FROM THE EDITORS

During the past two years, we have initiated several new features in the SAS Newsletter. Bob Maddin inaugurated the Profile section. We started a Comment section and printed several Letters to the editors. We have also tried to present more frequent Research Reports. We need to receive more contributions from you, the readers, for the entire newsletter. We are also soliciting your response to the innovations of the last two years. Your input will be of great help to Pat Martin, who will become editor of SAS Newsletter with the fall issue. Please write to us soon.

Rip Rapp   Judy Holz

RIP RAPP   JUDY HOLZ

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MEETING ANNOUNCEMENTS

The 10th Annual Conference of the Society of Ethnobiology will be held 5-8 March 1987 at the Florida State Museum, University of Florida, Gainesville. Papers are invited on the following and related topics: cultural ecology, plant and animal domestication, ethnozoology, zooarchaeology, ethnobotany, archaeobotany, palynology, ethnopharmacology, human diet and nutrition, folk taxonomy. For further information please write to Elizabeth S. Wing, Florida State Museum, Gainesville FL 32611 (telephone 904: 392-1721).

NEWS OF ARCHAEOMETALLURGY

- Dr. David A. Scott of the Institute of Archeology, London University, will give a course on the Metallography of Ancient Metals at the Conservation Analytical Laboratory of the Smithsonian Institution on 6-10 October 1986. The fee is $275 including lunches. Applications are being taken on a first-come, first-served basis. Applicants should send Martha Goodway, CAL MSC, Smithsonian Institution, Washington DC 20560 a letter with their name, address, telephone number, institutional affiliation (if any), address, job title, and a short statement of their reasons for wanting to attend and their experience in metallography. CAL supports a substantial part of the course cost, so there is a limit of ten students. Each student will be assigned a microscope and Dr. Scott will bring more than 200 prepared specimens of archaeological metals for practice in metallographic interpretation.

- Professor K.T.M. Hegde of Baroda University was Visiting Fulbright Professor this spring in the Center for Archaeological Research and Development (CARD) at Harvard. Professor Hegde lectured there on Ancient Indian Zinc Distillation Technology in reference to the recent excavations he took part in at Zawar, near Udaipur. The majority of the discarded retorts that litter the ground there are of 19th-century date. Professor Hegde also discussed parallels between the traditional Indian zinc distillation process and Champion's patent of 1747.

- The Society for the History of Technology (SHOT), the History of Science Society, the Philosophy of Science Association, and the Society for the Social Studies of Science (4S) will hold their annual meetings jointly in Pittsburgh on 23-26 October.

- The seventh annual Lowell Conference on Industrial History will meet October 30 - November 1 in Lowell MA. The theme will be "Politics and Industrialization." For information write Robert Weible, Lowell National Historic Park, 169 Merrimack Street, Lowell MA 01852 or telephone him at (617) 459-1027.

- Those who are interested in publishing a paper in Archaeomaterials should write the editor, Dr. Tamara Stech, at the University Museum, 33rd and Spruce Streets, Philadelphia PA 19104, or call her at (215) 898-4062.

- If you have archaeometallurgical news to contribute, please call Martha Goodway at (202) 287-3733 or write her at CAL MSC, Smithsonian Institution, Washington DC 20560.

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EVALUATING PREHISTORIC CERAMIC CLAYS

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and
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Department of Mineral Sciences, Smithsonian Institution

Since the late 1970s emphasis in ceramic research has been shifting to studies of production. The attempt to understand the supply side of a trade network and how it is organized brings archaeologists face-to-face once again with aspects of prehistoric technology. Reconstruction of production involves understanding how people used technology, including how and why resources were selected and processed. Reasons for choice of resources relate to technological sophistication as well as to product specialization within and between communities. These issues are intimately connected with decision making in ceramic manufacture and the subsequent organization of production.

