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SAS News

The King is Dead ... ... Long Live the King!

At the annual business meeting in St. Louis this past April, the presidency of the SAS changed hands. Here are perspectives on the state of the Society from the outgoing and new presidents.

Past President's Message
James Burton

The past two years have been a big transition for the SAS. Members who have been with us during this transition will probably most notice now receiving the *Journal of Archaeological Science*, along with an enormous increase in membership fees. We had great concern that this fee increase would cause a serious membership loss. Fortunately, new members wishing to receive *JAS* compensated for lost memberships. But we still wear the albatross of trying to balance increasing journal costs with the need to avoid further dues increases (90% of which is used for the *Journal* and the *Bulletin*).

You may have additionally noticed that the *Bulletin* has significantly expanded compared to a few years ago: more news, reviews, conference reports, even listing job opportunities in archaeometry! Reading the *Bulletin*, you hopefully noticed other SAS activities that are the fruits of years of planning and preparation.

The first of the series, *Advances in the Archaeological and Museum Science*, published by the SAS through Plenum Press, is now in print. The second volume, *Science and Technology in Historic Preservation*, is in progress, and others are being planned. For more information see the previous *Bulletin* issue, Vol. 16 (2).

As Internet and electronic mail become increasingly profound means for the dissemination of information, the SAS has organized SAS-net (archsci@fandm), an electronic network of archaeological scientists, and SAS-depot, an Internet-accessible facility for information storage and retrieval. If you are not using these or other Internet facilities, you should be! *SAS Bulletin*, Vol. 14(4) has instructions for using SAS-net and SAS-depot.

The SAS-sponsored symposium at this year's Society for American Archaeology meeting in St. Louis was well

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President's Message
Ervan G. Garrison

The Society of Archaeological Sciences now enjoys the benefit of an excellent journal to go with an excellent newsletter. Our outgoing President certainly deserves credit for these and other contributions to the SAS that came on his watch. I hope I can point to something as substantive at the end of my term. At this time I am busy promoting SAS through the vehicle of professional conferences - first, our participation in the Plenary Session of the 1994 Conference for Historical and Underwater Archaeology by virtue as my role as Plenary Chair and second, as organizer of a conference on Archaeometry in the 21st Century. The archaeometry conference proposal is currently before the administration of my academic home - the University of Georgia. I hope to have good news to report by the fall as to its funding. SAS did well in sponsoring the symposium at the Society for American Archaeology meeting in St. Louis. I heard numerous

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In This Issue

Technical Report: Selecting a Resistivity Meter

Bruce Bevan
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Resistivity meters are excellent for locating a wide variety of underground features, including stone or brick rubble, and they will also detect refilled pits or trenches. They give good results at a greater number of archaeological sites than will any other geophysical instrument. If you are interested in beginning your own geophysical surveys, a resistivity meter should be your first purchase. These instruments can be relatively inexpensive and surveys with them are rather easy to do. The following notes will give you information about the different resistivity meters which are available for sale or rental. Approximate prices are given in US dollars; the least expensive meters are listed in the first section. Later sections of this report outline some of the procedures for doing resistivity surveys; the topics will become increasingly complex later.

In the SAS Bulletin 14(4), Oct.-Dec. 1991, Bruce Bevan provided some practical tips on what types of field magnetometers are available, and how to choose/buy the one best suited for your survey needs. Here he does the same for electrical resistivity and electromagnetic conductivity meters. Together, these methods comprise the most widely used geophysical survey methods at archaeological sites.

INTRODUCTION

Earth materials vary widely in electrical resistivity. Moist, saline, clayey, or humic soil has a low resistivity; electrical current readily flows though it. Dry, sandy, rocky, or porous earth is the opposite and has a high resistivity. A resistivity meter easily detects the difference between these types of soils. A map showing these contrasts can provide a good guide for your excavation planning.

You can buy a resistance meter in a store which sells electrical supplies; modern versions of these are called digital multimeters. Unfortunately, these meters cannot be used for your geophysical survey. These meters have two wires which connect to the measurement points; you need a special meter which has four connections and wires. Each of these four wires goes to a metal electrode which is driven into the soil to a shallow depth.

There are three related types of resistivity survey which you can do. The most common survey is called resistivity profiling. For this type of survey, the four electrodes can be set along a line with equal spacing between the electrodes; this is called the Wenner configuration of electrodes. After you have made a measurement, an end electrode and its wire are moved along the line, past the other three electrodes, and the next measurement is made. A line of measurements is made this way, generating a resistivity profile.

The second type of survey is called a resistivity sounding. This approach allows you to estimate the depth and thickness of soil layers. Again, the four electrodes can be equally spaced along a line. After a measurement is finished, each of the electrodes is now moved so that the spacing between the electrodes is larger, but the midpoint of the four remains at the same place. As the spacing between electrodes gets larger, the measurement averages to a greater depth into the earth. An analysis of these measurements can give a prediction of the types of soil which you will encounter in an excavation.

