeNiro and Epstein 1981; Schoeninger et al. 1983; Ambrose and DeNiro 1986; Walker and DeNiro 1986). They will be employed here to assess whether aberrant strontium ratios are linked to dietary factors. In a similar vein, recent work on archaeological skeletal materials has demonstrated that O isotopes in teeth successfully can distinguish between individuals of local and non-local origin (e.g., White et al. 1998**;** Dupras and Schwarcz 2001). Assuming that humans were drinking local water sources, O isotopes in body water and in tooth enamel should be an accurate reflection of O isotope values in environmental water (Longinelli 1984; Koch et al. 1989; Fricke et al. 1995) and thus provide an alternate marker of origin.

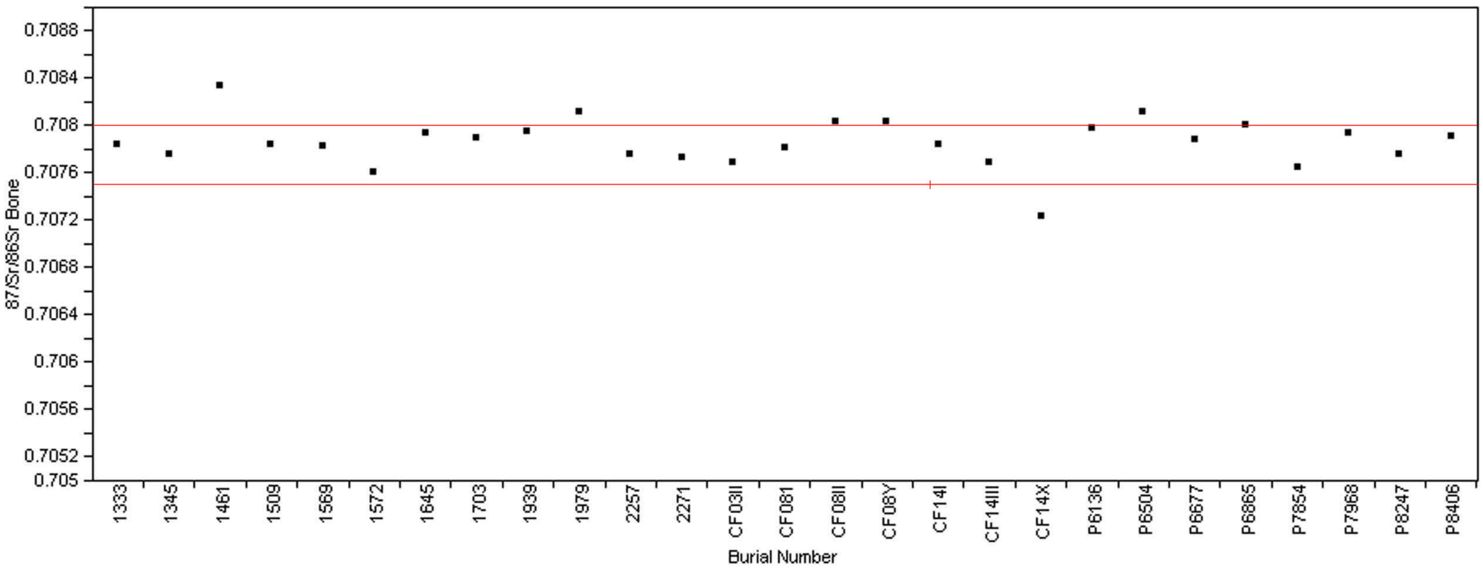

Figure 4. Strontium isotope ratios for bone from individuals buried at the site of Ancón. The area within the two red lines indicate the range of strontium isotope values for the Ancón region based on two soil samples (±2 s.d.). Several individuals (n=3) had Sr isotope ratios well above Ancón's range, while one individual (CF-14-X) had a Sr isotope bone value significantly below the rage of local values.

Conclusion

The current study underscores one very important point for the future of strontium isotope research: the issue of dietary bias. This is a particularly acute problem when analyzing coastal populations who may have regularly consumed marine resources or groups of people in marginal ecozones who may have relied on imported foodstuffs. Multiple classes of isotopic data have been shown to yield more reliable results than any one test alone (Sealy et al. 1995; Bryant et al. 1996; Bentley et al. 2005; Bentley 2006) and should be integrated into strontium isotope studies if researchers suspect that past individuals may have consumed non-local or non-terrestrial resources.

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Elemental Interaction: Stylistic, Compositional, and Residue Analyses of Copper Age Ceramics on the Great Hungarian Plain

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University of Arizona

Since 1998 the Körös Regional Archaeological Project has been investigating the transition from the Neolithic to the Copper Age (ca. 4500 B.C.) in the eastern Carpathian Basin (http://www.anthro.fsu.edu/research/koros/). This transition coincides with dramatic changes in house form, settlement layout, settlement distribution, and mortuary customs. These changes affected nearly every aspect of social organization. Several years of excavation at two adjacent Early Copper Age settlements (Vésztö-Bikeri and Körösladány-Bikeri) has produced many independent study projects related to ceramics. The projects described here examined ceramics from other sites in the study area as well (Figure 1) in order to gain a regional perspective on the social changes that occurred during this transitional period.

Stylistic Analysis

Stylistic analysis of ceramics from the Körös basin study region consisted of a comparative examination of the frequency of incised ceramic decoration between sites (Parkinson 1999). The study examined both Late Neolithic (ca. 5000-4500 B.C.) and Early Copper Age pottery (ca. 4500 B.C.; Figure 2). Compared to Late Neolithic pottery which clearly differentiated into three styles associated with cultural groups (Tisza, Csozhalom, and Herpály), Early Copper Age ceramics revealed a pattern of stylistic homogeneity and uniformity across the study region. Combined with settlement data, it appears that boundary maintenance (inferred by pottery style) was relaxed during the Early Copper Age, likely as the result of "tribal cycling" or changes in social and economic structure and relationships from centralized villages to more dispersed hamlets (Parkinson 2006).

Petrographic Analysis

The petrographic analysis (conducted at Millsaps College) qualitatively and quantitatively examined ceramic and daub samples from four sites in the study region, and was aimed at identifying compositional variation in the fabric of ceramics from four sites in the study region (Parsons 2005). Any identifiable variation would have implied the movement of ceramics from one site to another, and could have elucidated patterns of trade and exchange. However, all of the samples fit within a certain range of similar characteristics. Petrographic point counting revealed no quantitative distinction between samples collected from the sites. Although indistinguishable based on point counting alone, ceramic and daub samples are easily qualitatively differentiated, with daub containing more "void" space (trapped air contained within the matrix of the daub) and fewer clay temper-like inclusions. No discernable pattern emerged that explains the few samples that do not fit the overall description perfectly.

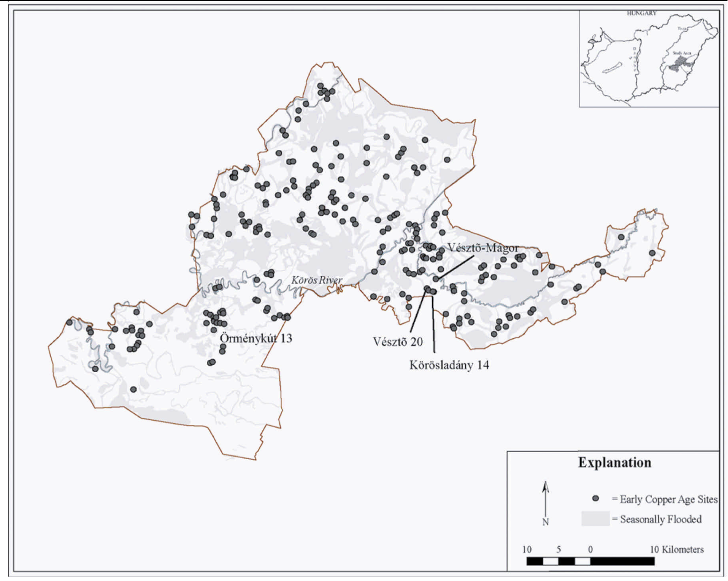

Figure 1. Map of the study area, showing the location of the sites studied.

Such being the case, Parsons (2005) concluded against an extensive pottery trade network, and instead argued for the local gathering of clay and production of ceramics. However, it must be remembered that the uniform geology of the region and, therefore, the relative homogeneity of the raw materials used in ceramic production in the region, may confound petrographic results and obscure evidence for trade in pottery during the Early Copper Age.

Chemical Analysis

Chemical analysis of ceramics was done using time of flight-laser-ablation-inductively coupled plasma-mass spectrometry (TOF-LA-ICP-MS) to characterize raw clay sources and pottery. The experiment tested for possible variation in the chemical composition of the Körös region's clay. The goal was to establish local versus non-local sherds, using these results to infer the degree of social interaction and boundary permeability in the Early Copper Age. The assumption was that, despite uniform loess deposits in the region that contribute to geologic homogeneity, large river systems of the Tisza, Körös, and Maros that drain from the Carpathian Mountains may carry foreign materials from which the clay weathers, thus allowing for trace chemical composition of archaeological clay sources.

This compositional data on ceramics and clay from Early Copper Age sites in southeastern Hungary has shown that although the clay that defines the Great Hungarian Plain is compositionally similar, it is variable over a distance of at least 80 km (Duwe 2005). Analysis of pot sherds from six sites within 80 km area reveals subtle differences in trace element composition across the Körös drainage. In understanding what this variation looks like, we were also able to set the future

Figure 2. Two reconstructed ceramics excavated from Vésztö-Bikeri, both showing typical Early Copper Age shapes.

research agendas of compositional work and define the scale of analysis and the scale of "source." When the presence of non-locally produced pottery is examined, it appears to be highly exchanged but non-directional, suggesting a high degree of social interaction and low boundary maintenance that concurs with Parkinson's (2006) results. These data suggest that cultural boundaries in the Early Copper Age are permeable and fluid.

Residue Analysis

Residue analysis of ceramic samples gathered from sites in the study area aims to answer the question, "is dairying related to the social and cultural changes observed at the Neolithic/Copper Age transition?" Bökönyi (1988) suggests that the shift was related to an increase in cattle husbandry, which is the local manifestation of the secondary products revolution. Other recent residue analysis studies show that dairying started sometime in the Neolithic on the Great Hungarian Plain (Craig et al 2005). This project aims to determine the extent of dairy use during the Neolithic and Copper Ages, and to examine how dairy use may have changed over time.

When testing for milk residues, there are two key fatty acids (lipids) that should be present. They are hexadecanoic acid (C16:0) and octadecanoic acid (C18:0). When both of these acids are found in a vessel's residues, it may have held a milk product. Further residue testing steps are then needed to confirm the identity of the residues. Initial testing of 20 samples (taken from pedestalled vessels from the Early Copper Age) did not find both hexadecanoic and octadecanoic acids present, implying that these vessels do not contain dairy residues. During the K.R.A.P. 2006 summer season, 339 more samples were collected for analysis. These samples came from 10 sites dating from the Early Neolithic to the Late Copper Age. They represent the full range of vessel types used and a variety of in-site contexts. It is hoped that further analysis will provide us with more complete results.

Conclusions

Initial residue analysis did not identify any dairying residues in pedestalled vessels dating to the Early Copper Age. Hopefully, an expanded field of vessels will reveal a pattern of use that illuminates the initial extent of dairy use. Despite the lack of variability shown by stylistic analysis (a pattern later repeated in petrographic analysis), it initiated a line of study that is beginning to yield useful information for understanding the transition between the Neolithic and the Copper Age in the Carpathian Basin, primarily in the use of chemical characterization analyses of ceramics and clay. Ceramic stylistic variability, as well as the results from the TOF-LA-ICP-MS analysis, have substantiated the interpretation of relaxed social boundaries and social and economic transformation during the transition to the Early Copper Age. Further petrographic research is planned that will involve more samples gathered from a larger number of sites in hopes of identifying (through compositional or manufacturing differences) the variability indicated by the chemical analysis.

