FROM THE EDITOR

A year or so ago I began compiling and distributing a Directory of Graduate Programs in Archaeological Geology and Geoarchaeology. The November 1984 edition describes graduate programs in fifteen universities. If you would like a copy please write or call (College of Science and Engineering, 108MG, University of Minnesota, Duluth MN 55812 - (218) 726-7201).

Joe Lambert and I believe that it may be valuable to students and faculty to have an analogous Directory of Graduate Programs in Archaeometry and Archaeological Science. Please let us know if you agree (or disagree).

In the process of having the research report in this issue reviewed, it became apparent that many archaeometrists with a statistical bent disagreed with the author of the report. I hope interested parties will write their views. These will go in a new COMMENT section of the newsletter. Let us hear from you on these issues!

Rip Rapp

RIP RAPP

SAS NEWSLETTER

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For inquiries concerning change in addresses, information from membership records, and other business affairs, contact: Office of the General Secretary, SAS, Radiocarbon Laboratory, Department of Anthropology, University of California, Riverside, California 92521 U.S.A.

SAS

MEETING ANNOUNCEMENTS

ARCHAEOLOGICAL INSTITUTE OF AMERICA

The **Archaeological Institute of America** (AIA) intends to have a "Science Exhibit" at its 1985 annual meeting 28-30 December 1985 in Washington, D.C. A few years ago AIA and the Association For Field Archaeology (AFFA) jointly held a successful "science fair" exhibit at the AIA meetings. Exhibits included scientific instrumentation (e.g., geophysical prospecting instruments), poster results of archaeological science investigations, and microcomputer analysis and display of data. SAS members and others interested in participating in the science exhibit at the AIA meetings please contact **Rip Rapp, College of Science and Engineering, University of Minnesota, Duluth MN 55812 (218) 726-7201.** Unfortunately, no funds are available to underwrite costs for this exhibit.

ROUND TABLE

As part of the activities of the Commission for Nomenclature of Bone Industries, under the direction of **M. Camps-Fabrer, Working Group No. 1**, "Unspecialized Bone Industries," is holding its Second Round Table at the Institut de Paleontologie humaine (1, rue R. Panhard 75013 Paris, FRANCE), 8-10 May 1985.

A publication containing papers presented at the First Round Table, held in 1984, will be available in March 1985.

For further information, contact **Marylene Patou (co-director with Professor E. Aguirre of the working group), at the Institut de Paleontologie humaine, 1, rue R. Panhard, 75013 Paris, FRANCE, telephone (1) 331-6291.**

PHYTOLITH CONFERENCE

The second **Phytolith Research Conference** will be held in Duluth, Minnesota, **27-28 April 1985**, at the University of Minnesota-Duluth. Rip Rapp and Sue Mulholland of the Archaeometry Laboratory will host the meeting. Papers on phytoliths in plants and archaeological sediments are scheduled for the morning sessions. Afternoon sessions will be devoted to microscope presentations and panel discussions.

PHOTO ALBUM

PHYTOLITHS

PHOTOS COURTESY OF THE ARCHAEOMETRY LABORATORY UNIVERSITY OF MINNESOTA-DULUTH

DUMBBELLS FROM ARUNDO DONAX

ROD FROM AGROSTIS SCABRA

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CLUSTER ANALYSIS - INTERPRETING CHEMICAL ELEMENT DATA FROM ARCHAEOLOGICAL CERAMICS

Vincent J. Robinson
Department of Chemistry
University of Manchester, M13 9PL, U.K.

It is now well known that variations in chemical elements in ceramics provide powerful, often definitive, information on provenance. One can obtain a vast amount of data by measuring up to about 30 elements in hundreds of sherds, but reducing this data to manageable proportions is a major problem. A number of statistical techniques may be used, the most popular being discriminant analysis and cluster analysis. In our own work, we have come to believe strongly that cluster analysis is by far the best method available, although it is by no means a complete solution.

Cluster analysis attempts to assess similarities between sherds by comparing element concentrations. Sherds with similar concentrations are then grouped together into clusters. Ideally, concentrations within each cluster cover a narrow range, but large differences are exhibited between clusters.