The third type of resistivity survey is just a combination of profiling and sounding; this allows a resistivity pseudosection to be generated. As the name indicates, a pseudosection provides an estimate of the cross-sectional form of features which are underground along a line.

There are disadvantages to resistivity surveys. They can be slower than other surveys. If the soil contains boulders or large tree roots, false patterns may result which will mask those which you wish to find. The wires can become tangled in brush and the electrodes cannot be driven into hard pavements.

If you wish to learn more about the basics and procedures of resistivity surveying, excellent introductions have been given by Clark (1990), Carr (1982), and Aitken (1974). For a more technical discussion, you could check the books by Burger (1992), Scollar and others (1990), Telford, Geldart, and Sheriff (1990), or Orellana (1982).

It can be helpful to learn about doing resistivity surveys from someone who is expert in this type of work. The National Park Service has a training course in the methods of geophysics and remote sensing. For information, please contact the course coordinator: Steven L. DeVore, Interagency Archeological Services - NPS, P.O. Box 25287, Denver, CO 80225-0287, USA; phone 303-969-2882.

INEXPENSIVE METERS

Should you plan to do resistivity surveys for only a few days per year, you should first consider one of the resistivity meters which cost in the range of $1,000 - 2,000. If this is more than you wish to spend, you might build your own instrument (Williams 1984) if you are familiar with the construction of electrical circuits. Most of the manufacturers below will also rent their instruments; if you are an infrequent or new user of resistivity meters, this may be the least expensive for you.

A very wide selection of resistivity meters, designed specifically for archaeological applications, is available from Geoscan Research, Heather Brae, Chrisharben Park, Clayton, Bradford, West Yorkshire, England BD14 6AE, phone 44-0274-880568. The representative in the USA for this firm is Geoscan Research USA, P.O. Box 383, Sea Ranch, CA 95497, USA; phone 707-785-3384. The Geoscan Research model RM4 resistance meter is simple to operate; a liquid crystal display (LCD) shows the measurement of resistance. The instrument is 8 by 16 cm in size and AA size cells power it for over 20 hours. A variety of different types of electrodes are available, but you can also easily make your own with wire and spikes from a hardware store.

Electrical engineers use resistivity meters to measure how well an antenna or power station is grounded to the earth. This provides a fairly large market for inexpensive meters. Two of these types of resistivity meters are available from Gossen GmbH, Postfach 1780, D-8520 Erlangen, Germany, phone 49-09131-827-1. Their model Geohm 3 meter has a LCD to show the resistance; four size C cells power the instrument for more than 1000 measurements. The meter weighs less than 1 kg and has dimensions of 7 by 17 by 19 cm. The instrument is simple to operate, for a single button starts the measurement; the meter turns off automatically in about a minute.

For over ten years, I have used these Geohm 3 meters for most of my resistivity measurements; they have worked very well except for one major flaw. Every one of the meters which I bought a decade ago has had the LCD go bad in about 5 years; the display is completely black and unusable. This LCD was made by General Electric and possibly newer displays will have a longer life. Should you have one of these instruments with a defective display, replacement LCDs are available from the manufacturer for a cost of about $100. For my meters, I have put in generic LCDs which cost $15; this requires a tedious rewiring of the LCD, but if you would wish to try this, please write me.

The other instrument from Gossen is the earlier model Geohm 2. This instrument has an analog meter; a knob is turned until the meter pointer is centered at zero and then the knob shows the resistance value. This is therefore slower than the instruments above. However, the simple design of this meter makes it rugged and means that some repairs to it can be done in the field. The meter is powered by a 4.5 volt battery which is more difficult to locate in the USA than in Europe. Bicycle shops sell this battery in the USA, although you can also make a replacement battery pack which has three of the AA size cells.

A distributor in the USA for these Gossen meters is: Texmate Inc., 995 Park Center Drive, Vista, CA 92083-8397, USA; phone 619-598-9899. The instruments can also be purchased or rented from John D. Fett Instruments, 4807 Spicewood Springs Road, Bldg. 2, Austin, TX 78759, USA; phone 512-346-4042.

Another company sells a variety of simple resistivity meters with a general model name of Megger. This company is AVO International, 510 Township Line Road, Blue Bell, PA 19422, USA; phone 215-646-9200 or 800-366-5543. The instruments are available in Europe from AVO Megger Instruments Ltd., Archcliffe Road, Dover, Kent CT17 9EN, England; phone 0304-202620.

The Megger models DET3/2 and DET5/2 are both about the same size and weight as the instruments above and both also have LCDs for showing the measurement; no meter nulling is needed. The model DET5/2 has a built-in rechargeable battery; since this only has a life of 4 hours, a full day's work could not be done with it. The model DET3/2 uses a hand crank generator to power the instrument; while this slows the speed of the measurement, if you make only infrequent measurements, you will not need to be concerned about batteries. The model ET3/2 also has a hand crank generator; furthermore, it has a null-indicating meter like the Gossen Geohm 2 above. While this makes it slow, it is also very trouble-free; I keep one handy for a backup to my other meters and it has always worked.

