SAS Bulletin

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SAS News

News of Geoarchaeology

Meeting News. *AMQUA 1991: High Resolution Paleoclimatic Records: Annual to Decadal Time Scales.* The American Quaternary Association, 12th Biennial Meeting will be hosted by the University of California, Davis on August 24-26. The keynote speaker will be Malcolm Hughes, Laboratory of Tree-Ring Research, University of Arizona.

Invited speakers: M. Stuiver, M. Tushingham, A. Schimmelmann, S. Banerjee, B. Atwater, G. Carver, P. Groote, A. Morgan, S. Porter, D. Yamaguchi, H. Schwarcz, T. Swetnam, L. Graulich, P. Mehringer, D. Stahle, J. Cole, A. Catchpole, and D. Graybill will discuss high-resolution records from radiocarbon dating, tide-gauge records, varved sediments, loess, ice-core records, lichenometry, tree-ring analysis, speleothems, pollen, corals, and historical evidence. A number of pre- and post-conference field trips are scheduled to California, Oregon and Nevada. Contact Carolyn Norlyn (tel 916-757-3331) for information on attending the conference.

News items. Henry P. Schwarcz of McMaster University received the 1991 Archaeological Geology Division Award at the annual Geological Society of America meeting in San Diego for "outstanding contributions to the interdisciplinary field of archaeological geology" for his work on dating methods.

A scholarship fund has been established in memory of geoarchaeologist Jonathan O. Davis. An initial award of $750 will go to a graduate student doing geology-related research in the Great Basin or surrounding areas. For more information, write the Executive Director, Quaternary Sciences Center, Desert Research Institute, Box 60220, Reno, NV 89506. Contributions are also welcome.

Recent Publications: *Soils in Archaeology: Landscape Evolution and Human Occupation;* Vance T. Holliday, editor, Smithsonian Institution Press, January, 1992.

Deciphering a Shell Midden; Julie E. Stein, editor, Academic Press, April 1992.

Robin L. Burgess, Military Airlift Command, DCS - Logistics and Engineering, Scott Air Force Base, IL 62225-5001; telephone 618-256-5764. □

News of Archaeometallurgy

Meeting News. An intensive two-day international seminar on the subject of "Disaster Prevention, Response, and Recovery: Principles and Procedures for Protecting and Preserving Historic/Cultural Properties and Collections" has been announced by *Technology and Conservation* magazine and the Massachusetts Institute of Technology Museum for 23-25 October 1992. The sessions will be held on the MIT campus in Cambridge, Massachusetts. Registration is first-come, first-served and the fee is $250 before August 15th, $290 thereafter. For more information write Susan Schur at Technology and Conservation, One Emerson Place 16M, Boston MA 02114, telephone 617-227-8581, or Robert Hauser, New Bedford Whaling Museum, 508-997-0046.

The first call for papers for the *International Symposium on the Catalán Forge,* to be held in Spain on 13-17 September 1993, has gone out. Subjects to be discussed include metallurgical study of the Catalán Forge process and of its products, archaeology of the forge, the relationship to other iron producing methods, economic, social and environmental aspects, and practical experiments. For further information write the Secretariat of the Symposium, Dr. Estanislau Tomas, A.M.C.T. (Associacio del Museu de la Ciencia i de la Tecnica i d'Arqueologia Industrial de Catalunya), Via Laietana 39, S-09003 Barcelona, Spain, telephone 319 23 00, fax 310 06 81.

News items. Members of the Historical Metallurgy Society will be saddened to learn that Roger Ward died suddenly albeit peacefully on January 25th, at his home in Wales. He was serving as the Hon. Secretary of the HMS. Mrs. Ward's address is South Cottage, 2 South Terrace, Sotherndown, Bridgend, Mid Glsmorgan CF32 0RN, Great Britain.

Publications. Rare and out of print books and other publications on mining history, chiefly of North America, are offered by Gold Hill Books, P.O. Box 1523, Longmont Colorado 80502, telephone 303-651-2985.

Martha Goodway, MRC 534, Smithsonian Institution, Washington DC 20560; telephone 301-238-3733; fax 301-238-3709. □

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Included in this issue is a membership list for the Society for Archaeological Sciences, as of the beginning of this year. We will make electronic mail addresses and professional interests available with future lists. Country is USA unless otherwise indicated; U.S. state abbreviations are used.

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Meetings (cont. from p. 23)

Aug. 23-29. 3rd International Conference on Geomorphology. Hamilton, Ontario, Canada. Derek C. Ford, Department of Geography, McMaster Univer-sity, 1280 Main St. West, CDN-Hamilton, Ontario L8S 4K1, Canada.

Aug. 25- Sept. 3. 49th Biennial Session of the International Statistical Institute. Firenze, Italy. ISI Permanent Office, 428 Prinses Beatrixlaan, P.O. Box 950, 2270 AZ Voorburg, Netherlands.

Sept. 10-17. 13th Congress, International Union of Anthropological and Ethnological Sciences. Mexico, D.F., Mexico. Linda Manzanilla, Instituto de Investigaciones Antropológicas, Universidad Nacional Autonoma de Mexico, Ciudad Universitaria, Coyoacan, D.F. 04510, Mexico. Theme: Cultural and biological dimensions of global change.

Oct. 25-28. Geological Society of America, Annual Meeting. Boston, Massachusetts, USA. Vanessa George, GSA, Box 9140, Boulder, CO 80301, USA; tel 303-447-2020.

1994

* Feb. 18-23. American Association for the Advancement of Science, Annual Meeting. San Francisco, California, USA. AAAS, 1333 H Street NW, Washington DC 20005, USA; tel 202-326-6400.

* April 18-24. 59th Annual Meeting of the Society for American Archaeology. Anaheim, California, USA.