Why can this not be done by eye? In simple cases, visual inspection can indeed reveal group structure, but a large number of elements - up to 30 per sherd - makes a purely visual approach a practical impossibility. A more serious objection, though, is the need for an objective criterion for assessing the importance of one element versus another. Consider the following table showing concentrations of two elements in three sherds:

Element	A	B
Sherd		
1	High	High
2	High	Low
3	Low	Low

Should we combine sherd 2 with 1 or 3? It depends on the relative importance we give to A and B in assessing overall similarity. (This apparently simple problem is fraught with complications too involved to treat here; they are dealt with in a paper submitted to the Journal of Archaeological Science.) Cluster analysis - and indeed all methods of statistical analysis - will implicitly make choices about weighting elements, and it is not surprising that altering these weightings can completely change the outcome of the statistical analysis. There is no completely objective method of choosing these weightings, so such analyses must be undertaken with utmost care.

What is the difference between cluster analysis and other methods? In cluster analysis, groupings are entirely defined by trace element concentrations; there is no archaeological input apart from the obvious but important initial choice of sherds. Thus there is no requirement that groupings produced by cluster analysis bear any relation to archaeological preconceptions about which groups might be present. As a result, cluster analysis can produce new information - e.g., new groupings whose archaeological significance is only apparent after analysis. Sometimes groups appear that have no apparent archaeological significance, even though cluster analysis has been carried out carefully and correctly. This effect may be due to lack of

archaeological knowledge about the sherds; obviously, it is important to know as much as possible about the sherds to be analyzed.

Most other methods of statistical analysis (including discriminant analysis) require some guesses about the groupings thought to be present. These methods are much less critical than cluster analysis in questioning archaeological preconceptions.

Cluster analysis is as easy to use as a "black box"; the CLUSTAN package, for example, contains most of the useful routines, although there are still some problems. Some guidelines we would suggest: 1) Choose the sherds carefully; 2) Check the precision of the concentration measurements by rechecking a few (10%) of the sherds several times; 3) Use cluster analysis - preferably Ward's method, and the RELOCATE procedure in CLUSTAN - but be prepared to look critically at the weighting factors of individual elements. For example, a population that contains "outliers," or has very disparate groupings along with rather similar groupings, is likely to give anomalous weightings to some elements and distort the final grouping patterns.

A method that works well in practice is one we call "fuse and divide." The population is "fused" down to a single cluster using Ward's method. From the resulting dendrogram, we can identify "outlying" individuals or small groups. These are removed and the cluster analysis is repeated. If the population is now clearly divided into major groups, (for example, two or three) these are then separated and analyzed individually to check for any further structure within them, and so on. The validity of groupings obtained from Ward's method should always be verified using the more reliable RELOCATE procedure. The final limit of the division process is reached when groups are too small (less than about six sherds) or when element concentrations are too similar to allow for meaningful separation.

How good is the provenance information that can be obtained? Our experience suggests that, given a reasonable variation in geochemical composition in the region under study, one can distinguish clay sources as close as ten miles apart. It is not always possible to do this - with early material, for example, the manufacturing technology was often not good enough to produce sherds of the requisite homogeneity. But the method does suggest that trade/exchange patterns can be studied over smaller areas than previously.

Although cluster analysis has limitations, it is the best statistical method we have. The main difficulties have already been alluded to, but to illustrate what can be achieved, I point to our study of Roman amphorae from North Africa in which we have found over fifty independent and separate groupings. I am sure there is no other method by which such a complex population could have been analyzed.□

Dr. V. J. Robinson, this issue's research reporter, was born in Liverpool, England. He received his B.Sc. (Honours Chemistry) in 1959 from Liverpool University and completed his Ph.D. in 1964. After a few years in the chemical industry, Dr. Robinson taught at Liverpool Polytechnic. Since 1967 he has taught at Manchester University. Robinson's research interests involve several areas of nuclear science, including high energy (heavy ion) nuclear interactions and radiation effects in crystalline solids. He is now part of a research group including five graduate and post-doctoral scientists, most working on archaeological projects mainly from Mediterranean sites. Robinson finds his subject stimulating because "it is a real-life scientific detective story and because I much enjoy cross-disciplinary interactions with ceramic archaeologists, geologists, and statisticians."