A final inexpensive resistivity meter is the model 4500 instrument from AEMC Instruments, 99 Chauncy Street, Boston, MA 02111, USA; phone 617-451-0227 or 800-343-1391. This meter is somewhat similar to the Megger model DET5/2, but this has a somewhat longer battery life and also can be used with an external 12 V battery.

Resistivity meters which are used for testing electrical grounds need only three rather than four terminals; these meters are often called ground resistance testers. Most of the meters mentioned above can be switched to this three-terminal mode. You must be careful not to do this accidentally, or your measurements will be wrong. Other resistivity meters are sold only for testing grounds and have only three terminals on them. It would be best not to use these three-terminal resistance meters for archaeological surveys, but if you have nothing else, they may provide adequate data.

MODERATELY-PRICED RESISTIVITY METERS

These instruments cost in the range of $3,000 to $5,000. They are typically made for soil scientists or engineers who wish to determine the characteristics of the soil to a depth of 10 - 30 m. The inexpensive instruments listed above are designed for exploring to a maximum depth of roughly 10 m, but that shallow depth is all that is needed for most archaeological surveying. However, these more expensive meters can also make more accurate measurements, particularly if electrical noise is affecting the meter. The meters are also more rugged than those above.

The Megger DET2/2 (with address above) is one of these meters; its measurements are automatically displayed on an LCD. This meter has a rechargeable battery, but an external battery can also power it. The three following meters are rather similar to each other. Each of these meters is the older design which requires manual nulling to measure each resistance, like the Gossen Geohm 2 mentioned above. The three manufacturers and their models are: Keck Instruments model IC-69 (1099 West Grand River Avenue, Williamston, MI 48895, USA; phone 517-655-5616 or 800-542-5681); Bison Instruments model 2350B (5708 West 36th Street, Minneapolis, MN 55416, USA; phone 612-926-1846); and ELE International model Strata Scout R-40C (Soiltest Products Division, 86 Albrecht Drive, Lake Bluff, IL 60044-8004, USA; phone 708-295-9400 or 800-323-1242).

EXPENSIVE RESISTIVITY METERS

These instruments cost in the range of $6,000 to $12,000. The more elaborate design of these meters allows them to be faster, operate easier, or to measure more accurately or deeper.

The Geoscan Research model RM15 meter allows each measurement to be stored electronically within the instrument; all the resistivity instruments above require that measurements be manually recorded in a notebook. To further increase the speed of this instrument, measurements can be made and stored automatically when the probes are put in the soil, without having to push a button. This instrument, like the RM4 above, is commonly operated with a twin electrode array; with this procedure, two electrodes are fixed at an area outside the survey grid and two electrodes are mounted rigidly on a frame which is moved about the survey area. The RM15 meter is mounted on this frame. Rechargeable batteries power the meter for about 8 hours.

The data logger of the RM15 is configured for measurements of square grids which are 10, 20, or 30 m on a side, with measurements spaced by 0.25 to 1 m. Since each measurement is recorded along with its coordinates in the logger, the data can be transferred to a computer and displayed without any need for manual recording. The square grids are ideal if you wish to survey large areas, a small grid at a time. It is not practical to use this instrument to make long lines across grids larger than 30 m. While I find it faster to survey long lines, many people prefer to survey with the procedures for which this meter is ideal.

Another resistivity measuring system has also been developed for archaeological applications. This is the RATEAU equipment, designed in France for very high speed and resolution surveys. With this equipment, electrical contact is made with the earth through jets of conductive water; this allows essentially continuous measurements along lines (Hesse, Jolivet, and Tabbagh 1986). The pumps and water reservoirs can be mounted on a tractor and moved along lines across the site. I believe that this equipment is commercially available, but I have not been able to determine its cost.

While the instruments above were designed with archaeologists specifically in mind, other resistivity meters are designed for more general applications. One of these instruments is the Geopulse resistivity meter manufactured by Campus Geophysical Instruments, University of Birmingham Research Park, Vincent Drive, Edgbaston, Birmingham, B15 2SQ, England; phone 44-(0)21-471-5040. This resistivity meter has a computer interface for controlling the instrument and also recording the measurements; this meter is designed to be set on the ground for each measurement, and not carried continuously with the operator. A distributor for this equipment is Scintrex Ltd., 222 Snidercroft Road, Concord, Ontario L4K 1B5, Canada; phone 416-669-2280.

Another computer-interfaced resistivity meter is the Terrameter SAS 300C from ABEM AB, Box 20086, S-16102 Bromma, Sweden, phone 46-8-764-60-60. Distributors in the USA for this instrument are SAGA Geophysics, Bldg. B, 10710 D-K Ranch Road, Austin, TX 78759, USA, phone 512-258-7599, and Terraplus USA, P.O. Box 4342, Highlands Ranch, CO 80126, USA, phone 303-791-0727. I have a model SAS 300B meter from this manufacturer which I use for those applications where I need a computer interface or where I need deep, accurate measurements; in the seven years which I have used it, the meter has worked without flaw.