* June 5-11. Geochronology, Cosmochronology and Isotope Geology (ICOG-8). Berkeley, California. Garniss H. Curtis, Institute of Human Origins-Geochronology Center, 2453 Ridge Road, Berkeley, CA 94709, USA; tel 415-845-4003; fax 415-845-9453. □

Miscellany

Martin Jones, who became the first holder of the George Pitt Rivers Chair in Archaeological Science at the University of Cambridge, has succeeded Dr. Susan Limbrey (University of Birmingham) as Chairperson of the Archaeological Science Committee of the Council for British Archaeology.

From British Archaeological News, 6(1), January 1991. □

Laboratory Profile

Archaeometry Laboratory, University of Cape Town

STAFF

The present staff of the lab consists of: Prof. Nikolaas J. van der Merwe (Ph.D. Yale 1966), Director (part-time and Landon T. Clay Professor of Scientific Archaeology at Harvard University); Assoc. Prof. Andrew Sillen (Ph.D. Pennsylvania 1981), Deputy Director; Judith Sealy (Ph.D. Cape Town 1989), Lecturer; Julia Lee-Thorp (Ph.D. Cape Town 1989), Sr. Scientific Officer; John Lanham (B.A. Honours Cape Town 1986), Sr. Research Officer; Duncan Miller (Ph.D. Cape Town 1986), Sr. Research Officer; Sharma Saitowitz (M.A.Cape Town 1990), Research Officer; Cheryl Gilbert (B.A. Honours Cape Town 1991), Research Assistant; Gavin Evans (M.Sc. Cape Town 1982), Research Assistant.

HISTORY

The Archaeometry Laboratory at the University of Cape Town was started in 1974 on the appointment of Nikolaas van der Merwe as the first Professor of Archaeology at the university. The laboratory did not have premises or equipment until 1976. Initial work was on indigenous technology in Africa, and the radiocarbon dating of iron. Identification of marijuana residues in archaeological smoking pipes was another early interest. The research direction of the laboratory was greatly altered as a result of collaboration with Dr. John Vogel of the Pretoria Radiocarbon Laboratory and the realization that the systematics of stable carbon isotope ratios, hitherto used to calibrate carbon-14 dates, provided a means for reconstructing ancient diets by analysing skeletal collagen. This procedure is based on the different isotopic fractionations introduced by different photosynthetic systems in plants (C_3, C_4 and CAM). This observation, namely that different kinds of photosynthesis produce plant tissues with characteristic carbon isotope ratios, and that these ratios are reflected in the bodies of consumers higher in the food chain, provides the basis of the entire field of dietary reconstruction using stable isotope tracers.

The UCT laboratory already had equipment for preparing carbon dioxide for radiocarbon dating from iron samples. A similar system was designed for the new stable isotope technique, along the lines of the Craig glass system. In its early years, the laboratory was staffed by a part-time student assistant who prepared three gas samples per week. The completed samples were then flown to the radiocarbon dating laboratory in Pretoria, more than a thousand miles away, where $^{13}C/^{12}C$ ratios were measured on a mass spectrometer in which gas pressures were equalized by raising or lowering a bottle of mercury. The difference in isotopic ratio between the sample and the standard reference gas was measured with a ruler on a paper trace. These efforts paid off, however, in the form of some of the first publications using stable carbon isotope measurements to reconstruct ancient human diets. In these studies $^{13}C/^{12}C$ measurements were used to trace the spread of maize agriculture in North and South America (Vogel and van der Merwe 1977; van der Merwe and Vogel 1978; van der Merwe, Roosevelt and Vogel 1981).

In the intervening 15 years, the laboratory has expanded its research directions, increased its staff, and has recently moved into specially-designed new premises. We now have several stainless steel gas preparation lines for stable carbon, oxygen and nitrogen isotope measurements, as well as a Micromass 602E stable light isotope mass spectrometer, a GBC atomic absorption spectrophotometer, Shimadzu IR-460 infra-red spectrometer, a u-v/visible spectrometer, and a host of smaller equipment such as ion-specific electrodes, etc.

One section of the laboratory is set up for materials research, with a Reichert-Jung Polyvar Pol dual purpose metallographic/petrographic microscope and facilities for preparing polished and thin sections. These include a rotary diamond saw, a double flat bed grinder and a variable speed polishing unit.

Members of the laboratory also have access to analytical facilities in other parts of the university, such as scanning electron microscopes, X-ray fluorescence and X-ray diffraction spectrometers, an electron microprobe and a recently-installed solid source mass spectrometer for heavy isotopes.

CURRENT RESEARCH DIRECTIONS

A. Materials Analysis

The initial materials analysis focus of the UCT Archaeometry Laboratory is maintained in several projects. Duncan Miller is involved in the analysis of archaeological ceramics, stone, shell and amber. He is also investigating early indigenous mining and metallurgy in southern Africa through metallographic and X-ray fluorescence analysis of metal artefacts and smelting products. He has recently completed a study of a large assemblage of iron and copper artefacts from Early Iron Age sites in the Tsodilo Hills, northwestern Botswana (in preparation as a monograph). This is the first comprehensive analysis of such an assemblage, and is part of a long-term project aimed at characterising the indigenous metals technology of the last 2000 years. One important issue here concerns the possible influence of first millennium A.D. Arab traders along the

east coast of Africa on African metalworking technology. Work currently under way includes the description and analysis of material from Mapungubwe, thought to have been the predecessor of Great Zimbabwe as a regional trading centre in south-eastern Africa.

Trade patterns may also be traced through analysis of the glass beads which have been sought-after exotic items in Africa for several years. Sharma Saitowitz is studying glass trade beads from southern African Iron Age and historical sites. She is developing a typology for classifying and comparing bead assemblages, and performing physical and chemical analyses of the beads themselves, including measurements of refractive index, bulk density, and elemental analysis by microprobe (Saitowitz 1988, 1990).