NEWS OF ARCHAEOMETALLURGY

■ A conference on copper and bronze analysis, with an excursion to a mining site of the bronze age is being planned for September in Schladming, Austria. For information write **Dr. Gerhard Sperl, Erich-Schmid-Institut fur Festkorperphysik der Osterreichischen Akademie der Wissenschaften, A-8700 Leoben, Austria.**

■ **Parks Canada** has published **A Frontier Fur Trade Blacksmith Shop 1796-1812** by **John D. Light and Henry Unglik** (Ottawa, 1984, ISBN 0-660-11652-9). Most of this 130-page publication deals with Unglik's metallographic study of axes and his examination of slag and iron found at Fort St. Joseph, Ontario. The publication can be obtained from the **Canadian Government Publishing Centre, Supply and Services Canada, Hull, Quebec, Canada K1A 059** for $7.45 in Canada, $8.95 elsewhere.

■ **Dr. John Stubbles'** The Original Steelmakers has been published by the Iron and Steel Institute of AIME. Dr. Stubbles' address is **Research Center, LTV Steel, 6801 Brecksville Road, Independence OH 44131, telephone: (617) 524-5100X213.**

SPECIAL INTEREST

FLINTKNAPPING SCHOOL

The Flintknapping Fieldschool, started by Dr. Don Crabtree in the late 1960s, has been conducted for the last five years in the Sawtooth National Forest of central Idaho under the direction of Dr. J. Jeffrey Flenniken. In this scenic environment of Lodge Pole pines, trout streams, and glacially carved mountains, students study lithic technology eight hours a day, six days a week for four and a half weeks. In addition to the regular content of the course each student brings to class his or her particular expertise in lithics. Add to this the actual practice of flintknapping and the result is an intensive learning experience that cannot be duplicated anywhere else.

The school is offered through the Department of Anthropology, Washington State University. Based on a letter of interest, vita, and two letters of recommendation, seven students will be selected to attend. Each student applicant should currently be a gradu-ate student or have been accepted by a graduate program beginning fall 1985. Individuals with advanced degrees or employed as anthropologists/archaeologists are encouraged to apply.

The Fieldschool will begin 12 June and end 15 July. A tent camp including all necessary equipment will be provided by Washington State University. Each participant must supply a sleeping bag and clothes suitable for outdoor work. Cost is $65 per credit hour (the class is four credit hours) payable to Washington State University, plus a $400 special fee (to cover tool kit, raw materials, guest knappers, vehicle, fieldtrips, etc.). Send applications to **Dr. J. Jeffrey Flenniken, Department of Anthropology, Washington State University, Pullman, Washington 99164-4910.**

DEADLINE FOR SUMMER NEWSLETTER 15 MAY 1985

SAS

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STATE SOILS LAB UW-MILWAUKEE

HEAVY METAL (AA) ANALYSIS CAPABILITY FOR:

Element	Cost/Sample	Element	Cost/Sample
Zn (zinc)	3.00	W (tungsten)	6.00
Cd (cadmium)	3.00	Ag (silver)	6.00
Mg (mercury)	6.00	Al (aluminum)	3.00
Cr (chromium)	3.00	K (potassium)	3.00
Fe (iron)	3.00	Ca (calcium)	3.00
Ni (nickel)	3.00	Mg (magnesium)	3.00
Cu (copper)	6.00	Na (sodium)	3.00
Mo (molybdenum)	3.00	Mn (manganese)	6.00

ACCURATE CEC (Kjeldahl method, cation exchange capacity) ANALYSIS

CUSTOM RESEARCH LAB WORK (sieve analysis, texture analysis, phosphate fractionation, total phosphate, etc., for archaeological and other soil analysis)

For information, contact: UWM-UWEX State Soils Lab, Sabin Hall 371, UW-M, Milwaukee WI 53211, or phone (414) 963-4862 or 963-4894.