Much current ceramic technology research focuses on the rationale behind the selection of temper types with respect to how they influence the suitability of vessels for specified functions. Prehistoric clays, however, have proved to be more difficult to evaluate since many characteristics that influence their selection and preparation are not directly measurable in the fired ceramic. For example, we know that different mineralogical clay types vary in their workability, shrinkage, and firing characteristics; however, mineralogical analysis of fired pastes is seldom conclusive about technological limitations of the original clay because firing transformations and the presence of impurities make identification of original clay mineral difficult.

One way to enhance our understanding of criteria for clay selection is to examine the major and minor element chemistry of the fine-grained matrix of the pottery. Such compositional data bear directly on the physical properties of the finished product because they determine the nature of the reactions that occur in the firing process. Clays are mixes of constituents--clay minerals and other mineral and organic impurities--in varying particle sizes. In particular, the constituents in the clay- and silt-size fractions in the clay determine the effective firing ranges for producing strong, impermeable ceramics because even at relatively low temperatures the fine fraction is likely to undergo firing alterations. For example, a refined kaolin approaches the composition of pure kaolinite. A kaolin ceramic is quite refractory, with a softening point of around 1700°C. With the addition of impurities, either in the crystal structure of different clay minerals or in other constituents in the clay- and silt-size fraction of a deposit, oxides are available to act as fluxes when the material is fired. The proportions of each of these oxides relative to alumina, and the relative proportions of each within clay bodies differentiate the materials' responses to heat, dictate the firing parameters of each clay, and permit us to distinguish clays as technological "types" based on similarities in response and final properties under similar firing conditions.

We have found it useful in comparing and evaluating the technological characteristics of clays to express the compositions as ratios of oxides to alumina. It is not the absolute amount of flux in a clay that determines its effect in firing, but rather its abundance relative to alumina. Similarly, the relationships among the different fluxes are affected by their proportions relative to alumina. To illustrate the differences among commercial clays used for different purposes, and with different firing parameters, patterns of oxide-alumina ratios for specimens of several commercial clay types are illustrated in Figure 1. The patterns characterize the clays as technological resources. Silica-alumina ratios are also important in understanding the firing behavior of clays, but the ratios are not included in the diagram because they are of a much greater magnitude than the other ratios.

Each of the commercial clays has a discrete set of firing parameters that can be assessed roughly from the distinctive pattern. Fire clay is most similar to pure kaolin. It has very few fluxes and thus is a refractory material, also requiring temperatures in excess of 1670°C to fuse. Sewer pipe and brick clays are similar in their functional requirements, but the former has a longer firing range due to less CaO. The distinctions are important for modern specialized commercial purposes and are reflected in the different ratio patterns. Because of their high amounts of NA_2O and K_2O, these red-burning clays will vitrify between 890° and 1150°C; this is essential for use of the wares. Although bentonite is readily fusible due to the high amounts of all fluxes, it is seldom used alone as a clay body for commercial purposes because it is very sticky and has too great a drying shrinkage. It is often added to other clay materials and used in glazes where its CaO-related glass-forming properties are desirable. Its firing properties are also distinctive from the other clays illustrated here.

Prehistoric ceramics, of course, generally have more heterogeneous bodies than commercially made wares because of tempering and restricted refining. Nonetheless, by limiting chemical analyses to the fine fraction we can understand the relative technological merits of the clays employed and the potters' successes in obtaining maximum results from their materials. Nonplastics obviously are important, but their significance in the firing process is better assessed when firing characteristics of the clay matrix are known.

In our research we have been able to avoid to a considerable extent the temper component of ceramic pastes by using electron microprobe analysis of ceramic thin sections. The ARL microprobe in the Dept. of Mineral Sciences at the Smithsonian is ideal for the technique because it is possible to analyze for nine elements simultaneously. Using a defocused electron beam, a large area of clay matrix can be analyzed by moving the beam in traverses that avoid inclusions larger than approximately 60 microns in size. In cases where large inclusions are too abundant to scan effectively, a series of spot analyses can be performed. In each case, ten 10-second counts are used to sample different areas of the thin section to obtain an average composition of the ceramic matrix. The results are expressed as percentage compositions of the following oxides: Al_2O_3, SiO_2, FeO, MgO, CaO, K_2O, Na_2O. The composition data are used to calculate the oxide ratios for evaluating the prehistoric ceramic clays. We expect these clays to show more variation than commercially refined ones, but by comparing patterns we can evaluate the firing potential of the prehistoric clays and determine whether prehistoric pyrotechnology and product function were well-matched with the clays chosen.