B. Isotopic and Elemental Chemistry

The major research direction of the group continues to be the investigation of palaeodietary questions using stable isotopes and trace elements. Current projects include a study of the resource base of early complex societies in Ecuador (maize or seafood?). Other projects focus on ancient diets in the Amazon, Peru, Israel and Africa.

The Archaeometry Laboratory is situated within an active archaeology department with strong research interests, particularly in the African Palaeolithic and Iron Age, and historical archaeology. We are constantly reminded of current issues in these fields, and some of our most productive research stems from collaboration with our colleagues. Many readers will be aware of the debate about the "seasonal mobility hypothesis" proposed by John Parkington, suggesting that hunter-gatherers in the south-western Cape of South Africa moved seasonally between the coast and the interior. Isotopic analyses of these peoples' skeletons, and the foods that they ate, suggest otherwise and have prompted fundamental re-evaluation of the kinds of arguments archaeologists use in developing such hypotheses (Sealy 1986; Sealy and van der Merwe 1985, 1986). Searching questions from John Parkington, however, are stimulating us to think much more critically about the uncertainties associated with $^{13}C/^{12}C$ measurements (Parkington 1986, 1991; Sealy and van der Merwe in press).

These studies centre around the measurement of stable carbon isotope ratios in bone protein, which is the best-understood and most widely applied technique. Other methods are being developed and tested, partly in the UCT laboratory. These include measurements of $^{15}N/^{14}N$, Ba, Sr, Ca and $^{87}Sr/^{86}Sr$. Accurate dietary reconstructions, particularly in the more distant past, require an understanding of the environments of the time. Isotopic and trace element data for animal species of known diet, or other well-understood biological indicators, offer clues to the reconstruction of palaeoenvironments. Members of the group are exploring the shifting boundaries of different climatic zones in southern Africa since the last glacial maximum. A similar project is planned for the Near East, where climatic changes may have had a bearing on the origins of agriculture. Anne Cohen, a doctoral candidate, is examining the mineralogical composition and oxygen isotope ratios of marine mollusc shells from archaeological sites along the southern African coast. Her results will show whether climatic events well-documented in the northern hemisphere extended to these southerly latitudes.

Members of the Archaeometry Research Laboratory at the University of Cape Town, in the mass spectrometer lab. Standing: Anne Cohen, Duncan Miller, Nick van der Merwe, Gavin Evans, Cheryl Gilbert, John Lanham. Sitting: Julie Lee-Thorp, Andrew Sillen, Judy Sealy, Sharma Saitowitz.

An important aspect of the palaeoenvironmental research at UCT centres around Julia Lee-Thorp's efforts to extend the time-depth of carbon isotope analyses of bone into the more distant past. Most such studies are done on both protein, since this has been shown to be relatively immune to post-mortem isotopic alteration if extracted by appropriate laboratory procedures. Gradual degradation of the protein means, however, that we cannot (yet) extract organic residues for isotopic analysis from very ancient bones. Lee-Thorp has shown that reliable $^{13}C/^{12}C$ results can be obtained from carbonate in the mineral phase of tooth enamel, even in specimens many tens or hundreds of thousands of years old (Lee-Thorp 1989; Lee-Thorp and van der Merwe 1987, 1991). Her techniques are currently being applied to investigation of the diets of australopithecines and early *Homo* from Swartkrans and Sterkfontein, in order to test the hypothesis that different species of hominids occupied different dietary niches.

Francis Thackeray, a recent post-doctoral researcher in the group, used the same methods to analyse even older material: Permian dicynodont tusks. Changes in $d^{13}C$ in the bones of a single species over several million years probably reflect variations in the atmospheric carbon dioxide balance 250 million years ago (Thackerary et al. 1990).

Isotopic tracers can be valuable tools in modern, as well as fossil environmental studies. Controversies over the desirability or otherwise of selling ivory and rhinoceros horn from culled animals hinge on the question of how to distinguish legally culled material from that obtained by poachers. Conservationists who favour controlled trade in these commodities point out that considerable amounts of money could be generated for conservation. Opponents of the trade maintain that such operations are impossible to police. Elephant and rhino are today confined to a number of circumscribed game refuges. Studies of the carbon, nitrogen, and strontium isotopic composition of elephants from various localities in Africa, carried out in the UCT Archaeometry Laboratory in collaboration with colleagues from the Bernard Price Institute of Geophysics at the University of the Witwatersrand show that it is possible to "source" ivory in this way, thus providing an independent check of claims about its origin (van der Merwe et al. 1990).

Since Andrew Sillen joined the group in 1985, we have been involved in trace element as well as isotopic studies of ancient diets. Trace element work has long been plagued by problems of post-mortem contamination of bone by elements from the soil matrix. The solubility profile technique developed by Sillen (1986, 1991) is designed to address this complication, and development and application of this methodology continues. One current study concerns reconstruction of fossil foodwebs at Swartkrans, using solubility profiles and Sr/Ca measurements to explore relationships between various species of fossil fauna. Surveys of the trace element levels in modern bones are essential for accurate interpretation of data from fossils. Analyses of contemporary specimens thus form an important parallel theme in this research (e.g. Sillen 1988; Sealy and Sillen 1988. See also Tuross et al. 1989; Sillen 1990).

The chemical characterisation of burned residues from Plio-Pleistocene archaeological sites is a new research direction being developed by Andrew Sillen in collaboration with colleagues at the Carnegie Institution of Washington. Pyrolysis GC/MS of burned bone may offer not only a useful way of tracking diagenesis of the organic phase of bone, but perhaps even a palaeothermometer enabling researchers to distinguish between natural fires and intentional, controlled use of fire at early hominid sites (Hoering and Sillen 1990).