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Thermogravimetric Analysis (TGA) of Archaeological Materials, Part I: Lime Plaster

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Thermal analysis is based on the measurements of changes in a physical property of a substance as a function of temperature. Temperature affects almost all physical and/or chemical constants of a substance, which are determined by heat transmission and thermokinetic processes. There are a number of methods and techniques of thermal analysis (e.g., Charsley and Warrington 1992; Todor 1976; Wendlandt 1986; Wunderlich 1990), some of which have been applied to the compositional analysis of archaeological materials, in particular, differential thermal analysis (DTA) and thermogravimetric analysis (TGA). DTA is used to measure changes in the heat content of a substance, which is related to phase transformation of a substance (Mackenzie 1970), and TGA is used to measure weight changes in a substance as a function of time and temperature under controlled gas environments (Earnest 1988). Both methods have been applied to ceramic materials, mortars, concretes, and other archaeological materials, mainly in Old World contexts. In this article, we will present an overview of TGA and its application to archaeological materials from the New World. In Part I, we will discuss the utility of TGA for the compositional analysis of lime plaster. In Part II, which we plan to present in the next issue of the SAS Bulletin, we will discuss how TGA can be used to infer the original firing temperature of pottery.

Basics of TGA

The specimens for TGA (and most thermal analyses) need to be first crushed into a fine powder as opposed to grinding. It has been reported that grinding causes the formation of altered or even amorphous surface layers (Warne 1992:5). The powder is then placed in a container or a furnace.

Various gas environments can be chosen according to the goals of the analysis. For example, the dry air was used for ceramics to simulate the original firing processes as closely as possible whereas helium was used for plaster to reduce the buoyancy correction in our analysis.

The heating rate can be set up on the instrument. Although 10 °C per minute has been used as a generally acceptable rate, the heating rate has an effect on the reaction temperature and needs to be selected according to the goals of the analysis. In general, increased heating rates cause reactions to occur at somewhat higher temperature with a decrease in the reaction temperature range (Warne 1992:6). Conversely, lower heating rates provide maximum peak separation at the expense of poorly defined peaks (Warne 1992:6).

For most TGA instruments, an electro-balance is used to measure detailed weight changes with microgram sensitivity during the analytical heating process, which can then be used to determine both the final weight loss and the weight loss at any point during the analysis (Figure 1). Most TGA provides charts of both the thermogravimetric (TG) and differential thermogravimetric curves (DTG, not to be confused with DTA) (Figure 2). The TG curve shows changes in the weight loss vs. time and the DTG curve shows the differential weight loss per unit of time (per minute in the figure). The TG curve is usually used to determine weight loss vs. time or temperature. It can also be used to calculate the composition of a sample if different episodes of weight loss can be clearly associated with different sample components. The DTG curve facilitates observation and quantification of these different episodes of weight loss,

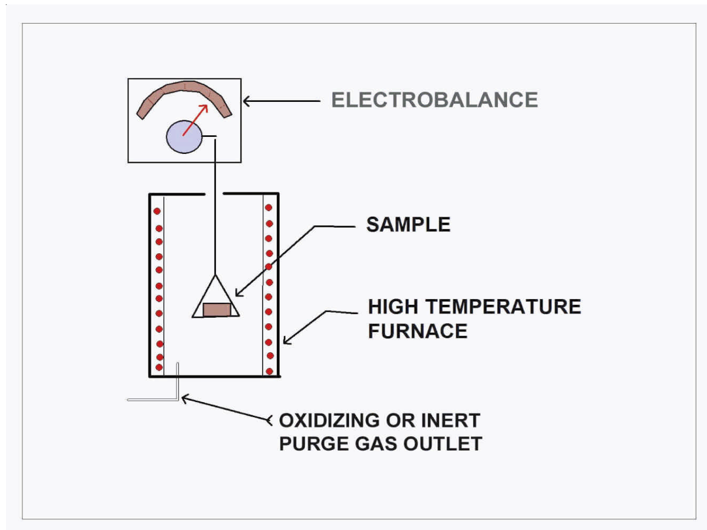

Figure 1. A schematic view of the instrument for TGA.

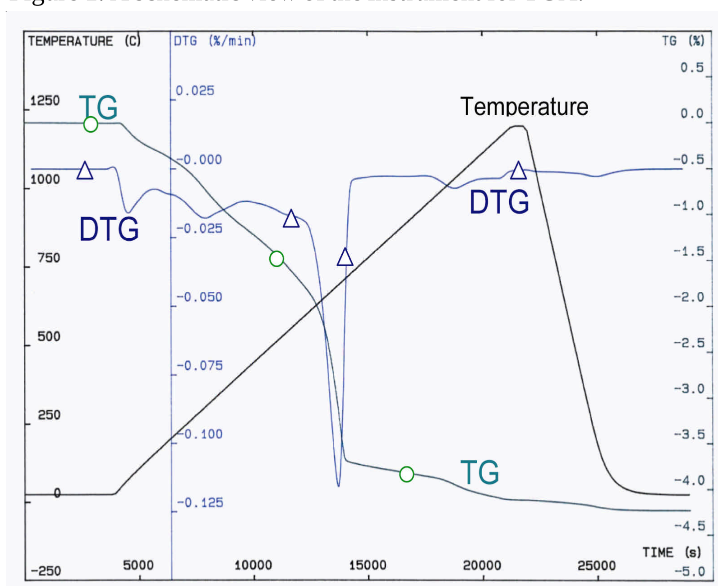

Figure 2. An example of the chart showing TG and DTG curves. Note that a small amount of weight loss appears to occur on cooling. This is indicative of the small level of error associated with the buoyancy effect. If this effect significantly impacts the data, background samples that do not lose weight on heating can be run, so that the buoyancy effect can be "subtracted out."

although there are often overlaps in the reaction temperatures associated with different weight loss events.

In general, the weight loss associated with lime plaster, mortar, and ceramic samples occurs as a result of dehydration up to 200 ^{o}C, dehydroxylation at ca. 200-600 ^{o}C, and carbonate decomposition at ca. 600-900 ^{o}C. These temperature ranges may vary depending on the nature of the specimens. In general, minerals or substances have specific temperature range(s) over which they undergo thermal decomposition, which under ideal conditions makes it possible to detect the composition of the specimen.

TGA on Lime Plaster

First, we provide a brief overview of the lime production process to better understand how TGA works for the compositional analysis of lime plaster. Lime production begins by heating $CaCO_3$-containing raw materials (e.g., limestone, shell) to ca. 900 ^{o}C to drive off carbon dioxide. This produces calcium oxide (CaO) or quicklime. The mixture of quicklime and water forms a hydroxide paste known as slaked lime ($Ca(OH)_2$). When slaked lime is exposed to air, it absorbs atmospheric CO_2 to reform calcium carbonate ($CaCO_3$), thus forming a mortar joint or a hardened plaster surface. The slaked lime is generally mixed with an aggregate, such as sand, clay, or crushed limestone. Depending on what is mixed, lime plaster or mortar can be classified into pure lime plaster, hydraulic mortar, pozzolanic concrete, and so on.

European scholars have been concerned mainly with distinguishing different kinds of mortars and used TGA to quantify the content of CO_2 bound to carbonates as well as water bound to hydraulic components (e.g., Bakolas et al. 1995, 1998; Moropoulou et al. 1995, 2003; Silva et al. 2005). Only pure lime plaster has been reported to date in the Prehispanic Americas (e.g., Hansen 2000; Magaloni et al. 1992). Hence, we can concentrate on the weight loss associated with CO_2 loss from $CaCO_3$. Thus, from the total CO_2 loss, we can calculate the proportion of lime within the plaster and examine whether there are specific recipes in terms of the proportion of lime and non-lime components.

In theory, the onset temperature of CO_2 loss for calcite is ~600 ^{o}C and the reaction completes at 900 ^{o}C (e.g., Lawrence et al. 2006). However, the temperature of weight loss is variable depending on the nature of $CaCO_3$. Paama et al. (1998) note that the weight losses at the reaction temperature near 750 ^{o}C indicate the loss of CO_2, not from pure $CaCO_3$, but from re-carbonated lime. Silva et al. (2005) suggest that poorly crystallized carbonate decomposes at lower temperature. Also, mixed materials within the plaster cause some variations in the reaction temperature of calcite. Bakolas et al. (1995, 1998) note that carbonates decompose below 600 ^{o}C when soluble salts are present in the samples. Branda et al. (2001) note a continuous weight loss starting from about 400 ^{o}C for their pozzolanic concrete samples and suggest this is due to CO_2 removal from the reaction between silicates and $CaCO_3$, which produces calcium silicates and CO_2. They argue that the weight loss in the range of 400-900 ^{o}C should be taken for the calculation of the $CaCO_3$ content.

It is fairly simple to calculate the proportion of $CaCO_3$ within the plaster from the measurement of CO_2. Molecular weight of $CaCO_3$ is 100.09 and that of CaO is 56.08. Thus, the original mass of pure $CaCO_3$ loses 44.01 percent of its weight after it is completely decomposed. If weight loss of a specimen at a 600-900 ^{o}C range is either more or less than 44 percent, it means that the specimen contains materials other than calcite.

Case Study: Lime Plasters from Teotihuacan, Mexico

The samples for this study come from the Moon Pyramid, Teotihuacan, Mexico, which is the second largest structure in the city. The recent excavations directed by Saburo Sugiyama and Rubén Cabrera have revealed its architectural sequence, consisting of seven superimposed pyramids, denoted as Monuments 1 through 7, from the oldest to the most recent (Cabrera and Sugiyama 1999; Sugiyama 2004). For this study, lime plasters from Monuments 5 and 7 were chosen because their condition is relatively good and amenable to analysis. In total ten samples were analyzed: four from Monument 5 and six from Monument 7 (Figure 3).

We conducted TGA using a Setaram TG92 thermal analysis system at the LeRoy Eyring Center for Solid State Science (CSSS) at Arizona State University (http://www.asu.edu/clas/csss/csss/). First, the powdered samples (ca. 50 mg) were held for one hour at ambient temperature in a helium environment to establish the original sample weight. Next, the samples were heated at a rate of 4 ^{o}C per minute until a maximum temperature of 1100 ^{o}C is reached. The maximum temperature was maintained for ten minutes. The samples were then cooled at 20 ^{o}C/minute to 20 ^{o}C and held at 20 ^{o}C for one hour to establish the final weight loss.

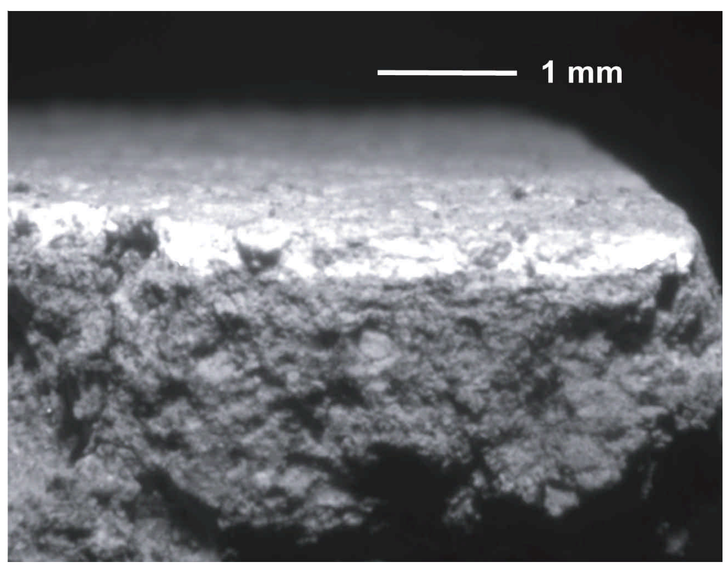

Figure 3. A thin layer of lime plaster on top of the clay mortar (Monument 5, Teotihuacan).

We also conducted *X*-ray diffraction (XRD) analysis on a subset of the samples for the identification of mineralogical composition. The samples include two from Monument 5 and two from Monument 7. The analysis was conducted at the Department of Chemistry and Biochemistry, ASU, using a Rigaku D/MAX-IIB *X*-ray diffractometer. Scans were done for 2? = 5° to 90° and with steps of 0.02 °/s. Samples were ground into powders for the analysis.

Results and Discussion

XRD analysis detected only pure calcite for all the samples except for a floor sample of Monument 7, which contains other minerals including albite and amphiboles. Our samples have a high $CaCO_3$ content, and little other material is left to be detected by XRD. Goren and Goldberg (1991) proposed processing the samples in dilute HCL and analyzing the residues through XRD in order to gain more information on the composition of non-carbonate contributions to the samples. However, since the amount of our plaster samples was limited, we left this analysis until more samples can be obtained. The non-carbonate components of the samples were likely used as tempering materials within the lime matrix.