Many other manufacturers, including Bison Instruments, have instruments which have been developed specifically for very deep geophysical exploration. These instruments are usually too expensive for archaeological surveys, and they may be fairly cumbersome to carry about an archaeological site. However, if one is available in your country, it may be easier to use it than to import a simpler instrument from another country.

CONDUCTIVITY METERS

These instruments also measure the electrical resistivity of the soil. They have no wires or electrodes for connection to the earth and the instrument need not touch the ground. These are technically called electromagnetic induction meters and, electronically, they are not too dissimilar to one type of metal detector. The analog or digital meters for these instruments indicate the electrical conductivity of the soil. Conductivity is simply the reciprocal of resistivity. A resistivity of 100 ohm-m is the same as a conductivity of 0.01 siemens per meter, which is usually called 10 mS/m (millisiemens per meter). The advantage of conductivity surveys over earth-contacting resistivity surveys is that conductivity surveys are usually faster and easier; also, they can more easily be done in brushy areas and over hard pavements. Their main disadvantage is that there is little control of the depth of investigation of an instrument; it is fixed by the manufacturer. These conductivity meters also detect metal rather too readily; metal trash or utility lines in the soil can mask the soil contrasts which are sought.

Several different conductivity meters are manufactured by Geonics Ltd. (1745 Meyerside Drive, Unit 8, Mississauga, Ontario L5T 1C6, Canada; phone 416-670-9580); these range in price from about $6,000 to $13,000. The shallow-exploring model EM38 is excellent for many archaeological applications; it detects features to a maximum depth of about 1.5 m. This instrument is about 1 m long; a 9 V battery powers it for about 30 hours. The model EM31 meter is for deeper surveys. It has a 3.7 m-long boom which is carried horizontally at waist height; it measures the surface-weighted average conductivity of the earth to a depth of about 6 m. It weighs 9 kg. This meter is powered by 8 C cells which last about 20 hours of field work.

Both of these instruments can be operated with data loggers, which are essentially specialized field computers for storing measurements; these loggers help one to make fast, accurate measurements. I have used my EM38 and EM31 for about a decade, and they have worked well. The EM31 once malfunctioned with erratic shifts in its calibration after a metal object was passed, but this was repaired by the manufacturer.

While the depth range of the EM38 is suitable for many archaeological searches, it gives its best measurements with soils which are not too sandy. Soil with a conductivity lower than about 5 mS/m can cause inaccurate readings due to several effects. Electrical interference from lightning or power lines is one factor; this can be reduced by averaging several measurements at one location. Thermal drift of the electrical circuitry as the instrument goes from sunny to shaded areas is another problem; this can be reduced by encasing the instrument within about 2 cm of insulation and a sun shield. The last problem is the abrupt changes in the readings when the instrument passes small, shallow metal objects; this can be reduced by carrying the instrument about 10-30 cm in the air. With this combination of techniques, this instrument can be used to make conductivity maps with precise contours at intervals of 0.1 mS/m.

PROCEDURES FOR RESISTIVITY MAPPING

Resistivity surveys can be speeded with a crew of several operators. The two-dimensional pattern of resistivity is mapped by doing resistivity profiles along parallel lines. With the Wenner configuration mentioned above, each measurement is recorded at the midpoint of the four electrodes. After you have made a grid of measurements, you can show the pattern of your numbers readily by drawing a contour map of them. You may do this by hand, or you may use a computer to draw this map. With that map, or in your report, it is important to mention the type of array configuration, the spacing between the electrodes, and the orientation of the array. It can also be valuable to say the date of the survey.

The books referenced in the Introduction show many examples of resistivity mapping. Journal articles also illustrate other applications, including the location of building rubble (Shapiro 1984) and unmarked graves (Ellwood 1990).

RESISTIVITY SOUNDING

All of these resistivity meters measure resistance, in ohms, and it is quite acceptable to plot your geophysical measurements with this unit. The fundamental parameter which quantifies the electrical difference between types of soil is called resistivity, and has a unit name of ohm-meters. If you know the resistivity, you can estimate the type of soil which is below the surface just by looking up the values in a handbook (McNeill 1980). Your excavation plans might be aided if you know if the soil is sandy or clayey.

It is easy to convert from your resistance measurements to apparent resistivity. For the Wenner configuration of electrodes, simply multiply the resistance by $2\pi a$, where a is the spacing between electrodes. For example, if a resistance of 10 ohms is measured with the electrodes spaced by 1 m, the resistivity is 63 ohm-meters. This suggests that the soil could be a silty-loam.

A resistivity sounding will give better information about how the soil changes with increasing depth. The measurement procedure is outlined in the Introduction. Your data can be easily analyzed by a process called curve matching. All you do is to compare your plotted measurements to a set of published curves which have been calculated. One such set of curves, calculated by Orellana and Mooney, is available for $58 from Bison Instruments (address above). A similar publication is available from the European Association of Exploration Geophysicists (P.O. Box 298, 3700 AG Zeist, The Netherlands). In the past, analysis of resistivity soundings has sometimes been done using techniques called the Barnes layer method or Moore's method of cumulative resistivity; these approximations no longer need to be used.