In addition to these projects, based within the laboratory, there is extensive cooperation between members of the archaeometry group and researchers outside the archaeology department, principally in the life, earth, and bio-medical sciences. Examples of such collaboration involving isotopes including the tracking of food-webs and oceanic circulation patterns in the southern oceans, and the development of safe stable isotopic tracers for monitoring liver function in new-born infants.

FUNDING AND TRAINING

The laboratory is funded mainly by the Foundation for Research Development: the South African equivalent of the NSF. FRD grants are made to individuals or research teams. Our team is led by Nick van der Merwe, with Andrew Sillen and Judith Sealy as team members. John Lanham and Julia Lee-Thorp are full-time Senior Scientific Officers within the group, and provision is made for masters and doctoral students, as well as post-doctoral fellows. Additional funding comes from the University of Cape Town. The materials analysis work done by Duncan Miller and Sharma Saitowitz is funded by Anglo-American De Beers and by the Human Sciences Research Council.

Archaeometry is taught at the undergraduate as well as the graduate level at Cape Town. Opportunities exist for students wishing to specialise in archaeometry to complete master's and doctoral degrees by thesis. We welcome enquiries from prospective graduate students, post-doctoral fellows or more senior scientists interested in carrying out collaborative research.

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Contributed by Judith Sealy, Archaeometry Laboratory, Department of Archaeology, University of Cape Town, Private Bag, Rondebosch, Cape 77000, South Africa.

Book Review

The Chemistry of Prehistoric Human Bone.

T. Douglas Price, editor. School of American Research Advanced Seminar Series. Cambridge University Press, Cambridge, 1989, xxiv + 291 pp., tables, figures, references, index. $49.50 (cloth).

Reviewed by Stanley H. Ambrose, University of Illinois, Urbana.

In the quest for more realistic and accurate reconstructions of prehistoric human diets, archaeologists and biological anthropologists have cast their nets widely and have incorporated an increasingly diverse array of analytical methods. Sophisticated and expensive instruments are now employed to measure elemental and stable isotopic variation in bones and teeth. Research at the elemental and isotopic level has been advancing rapidly since the 1970s, and only in the last five years have the potentials, limitations and problems with the methods become apparent, and future directions for research clearly defined.

The Chemistry of Prehistoric Human Bone is a collection of papers from the first Advanced Seminar on Bone Chemistry, held at the School of American Research (SAR), Santa Fe, in March 1986. This volume is packed with useful information for the specialist and general reader. It is remarkably free of typographic errors and has a detailed index. I find it to be an extremely valuable resource for my own research. Because of the fast pace of advances in the field it is best considered a snapshot of the state of the art of this rapidly evolving field as it appeared in 1986 (the latest date for references cited in most chapters). It presents a fairly accurate picture of the field at that time and suggests the trajectory of future trends in paleodietary and bone chemistry research.

Prior to this time the isotopic and elemental composition of bone was largely interpreted in terms of diet. Most contributors to the SAR proceedings acknowledge the existence of significant sources of non-dietary variability. Variability due to methods of sample purification and preparation of collagen for isotopic analyses and of apatite for trace element and isotopic analysis are discussed by Chisolm and Sillen, respectively. Diagenesis of bone mineral, its effects on trace element abundance (particularly strontium), and its detection are addressed by Price, Sillen, and Buikstra et al. "Antagonisms" between elements (the inhibition of uptake of some trace elements by other dietary components) are discussed by Buikstra et al. and Armelagos et al. Metabolic and physiological effects on collagen and apatite are discussed by Armelagos et al.

Although diagenesis does not appear to be a significant issue for isotopic analysis of collagen, the effects of environmental variability within and between foodwebs are complex and significant. Van der Merwe has turned

some of the predictable and well-understood sources of natural isotopic variation to his advantage by using carbon isotope ratios of herbivore bones to reconstruct environmental change. Chisolm notes the uncertainties these sources of variation, as well as variation in nutrient composition (fats versus proteins and carbohydrates), pose for dietary reconstruction. Schoeninger notes that the large variation in bone strontium abundance within and between trophic levels and microenvironments often precludes straightforward dietary interpretations, and she illustrates this with the analysis of modern mammalian herbivores, carnivores, and humans from a small well-defined area in northern Kenya.

Several authors note the uncertainties of the relationship between levels of trace elements in the diet and in bone, the amount of intra- and interindividual variation on a given diet, and how antagonistic elements, physiology, metabolism, and disease may affect this relationship. Similarly for carbon isotopes in bone collagen, Chisolm, Schoeninger, and van der Merwe raise the important question of the pathways carbon follows from food to collagen and carbonate in apatite. Does dietary protein go mainly to collagen, and lipids and carbohydrates mainly to carbonate (the Krueger and Sullivan model), or are the carbon atoms from protein and energy sources scrambled before incorporation into bone mineral and protein? (One could also ask whether there is more or less scrambling on high versus low protein diets).

The book opens with a foreward by Price, which is largely a personal account of how he became involved with elemental and isotopic techniques of diet reconstruction in order to address questions raised in his archaeological research. Chapter 1, also by Price, briefly outlines the scope of the volume and the approaches to diet reconstruction. The discussion of basic principles is too brief to stand on its own, but this is thoroughly covered by the introductory paper of the previous collection he edited, which appeared in the *Journal of Human Evolution*, vol. 14 (pp. 417-551) and does not need to be repeated here.

Chisolm provides a very thorough, useful, and authoritative review of the diverse sources of variability in diet reconstruction with stable carbon isotopes of bone collagen, including variation due to sample preparation, instrumentation, biochemical composition of diet (proteins, carbohydrate, fats), trophic level effects, and environmental variation.