Based on the results of TGA, the proportion of $CaCO_3$ was calculated for each sample (Figure 4). These results clearly show two distinct patterns of change in the composition of lime plasters. First, for both Monuments 5 and 7, plasters from walls contain a higher proportion of $CaCO_3$ than those from floors. The second pattern is a decrease of the proportion of calcite over time. Plasters of Monument 5 have a higher proportion of $CaCO_3$ than those of Monument 7 when compared floor to floor and wall to wall.

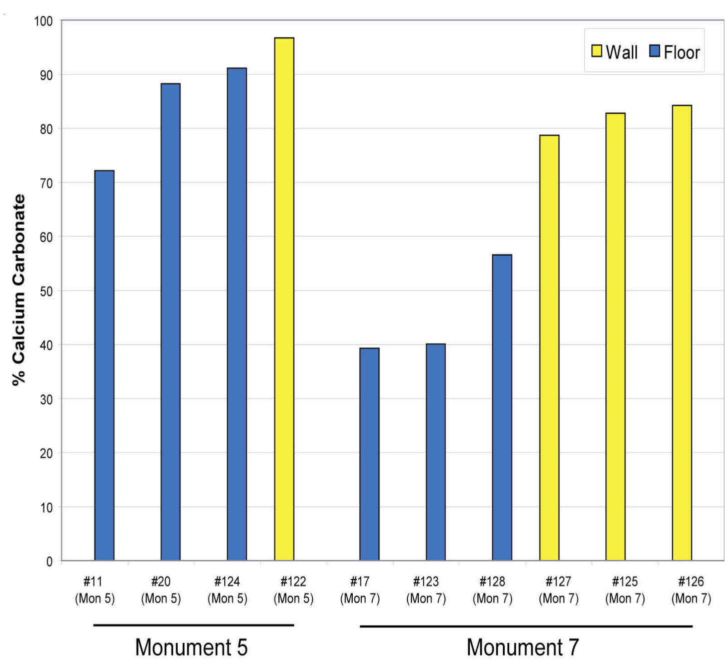

Figure 4. The proportion of calcium carbonate within the lime plaster samples from Monuments 5 and 7 of the Moon Pyramid, Teotihuacan.

From the examination of the TG and DTG curves, we noticed that all the samples have the same pattern except for three floor samples from Monument 7 (Figure 5). The majority of the samples start releasing CO_2 at 600-650 °C with its peak at around 750 °C and the reaction completes at 800 °C, as seen in Figure 5a. The slight weight loss observed on the TG curve before ~600 °C may be associated with very low levels of dehydration/dehydroxylation. Monument 7 floor samples also share the general characteristics of this pattern. However, they also exhibit slow, but substantial and continuous weight loss on the TG curve that starts below 100 °C, as seen in Figure 5b. XRD on one of these samples detected amphiboles that contain hydroxyls (OH groups). It is possible that a low level of sample dehydration along with dehydroxylation of these hydroxyls occurred up to ~500-600 °C, although dehydroxylation of these minerals usually takes place at much higher temperatures. Also, it is possible that the samples contain soluble salts although no salts were observed in the XRD patterns. Further research is necessary to clarify this point.

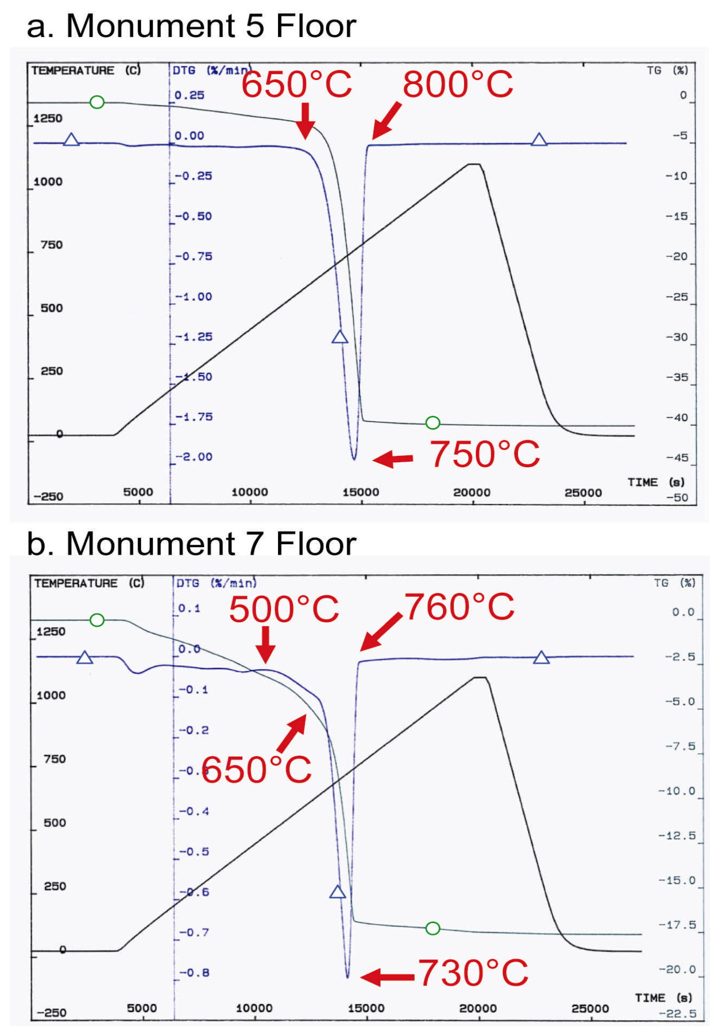

Figure 5. Comparison of TG and DTG curves for samples from Monument 5 (a) and Monument 7 (b). Note that very little weight change occurs on sample cooling. This is indicative of the low-level of error associated with the buoyancy effect when helium is used as the carrier gas for TGA.

Conclusion

This article has shown that TGA is a useful tool for characterizing the composition of lime plaster. The application of TGA on pure lime plaster is fairly simple and the quantification of $CaCO_3$ helps define temporal and spatial variability in the lime plaster production. One of the limitations of TGA of lime plaster is that it is difficult to distinguish lime used as binder and crushed limestone used as aggregate (cf. Bakolas et al. 1995). In the case of the Moon Pyramid samples, few crushed limestone fragments are identified, but plasters from other regions of Mesoamerica, especially the Maya area, contain crushed limestone as an aggregate (Hansen 2000), although TGA is still useful for quantifying non-carbonate components of lime plaster. Through combining with other kinds of analysis such as XRD and thin section analysis, TGA studies of lime plaster hold potential value in studies of craft production and consistency of practices over the production processes.

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Variable Length-Scale Documentation of Stone Tool Microtopography to Determine Use

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For archaeologists studying stone tools used by past peoples, one main area of interest has been tool function. Consequently, archaeologists interested in lithic use-wear have increasingly focused on methods that emphasize objectively acquired, reproducible data (for example see Barcelo et al. 2001; Beyries et al. 1988; Bietti 1996; Christensen 1992; Gonzalzez-Urquillo and Ibanez-Estevez 2003; Grace 1989; Kimball et al. 1995; Rees et al. 1991; Šmit et al. 1999; Stemp and Stemp 2001, 2003; Vila and Gallart 1993). The ultimate goal of these methods is a successful transition from documenting use-wear on experimentally produced stone tools in controlled laboratory conditions to the reliable quantitative acquisition of use-wear information from lithic artifacts recovered from archaeological contexts.

The objective of these experiments is to determine the possibility of differentiating the uses of stone tools, based on contact material type, by a conventional height parameter and by a scale-based fractal characterization of measured profiles. The approach is to manufacture simple stone tools, wear them through contact with different materials, measure profiles from the used tools, and then compare the two kinds of profile analysis (height analysis and scale-sensitive fractal analysis by length-scale see Beyries et al. 1988) for their ability to differentiate the worn tools based on the contact materials.

Equipment and Profile Analysis

To measure surface microtopography, a laser profilometer, manufactured by Ulrich Breitmeier Messtechnik (UBM), was used (see Rees et al. 1991; Šmit et al. 1999 for a description of the equipment and its functional parameters). Line scans (profiles) of stone tool surfaces were taken to measure surface roughness over multiple length scales, which permitted the mathematical characterization of surface microtopography. To accomplish this, the conventional height parameter, root-mean-square (rms) roughness R_q was chosen. It is defined as the root mean square of the values of all heights of a given surface profile (ASME 2002). Before calculating R_q, the profile is filtered to remove the larger scale of the form of the object. The rms roughness is calculated about a mean line, (z=0), which is positioned in z to minimize the value of R_q.

$$R_q = \sqrt{\frac{1}{N}\sum_{n=1}^{N} z_n^2} \qquad \text{(ASME 2002)}$$

Since measured heights vary in a chaotic way and are distributed along a profile, the value of R_q should be expected to be dependent on the length of assessed measurement, as a larger assessment increases the chances of finding larger heights. Additionally, since R_q is based on a summation after filtering to remove form, for any given form, R_q is independent of the order in which the elevations on the profile are measured. Therefore, many profiles that are different can have similar R_q values. Any profile with about the same collection of heights, regardless of the order will have about the same R_q value. The lack of dependence of R_q on the order of heights presents problems in differentiating surfaces using R_q.

The application of length-scale analysis to the stone tool surface profiles was undertaken to provide a characterization parameter that depends on the order of the heights and on the spacing of the features. The relative length is the ratio of the calculated length (CL) of the profile divided by the nominal length (NL).

$$RL(s) = \frac{CL(s)}{NL} \qquad \text{(ASME 2002; Brown and Savary 1991)}$$

This analysis algorithm calculates the change in apparent, or calculated, length (CL) with respect to the scale of observation, or calculation (s), by a series of virtual tilings with line segments. The length of the line segment is the scale of calculation or observation (Figure 1).

The relative length can be shown to be related to the inclinations on the profile. It is a weighted average of the inverse of the cosine the line segment tile makes with the nominal horizontal, or datum, as shown below.

$$RL(s) = \sum_{i=1}^{N} \frac{1}{\cos\theta_i}\frac{p_i}{P} \qquad \text{(Brown et al. 1996)}$$

The relative lengths (RL(s)) from the profiles are subsequently compared statistically at each scale using the F-test (Lipson and Seth 1973) to establish a level of confidence for the differentiation at each scale represented in the measured profiles. The scales with a high level of confidence, indicated by the mean square ratio (MSR), are the scales at which the tools are differentiable. The supposition that fractals (Lipson and Seth 1973; Mandelbrot 1977) and, in particular, the scale-sensitive fractal analysis length-scale relations are less dependent on the assessed profile length was tested.

The relative lengths calculated from the profiles measured on each of the used tool surfaces were then subjected to a series of F-tests to determine whether tools worn in contact with different raw materials could be differentiated quantitatively. The F-test is used to determine whether two populations are differentiable based on the samples, their means and their standard deviations (Lipson and Seth 1973). It compares the variation within each sample to the variations between the samples making it possible to determine the level of confidence of finding the same difference from similar samples from the same populations.

Experimental Procedure

Two series of experiments documenting surface roughness were undertaken using the UBM profilometer to measure stone

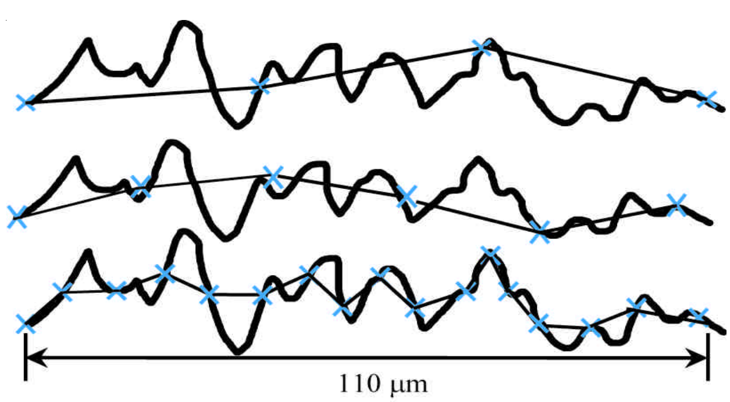

Figure 1. Length-scale analysis shown on a simulated profile. The profiles have with 3 (top), 5 (middle) and 16 (bottom) steps of 40, 25 and 10µm, providing calculated lengths of 120, 125 and 160µm and relative lengths of 1.091, 1.138 and 1.455 respectively.

flakes made from fine-grained East Anglian/Brandon flint. In the first series, four flint flakes were each used for 20 minutes on different contact materials (Tool #1.1: sawing queen conch shell, Tool #1.2: sawing sugar maple, Tool #1.3: sawing soaked deer antler, and Tool #1.4: scraping dry cow hide). Following use, the flakes were washed in hot water to remove any contact debris adhering to their surfaces, placed in a warm 15% HCl solution for 15 minutes, and then rinsed again in warm water. On all four flakes, surface line scans were taken parallel to the used edge of each tool. The parallel line scans were acquired from two different regions (A and B) on each used tool surface.