Resistivity soundings can be analyzed with greater precision, although not necessarily greater accuracy, with computer programs. Several of the manufacturers of the instruments sell this software. Resistivity analysis software is also available from Interpex Ltd. (P.O. Box 839, Golden, CO 80401, USA; phone 303-278-9124) and Geo-Compu-Graph Inc. (Box 2263, Ponca City, OK 74602, USA; phone 405-765-9631). These programs cost at least several hundred dollars. Unlike these commercial programs, public domain programs will usually have the source code available; this means that you can modify the program and verify its basic algorithm. A list of many of these programs has been given by Gibbs and Krajewski (1991). Analysis programs are also published in a book by Koefoed (1979).

THE CHOICE OF ARRAY CONFIGURATION

The four earth-contacting electrodes of a resistivity measurement can be arranged in a wide variety of different ways. A common method is that of putting them along a line and making the space between each electrode the same; this is called the Wenner configuration. The electrodes might also be put at the corners of a square; this square configuration has also been used a lot for archaeology. The twin electrode array was mentioned above; by having only two moving electrodes the survey can be simplified and therefore speeded.

There can be good reasons for using one array configuration and not another. The two configurations which I use are the Wenner and the pole-pole array. I use a variant of the Wenner array for resistivity sounding; this is called the offset Wenner array (Barker 1981). This configuration has the advantage that lateral changes in the resistivity can be detected and partially corrected, allowing more accurate analysis of the measurements. For resistivity profiling, I use the pole-pole array because it is fast and easy for one person to do a survey. Like the twin electrode array, two reference electrodes are at fixed locations during the survey. Typically, I will set the current reference electrode about 200 m distant from the middle of the survey area. Then the voltage reference electrode is taken about 100 m toward that electrode and then about 100 m to the left or right; this keeps it at about the zero potential line between the fixed and moving current electrodes. With this pole-pole array, the resistance readings can be converted to apparent resistivity by multiplying them by 2π and then by the spacing between the moving current and potential electrodes; this is the same calculation as for the Wenner array. A knowledge of the soil resistivity can aid the interpretation of a geophysical map; while the twin electrode array does not allow the calculation of resistivity, if you only wish to do nontechnical analysis of your data, this is OK. One disadvantage of the pole-pole array is that it has more trouble with electrical interference due to the long wires.

RESISTIVITY PSEUDOSECTIONS

A resistivity profile accentuates features within a depth range determined by the electrode configuration and spacing. If the wrong spacing is selected, your feature of interest may be only faintly detected. With a resistivity pseudosection, you can get around this problem by having a group of profiles made with a series of different electrode spacings. These can be plotted as a contour map with the electrode spacing along the vertical axis; this vertical dimension then gives a rough indication of relative depth. This is why the plot is called a pseudosection. I have always found that, for richness of detail, the next best thing to a ground-penetrating radar profile is a resistivity pseudo-section. Examples of a resistivity pseudosections have been given by Imai and others (1987) and Roosevelt (1991).

One way of measuring a resistivity pseudosection takes a lot of time. You could make a resistivity profile with an electrode spacing of 1 m, then go back and remeasure the profile line with a spacing of 2 m, then 3 m, and so on, possibly to a maximum spacing of 10 m. If there is a person available to move each electrode, the survey will go faster, but will still be tedious to do.

Instruments which will automate the measurement of pseudosections are coming onto the market now. For these instruments, possibly 30 to 150 electrodes are set along a line on the ground; electrical cables connect these electrodes to a computerized control system which selects a group of electrodes, connects them to the resistivity meter, makes the measurement, and stores it. These systems remove much of the drudgery of making the many measurements of a pseudosection. However, these systems are very complex and their cost is in the same range as ground-penetrating radar: $20,000 to $70,000.

One instrument for these automated measurements is the McOhm-21 from Oyo Corp., 2-6 Kudankita 4-chome, Chiyoda-ku, Tokyo 102, Japan, phone 81-(0)3-3234-0811. This instrument can switch as many as 250 electrodes on three different arrays. As each measurement is made, the signal waveform is displayed on an oscilloscope as a test of noise; several measurements can be averaged to reduce it if needed. After the pseudosection measurements are completed, they can be immediately displayed as a cross-section on the oscilloscope, and an approximate but useful analysis of the data can be done with the computer within the instrument. With 32 electrodes and measurements to the maximum depth with the pole-pole configuration, there are 496 measurements to be made; this instrument takes about 2 hours for the measurements themselves, not counting the time to set up for the survey. The measurement sequence is fully controllable by a normal computer data file which determines the switching of the electrodes.

In the USA, this instrument is available from Oyo Geospace, 7334 N. Gessner, Houston, TX 77040, USA; phone 713-939-9700. Thanks to John Mims, a geophysicist at that company, I was able to test this automated system at an archaeological site. It gave us excellent data across a refilled fortification ditch.

Several other companies also sell these automated resistivity systems. These include Campus Geophysical Instruments and ABEM, with addresses above. In addition, some other companies are also developing these systems; Geoscan Research and Bison Instruments should shortly have these systems available.