In Figure 2, patterns for several pastes from prehistoric Southwestern ceramics are illustrated. The ratios are similar to the sewer pipe and brick clays in the amount and mixes of most of the oxides. These clays are suited to the upper limits of open-firing, as long as the CaO is involved in the fusion sufficiently to prevent the formation of quicklime. In fact, the high amount of CaO makes the clay unsuitable for uncontrolled firing much above 1000°C because of its very limited firing range. Furthermore, the presence of so much calcium oxide affects the color development of the iron oxide in oxidizing firings. Even at low firing temperatures, WM 24 would be harder fired due to its higher alkali ratios and its color development under oxidation conditions would be redder. The CaO should be more readily taken into the fusion as well. These patterns suggest that the physical differences observed among the sherds are caused by characteristics of the original clays rather than variations in firing schedule.

The variation observed in the patterns also raises questions about access to clays. These ceramics are from one small hamlet representing a short period of occupation and manufacture. Multiple patterns in pastes from this small unit suggest that there is no significant technological discrimination being practiced in the choice of resources. To address this question, we undertook extensive survey and sampling of clays in the area. These also were analyzed by microprobe to determine how much variability existed in the local resources. The data were plotted for comparison with the clays; Figure 3 illustrates examples of clays from the three clay-bearing formations around the site. First, it can be seen that clays from the Mancos Formation and those associated with the Dakota sandstones represent discrete types in terms of their technological limitations. Furthermore, these types are not present in the analyzed pastes. Since these clays were not used, some selective exploitation occurred. The low amounts of fluxes in the Dakota-associated clays make them very refractory, whereas the high amount of CaO counteracts the low-temperature fluxes in the Mancos clays. Further, the Mancos clays are highly lithified and require special preparation for use. Clays from the Morrison formation are much more variable than those from the other two formations, but in no case do their variations reproduce the patterns of the Mancos or Dakota clays. Although there are no exact matches with the ceramics, the clay patterns are technologically consistent with those of the ceramics.

It must be emphasized at this point that we are not presenting a sourcing technique. We wish to see which clays in the area show the same potential technological characteristics and compositional patterns as those found in the ceramics. If potters were using local clays, it is likely that they mined these materials from the heterogeneous Morrison clay lenses rather than from those of the Dakota or Mancos formation; only the Morrison clays share similarities in patterns and potential firing responses with the ceramics. Precise sourcing would be more complex.

The value of the analysis lies in the interpretations that can be made about production. First, even at this level of small-scale domestic production, discrimination among clay resources was practiced. Given the variety of clay types available in this locale, potters consistently chose those clays with compositions best suited to the primitive low-temperature, open-firing technology. Second, apart from the predominant pyrotechnological considerations, there was no restriction in access to deposits, nor was there standardization in the use of clay beds by potters from the same hamlet. The patterns shown represent ceramics of the same utilitarian class; the variation indicates that except for possible differences in workability, most Morrison formation clays were roughly equivalent for the technology and range of uses of the fired ceramics.