In the second series, the line scans on four flakes were performed parallel to the used edge of each tool in only one region. These flint flakes were also each used for 20 minutes, but on two different contact materials (Tool #2.1 and Tool #2.2: sawing conch shell, Tool #2.3 and Tool #2.4: sawing dry deer antler). Within the measurement distance of 2 mm, parallel profiles were measured in the selected regions of each stone tool surface to examine the variation of the rms surface roughness (R_q) over increasing evaluation lengths with incrementally greater distance from the used edge.

Experimental Results and Discussion

The rms surface roughness (R_q) values were calculated for all the measurements in terms of the means and standard deviations for each wear group, designated by contact material. In Table 1a, the mean rms roughness varies between 21.5 and 5.6 µm, and the stone tool surface used to work shell is more than twice as rough as any of the others based on the measured rms profiles. Note that some of the standard deviations are relatively large varying between about 35% and 77% of the means.

The results in Table 1b are distinctly different from Table 1a, even in the case of Tools #1.1 versus #2.1 and #2.2, when the tools are used on the same material (shell). The rms value for the profiles measured from the tool was used on shell in the first series is about five times greater than for those in the second. Based on the rms values, tools used on dry antler in the second series are most similar to the tool used on soaked antler from the first series. The standard deviations in the second series are smaller than those in the first, rising only to 31% of the mean.

The results of the F-test applied to the rms values are shown in Tables 2a and 2b for the first and second series, respectively. Each tool in each series is considered separately and compared with the others in the series. The minimum MSR (mean square ratio) values for 99% confidence are also shown in the legends with the tables. The results indicate that the rms is capable of differentiating four of the six tool pairs in the first series (Table 2a). The exceptions include the tools used on soaked antler from those used on shell and wood, which were not differentiable.

In the second series (Table 2b), none of the tools were differentiable. Therefore, it would be desirable to find a parameter that could differentiate the tools that were used on the different materials, and yet not differentiate, or at least not differentiate in the same way, the tools that were used on the same material. The failure to differentiate Tools #2.1 from #2.2 and Tools #2.3 from #2.4 in Table 2b is not bad; however, the failure to differentiate either of the tools used on shell from either of the tools used on antler is certainly of concern. Overall, the rms parameter performed satisfactorily on three out of six combinations in the second series.

An example of the relative lengths calculated as a function of scale is shown in Figure 2. The profiles were measured from the tools used on wood and antler. The plot shows that wood tends to have greater relative lengths, especially at scales below about 0.1mm. Note that at the large scales the relative lengths tend towards one. At these scales, the tiling is coarse enough to be insensitive to the texture details and therefore the

Table 1a. Means & standard deviations of rms (R_q) for the 1st series.

Contact material	Number of profiles	Mean rms (R_q) mm	Standard deviation of rms (R_q) mm
1.1 shell	23	0.0216	0.0133
1.2 wood	24	0.0095	0.0073
1.3 soaked antler	24	0.0056	0.0037
1.4 dry hide	24	0.0068	0.0024

Table 1b. Means & standard deviations of rms (R_q) for the 2nd series.

Contact material	Number of profiles	Mean rms (R_q) – mm	Standard deviation of rms (R_q) mm
2.1 shell	12	0.0043	0.0004
2.2 shell	12	0.0045	0.0014
2.3 dry antler	12	0.0040	0.0009
2.4 dry antler	12	0.0040	0.0012

Table 2a. First series MSRs from F-test for differentiation. The minimum required for 99% confidence is 5.087. Values below this minimum are shaded.

Material		Shell	Wood	Soaked Antler
	no.	*1.1*	*1.2*	*1.3*
Wood	*1.2*	5.368	------	------
Soaked Antler	*1.3*	2.898	1.784	------
Hide	*1.4*	16.795	34.272	30.817

Table 2b. Second series MSRs from F-test for differentiation. The minimum required for 99% confidence is 5.664. Values below this minimum are shaded.

Material		Shell	Shell	Dry Antler
	no.	*2.1*	*2.2*	*2.3*
Shell	*2.2*	0.121	------	------
Dry Antler	*2.3*	0.901	1.161	------
Dry Antler	*2.4*	1.000	1.082	0.0355

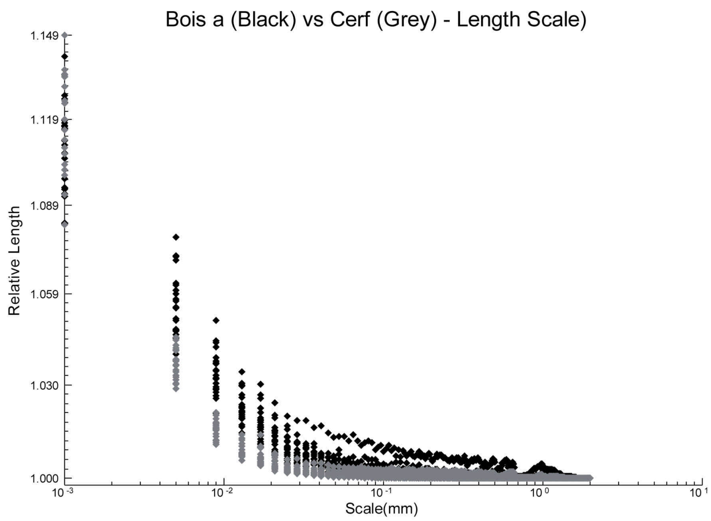

Figure 2. Length-scale plots showing the relative lengths as a function of scale for series one - wood (black) versus antlers (grey).

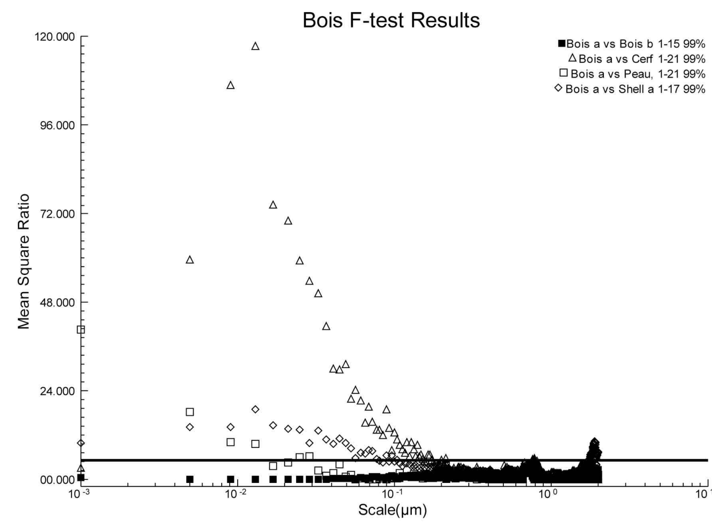

Figure 3. Results of the F-test for wood (bois).

surfaces are comparatively smooth. At finer scales, the relative lengths increase as do the differences in the relative lengths between the profiles.

A plot typical of the application of the F-test to the relative lengths at each scale in the first group is shown in Figure 3, providing the MSR for wood, measured in region A, resulting from a comparison with wood measured in location B, as well as the other surfaces compared with wood measured in region A. The horizontal line indicates the minimum MSR for 99% confidence. Figure 3 is typical of the F-test results of this type for series one. For all four of the tools used on the different materials in series one, when the two locations used on the same material are compared the MSRs never rise to the level of 99% confidence at any scale. Whereas the other comparisons with other tools all have MSRs that clearly rise above the 99% confidence level at some scales about 0.1mm. The heavy clusters of points that rise above the 99% confidence level at scales of about 1mm and above are in the regions where the relative lengths are nearly one and the surfaces are nearly smooth, so these are thought to be unimportant and have been ignored in this study.

A similar plot of the MSR as a function of scale for the second series is shown in Figure 4. Two kinds of comparisons are represented. The solid triangles show comparisons of the tools used on the same materials, whereas the open triangles are for comparisons between two sets of two tools used on different materials. There are two horizontal lines because the comparison between the two sets of tools has more measurements, resulting in a lower MSR for 99% confidence than when each tool is considered separately (solid triangles). Again, the large MSRs at scales around 1mm are thought to be unimportant. At the finer scales, the difference between the two sets of tools, one used on shell (coquille) and the other on antler (cerf), represented by the open triangles, generally shows better differentiability than the comparisons of the tools used on the same materials. This differentiability is at scales below about 0.07 mm. While the ranking changes at a scale of 0.005 mm, the difference is most distinct at a scale of 0.001 mm, coinciding with the y-axis, where the MSR for differentiating the two groups is 96. This ability of the relative lengths to consistently differentiate the tools used on different materials, while not differentiating the tools used on similar materials, indicates that it has good potential as a parameter for assisting in the determination of tool use.

Conclusion

These experiments demonstrated that the F-test could be used to determine whether samples from two populations of used stone tools were differentiable. The F-test applied to the rms values indicated that rms has an advantageous result in differentiating tools that were used on different materials, while not differentiating tools that were used on the same materials four out of nine times and two out of two times, respectively.

However, the F-tests applied to the relative lengths as a function of scale show that relative lengths are capable of differentiating worn tools according to the material they were used on in every case at some scales. The stone tool surfaces used on different contact materials demonstrated the greatest differentiation at smaller length scales, with the greatest confidence data consistently occurring below 0.1 mm. As length scale increased, the ability to differentiate between these tools decreased.

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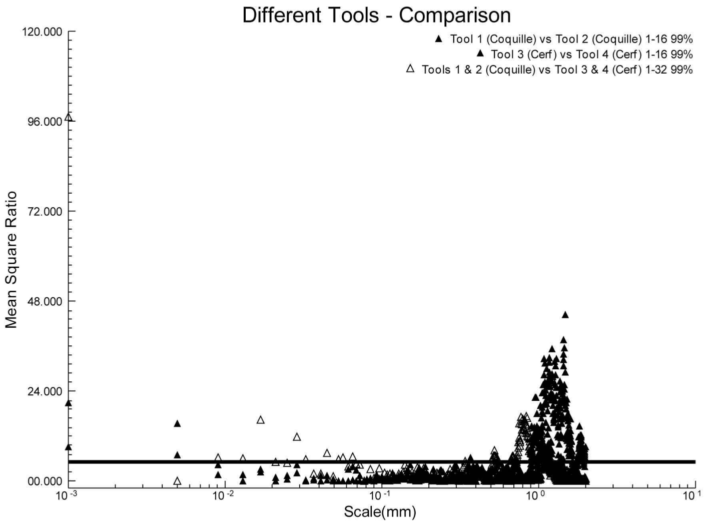

Figure 4 MSR from the F-test as a function of scale for the second series.

Lausanne, Switzerland for their contributions to and feedback on this research project. We would also like to acknowledge the assistance of Surfract, www.surfract.com in our work.

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Archaeological Chemistry

Nora Reber, Associate Editor

Hello, archaeological chemists (and friends)! Below is a quick run-through of news and events from around the world. If anyone has any suggestions, additions, or comments, please e-mail them to me at rebere@uncw.edu.

Upcoming

The 2007 24th Annual Visiting Scholar Conference at the Center for Archaeological Investigations at Southern Illinois University Carbondale will be March 23-24, and will be on the topic "The Archaeology of Anthropogenic Environments." Titles and abstracts (200-250 words) should be submitted by November 27, 2006 to Rebecca M. Dean, Center for Archaeological Investigations, Mail Code 4527, Southern Illinois University, Carbondale, Carbondale, Illinois 62901.

There has apparently been a change of date for The 2nd International Archaeometallurgy in Europe conference, which is now scheduled for 17-21 June, 2007, still in Grado and Aquileia, Italy. Titles and abstracts of papers are due by November 30, 2006. Topics covered will include mines, ancient ores and refractories, ancient slag, archaeometry, archaeomaterials, and conservation science. More information is available at the conference website: http://www.aimnet.it/archaeometallurgy2.htm.

The 6th World Archaeological Conference will take place 20-27 May 2007, in Jamaica. Session proposals will be accepted through December 31, 2006, and the deadline for individual paper submissions is February 28, 2007. For more information, visit the website at http://ehlt.flinders.edu.au/wac/site/confer_wac-6.php.

The ASMOSIA VII proceedings will be published as a supplement volume of the Bulletin de Correspondance Hellenique, vol. 51. The publication date is not yet available.