Schoeninger presents a novel and sophisticated approach to refinement of dietary interpretations using the isotopic analysis of prehistoric Pueblo agriculturalists and 17th and 18th century Dutch whalers. Briefly, this involves using estimates of the weighted percentage contribution of calories (for carbon) and protein (for nitrogen) from each potential dietary resource derived from archaeological and ethnographic data to predict the carbon and nitrogen isotope ratios of collagen. Manipulation of the weighted contributions of each resource to match the actual isotopic results should then produce an accurate estimate of diet composition. In order to successfully apply this technique, accurate information on the isotopic composition of local resources and the isotopic fractionation factors between diet and collagen is needed. Insufficient data on the diet-tissue isotopic fractionation factors and isotopic composition of dietary resources actually exploited by the human populations were available to simultaneously "solve" the diets for both isotopes. With sufficient data, however, the method should work well and further research along this line should be encouraged.

Ericson, West, Krueger, and Sullivan address the development of maize agriculture in the Viru Valley, Peru. This is the only paper to use carbon and nitrogen isotopes of collagen and carbon in carbonate to reconstruct diets, and it is the only one that does not address methodological or interpretive issues. A wealth of subsistence and settlement data is summarized, and isotopic informationon many sites is presented. Unfortunately, the points plotted in figure 4.3 cannot be replicated from the raw data presented in the tables, and the conclusion that maize consumption increased through time does not appear to be supported by the isotopic data. Some graphs have axes with $\delta^{13}C$ values decreasing, and others increasing from the origin. This can only confuse the reader. Delta values should always increase away from the origin.

Van der Merwe provides a thorough and succinct discussion of environmental variations in foodweb carbon isotope ratios. It appears that prehistoric foodwebs probably had higher $\delta^{13}C$ values overall, dry habitats have higher values than wet ones, and forest floors have lower values than open habitats. There are no fixed values for the carbon isotope ratios of the C_3 and C_4 end-members of local foodwebs. Global averages may not be relevant, and baseline foodweb carbon isotope values must be established for each time and biotic community in which human diet reconstructs are undertaken.

Price uses a multielement approach for the identification of diagenetic alteration of trace elements in bone. Using sample sets from South Africa, Sweden and Wisconsin, Fe, Al, Yt, and Zr are identified as indicators of diagenesis. Strontium covaries with these elements in one case, and produces results inconsistent with expectations in the others. He concludes that there is no longer any question that levels of Sr in bone can be modified by diagenesis, and that multielement analysis for detection of diagenesis should be mandatory.

Buikstra et al. provide an extensive, thorough, informative, and useful review of previous research and the fundamentals of diet reconstruction with trace elements. They also describe methods of identification of diagenesis involving multivariate analysis of covariance of 14 elements in bone mineral and $\delta^{13}C$ of collagen. This multivariate approach is applied to the analysis of femurs from three mortuary sites in the lower Illinois Valley. Principal components analysis is performed on the data. The authors conclude that Al, Fe, Zn, Cd, and Mn are affected by diagenesis, and Ba and Sr covary as replacements for Ca.

Sillen provides a sophisticated and useful discussion of the chemical mechanisms of diagenetic alteration of bone apatite and its effects on the isotopic and elemental composition of bone. Characterization of diagenesis with IR and XRD and Ca/P ratios is clearly illustrated. Sillen's most important contribution to paleodietary research is the development of a method for removal of diagenetic mineral phases and the recovery of a biological Sr signal. The principles and methods of biological apatite purification are clearly explained. The onset of mineral diagenesis appears to be delayed until collagen is lost from bone. This may explain why specimens from the Viru Valley of Peru that were analyzed by Ericson et al. and characterized as having poorly preserved collagen, also have unusual spacings between collagen and apatite carbon isotope ratios. Perhaps characterization of the preservation of collagen should be routinely incorporated into trace element studies.

Armelagos and his colleagues review normal aspects of bone development, maintenance, remodeling, physiology, function, microstructure, and biochemistry. The description of osteon structure and development is particularly useful. The ways in which collagen synthesis and stability are affected by disease and dietary deficiencies are described. Factors affecting the uptake and biological role of trace elements are also reviewed. They recommend integration of chemical, isotopic, and micromorphological evidence for dietary reconstructions.

The final chapter is a joint statement by the ten participants in the Seminar that outlines some conclusions and recommendations for the use of reference materials, the standardization of sample preparation methods, and the reporting of data. In this regard, I recommend the standardization of graphic presentation of carbon isotope data, and also note that the coefficient of variation is an inappropriate summary statistic for stable isotope ratios. Some areas of inadequate knowledge are identified, such as those relating to diet-bone isotopic and elemental fractionation factors and are currently being addressed through experimental research and observations in natural environments. Future directions for research are suggested.

In the previous collection of papers on prehistoric diet and bone chemistry edited by Price, non-dietary contributions to elemental and isotopic variability of bone received little notice and many assumptions were not closely examined. A growing awareness of the complexities of the relationship between the abundance of trace elements and stable isotopes in the diet and in buried bones reflects the maturation of the field. The third collection of papers on the subject, resulting from the second Advanced Seminar held in Cape Town in June 1988, appeared as a special issue of the *Journal of Archaeological Science*, volume 18, no. 3, pp. 225-416, May 1991. The next seminar, from a meeting that was held in Bad-Homburg, Germany, 2-6 September, 1991, is being edited by Joseph Lambert and Gisela Grupe as *Prehistoric Human Bone: Archaeology at the Molecular Level*, Springer-Verlag, 1992. □

Support for Graduate Research

University of Missouri. The Missouri University Research Reactor (MURR) supports visiting doctoral candidates in archaeology for periods of 3 - 6 months. The purpose of the program is to provide exceptionally well-qualified students with the opportunity to include archaeometric analysis in their dissertation research projects. Besides access to neutrons for neutron activation analysis, the MURR archaeometry laboratory has gamma-ray detector systems, petrographic microscopes, ultrasonic disaggregation equipment, a programmable furnace, and a variety of computing facilities. Projects appropriate for the program would include chemical and petrographic characterization of pottery, chemical sourcing and hydration dating of obsidian, and sourcing of chert. Participants receive guidance in all phases of the analysis.