Note and Acknowledgments

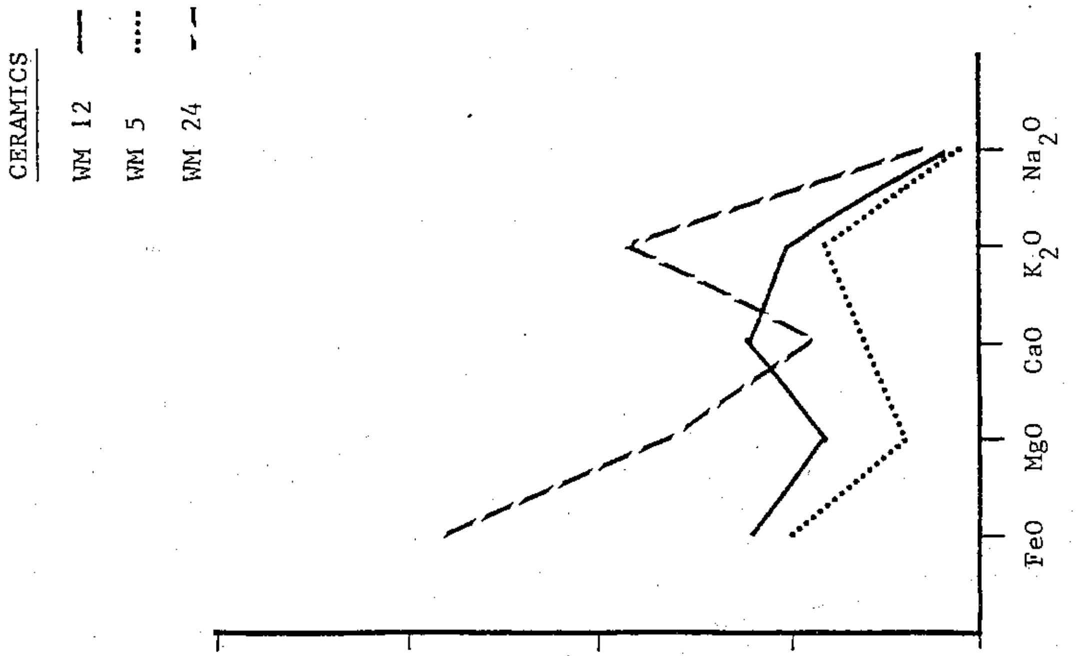
A more detailed discussion of the methodology and results for the Southwestern ceramics is forthcoming. Data for Figure 1 were taken from McNamara, 1938.

We would like to thank the following people at the Smithsonian Institution for their assistance in various stages of the project. Richard Johnson and Frank Walkup prepared the ceramic thin sections. Eugene Jarosewich and Joe Nelen assisted with the electron microprobe analysis and the clay sample fusions. Dorothea De Atley prepared the clay samples for analysis. David Madsen of the Utah Historical Society provided the ceramic assemblages.

Reference

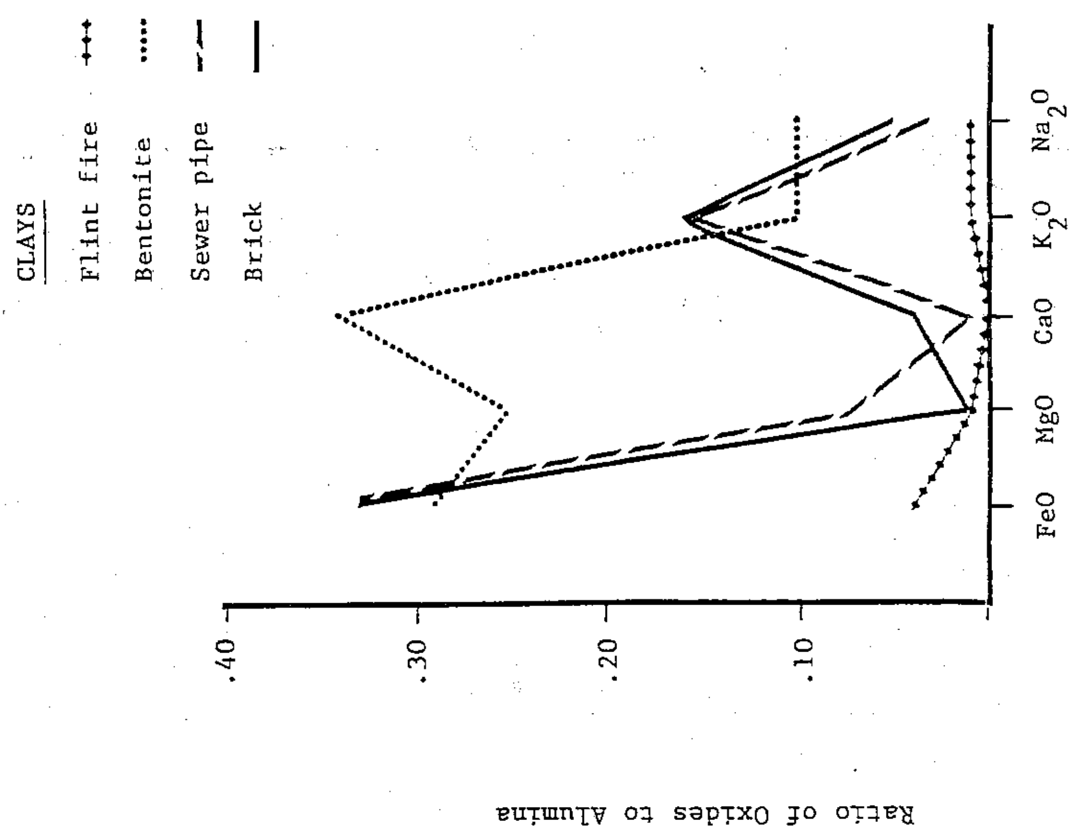
McNamara, Edward P. 1938. Ceramics, Vol. II, School of Mineral Industries, The Pennsylvania State College, p. 34.