Recent Conferences

The British Organic Geochemistry meeting was June 28-29, at Open University in Milton Keynes, Britain. I have not been able to obtain a program or abstract list from this event—if anyone has a copy please send it to me!

Many of you probably attended the 36th Annual International Symposium on Archaeometry, May 2-6 in Quebec City, Quebec, and there are many too many talks of interest to cover in this article. The session on dating of organic and inorganic materials included papers on luminescence, ^{14}C dating of plasters and bones, tree-ring chronology, lead dating, amino acids in calcite, and synchronizing the Egyptian absolute and historic chronologies. The session on biomaterials, including DNA, diet, organic residue analysis, and agricultural archaeology was likewise of interest to many archaeological chemists, as were the sessions on technology and provenance of stone, pigments, and plaster, and the technology and provenance of ceramics and glass, with a focus on isotope studies in glass. The session on technology and provenance of metals covered an extensive range of metals studies from around the world.

The Archaeological Sciences of the Americas Symposium, 2006 took place on September 13-16. Since the conference focused primarily on archaeological chemistry, geochemistry, and geophysical techniques, there were many papers of interest to chemical archaeologists. Below are a few, but a full listing can be obtained at http://asas06.ltc.arizona.edu/. L. Barba, the keynote speaker, also presented on "Chemical residues in floors and domestic activities in Teotihuacan." Trace element analysis was covered by "Alimentary patterns in Teotihuacan people seen from trace elements," by R. Valadez Azua. There were a large number of papers on isotopic analysis, including "Beyond the climate versus culture polemic: re-evaluating Holocene human-river environment interactions using new ^{14}C database and meta-analysis methodologies," by M. Macklin, "^{87}SR/^{86}Sr sourcing of three tree species used in Anasazi Great House construction at Chaco Canyon, New Mexico: comparison and review," by A. Reynolds, N. English, and J.L. Betancourt, "Analysis of absorbed organic residues in prehistoric milling tools: case study from Central California," by T. Buonasera, "Sex, status, and stable isotopes in South America," by R. Tykot, "An examination of prehistoric residence change in Middle Horizon, Peru, using multiple isotopic analysis," by N. Slovak, and "Stable carbon and oxygen isotopes in pedogenic carbonate as paleoenvironmental indicators on the southern Colorado plateau for the Paleoindian and Archaic periods," by A. Kowler. "Toward the compound-specific dating of archaeological Maya Blue," by K. Duffy, G. Hodgins, and G. Chian was on the cutting-edge topic of compound-specific analysis. Other papers of interest include "Hohokam surfaces of habitation: chemical residues, social space analysis, and statistics," by S. Lopez Varela and C. Dore, "Chemical and paleoethnobotanical signatures for everyday life at ancient Chunchucmil, Yucatan, Mexico (400-600 A.D.)" by S. Hutson and R. Terry, "Ceramic provenance and community organization in the Uplands north of Phoenix," by A. Lack and D. Abbott, and "Using simple methods for field testing hydrophilic soluble salts in excavated ceramics and surrounding soil," by M. Emery, J. Johnson, J. Ravensloot, and L. Borstoff.

The 2nd International Symposium on Biomolecular Archaeology took place in Stockholm on September 6-8 of this year.. Food Production and Consumption, a session chaired by Julia Lee-Thorp, included papers on nitrogen isotopic fractionation by Noreen Tuross, milk detection through calcium isotopes, by Nan-chin Chu, Gideon Henderson and Robert Hedges, identification of perfumes in pottery by Val Steele and Ben Stern, identifying the transition to agriculture in southern Scandinavia by means of organic residue analysis, by Oliver E. Craig, Marcus Forster, Ben Stern, Soren H. Andersen, Eva Koch, Anders Fischer, Andrew Stott, and Carl P. Heron, and organic contribution into anthropogenic sediments in a Syrian tomb by Matthew A. James, Anna Mukherjee, Francesca Robertson, Peter Pfalzner, and Richard P. Evershed.

The session on Degradation/diagenesis, chaired by Matthew Collins, also had several talks of interest, as did the session on New Techniques, chaired by Anders Gotherstrom. This fascinating session included talks on "New developments in proteomics for the analysis of archaeological organic residues," by Caroline Solazzo and Christian Rolando, "New investigations into the *Pistacia* resin about the Ulu Burun shipwreck," by B. Stern, C. Heron, T. Tellefsen, and M. Serpico, "A comparative study of GC/C/IRMS and irm-LC/MS: implications for palaeodietary studies in archaeology," by Noah V. Honch, James S.O. McCullagh, and Robert Hedges, "Stable hydrogen isotopes and trophic levels in archaeological material," by Linda M. Reynard and Robert Hedges, and "Compound-specific determination of D values of animals for the reconstruction of ancient diet," by David Chivall, Nicola Brandon, Sebastian Payne, and Richard P. Evershed. This session ended with a six-person closing discussion.

Books

The release of the 2nd edition of *Archaeological Chemistry*, by Zvi Goffer and James D. Winefordner, originally set for July 28, 2006, has apparently been delayed until December 22, 2006. It includes a chapter on computer techniques in archaeological chemistry, and updates on techniques.

Physical Techniques in the Study of Art, Archaeology and Cultural Heritage, Volume 1, edited by David Bradley, was released on August 22, 2006. This volume is part of the series *Physical Techniques in the Study of Art, Archaeology* *and Cultural Heritage* published by Elsevier Science. It includes chapters on X-ray scattering applied to bone minerals and parchment, as well as kohl, and x-ray and neutron digital tomography.

An application of archaeological chemical techniques to the Mayan collapse is described in *Diet, Health, And Status Among the Pasion Maya: A Reappraisal of the Collapse* by Lori E. Wright, released on June 30, 2006. I haven't read it yet, but it looks like an interesting approach to the Classic collapse.

Histories of Maize: Multidisciplinary Approaches to the Prehistory, Linguistics, Biogeography, Domestication, and Evolution of Maize, edited by John Staller, Robert Tykot, and Bruce Benz was released on May 2, 2006. This is a really excellent reference on maize and maize science around the world, and has chapters applying archaeological chemistry to this topic, particularly in the section on "Stable isotope analysis and human diet." I have read this one, and can recommend it without reservation for maize-hounds.

For archaeological chemists interested in identifying microorganisms, a new resource was published last winter*: Identification of Microorganisms by Mass Spectrometry*, by Charles L. Wilkins, Jackson O. Lay, James D. Winefordner. This book covers a variety of analytical techniques in the identification of unknown microorganisms.

Archaeological Ceramics

Charles C. Kolb, Associate Editor

The column in this issue includes five topics**:** 1) Reviews of Books on Archaeological Ceramics; 2) New British Archaeological Reports, International Series-2006; 3) British Archaeological Reports, British Series-2000 to 2006; 4) FAMSI: Foundation for the Advancement of Mesoamerican Studies, Inc.: Recent Reports on Ceramics; and 5) Exhibitions.

Reviews of Books on Archaeological Ceramics

Judith A. Habicht-Mauche, Suzanne L. Eckert, and Deborah L. Huntley (editors), *The Social Life of Pots: Glaze Wares and Cultural Dynamics in the Southwest, AD 1250-1680*, Tucson: University of Arizona Press, 2006. xi + 324 pp., 28 line illustrations, 14 halftones, 25 tables, ISBN 978-0-8165-2457-0 (hardcover), $50.00. The papers in this volume, dedicated to Anna. O. Shepard, focus on glaze ceramics from the American Southwest, especially the Pueblo IV period (1275-1400 CE). These revised presentations derive from a Society for American Archaeology symposium, "The Social Life of Pots: Glaze Wares and Cultural Transformation in the Late Prehistoric Southwest," held in Denver in 2002 that brought together researchers who included graduate students, recent PhDs, and experienced ceramic specialists trained in a variety of analytical methodologies. Organizers Habicht-Mauche (University of California at Santa Cruz), Eckert (Texas A & M University), and Huntley (Southwest Archaeological Consultants, Santa Fe) enlisted Linda Cordell (University of Colorado Museum) and Miriam Stark (University of Hawai'i) as the symposium's discussants and their splendid written contributions are included in this edited volume. The main thrust of the collected presentations is to better understand Southwestern history and the migrations of peoples in the American Southwest through the technological analysis of a particular class of ceramics – glazed pots – which, in turn, sheds light on the social lives of Puebloan peoples of the thirteenth through seventeenth centuries. The research reported covers the entire chronological range of glaze ware production from the 13th century up to the Early Colonial period. The studies employ a variety of analytical techniques, including typological and stylistic, thin-section optical petrography, INAA, electron microprobe, and ICP-MS. Four of the chapters have a total of 13 endnotes (pp. 273-275) and there is a 511-item Bibliography, a list of contributors and their affiliations and e-mail addresses, several paragraphs about the editors, and a six-page double-column Index containing predominantly proper-nouns. Zuni (rather than Zuñi) is used throughout. *The Social Life of Pots*, although focusing on specific wares produced and distributed in a restricted geographic region and in a delimited time period, offers a great deal to researchers who deal with ceramics outside of the social landscape of the American Southwest from the 13th to 15th centuries. The editors and contributors demonstrate how research on ceramic technological and stylistic issues can lead to sociocultural inferences based on solid evidence. The papers examine inter- and intra-community dynamics, inter-regional exchange, migration, and changes in ideologies, provide a further baseline for continued and expanded research on glaze painted ceramics and other wares. This is a splendid book with especially cogent assessments by Stark and Cordell and strong editorship by Habicht-Mauche, Eckert, and Huntley. Anna Shepard would be pleased.

Eduardo Williams (editor), *Etnoarqueología: El contexto dinámico de la cultura material a través del tiempo*, El Colegio de Michoacán, Zamora. Michoacán, México, 2005; 309 pp., tables, illustrations, references cited; ISBN 970-679-165-5, $25.00 US. (Ordering information may be obtained at www.colmich.edu). This is a very significant monograph and will be an important contribution to the disciplines of archaeology, ethnohistory, ethnography, and history. Oriented to West and Central Mexico, the results presented and data assembled will have a significant impact on our understanding of past human culture in all of Mesoamerica and, indeed, the understanding of prehistoric and historic human culture throughout the world. Eduardo Williams is well known and highly regarded among his archaeological and anthropological colleagues in Mexico, the United States, and Europe. He is perceived as a thoughtful and meticulous scholar who has contributed (and continues to provide) salient research which contributes greatly to our understanding of the archaeology, ethnography, and especially the ethnoarchaeology of West Mexico and Mesoamerica in general. In this current research effort, Williams demonstrates his ability to collect a corpus of contributions on a very significant topic in current archaeological research. These papers are at the cutting-edge of current ethnoarchaeology and add immeasurably to our understanding of ancient processes and technologies whether these be the fabrication of pottery vessels, the production of salt, lake and lakeshore subsistence resources, fiber processing, or the manufacture of copper and bronze tinklers (cascabeles). The volume has an Introduction and eight chapters, each of having its own bibliography and these are illustrated profusely. Six chapters are strictly ethnoarchaeological in their presentation, and two have experimental archaeology as a basic organizing principle but also elucidate ethnoarchaeological topics. Each chapter has separate sets of references cited. Overall, there are 100 figures, 24 tables, and 417 references. Papers by Philip Arnold, Sandra López de Varela, Dorothy Hosler, and Dean Arnold focus on ceramics, while the chapter by Mary Hrones Parsons considers ceramic spindle whorls. Several of theses presentations were originally recently presented orally in Ceramic Ecology symposia at the American Anthropological Association annual meetings. These are splendid papers that are significant well beyond Mesoamérica and northern South America. Researchers interested in ethnoarchaeological problems, ceramic ecology, and other paradigms will find the presentations informative and essential reading. A few minor typos have crept into the references but are easily identified.