It is possible to construct a simple resistivity pseudosection system which requires more work to operate, but is just as fast as a fully-computerized system. For my system, I use a 50 conductor telephone cable to connect between 32 stainless steel electrodes along a line and 32 corresponding bolts on a wooden board. Since I usually have two of these setups, there are 64 electrodes along each pseudosection. Using the pole-pole configuration, I connect two terminals on this junction board to a Gossen Geohm 3 resistance meter. As soon as each measurement is displayed, I enter it into a computer by hand. To move to the next electrode position, usually only one terminal must be changed on the junction board.

While it takes about an hour to set up to make a single pseudosection, measurement with 64 electrodes to a maximum electrode spacing of 20 (or 1070 measurements) takes less than 2.5 hours. While my ABEM SAS 300B could be used to transmit its readings directly to a computer, this resistivity meter is slower to operate than the Geohm 3. Not counting the cost of the computer and resistivity meter, the total cost of this simple switching system is less than $100. While one must be very careful about interference between the current and voltage lines of the cable connecting the resistivity meter and electrodes, my tests with this system have not shown any serious problems with it so far.

There are different approaches to the interpretation of resistivity pseudosections; all of them are complex procedures. In the past, geophysicists have typically used a computer to generate two-dimensional resistivity models for a given distribution of resistivity; after comparing the model calculations to the measurements, the model is changed and recalculated. Iterations like this result in a model whose calculated resistivity closely matches the measurements and therefore the model estimates the two-dimensional distribution of resistivity in the earth. This process can be automated on a computer.

A related procedure is called tomography (Webster 1990). While the definition of tomography for geophysical applications is not yet clear, its goal is an "image" of the cross-section with a high spatial and parametric resolution, unlike the rather blocky image which results from the resistivity inversion procedure described above. A tomographic analysis of a resistivity pseudosection is quite difficult, partly because the electrodes are placed only on one side of the cross-section to be investigated; for most other types of tomography, measurements can be made on two or all sides of the object to be investigated, and this allows much sharper definition of the features within.

CONCLUSION

There is a wide variety of instruments available for your resistivity surveys. The range in cost is also huge. While the more expensive instruments might allow you to measure faster, the accuracy of your measurements will generally be little affected by the price of your meter.

I thank my colleagues for providing me with information for this report. If you have additional notes on resistivity meters or surveys, please submit them to this bulletin.

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Editor's Note

Yes, this third issue of the year is several months late. This is the editor's fault, for which he wishes to apologize. We expect to have the last issue of the year ready soon.

If you are tired of getting your Bulletin in an untimely fashion, you can do something about it. You can volunteer to become the next editor of the Bulletin. My tenure should expire in the middle of 1995. I am ready to start grooming a successor. If you are interested, please contact me.

Garrison (continued from p. 1)

compliments from our non-SAS colleagues regarding that session which was very well attended. I believe conferences will remain an excellent venue for getting the archaeological science "message" out to the larger body of archaeology in general.

That message is an important one, particularly in today's archaeology. We as practitioners of our various scientific specialties are aware of the conservatism that permeates archaeology when it comes to accepting and fully utilizing these powerful analytical techniques and methodologies. In point of fact the problem of acceptance and appropriate utilization of any archaeological science devolves onto the issue of methodology. Until our archaeological colleagues admit the archaeological sciences into their methodology as the powerful heuristic tools we know them to be, then little real growth in our discipline can be realized. In other words "they" have to see the need for scientific inquiry into archaeological problems. Conferences help in illustrating and defining this need.

There are two areas in the landscape of today's archaeology that can both accelerate or retard the progress in the understanding and use of the archaeological sciences; one involves recent laws in the U.S. which restrict access to burial-related materials in current museum holdings, and those that remain unexcavated. In addition to these new legal constraints there is the disturbing anti-scientism of the so-called "Post-Processual School" in today's archaeology. The latter abrogates the positive role science has played in humanistic inquiry. Indeed if this perspective is as Ian Hodder has portrayed it to be in the following statement (Hodder 1991:14) "Many people do not want a past defined as a scientific resource by us but a past that is a story to be interpreted," I will freely admit to some very turgid and uninspired writing by myself and others when it comes to reporting insights into the past as gained through science, but that is more a question of style than epistemology. Stanley South, in his recent review article for *Historical Archaeology*, takes issue with Hodder with the following statements: "For writing stories where little empirical data exist the scientific method is not necessary. ...Our profession needs both the tools of humanities and science in our efforts at understanding the past" (South 1993:17). I concur with South but recognize that archaeology in the 1990's is a vastly different enterprise given the new legal, ethical and theoretical challenges.

The archaeological sciences can help meet these challenges. The challenges to us deal with the problems of what we can know and how we can know. Nothing new here, but the archaeology of today asks for a justification of the techniques and methods in providing insight into the past. I believe, as most of you do, that science is the best way of gaining insight into most phenomena. It is our way of knowing. It may be, as Hodder and others charge, that it is value-laden and culture-bound to a certain degree, but it is still the only pan-human methodology that transcends the real cultural diversity that today's world presents.