The program pays a stipend of $900 per month while participants are in residence. Additionally, participants have free access to neutrons, analytical equipment, computers, and office space. Certain expendable supplies, primarily high-purity quartz vials consumed in neutron activation analysis, must be paid for out of the stipend or other funding sources, at a cost of $12.00 to $20.00 per sample irradiated.

Eligible advanced graduate students will have completed necessary fieldwork and identified a specific problem to which the analyses proposed for completion at MURR will make an important contribution. Materials to be analyzed must be in-hand upon the participant's arrival at MURR. Application is by means of a 10- page research proposal outlining the project's problem orientation, background information, description of the collection(s) to be analyzed, description of analytical techniques to be employed, and specific statement of why MURR is the best place to accomplish the research. Accompanying supporting documentation must include a CV and letters of reference from the major advisor and one other individual. Applications will be accepted on a continuous basis.

Interested students should call or send a letter of intent with a brief project description to either: Michael D. Glascock, (314) 882-5270, GLASCOCK@ MURRVAX, or Hector Neff, (314) 882-5267, NEFF@ MURRVAX, Research Reactor University of Missouri Columbia, MO 65211.

University of Bradford. "A Computer Simulation of Fluxgate Gradiometer Anomalies for the Interpretation of Archaeogeophysical Data" is a collaborative project between Geophysical Surveys of Bradford and the Department of Archaeological Sciences at the University of Bradford. The successful candidate will be registered for a higher degree, and funded for three years to determine the feasibility of identifying anomalies using modelled data. Write to Dr. Carl Heron, Department of Archaeological Sciences, University of Bradford, Bradford, West Yorkshire BD7 1DP, United Kingdom; fax 0274-728497. □

Meetings Calendar

Susan Mulholland, Archaeometry Laboratory, University of Minnesota-Duluth, 10 University Drive, Duluth MN 55812; e-mail SMULHOLL@ UMNDUL; tel 218-726-7957; fax 218-726-6556.

New listings are marked by a *; new information for previous listings indicated by a +. More information on some meetings is given in previous Bulletins as indicated, e.g., "12(4):13" for volume 12, number 4, page 13.

* June 1-4. Remote Sensing Meeting. Toronto, Canada. Nancy Prout, Ontario Centre for Remote Sensing, Fourth Floor, ICI Bldg., 90 Sheppard Avenue East, North York, Ontario M2N 3A1, Canada; tel 416-314-1300; fax 416-314-1336.
* June 7-12. American Nuclear Society Annual Meeting. Boston, Massachusetts, USA. Meetings Department, ANS, 555 N. Kensington Avenue., La Grange Park, IL 60525, USA; tel 312-352-6611).

June 8-13. 4th International Conference on Ground Penetrating Radar. Rovaniemi, Finland. Pauli Hanninen, Geological Survey of Finland, Neulaniementie 5, SF-70210 Kuopio, Finland; fax 358-71-205-215.

June 9-11. 6th International Working Conference on Scientific and Statistical Database Management. Switzerland. James C. French, Institute for Parallel Computation, School of Engineering and Applied Science, Thornton Hall, University of Virginia, Charlottesville VA 22901, USA; e-mail french @virginia.edu.

* June 15-17. 1st Thematic Conference on Remote Sensing for Marine and Coastal Environments. New Orleans, Louisiana, USA. Nancy Wallman, ERIM/Marine Envi-ronment Conference, Box 134001, Ann Arbor, MI 48113-4001, USA.
* June 15-18. Deterioration and Conservation of Stone. Lisboa, Portugal. Laboratorio Nacional de Engenharia Civil, Av. Brasil 101, 1799 Lisboa Codex, Portugal; tel 351-1/8482131; fax 351-1/897660.
* June 17-19. 4th Symposium on Computer-Enhanced Analytical Spectroscopy (CEAS-92). Salt Lake City, Utah, USA. Charles Wilkins, CEAS-92 Chairman, Department of Chemistry, University of California-Riverside, Riverside, CA 92521, USA; tel 714-787-3518; fax 714-787-4713.

June 18-21. New England Antiquities Research Association. Providence, Rhode Island, USA. Suzanne Carlson, 2 Oxford Place, Worcester, MA 01609, USA; tel 508-752-3490; fax 401-949-5342. 14(4):14.

June 22-26. 5th International Meeting on Statistical Climatology. Toronto, Canada. F.W. Zwiers, Numerical Modeling Division, Canadian Climate Centre, 4905 Dufferin Street, Downsview, Ontario, Canada M3H 5T4.

June 22-26. International Conference on Environmental Change; sponsored by Ente Colombo '92. Genoa, Italy. General Secretariat, c/o/ Ente Colombo '92, Via Sottoripa 5, Palazzo Sera Gerace, 16123 Genova, Italia; tel 10-284111; fax 10-292693.

* June 23-25. 1992 American Chemical Society Summer Symposium: Fluorescence and Photothermal Spectroscopies. Logan, Utah, USA. Stephen Bialkowski, Depart-ment of Chemistry and Biochemistry, Utah State University, Logan, UT 84322, USA; tel 801-750-1907; fax 801-750-3390; bitnet SBIALKOW@ USU; internet SBIALKOW@ CC.USU. EDU.

July 3-5. Symposium on Subglacial Processes, Sediments and Landforms. Northern Ireland. George F. Dardis, Sedimentology and Palaeobiology Laboratory, AHEC, East Road, Cambridge, CB1 1PT, UK; fax: 0223-352973.