Beth Cohen, *The Colors of Clay: Special Techniques in Athenian Vases* (Los Angeles: J. Paul Getty Museum, 2006, 384 pages, 240 color and 57 b/w illustrations, 1 map, ISBN 0-89236-571-4, hardcover, $85.00. Art historians regard Greek vases are one of the world's finest ceramic traditions, and the Athenian vessels are especially valued as works of art and for the technical abilities of their creators. Even before a vase became a painted masterpiece, its graceful lines and elegant proportions made it a "masterpiece of form." This well-illustrated and highly descriptive catalogue documents a major exhibition at the Getty Villa (June 8 through September 4, 2006), that is the first ever to focus on 103 ancient Athenian terracotta vases made by techniques other than the well-known black- and red-figure styles between 550 and 340 BCE. The exhibition and catalog include ceramics executed in bilingual, coral-red gloss, outline, Kerch-style, white ground, and Six's technique, as well as examples with added clay and gilding, and plastic vases and additions. Most of these techniques were first developed around 525 BCE, an extraordinarily fertile period of experimentation in the Athenian pottery industry. The exhibition and catalogue present new insights gained by conservators and scientists into the methods and materials used by ancient vase makers. A few introductory remarks about the production process will provide a context. A three-stage firing process was essential to achieving the distinctive look of Athenian vases. Prior to firing, vase-painters painted the red-orange clay with a liquid clay slip, or clay-water mix. During the three-stage firing, the clay slip turned into shiny black gloss, coral-red gloss, or matte white, depending on the type of clay slip used. Vase-painters sometimes applied further decoration, including bright, colorful pigments and gilding, after firing. The volume is written primarily by Beth Cohen, a highly-regarded art historian who has published on classical Greek and Roman and Italian Renaissance art. Separate essays have been written by Marion True, Jeffrey Maish, Marie Svoboda, Susan Lansing-Maish, and Kenneth Lapatin (all of the J. Paul Getty Museum); Joan Mertens (Metropolitan Museum of Art, New York); and Dyfri Williams (British Museum, London).

David French (editor), *Canhasan Sites 2: Canhasan I: The Pottery* Monograph 32, Ankara: The British Institute at Ankara (distributed in the U.S. by The David Brown Book Co.), 2005, xvi + 293 pp. 204 figures, 10 plates, bibliography; ISBN 11-898249-16-4 hardcover, $90.00. Reviewed in *Bryn Mawr Classical Review* 2006.07.31 by Charles C. Kolb. The review may be accessed at http://ccat.sas.upenn.edu/bmcr/2006/2006-07-31.html.

New British Archaeological Reports, International Series (2006)

Marina Castoldi, con un contributo di Silvia Bruni e Vittoria Guglielmi, *La ceramica geometrica bicroma dell'Incoronata di Metaponto (scavi 1974-1995*). BAR S1474, 2006, ISBN 1 84171 7347. £36.00. A copy of the volume is not yet available for assessment.

Xiangming Dai, *Pottery Production, Settlement Patterns, and Development of Social Complexity in the Yuanqu Basin, North-Central China*, BAR S1502, 2006, viii + 129 pages; 79 figures, maps, plans, drawings and photographs; 18 tables; 8 Appendices including Gazetteer and data. ISBN 1 84171 939 0, £30.00. The author investigates the development of social complexity and the changes of modes of pottery production from the Neolithic to early Bronze Age in the Yuanqu Basin, north-central China. The research focuses on the development of specialized pottery production in different societies. Through settlement pattern studies, the author examines the social changes during eight cultural periods from the Neolithic to the early Bronze Age (ca. 6200-1300 B.C.). The settlement analyses address 46 sites, including seven excavated sites in the Yuanqu Basin. This study argues that the initial and low-level specialization might occur in the simple and non-stratified society, and the dramatic change in the mode of pottery production or the degree of specialization is not necessarily related to the emergence and development of chiefdom-level societies, but rather associated with the formation of state-level societies, as demonstrated by the Yuanqu case.

Kostalena Michelaki, *Household Ceramic Economies: Production and Consumption of Household Ceramics among the Maros Villagers of Bronze Age Hungary*, BAR S1503, 2006, xvi + 224 pages; 24 tables; 109 figures, maps, plans, drawings and photographs, 4 appendices. ISBN 1 84171 9331. £40.00. The author examines the interrelationships between technology and society, using as its cultural-historical focus the Early and Middle Bronze Age periods among the Maros group villages of south-eastern Hungary. She notes that claiming that technology has a social foundation is not a new paradigm and that documenting it has proven difficult. Her research, using archaeological ceramics, provides this documentation. The author's emphasis is on technological activities and the human actors who performed them. Practice theory, with its focus on conscious social actors, provides the major theoretical direction. Methodologically, she examines a wide range of ceramic technological activities, embracing the concept of the 'operational sequence' (chaîne opératoire), following ceramics from the procurement and preparation of raw materials, through their forming, finishing and firing, to their use. From the potter's perspective, attempts to understand the choices made at each step of the production sequence and consider the ways in which they could have organized their labor. Michelaki employs methodologies borrowed from archaeology, geology and materials science in this research.

Alex Gibson (editor), *Prehistoric Pottery: Some Recent Research*. BAR S1509, 2006. vi + 116 pages; illustrated throughout. ISBN 1841719439. £30.00. In October 2004, more than 70 delegates met in the Department of Archaeological Sciences at the University of Bradford for the second International Conference on Prehistoric Ceramics. The conference was the second major biannual conference to be organized by the Prehistoric Ceramics Research Group. The call for papers for this meeting was deliberately broad in its scope – recent research – and such is the amount of work currently taking place on prehistoric ceramics across Europe (and further afield). The papers were selected to stimulate further research and cross conventional theoretical and methodological boundaries. The ten papers are: "The Origin of Graphic Modes of Pottery Decoration" (Yuri B. Tsetlin); "Pottery Deposition at Hambledon Hill" (Frances Healy); "Exchange and Art: Ceramics and Society in the Early Chalcolithic of Central Anatolia" (Jonathan Last and Catriona Gibson); "Organic Pigments in Pottery Decoration of Early Agrarian Cultures in the Vistula Drainage: 4th-3rd Millennium BC" (Aleksander Koœko, Jerzy Langer, Sawomir Pietrzak, and Marzena Szmyt); "Bell Beaker Gendered Cups in Central Europe" (Jan Turek); "Report on the University of Bradford Pilot Project into the Absorbed Residue Analysis of Bronze Age Pigmy Cups from Scotland, England and Wales (Alex Gibson and Ben Stern); "Holes: A Review of the Interpretation of Vessels with one or more Extra Holes from the Late Bronze Age and Iron Age in South Scandinavia" (Ole Stilborg); "The San Giovenale Pottery: Production and Raw Material" (Anders Lindahl, Embaie Ferrow, Daniel Fuglesang and Pia Sköld); and "Feasting in Later Iron Age and Early Roman Britain: A Ceramic Approach" (Sarah Ralph).

David V. Hill, *The Materials and Technology of Glazed Ceramics from the Deh Luran Plain, Southwestern Iran: A Study in Innovation.* BAR S1511, 2006, ISBN: 1841717460. £41.00. A copy of the volume is not yet available for assessment.

David R. M. Gaimster, *Studies in Contemporary and Historical Archaeology 1: The Historical Archaeology of Pottery. Supply and Demand in the Lower Rhineland, AD 1400-1800: An archaeological study of ceramic production, distribution and use in the city of Duisburg and its hinterland*, BAR S1518 2006, ISBN 1841719528. £37.00. 270 pages; 131 figures, maps, plans, drawings, graphs and tables. Eight dataset Appendices. This study of post-medieval ceramic production and consumption in the Lower Rhineland is prefaced by a survey of previous work and approaches in the field. With the initiation of large-scale urban excavations in the Lower Rhineland during the 1980s, particularly in the town of Duisburg, an extensive sequence of pottery has been recovered dating from ca.1400 to 1800, enabling archaeologists, for the first time, to re-examine traditional chronologies, attributions, and socio-economic interpretations. This survey comprises 95 individual assemblages of pottery from sites excavated in Duisburg and from towns and rural sites in the region. *Studies in Contemporary and Historical Archaeology* is a new series of edited and single-authored volumes intended to make available current work on the archaeology of the recent and contemporary past. The series brings together contributions from academic historical archaeologists, professional archaeologists and practitioners from cognate disciplines who are engaged with archaeological material and practices.

British Archaeological Reports, British Series (2000-2006)

C. Jane Evans, Laurence Jones and Peter Ellis, *Birmingham University Field Archaeology Unit Monograph Series 2: Severn Valley Ware Production at Newland Hopfields Excavation of a Romano-British kiln site at North End Farm, Great Malvern, Worcestershire in 1992 and 1994*, BAR 313, ISBN 1841712043. £27.00. 88 pages, 47 figures, 8 plates. This report presents the results of two campaigns of Romano-British archaeological investigation at Newland Hopfields, and makes a significant contribution to studies at a local, regional, and national level. It is not only the first Severn Valley ware production site to be explored in such detail, but it is also one of the few Romano-British pottery production sites generally for which this level of information has been gathered.

Chris Butler and Malcolm Lyne, *The Roman Pottery Production Site at Wickham Barn, Chiltington, East Sussex*, BAR 323, 2001, ISBN 1841712426. £24.00. viii + 98 pages, 40 figures, 22 photographs. The excavations undertaken at Chiltington in East Sussex revealed two Roman pottery kilns, as well as remains from prehistory and from medieval period. The kilns are well documented, and all the finds were examined and catalogued. Three phases were identified. The pottery produced on the site indicates a strong New Forest influence.

Rick Peterson, *Neolithic Pottery from Wales Traditions of construction and use,* BAR 344, 2003, ISBN 1841714801. £36.00. viii + 211 pages; 144 figures, maps, plans, drawings, photographs, tables, graphs. This work employs what is known about the Neolithic (4000-2400 BC) pottery of Wales to create a history of the meaning and use of that material. In a thought-provoking and original first section, the author deals with some aspects of the history of archaeology, philosophy and science, and attempts to draw these ideas together into a methodology suited to explaining the pottery of Neolithic Wales. The second section employs this methodology to tell the story of the pottery, studying examples from Llugwy in Anglesey to Tinkinswood on the Glamorgan coast. The work concludes with two detailed Appendices presenting radiocarbon dates.

S. Paul Jung Jr., edited by David A. Higgins, *The Archaeology of the Clay Tobacco Pipe XVII. Pollocks of Manchester: Three Generations of Clay Tobacco Pipemakers*, BAR 352, 2003, ISBN 184171528X. £47.00. viii + 390 pages; 191 figures, drawings, illustrations and photographs. This volume in the BAR series *The Archaeology of the Clay Tobacco Pipe*, is the first to be devoted entirely to the history and products of a single firm. When Edward Pollock opened his pipe works in Manchester in 1879, he laid the foundations of a family business that was to flourish for three generations. The company passed from father to son for 111 years until 1990 when Edward's grandson, Gordon, finally sold the business. During this time, a great deal of archive paperwork and old stock accumulated and it is this material that has allowed the author to provide one of the most detailed records of a pipemaking family and their factory ever published. The book includes dozens of illustrations and photographs showing the family, manufacturing process, pipes, advertising material and letterheads from the archives, and will provide a mine of information of relevance to a variety of different audiences. For archaeologists, museum curators and collectors there are illustrations and dating evidence for the various marks and patterns of pipe that were used by three of the main Manchester firms. For industrial historians, practical potters or those with a technical interest there are detailed accounts of the manufacturing and firing processes. For social and economic historians there is information on production figures, pay and labour conditions, trade unions and manufacturing costs. For genealogists and local historians there are details of how the family was intimately connected with the business, the names of employees who worked at the factory, and a mass of dated correspondence with other companies and individuals from all over the country – transcribed with examples of printed letterheads. Above all, this work addresses the nature and evolution of traditional pipe making during the course of the twentieth century, a period that has hitherto received very little attention. This book makes a significant and lasting contribution to our understanding of the clay tobacco pipe industry and provides a detailed case study from which broader comparisons, both geographical and temporal, can be made.

S. D. White, edited by Peter Davey and David A. Higgins, *The Archaeology of the Clay Tobacco Pipe XVIII. The Dynamics of Regionalisation and Trade: Yorkshire Clay Tobacco Pipes c1600-1800*, BAR 374, 2004, ISBN 1841716294. £54.00. xiii + 567 pages; 283 figures, maps, plans, plates and drawings; 54 tables. As early as the eighteenth century, clay tobacco pipes attracted the attention of antiquaries. In more recent years clay tobacco pipes have proved to be one of the most useful artefact types that an archaeologist can recover from a Post-Medieval site. They spanned class and gender being smoked by men and women from all walks for life, and, as such, are seen by many scholars as the 'ideal type fossil' for the period 1600 to 1900. 1979 saw the establishment of the research series, *The Archaeology of the Clay Tobacco Pipe*, which was seen as a quick means of publishing new archaeological research. Since 1979 seventeen volumes in this series have been published by British Archaeological Reports of Oxford. In this latest volume Susan White has chosen the historic English county of Yorkshire to explore questions such as: whether it is possible to define a style of pipe that is typical of a given study area? Is it possible to define products of individual centres within a given study area? Can trade dynamics of production centres within a given study area be assessed? Can the influence of external production centres be assessed? And if patterns can be identified, to what extent can they be explained from the historic record? Yorkshire was seen as an original and highly interesting area for research (particularly with regard to regionalisation and trade) as it is large enough for economic variables to come into play, yet small enough for evidence to be fully recorded at a reasonably detailed level. The work comprises ten chapters and a discussion of findings and proposals for future research. The three Appendices feature a list of Yorkshire pipe makers, transcriptions of selected wills, inventories and other documents relating to Yorkshire pipe makers, and summaries of collections.