Figures 1,2,3 follow on pages 6 and 7.



PREHISTORIC CERAMIC PASTES

Figure 2



COMMERCIAL CLAYS

Figure 1

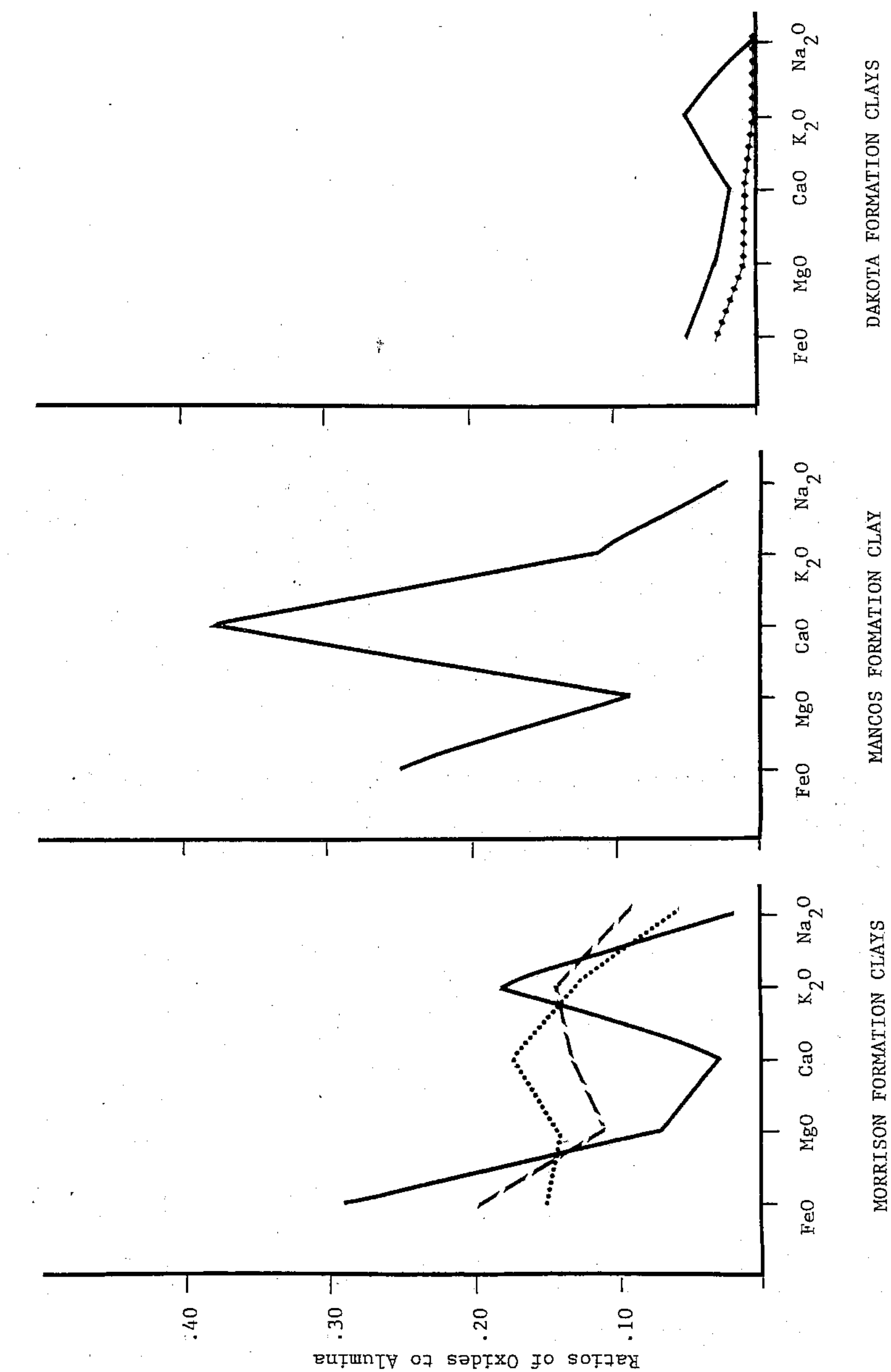

DAKOTA FORMATION CLAYS
MANCOS FORMATION CLAY
MORRISON FORMATION CLAYS
FeO
MgO
CaO
K_2O
Na_2O
.40
.30
.20
.10
Ratios of Oxides to Alumina

Figure 3

SAS CONFERENCE REPORT

BONE CHEMISTRY AND PAST BEHAVIOR

A Research Seminar at the School of American Research
Santa Fe, New Mexico: 2-8 March 1986

T. Douglas Price
University of Wisconsin-Madison

A number of problems persist in prehistoric research that have been difficult to resolve with traditional methods of analysis. Questions regarding diet and subsistence -- as they relate to sources of food, activities, status, trophic position, etc. -- have been particularly intractable. Archaeological sites seldom contain a reliable record of subsistence; plant remains are seldom recovered and animal bones are differentially deposited and preserved. Today, however, new methods involving the chemical analysis of prehistoric human bone promise answers to these long-standing questions. These techniques utilize both the isotopic and elemental composition of bone to look for traces of marine foods in the diet, the relative proportion of plants and animals in subsistence, or the utilization of certain species of plants, such as corn.

The study of prehistoric bone is an exciting frontier of archaeological research at the boundaries of chemistry, physical anthropology, and archaeology. A recent seminar at the School of American Research in Santa Fe, New Mexico was the focus of discussions among international specialists on the