July 6-10. 36th Annual Meeting of the Australian Mathematical Society. Perth, Australia. W.S. Perriman, School of Mathematics and Statistics, Curtin University of Technology, Bentley, Western Australia 6102, Australia; e-mail tsiewpf@ cc.curtin.edu.au.

July 8-11. EUROBIC I: 1st European Bioinorganic Conference. Newcastle upon Tyne, UK. Dr. John Gibson, The Royal Society of Chemistry, Burlington House, London W1V 0BN, UK; tel 071-437 -8656; telex 268001; fax 071-437-8883.

* July 12-18. International Working Meeting on Soil Micromorphology. Townsville, Queensland, Australia. Colin Chartres (IWMSM), CSIRO Division of Soils, GPO Box 639, Canberra ACT 2601, Australia; tel 61-6-246-5965; fax 61-6-246-5953.

July 13-17. 10th International Conference on Solid State Dosimetry. Washington DC, USA. Dr. S.W.S. McKeever, 10th SSD Conference, Department of Physics, Oklahoma State University, Stillwater, OK 74075, USA.

* Aug. 1-14. Meeting to Focus on Global Change. Washington DC, USA. ASPRS, Don Hemenway, 210 Little Falls Street, Falls Church, VA 22046, USA.

Aug. 9-14. 15th International Conference on Organometallic Chemistry. Warsaw, Poland. Prof. Dr. S. Pasynkiewicz, Warsaw Technical University, Faculty of Chemistry, Koszykowa 75, 00-662 Warsaw, Poland.

Aug. 9-19. 27th Congress of the International Geographical Union. Washington DC. A.R. de Sousa, Secretary-General, 27th International Geographical Congress, 1145 17th Street NW, Washington DC 20036, USA.

* Aug. 16-21. 9th International Biotechnology Congress. Crystal City, Arlington, Virginia, USA. Division of Biochemical Technology, American Chemical Society Meetings, 1155 16th Street NW, Washington, DC 20036, USA; tel 202-872-4402.

* Aug. 21-30. American Quaternary Association Biennial Meeting. Davis, California. Alan Morgan, AMQUA President, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada. See announcement, this issue.

* Aug. 22-27. 206th American Chemical Society National Meeting. Chicago, Illinois, USA. ACS Meetings, 1155 16th St. NW, Washington DC 20036, USA; tel 202-872-4396.

Aug. 23-28. 21st European Congress on Molecular Spectroscopy. Vienna. E.M. Schaup, c/o INTER-CONVENTION, Austria Center Vienna, A-1450 Vienna, Austria; tel 43-222-2369-2647; fax 43-222-2369-648; telex 11 1803 icos a.

* Aug. 23-28. 3rd International Congress of Human Paleontology. Jerusalem, Israel. Patricia Smith, Organizing Secretary, c/o International Ltd., P.O. Box 29313, 61292, Tel Aviv, Israel.

* Aug. 24-29. 2nd International Congress of Mayanists. Merida, Mexico. Comité Organizador del Segundo Congreso Internacional de Mayistas, Centro de Estudios Mayas, Instituto de Investigaciones Filológicas, Circuito Mario de la Cueva, Ciudad Universitaria, 04510 Mexico, D.F., Mexico.

Aug. 24-Sept. 3. 29th International Geological Congress. Kyoto, Japan. Secretary General, IGC-92 Office, P.O. Box 65, Tsukuba, Ibaraki 305, Japan; tel 81-298-54-3627; fax 81-298-54 -3629; telex 3652511 GSJJ. 14(4):15.

* Aug. 30-Sept. 4. Australian Rock Art Conference. North Queensland, Australia. Australian Rock Art Research Association and International Federation of Rock Art Organizations. AURA, P.O. Box 216, Caulfield South, Victoria 3162, Australia.

* Aug. 30-Sept. 5. Diatom Research International Meeting. Renesse, Netherlands. International Society for Diatom Research and Nederlands-Vlaamse Kring van Diatomisten. Conference Secretariat, AquaSense, Box 41125, 1009 EC Amsterdam, Netherlands; tel 31-20-5922244; fax 31-20-5922249.

Aug. 31-Sept. 4. XIII International Congress on X-ray Optics and Microanalysis. Manchester. Mr. P.B. Kenway, Manchester Materials Science Centre, University of Manchester/UMIST, Grosvenor Street, Manchester M1 7HS, UK; tel 061-200-3581; fax 061-200-3585.

Sept. 1-7. 8th Congress of the European Anthropological Association. Madrid, Spain. Maria Dolores Garralda, Sección de Antropología, Facultad de Biología, Universidad Complutense de Madrid, Ciudad Universitaria, 28040 Madrid, Spain.

Sept. 4-6. 4th Nordic Theoretical Archaeology Group (TAG) Conference. Helsinki. TAG/Ari Siiriainen, Department of Archaeology, Univ. of Helsinki, Meritullinkatu 1 A 4, 00170 Helsinki, Finland; Internet: siiriainen@cc.helsinki.fi, EARN/Bitnet: siiriainen@finuh. 14(4):15.

* Sept. 11-13. Environmental Change Meeting. Denver, Colorado, USA. Association for Women Geo-scientists. Leslie Anne Landefeld, Barranca Resources, 16150 W. 14th Place, Golden, CO 80401, USA; tel 303-278-1292.

Sept. 14-18. International Conference on Liquid Scintillation Spectrometry. Vienna. Dr. Franz Schonhofer, Austrian Society for Liquid Scintillation Spectrometry, Schopenhauerstrasse 71/11, A-1180 Vienna, Austria.

Sept. 14-18. 20th European Meeting of Statisticians. Bath. R. Sibson, School of Mathematics, University of Bath, Claverton Down, Bath BA2 7AY, UK.