Peter Warry, *Tegulae: Manufacture, typology and use in Roman Britain*, BAR 417, 2006, ISBN 1841719560. £34.00. 167 pages; 126 figures, maps, plans and drawings; 114 plates. Appendices with 5 datasets. Ceramic building material, particularly roofing material, is one of the most common finds on Romano-British sites, yet despite its abundance, it has been relatively little studied. Whole books have been devoted to relatively minor pottery types, but it is extremely rare for a book to devote as much as a single chapter to ceramic roofing material. This book is devoted to the study of ceramic roofing material, primarily tegulae. The author considers how they were made and develops and dates a typology. He examines the role of stamps and signatures and how these can inform the study of when and by whom the tegulae were made. Warry also analyses how the tiles were fitted onto pitched roofs, how these roofs were constructed and proposes four stages in their evolution. He suggests that tegulae might also have been used on some vaulted roofs. Finally the logistics, costs and economics of tile manufacture and distribution are addressed. The book follows a logical sequence considering how tegulae were manufactured, their typology and their dating in order to prepare the ground for the subsequent chapters on stamps and roof construction. The final chapter brings all the evidence together to examine the economic and social data that can be derived from a study of tegulae, grouped together as a single site. In contrast, where a useful assemblage of tiles has come from an individual site within a town, this has been identified separately from other assemblages within the same town. If these separate assemblages within the same towns are aggregated together then the number of individual sites falls from 104 to 85.

FAMSI: Foundation for the Advancement of Mesoamerican Studies, Inc.): Recent Reports on Ceramics

Recent reports available online include: Elin C. Danien (University of Pennsylvania Museum) "Paintings of Maya Pottery: The Art and Career of M. Louise Baker." http://www.famsi.org/reports/03029/index.html. Christina M. Elson (American Museum of Natural History), with contributions by Deborah Nichols (Dartmouth College), and Leslie G. Cecil and Michael D. Glascock (Missouri Research Reactor) "Aztec Elites and the Post Classic Economy: Instrumental Neutron Activation Analysis (INAA) of Museum Collections from Chiconautla, Mexico." http://www.famsi.org/reports/03019/index.html. Bradley E. Ensor (Eastern Michigan University) "Late Classic–Epi-Classic Ceramic Chronology at Islas de Los Cerros, Tabasco, México." http://www.famsi.org/reports/05024/index.html. Arturo René Muñoz (University of Arizona) "La Secuencia Cerámica de Piedras Negras, Guatemala: Tipos y Variedades." Spanish Version. http://www.famsi.org/reports/02055es/index.html. Eduardo J. Pérez de Heredia (cozuvice@yahoo.com) "Puente Chen K'u: La Cerámica del Cenote Sagrado de Chichén Itzá, Estudio de los Fragmentos Cerámicos de las Exploraciones de los Años Sesentas." Spanish Version. http://www.famsi.org/reports/97061es/section08.htm. Mónica Alejandra Pérez Galindo "Colección Dieseldorff: Corpus de cerámica del Clásico Terminal proveniente de Moldes." http://www.famsi.org/reports/03074es/index.html.

Exhibitions

Gifts of the Monkey Gods: Maya Crafts from Guatemala is an exhibition at the Museum of Anthropology, Wake Forest University, Winston-Salem, North Carolina 27109 from September 12 to December 15, 2006. Familiar to most people because of television specials and magazine articles about their Classic civilization and its mysterious tenth century collapse, the Maya people have not disappeared. Millions continue to live in twenty-first century Mexico and Central America. The Maya core area has always been Guatemala, where the people managed to preserve their culture in the face of the Spanish conquest, creation of an independent country, recent civil war, and the modern world. This new exhibit presents intriguing wooden masks, spectacular hand-woven clothing, delightful wooden sculptures, and other crafts made in Guatemala during the last century. Contemporary ceramics are included in the exhibit. Inspiration from the Monkey Gods, supernatural patrons of artisans during the Classic period, permeates the Maya works on display. On the first day of the exhibit, September 12, an opening lecture entitled "New Discoveries in the Maya World" was presented at the Museum by George Stuart of the Center for Maya Research. He discussed ancient Maya cosmology and religion and their relationships with modern Maya beliefs.

Parades: Freer Ceramics Installed by Gwyn Hanssen Pigott. The Freer Gallery in Washington, DC is the venue for an exhibition of Australian ceramic artist Gwyn Hanssen Pigott's seven "parades" of Chinese, Korean, Japanese, and Near Eastern vessels. The exhibition, which runs from November 4, 2006 to November 2007, focuses on color, form, and pattern rather than chronology and provenience.

Book Reviews

Stacey N. Lengyel, Associate Editor

Archaeology of the Middle Green River Region, Kentucky. William H. Marquardt and Patty Jo Watson (editors), University Press of Florida, Gainesville, 2005. xxii + 657 pp., 242 figures, 172 tables, index, pocket material. Price: $65.00 (cloth). ISBN 1-881448-14-2.

Reviewed by Scott W. Hammerstedt, Department of Anthropology, The Pennsylvania State University, 409 Carpenter Building, University Park, PA 16802 USA

This volume is a comprehensive presentation of nearly thirty years of research by the Shell Mound Archaic Project (SMAP) in the Big Bend region of western Kentucky, with a special focus on the Carlston Annis mound (15BT5). Begun by the editors in the early 1970s, the SMAP has involved multiple generations of archaeologists at many universities. While some aspects of this research have been published in piecemeal fashion over the years, the compilation of all data in one volume is welcome. The re-evaluation of Works Progress Administration (WPA) collections, combined with new fieldwork, is of great value. The result is a clear example of the importance of multidisciplinary research to archaeology and a model of excellence that should be emulated by future scholars.

The book is divided into three sections. Part 1 provides a history of the Big Bend (Watson and Marquardt) as well as a timeline for SMAP fieldwork (Marquardt and Watson). Also presented are reconstructions of the local environment (Stein) and a cross-cultural study of shell middens (May). This section serves to introduce the reader to both the local people and the area in which they live. The SMAP researchers were embraced whole-heartedly by the local community, many of whom were witnesses to earlier archaeological investigations by the WPA and, in one case, Clarence B. Moore. Of particular interest is the chapter by Stein that discusses the unique geology and hydrology of the Green River and its effect on site locations.

Part 2 presents the data generated during the project. This includes a discussion of the SMAP excavation strategy (Marquardt and Watson), site formation processes (Stein, Gorski, May), plant remains (Crawford, Wagner), shellfish (Baerreis, Patch, Claasen), faunal remains (Crothers, Glore, White), lithics (Marquardt), chert resources (Gatus), and demography and osteology (Mensforth, Ward, Belovich). While space does not permit me to discuss each in detail, the chapters in this section complement each other nicely and provide detailed information that will be of great value to researchers. The section closes with a detailed summary and comparison of both WPA-era and recent analyses of Middle Green River sites (Watson). Watson's chapter draws on the preceding analyses as well as scattered information from WPA reports at eight Green River sites. The value of the chapter lies in the presentation of numerous summary tables of burial and skeletal data that will make future studies in the region much easier.

Part 3 provides a summary of research on the Green River and suggests avenues for future work (Marquardt and Watson). It addresses the research questions that the SMAP was designed to answer and the relative successes and failures of the project to do so. People are brought into the equation, and the Green River Archaic is placed in the broader context of hunter-gatherer complexity and organization.

The book is clearly organized and easy to navigate despite its gargantuan size. This allows readers interested in obtaining information about specific aspects of the project to navigate the volume easily. Editors' introductions for each chapter provide a summary of what is to come and place the chapter into context with respect to the project as a whole. Tables and figures are clear, informative, and easy to understand. The only issue that I have is that some of the chapters, originally written in the 1980s, have not been updated. However, this was a conscious decision by the editors and does not detract from the interpretations made by the individual authors (who in some cases are deceased). Some may question the decision to place all the data in text form rather than in the increasingly popular book and CD package. Certainly, this approach would have resulted in a slimmer volume. The authors anticipate this criticism (p. xx) and justify their decision by expressing concerns over the permanence of digital data storage, respect for the work of the various authors, and the importance that the Green River Archaic has had to the development of North American archaeology.

Archaeology of the Middle Green River Region, Kentucky is a classic example of how a multidisciplinary archaeological project should be carried out. Members of the SMAP have worked hard to build a strong and lasting relationship with the current occupants of the Big Bend. As a result, current and future archaeologists working in this area (including myself) have a local community that is both interested in and passionate about archaeological work, and we are indebted to Marquardt, Watson, and their colleagues for their efforts. This research shows that WPA-era collections, despite their limitations, still have great utility to modern archaeologists using new techniques. The combination of history, geoarchaeology, osteology, and detailed artifact analysis makes this a volume that will remain important for many years to come.

People of the Shoals: Stallings Culture of the Savannah River Valley. Kenneth Sassaman, University Press of Florida: Gainesville, 2006. xxi + 194 pp., 53 figures, index. Price: $39.95. ISBN: 0-8130-2945-7.

Reviewed by Victor D. Thompson, Department of Anthropology, Building 13 Room 131 University of West Florida, Pensacola, Florida 32514, USA

The shelves of local big chain bookstores abound with popular accounts of the Maya, the Aztec, the Egyptians, and other, similarly, well-known peoples of the past. Lacking amongst these books are the accounts of the literally thousands of less well-known archaeological cultures. In particular, popular accounts of hunter-gatherer groups were seemingly non-existent until Jon Gibson's book *The Ancient Mounds of Poverty Point: Place of Rings* (University Press of Florida, Gainesville) was published in 2000. Perhaps the reason for this is that these groups are viewed as being less complex, and therefore less interesting to the public. Sassaman's book, *People of the Shoals*, shows this simply to be a fallacy. Sassaman's book provides a detailed account of the hunter-gatherer groups that inhabited the Savannah River Valley of Georgia some 4000 years ago. While lacking divine kings and stone pyramids, Sassaman shows that these are not needed to possess a complex and rich history, where people actively created their own destinies.

What struck me most about Sassaman's book was the tone of the work. It is reminiscent of the once standard ethnography that dominated anthropology for much of the 20th century. In fact, one might even call it an archaeological ethnography. Sassaman's reconstruction centers on "Stallings Culture," or the "People of the Shoals." The seven wonderfully illustrated chapters that comprise the book provide details on Stallings origins (ch. 1 and 2), their interaction with other ethnic groups (ch. 3), their technology and kinship (ch. 4), subsistence systems (ch. 5), political economy (ch. 6), and ultimately their fate (ch. 7). In these pages, we are given an intimate description of the life of the hunter-gatherer people who were the first to adopt pottery in their region. Simultaneously, Sassaman places theses groups in a larger context by describing their role in the culturally diverse landscape that was the Southeastern United States during the Late Archaic Period.

One of the great difficulties in writing for the general public is providing a primer for the archaeological concepts and history that most professionals take for granted. To this end, Sassaman does a wonderful job. Indeed, this may be one of the greatest contributions of the entire book. Throughout, Sassaman deftly weaves into his account complex anthropological concepts such as sedentism, post-marital residence patterns, critiques of social evolution, optimal foraging, history, agency, and structure to name but a few. Building on these ideas, he shows how these concepts are linked to archaeological inquiry. Specifically, he provides an excellent description of the link between his ideas and the scientific techniques that he uses to explore them. As he does with the theoretical points of his discussion, Sassaman provides a simplified, yet sophisticated, explanation of the scientific methods he used to collect the data that is ultimately behind this reconstruction.