subject of prehistoric human bone and past behavior. The group included George Armelagos of the University of Massachusetts, Jane Buikstra of Northwestern University, Pamela Bumsted of Los Alamos National Laboratory, Brian Chisholm of Simon Fraser University, Jon Ericson of the University of California-Irvine, Joseph Lambert of Northwestern University, Douglas Price (Organizer and Chair) of the University of Wisconsin-Madison, Margaret Schoeninger of Harvard University, and Andrew Sillen and Nikolass van der Merwe of the University of Cape Town.

The presence of these specialists from diverse fields provided a fertile atmosphere for both the resolution of certain questions and for the development of new research directions. The seminar format involved the brief presentation of research papers and the lengthy discussion of a variety of issues raised by those papers. The scientific papers and a summary of the consensus conclusions of the seminar will appear in a volume to be published in the School of American Research seminar series by Cambridge University Press.

Discussions concerned both the practical and theoretical connections between chemical measurements of bone and past human behavior. Changes in prehistoric human diet were a major topic of discussion, including the nature of early hominid subsistence and the evolution of human subsistence -- e.g., male vs. female diets, marine vs. terrestrial foods, the importance of plants vs. meat in the diet, and the transition to agriculture. The significance of prehistoric bone as a signal bearer for indicators of past climate and environment was also emphasized.