* Sept. 16-18. Biodeterioration of Archaeological Materials; sponsored by Science and Engineering Research Council/Biodeterioration Society. Portsmouth, UK. Prof. E.B. Gareth Jones, School of Biological Sciences, Portsmouth Polytechnic, King Henry Building, King Henry I Street, Portsmouth PO1 2DY, UK; tel 0705-842032; fax 0705-842070. The Bunker Memorial Lecture will be given by Bob Koestler of the Metropolitan Museum of New York. Sessions include: Agents involved in the biodegradation of archaeo-logical artifacts; Conservation techniques for waterlogged wood; Conservation/bio-deterioration of other materials.

* Sept. 20-27. Association of Preservation Technology. Philadelphia, Pennsylvania, USA.

Sept. 21-25. Paleoceanography and Global Change International Meeting. Kiel, Germany. ICP IV Organizing Committee, c/o GEOMAR Wischhofstrasse 1-3/ Building 4, D-2300 Kiel 14, Germany.

* Sept. 25-27. 23rd Annual Binghamton Geomorphology Symposium: Geomorphic Systems. Oxford, Ohio. Bill Renwick, Department of Geography, Miami University, Oxford, OH 45056, USA.

* Sept. 27-Oct. 1. American Institute of Professional Geologists Annual Meeting. Lake Tahoe, Nevada. Jon Price, AIPG, P.O. Box 665, Carson City, NV 89702, USA; tel 702-784-6691.

+ Sept. 28-30. Mediterranean River Environments. Cambridge, UK. Dr. J.C. Woodward, Department of Geography, Amory Building, Rennes Drive, University of Exeter, Exeter EX4 4RJ, UK.

Oct. 5-10. INTERKAMA 92 - 12th Market for Innovations in Measurement and Automation. Düsseldorf, Germany. Düsseldorf Trade Shows, Inc., 150 North Michigan Avenue, Suite 2920, Chicago, IL 60601, USA; tel 312-781-5180; fax 312-781-5188.

* Oct. 21-24. Southeastern Archaeological Conference. Little Rock, Arkansas. John H. House, Program Chair, P.O. Box 136, UAPB, Pine Bluff, AR 71601, USA; tel 501-535-4509. Deadline for papers and symposia proposals: Aug. 1. Dr. George R. Milner will present the keynote address, and a special tour of Toltec Mounds Archaeological State Park is planned.

Oct. 26-29. Geological Society of America, Annual Meeting. Cincinnati, Ohio, USA. Geological Society of America, 3300 Penrose Place, Boulder, CO 80301, USA; tel 303-447-2020.

* Oct. 31-Nov. 1. Two Cultures: Tradition and Change Symposium. Naples, Florida. The Collier County Museum, 3301 Tamiami Trail East, Naples, FL 33962, USA; tel 813-774-8476. Theme: Columbus Quincentennial and European Encounters in the Caribbean and Southeastern United States.

* Nov. 1-6. Soil Science Society of America Annual Meeting. Denver, Colorado. SSSA, 677 S. Segoe Road, Madison, WI 53711, USA.

Nov. 12-14. Trade and Discovery: The Scientific Study of Artefacts from Post-Medieval Europe and Beyond. Duncan Hook, Department of Scientific Research, British Museum, London, WC1B 3DG, United Kingdom. Abstracts due by May 31, 1992.

Nov. 15-20. Optical Society of America Annual Meeting/ OPTCON 92. Boston, Massachusetts, USA. OSA, 2010 Massachusetts Avenue NW, Washington DC 20036, USA.

Dec. 2-6. American Anthropological Association, Annual Meeting. San Francisco, California, USA. American Anthropological Association, 1703 New Hampshire Avenue NW, Washington, DC 20009, USA; tel 202-232-8800.

* Dec. 15-19. International Conference on Human Genetics in Celebration of the Birth Centenary of JBS Haldane. Calcutta, India. Partha P. Majumder, Anthropometry and Human Genetics Unit, Indian Statistical Institute, 203 B.T. Road, Calcutta 700 035, India.

* Dec. 27-30. Archaeological Institute of America. New Orleans, Louisiana, USA.

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Feb. 11-16. American Association for the Advancement of Science, Annual Meeting. Boston, Massachusetts, USA. AAAS, 1333 H Street NW, Washington DC 20005, USA; tel 202-326-6400.

* Feb. 28-March 5. Digital-image Processing Meeting. Kona, Hawaii USA. C.V. Freiman, Engineering Foundation, 345 E. 47th Street, New York, NY 10017, USA; tel 212-705-7835.

* March 14-18, 1993. 7th Conference on the Scientific Use of Statistical Software (SoftStat '93). Heidelberg, Germany. Abstract deadline: Aug. 1. SoftStat '93, ZUMA, Postfach 12 21 55, D-6800 Mannheim 1, Germany. Topics of special interest include: statistical programs in data analysis; interactive graphical data analysis; processing of very large data bases; cartography and geographic information systems; computer-assisted data collection.

* April 11-17. 58th Annual Meeting of the Society for American Archaeology. St. Louis, Missouri, USA.

May 15-19. Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting. Edmonton. J.W. Kramers, Alberta Geological Survey, Box 8330, Station F, Edmonton, Alberta T6H 5X2, Canada; tel 403-43807644.

July (dates unknown). Pithecanthropus Centennial: International Congress and Exhibition on the Environ-mental Context of Human Evolution. The Netherlands and Indonesia. Hans Beijer, Geological Survey of the Netherlands, P.O. Box 157, NL-2000 AD Haarlem, The Netherlands.

Aug. 9-12. Joint Statistical Meetings. San Francisco, California, USA. American Statistical Association, 1429 Duke Street, Alexandria, VA 22314-3402, USA.

Meetings (continued on p. 14)

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