Sassaman's book is based on more than 20 years of research in the region. It is no doubt that many archaeologists, especially those working in the area, will question some of Sassaman's interpretations. After all, this is the case with most archaeological research. While one of the most prolific researchers in Southeastern archaeology with numerous research reports, articles, books, and book chapters to his credit, some of the data used to reconstruct the history of the Savannah River Valley is so new that it is yet to be published in more traditional academic formats. This makes evaluating some of the arguments in this book difficult; however, this does not really detract from the book overall as it is not intended to be a comprehensive analysis with all the minute details of research written for academe. In the introduction, Sassaman reflects that he possibly should have waited until after the academic accounts were published to write the popular account. This begs the question if it is more important to publish first for the academic community. Obviously, there is a need for both academic and popular writing; however, few of us take the time to do the latter. Additionally, few academic institutions reward such work in terms of tenure and promotion. Sassaman is to be applauded for writing the popular account; the academic reports and papers will be published soon enough.

My one complaint about the book is that there are no citations within the text and there is only a list of references for further reading. This is a requirement of the Press, as I have noticed other books within the same series do likewise. While I understand the rationale that citations are not critical for a popular book, I think it is a mistake to assume that educated readers do not want them or that somehow they detract from the flow of the book. At the very least, a full bibliography should be included at the end of the book.

In general, Sassaman's book offers some provocative new ideas on Holocene hunter-gatherers. Indeed, it will serve as an inspiration for young (and old) archaeologists to further investigate the lives and developmental histories of these people. This stands in marked contrast to a recent edited volume where one of the authors lamented that the Archaic period datasets of his region are, "an essentially boring situation in which, as far as I can tell, only those devoted to the investigation of minutiae could be interested" (O. H. Prufer in *Archaic Transitions in Ohio and Kentucky Prehistory*, edited by O. H. Prufer et al., Kent State University Press, Kent, Ohio; p. 195). Too often, budding archaeologists are pulled in by the rich and obvious datasets that come with societies who frequently built monumental architecture and had institutionalized leaders. Sassaman shows us that, with a bit of creativity and a commitment to develop innovative scientific methods, these more elusive histories can be revealed.

This book belongs on the shelf and on the class syllabus right beside the popular works of Brian Fagan. It is a synthesis meant to impart an understanding of people and culture long since lost to the world and only known through the scattered remains left thousands of years ago. Sassaman has taken up the challenge to present a dynamic history of these people and succeeded. If we are to keep archaeology relevant in the 21st century, we need more books like *People of the Shoals* not only to illustrate the diversity of the past, but to explain the ever changing way archaeologists go about investigating that past and its meaning for us today.

Practical and Theoretical Geoarchaeology. Paul Goldberg and Richard I. Macphail, Blackwell Publishing: Malden, MA, USA, 2006. xii + 455 pp., 262 illustrations, appendices, index. Price: $64.95 (paper). ISBN: 0-632-06044-1.

Reviewed by Andrea K. L. Freeman, Department of Archaeology & Earth Science Program, University of Calgary, 2500 University Drive NW, Calgary, AB T2L 0B1 Canada

Over the past decade, I've had the opportunity to discuss with colleagues the challenges of teaching geoarchaeology in the classroom. Several authors have attempted to fill the needs of the college classroom by offering books on the subject.

Some of these, like Waters' *Principles of Geoarchaeology,* are restricted in subject coverage, focusing only on certain aspects of the field (such as geomorphology and stratigraphy). Others, such as Rapp and Hill's *Geoarchaeology: The Earth Science Approach to Archaeological Interpretation*, cover the field more broadly, but at an introductory level. Goldberg's previous offering (with Holliday and Ferring), *Earth Sciences and Archaeology*, an edited volume, offers sophisticated essays on a wide range of topics in the field; however, these essays are bound largely (with some notable exceptions) by the research interests of each essay's author and generally extend quite far beyond the cognitive capabilities of inexperienced undergraduates.

In this latest effort, Goldberg and Macphail attempt to bridge the gap between elementary methods and some of the more sophisticated or "theoretical" concepts in the field of geoarchaeology. They propose that this book serve as a "basic text" for advanced undergraduates and postgraduate students interested in the field of geoarchaeology. Because the undergraduate experience will vary among universities, instructors seeking texts should be aware of the background of their students; however, I would agree that the overall goals of the book are right on target. In this review, I will focus on the potential application of this text in the college classroom.

Practical and Theoretical Geoarchaeology is divided into three parts. The first section, titled "Regional Scale Geoarchaeology" deals predominantly with the basic concepts necessary for any geoarchaeologist dealing with geomorphology, sedimentology, soils, and stratigraphy. Many of the concepts are explained in greater detail in Waters' *Principles of Geoarchaeology* or in introductory tests in each of the cited fields of study.

What makes the contribution of Goldberg and Macphail unique is the way in which the authors connect these concepts with the goals of geoarchaeology. For example, in the chapter on soils (ch. 3), the authors discuss a variety of soil forming factors, such as solifluction and acidity. They then relate the impact of these processes on soils and on archaeological resources. I use this same technique in my undergraduate *Fundamentals of Geoarchaeology* course.

In Part I, as elsewhere throughout the book, the authors include some discussion of fundamental "low-level" theoretical concepts, such as "archaeological sediments" (parts of chapters 2 and 3) and the importance of stream order (and the extensive work documenting this by Rolfe Mandel in Kansas) in considering the potential preservation of archaeological sites on terraces (p. 109), though they do not employ Schumm's (1973) concept of "complex response" in this discussion. In this introductory section on basic concepts, there are places where the level of explanation for certain terms is inconsistent. For example, in their discussion of grain sphericity (p. 18), they discuss the concept of imbrication, but do not define or describe this term. Similarly, in their discussion of soil topography and relief (box 3.1), they use the term "catena" with no further explanation. Thus, a college course that utilizes this text must necessarily be gauged toward students with some background in the earth sciences or must include additional texts or instructional time elaborating on these concepts.

Part II is titled "Nontraditional Geoarchaeological Approaches" and covers landscape impacts, occupation deposits, experimental techniques, human materials, and forensic applications. Part II delves into how geoarchaeology can contribute to "middle-range" theoretical concepts in archaeology, such as ethnoarchaeology, settlement studies, and others.

The authors' strengths in micromorphological techniques are evident in this section of the book; however, the section goes well beyond the application of micromorphological techniques. Here, one of the greatest assets of the book, its encyclopedic coverage of research in the field, is evident. Both authors are knowledgeable about current research in geoarchaeology and have capitalized on their relationships with colleagues to provide detailed information about the methods and approaches being employed in the field worldwide.

Some of the examples used, particularly those dealing with soil micromorphology are discussed in great detail with further explanation described in parenthetical "boxes." In many of these cases, the discussions include suggestions for future research. Other topics are less thoroughly described (e.g., description of Gé et al.'s model of occupation surfaces on p. 214; compare detailed discussion of archaeological sites on terraces with listing of examples of sites in lacustrine settings in chapter 5), making the text more like an annotated bibliography rather than an instructional tool.

Instructors and advisors should carefully guide students interested in employing the techniques described, as it would be easy to use the breadth of citations as justification for the blind application of a technique. Nevertheless, the relevance of the cited works provides both instructor and student with a head start in the research process.

The final section, Part III, deals with field and laboratory methods and data reporting. Goldberg and Macphail again provide a unique and welcome contribution to the field by including a discussion of field techniques, an elaborate discussion of the value and pitfalls of laboratory methods, and suggestions for reporting data. This is followed at the back of the book by a series of appendices detailing field safety, sampling techniques, and processing suggestions. In addition, the numerous tables throughout the book provide information on relationships among geomorphic features and archaeological sites (Tables 5.4 and 8.1), recording strategies, and other compilations of information.

Most of the figures in the book are black and white, though all of excellent quality, and the authors have included thirteen color images, principally photomicrographs, but also several of stratigraphy or features at archaeological sites.

The language used in the book is occasionally marked by terminology used outside of North America, which is a welcome change, except in rare cases where the terms are undefined or when awkward phrases are produced. I'm not at all sure what "paleoanthropological fidelity" (p. 72) is, but I assume it has nothing to do with selling life insurance to paleoanthropologists or their specimens.

The term "theoretical" is highlighted in the title of this book. I suspect that archaeologists, in particular those who employ "high level" theory, will see the use of this term in the title as a glaring error. Theory in geoarchaeology can be entrenched in the earth sciences, in archaeology, or in some combination of the two. Frequently, archaeologists misinterpret the "low-level" theoretical concepts that frame our understanding of geoscientific processes as atheoretical. They are not, though many earth scientists would probably not employ the term "theory" in describing these concepts either. The fact that these scientific concepts are introduced in this book is an important contribution to the literature.

The authors also explore some theoretical concepts in archaeology, such as human impacts on the landscape and what Schiffer (1987) would call "cultural transformation processes." I would like to see better integration of archaeological and geoscientific theory, such as how landscape archaeology and theoretical concepts in geomorphology could be used together, but perhaps that is a challenge for future editions.

Used in conjunction with other learning techniques, the book would make an excellent text for an advanced undergraduate course and should be considered required reading for anyone exploring geoarchaeology at the graduate level.

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Books Available for Review

Contact the book review editor, Stacey Lengyel, if you are interested in reviewing any of the following books:

Arkush, E. N., and Allen, M. W. (Eds). 2006. *The Archaeology of Warfare: Prehistories of Raiding and Conquest*. Gainesville, FL, University Press of Florida.

Bell, E. E., Canuto, M. A., and Sharer, R. J. (Eds). 2004. *Understanding Early Classic Copan*. Philadelphia, University of Pennsylvania Museum Press.

Brodie, N., Kersel, M. M., Luke, C., and Tubb, K. W. (Eds). 2006. *Cultural Heritage, and the Antiquities Trade*. Gainesville, University Press of Florida.

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Fagan, B. 2006. *From Stonehenge to Samarkand: An Anthology of Archaeological Travel Writing*. New York, Oxford University Press.

Geier, C. R., Orr, D. G., and Reeves, M. B. (Eds). 2006. *Huts and History: The Historical Archaeology of Military Encampment during the American Civil War*. Gainesville, University Press of Florida.

Milanich, J. T. 2006. *Laboring in the Fields of the Lord: Spanish Missions and Southeastern Indians*. Gainesville, University Press of Florida.

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Ramos, J. (Ed). 2003. *Revista Atlántica-Mediterránea de Prehistoria y Arqueología Social*, Vol. 6. Cádiz, España, Universidad de Cádiz.

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Smith, F. H. 2006. *Caribbean Rum: A Social and Economic History*. Gainesville, University Press of Florida.

VanDerwarker, A. M. 2006. *Farming, Hunting and Fishing in the Olmec World*. Austin, University of Texas Press.

Upcoming Conferences

Rachel S. Popelka-Filcoff, Associate Editor

2006

4-6 December. 2nd International Conference on Remote Sensing in Archaeology, Rome, Italy. Contact: nfo@lapetlab.it General information: www.space2place.org/index.html.

7-9 December. 3rd Symposium on Preserving Archaeological Remains /in situ /(PARIS3) Amsterdam, The Netherlands. Topics on: Degradation Processes, Site Preservation and the Burial Environment, Preservation in Context - the Regional, National and International Setting, Two Decades of PARIS. General Information: www.falw.vu.nl/paris, Contact email: paris2006@falw.vu.nl.

11-15 December. American Geophysical Union Fall Meeting, San Francisco, California, U.S.A. Contact: AGU Meetings Department, 2000 Florida Avenue NW, Washington, DC 20009 USA; Phone: +1-202-777-7335; Fax: +1-202-328-0566; E-mail: meetinginfo@agu.org; General information: www.agu.org/meetings.

2007

4-7 January. The International Conference on Environmental, Cultural, Economic and Social Sustainability, Chennai, India. Full details of the conference, including an online call for papers form, are to be found at the conference website: www.SustainabilityConference.com.

4-7 January. American Institute of Archaeology National Meeting, San Diego, CA USA General information: www.archaeological.org/webinfo.php?page=10300

10-14 January. Society for Historical Archaeology 40th Annual Conference on Historic and Underwater Archaeology. Williamsburg, VA USA. Late abstract submission deadline: July 17. William M. Kelso, PhD, Jamestown Rediscovery 1365 Colonial Parkway Jamestown, VA 2081 757-229-4997 757-564-3844 FAX, kelso@apva.org General information: www.sha.org/conference.htm.

9-10 March. Disease in Global Environmental History. Toronto, Ontario, Canada. Submission deadline: November 15, 2006. 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 archaeological evidence for human manipulation of the environment, both as a context for modern environments, and as a source of data about past societies. Abstract deadline: November 27, 2006. General information: www.siu.edu/~cai/vsconference2007.html.

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

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