The more important aspects of the seminar discussions concerned problem areas in this new field: the development of comparable procedures for analysis, the utilization of interlaboratory reference materials, and the determination of additional sources of variation in human bone, with particular emphasis on post-depositional chemical changes. Comparability in methods of analysis and in the reporting of results will be major steps toward more useful and productive investigations. The seminar sent to the National Bureau of Standards its agreement on the use of a common reference material for all labs and a request for the development of a bone tissue standard.

There was consensus at the seminar that too little is known regarding the sources of variation in the composition of human bone. Although it is clear that environment and diet are major contributors, other biological and natural factors are also important. Differences within a population due to metabolism, age, gender, and reproductive status need to be investigated more thoroughly. Variability within a single bone, between teeth and bone, or within the skeleton of a single individual are also important areas for investigation. Diagenetic changes are apparent in most studies of prehistoric bone and cannot be ignored. It is clear that evidence from a variety of archaeological contexts must be considered in order to understand the effects of diagenesis on the reconstruction of past diet. Methods for the measurement of diagenetic change, including emphasis on a multi-element approach, were considered at the seminar. New directions for research include the examination of other elements and isotopes as potential indicators of past diet and behavior. Several recommendations resulted from the seminar, including a request to the National Science Foundation for the establishment of well-equipped, regional laboratories of archaeological chemistry around the country. One or more of these facilities should be equipped with a dedicated mass spectrometer for the examination of isotopic variation in archaeological bone and other materials.

It is apparent that the study of archaeological bone chemistry is at a turning point, in transition from an experimental procedure to a major research technique. Certainly there is justification for enthusiasm about the potential of this methodology to provide greater resolution for our views of the past. The seminar at Santa Fe may well have provided the essential groundwork to insure that such investigations move on firm footing and in exciting new directions. □

STEREOLOGY COURSE

Stereology is the study of three-dimensional structures as revealed in two-dimensional images. It is particularly useful with images from the light microscope and both transmission and scanning electron microscopes. However, much of the stereology literature has remained largely inaccessible to the casual worker because it is perceived as heavily mathematical and intimidating. This course introduces the principal methods of stereology in ways that encourage its practical use. The course will cover three main topics: manual methods, computer-assisted methods, and new developments in areas related to stereology but not part of its mainstream.

The course will be held 13-17 October 1986 at NCSU's McKimmon Center for Continuing Education. There will be four hours of lectures spread through each day from Monday morning through Friday noon, with the remaining time available for both structured and individual laboratory work. Lodging is available at the Mission Valley Inn, adjacent to the campus, with shuttle bus service provided. Tuition includes all course materials, as well as lunches. Registration will be limited to permit maximum hands-on use of laboratory equipment, and to keep lecture and discussion groups small for maximum benefit to the participants. Information on registration, tuition, and lodging is available from Dr. Bruce Winston, Department of Continuing Education, McKimmon Center, North Carolina State University, Box 7410, Raleigh, NC 27695 (or telephone 919-737-2261).

SAS RECENT PUBLICATIONS

Vance T. Holliday
1985. Archaeological geology of the Lubbock Lake Site, southern High Plains of Texas. Geological Society of America Bulletin 96:1483-1492.

Vance T. Holliday, Eileen Johnson, Herbert Haas, and Robert Stuckenrath
1985. Radiocarbon ages from the Lubbock Lake Site:1981-1984. Plains Anthropologist 30:277-291.

Michael Ripinsky
1985. The camel in dynastic Egypt. Journal of Egyptian Archaeology 71:134-141.

REQUEST FOR COOPERATION

The Conservation and Protection Committee of the American Rock Art Research Association (ARARA) is compiling a directory of experts on matters related to the conservation and protection of petroglyphs and pictographs. Rock art is deteriorating at many sites through natural or human means. Each situation varies; a wide range of expertise may be needed for one site. Anyone who can contribute to the directory or who would like to be involved in the conservation effort should write to ARARA, Box 1539, El Toro, CA 92630.

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