Test	Charge/Sample
Routine-pH, phosphorus, potassium organic matter, hand texture, soluble salts	4.00
Physical analysis	5.00
Ca and Mg (available)	3.00
Ca and Mg with CEC approximation	3.50
Accurate CEC (Kjeldahl)	5.50
Water soluble nitrate	2.00
Farm soils	3.00
Farm soils + Ca and Mg with CEC	6.00
Sieve analysis (extra charge of 0.25¢/sieve) for more than 5 sieves	2.00
Phosphate fractionation	25.00
Atomic absorption analysis for Zn, Pb, Cd, Cr, Fe, Ni, Mo, Co, Al, K, Ca, Mg, and Na	3.00 each
Atomic absorption analysis for Hg, Cu, W, Ag, and Mn	6.00 each

Results delivered in less than 5 days. For rush orders (2 days) please call: (414) 963-4894 or 963-4862.

REQUEST FOR COOPERATION

Melvyn D. Card is working in organic residue analysis in archaeology and is interested in contact with laboratories in the U.S. and Canada working on similar problems. Contact him at 17, Chrismund Way, Great Tey, Colchester, Essex, C06 1AZ, ENGLAND.

RECENT PUBLICATIONS

ARCHAEOLOGICAL GEOLOGY

Archaeological Geology, edited by **George Rapp, Jr. and John A. Gifford.** New Haven: Yale University Press, 1985, 435 pages, $35.

This volume of fourteen papers plus an extensive bibliography illustrates the scope of research at the disciplinary boundary between geology and archaeology. Archaeological Geology is the first general reference work demonstrating the wide range of application of geologic techniques to archaeology.

ANTHROSOLS

Robert Eidt, Department of Geography, University of Wisconsin-Milwaukee, has two recent publications:

1) **Advances in Abandoned Settlement Analysis: Application to Prehistoric Anthrosols in Colombia, South America.** 1984. University of Wisconsin-Milwaukee.

2) **Field and Laboratory Analysis of Anthrosols.** (Available from the State Soils Lab, Sabin Hall 371, UW-M, Milwaukee WI 53211.)

Eidt is also the author of a chapter on anthrosols in Rapp and Gifford: Archaeological Geology.

LABORATORY EXERCISES

Laboratory Exercises for Introduction to Archaeology
by **George Rapp, Jr., Susan Mulholland, John Gifford and Stanley Aschenbrenner.** Archaeometry Laboratory, University of Minnesota-Duluth, 1985, 132 pages.

This volume and the accompanying Instructor's Manual present seven laboratory exercises taught as part of an Introductory Archaeology course (freshman level). Topics covered include map use, dating by dendrochronology and pottery seriation, human and animal bone and rock identification, and a simulated archaeological excavation using a computer program. A "hands-on" approach is emphasized.

SAS

MEMBERSHIP TRIVIA

During the International Symposium on Archaeometry and Archaeological Prospection, held in March 1977 at the University of Pennsylvania in Philadelphia, five members of the SAS Acting Executive Board met to lay the groundwork for the formal organization and development of the society.

The society's principal concern was (and is) to encourage interdisciplinary collaboration and cooperation. SAS's primary goal was to provide a professional society for those involved in the broad spectrum of physical science applications in archaeology. Specific goals included the establishment of a forum for presentation and discussion of current issues and advances in the field; provision of information; promotion of interdisciplinary research designs in archaeology; maintenance of high technical standards and conduct; and cooperation with other archaeological associations and societies.

SAS originated with 100 charter members who joined between March and July 1977. The first SAS Newsletter, edited by Erv Taylor, appeared in Summer 1977. In the past eight years SAS has grown substantially; the society now numbers 400-500 members, many from outside the U.S. New members are welcome; the only prequisite for membership is an interest in archaeometric research.

SAS
University of Minnesota, Duluth
SOCIETY FOR ARCHAEOLOGICAL SCIENCES
College of Science and Engineering, 108 MG
10 University Drive
Duluth, Minnesota 55812-2496

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