The issue of cultural diversity in the U.S. has led to a direct confrontation between archaeology and Native American groups on the issue of access to human burial remains and associated grave goods. The law now requires a greater sensitivity to the views of Native Americans with regard to the display, analysis, and curation of the remains of *their* ancestors. In many instances, collections that lay in museums for years will be removed for disposition by the claimant tribes. The disposition of these remains can be continued curation, analysis under more stringent conditions, or simply reinterment. Whatever the choice, it is theirs by law to make, not that of the museum curator, archaeologist or scientist. To meet this challenge those of us involved in bioarchaeology and forensic anthropology must be creative in the choice of techniques and specimens for a specific research question. More *in-situ*, intensive short-term and non-invasive studies may become the rule.

Not all collections will be "repatriated." Some groups such as the Zuni do not want the skeletal remains of their ancestors back. In their eyes, these burials were desecrated by their archaeological removal. The Zuni will likely require that the holders of the materials continue to do so. The variety of responses to these new laws in the U.S. is just being known. It is sufficient for us as archaeological scientists to recognize these new developments and adjust or re-evaluate our approach to the study of human remains so both society and knowledge are best served.

SAS can lead in responding to these intellectual and social challenges as a voice for our discipline. SAS has an international character which gives it a perspective on these issues that "national" societies cannot hope to have. As I promised in my campaign statement, I wish to see SAS continue to grow in terms of international membership. To that end I see our new frontiers as the former Soviet Union and Asia. I charge our membership committee to explore effective methods for reaching our colleagues in these "frontiers." Maybe at the end of my term I too can look back with the satisfaction Jim Burton has earned. One thousand SAS members has a nice ring, don't you think?

REFERENCES CITED

Hodder, Ian
1991 Interpretive archaeology and its role. *American Antiquity* 56(1):7-16.

South, Stanley
1993 Strange fruit: Historical archaeology, 1972-1977. *Historical Archaeology* 27(1):15-18.

Burton (continued from p. 1)

attended and hope was expressed by an enthusiastic audience that there would be many more. The SAS is currently involved in several future symposia, being organized in conjunction with the SAA, the Society for Historical Archaeology, and the Archaeological Institute of America, as well as other symposia.

Although the SAS is becoming increasingly active, we're limited by the number of individuals involved in these projects. Involvement in SAS activities, especially since we are a relatively small society, is an excellent way to get to know others in the field of archaeological sciences and for them to know you. If you would like to become more involved or have ideas for additional activities for the SAS, please contact any of our executive officers.

It's been personally rewarding and delightful to have been president of the society during this transition, and I hope to continue to serve in an ancillary capacity for many more years. It will be interesting to observe the future development of the Society, but much more exciting to participate! □

News of Archaeometallurgy

Archaeometry 94, the International Symposium on Archaeometry to be held May 9-14 at the National Library in Ankara, Turkey, will have a session on the ancient technology and provenance of metals. Abstracts of papers (four copies, 200-300 words, in English) must be sent by December 1st to Archaeometry 94, Ay Melek Ozer, METU, Department of Physics, 06531 Ankara, Turkey. [See announcement, this issue.]

Alan M. Stahl, Curator of Medieval coins at the American Numismatic Society, is organizing a symposium on Medieval Metal and Metallurgy to be held at the 1994 International Congress on Medieval Studies scheduled for May 5-8, 1994, at Western Michigan University in Kalamazoo. Abstracts for 20-minute papers were due by September 15th. For further information write Dr. Stahl at the American Numismatic Society, Broadway at 155th Street, New York, NY 10032, USA, telephone 212-234-3130, fax 212-234-3381.

There will be a Symposium on the Application of Scientific Methods for Investigating Coins and Coinage on September 22-24, 1994, at the British Museum to review progress in the study of coins and coinage by scientific methods in the last quarter of a century, and the contributions these methods have made to numismatics. For further information write Miss K. Havercroft, Department of Conservation, The British Museum, London WC1B 3DG, UK, telephone 44-(0)71-323-8223.

Metallurgy in Numismatics, edited by M.M. Archibald and M.R. Cowell, the third volume in the series of this name, has been published by the Royal Numismatics Society as its Special Publication no. 24. It contains papers from the symposium on Techniques of Coin Production held in London in 1988, as well as some additional ones. It can be obtained for £40 from Spink and Son Ltd. (Book Department), Distributor or RNS Publications, 5-7 King Street, St. James, London SW1Y 6QS, UK, telephone 44-(0)71-930-7888.

The Archaeometallurgy column in *JOM, the Journal of the Mining, Metals, and Materials Society* being conducted by Vincent Pigott presented "The early use of metal by Native Americans on the Northwest Coast" by Michael L. Wayman in the July 1993 issue (volume 45, no. 7, pp. 60-64).

William D. Conner has begun to publish the *Archeo-Pyrogenics Newsletter*; volume 1, number 1 was issued in June. It is published at his own expense to keep members of the APG Society informed. The Society, which also publishes a journal, has an annual membership fee of $15. Its members take part in the excavation of archaeometallurgical sites in Ohio. Write Bill Conner at 4342 Knob Hill S., Columbus, OH 43228, USA, or telephone him at 614-276-5052, for more information.

H & K Publishing's list has a number of book titles, also a few videos, on practical blacksmithing. For a free catalogue of blacksmithing and foundry supplies write H&K Publishing, PO Box 284B, Xenia, OH 45385, USA.

Giles Carter has retired and moved to South Carolina. His new address is 234 Grove Drive, Clemson, SC 29631, USA.

If you have any archaeometallurgical news to contribute, please write or call

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

Funding Opportunities

Science-based Archaeology Committee Research Grants

Closing dates for applications are February 15 and September 15 each year. Further information from the SBAC Secretariat, SERC, Polaris House, North Star Avenue, Swindon SN2 1ET, UK, tel 44-(0)792-411-261, or from the SBA Coordinator Sebastian Payne, Ancient Monuments Laboratory, English Heritage, 23 Savile Row, London W1X 1AB, UK, tel 44-(0)71-973 3378, fax 44-(0)71-973- 3001.

British Academy Fund For Applied Science In Archaeology

The Fund for Applied Science in Archaeology (FASA) provides support for research involving the application of established techniques by paying for the work of an

Funds (continued on p. 19)

58th Annual Meeting of the Society for American Archaeology
St. Louis, Missouri April 14-18, 1993

Archaeological Science Symposium

An invited symposium entitled "Archaeological Science: Past Achievements/Future Directions" was sponsored by the Society for Archaeology Sciences. It was organized and chaired by R. E. Taylor (University of California, Riverside), James Burton (University of Wisconsin, Madison), and Rob Sternberg (Franklin and Marshall College). The half-day session was held the morning of Saturday, April 17, 1993.

Opening comments by R. E. Taylor highlighted that it has been many years since the publication of the comprehensive review, *Science and Archaeology*, edited by Don Brothwell and Eric Higgs. Plans are afoot (see *SAS Bulletin*, 16(2):1) to generate a new, comprehensive series of reviews of archaeological science, for which this symposium provided a good stimulus.

John Weymouth (University of Nebraska, Lincoln), presented the first of two papers dealing with geophysical prospection, "Magnetic Prospection as a Non-Destructive Tool for Archaeological Site Evaluation." In a largely historical overview, Weymouth properly credited the European community with the early work in this area. Work by Belshé in 1956 was followed by that of Aitken and Hall at Oxford in 1958 as part of a group that had been organized to do highway salvage. This work paved the way for the first Archaeometry conference at Oxford, and the founding of the journal *Archaeometry*. Scollar's research at Bonn in the 1960s was supported by the Volkswagen Foundation. The first American survey was done by Johnson and Black (1961) at the Angel Mound Site in Indiana, with 77,000 readings. Weymouth himself has been practicing since the early 1970s as one of the very few U.S. academics who has maintained a primary research interest in geophysical prospecting at archaeological sites.

In "You Can't Resist Them: Electrical and Electromagnetic Surveys," Rinita Dalan (University of Minnesota) pointed out that electrical resistivity was the first geophysical prospecting method used in archaeology, beginning in 1946 with Atkinson, focusing on Neolithic sites in Britain. Although early studies were not too successful, the better success of magnetometry in the late 1950s provided an extra stimulus to pursue resistivity, and beginning in the early 1960s, electrical conductivity. In these early years, speedy magnetometry was the "hare," and slow, electrode-encumbered resistivity was the "tortoise." Hence, resistivity focused on profiling, favorable features such as earthen structures, and areas of magnetic interference. The development of electromagnetic methods, such as the introduction of the Geonics EM31, started to give the hares a run for their money. The lack of innovation in interpretation was due in part to a reliance on excavation for ground-proofing. Dalan reiterated Weymouth in pointing out that geophysical methods have impacted archaeology through the introduction of rapid, nondestructive methods that could help to plan a dig. Dalan also suggested that the factor of scale will influence the nature of the geophysical work, from microscopic emphasis on material properties, to the mesoscopic emphasis on site surveys, to the macroscopic emphasis on landscape studies. Looking into the next decade, she foresees more problem-oriented research, methodology tailored towards specific sites, use of complementary methods, increasing automation, and laboratory studies of material properties.

W. Fredrick Limp (University of Arkansas, Fayetteville), in "Viewing the Landscapes of the Past Through the Eyes of the Future," presented some stunning graphics to illustrate a number of breakthroughs in archaeological analysis, computing and visualization: exploratory data analysis, spatial statistics, geographic information systems (GIS), satellite imaging, photogrammetry, global positioning system (GPS), virtual reality, wide-area information systems and image databases. Limp suggested that the impact of any new technology or technique will lag behind its introduction. Immediate preoccupation with the technology itself may overshadow questions of its application. Tools are yet lacking to examine multidimensional data in multidimensional ways. As Dalan pointed out in the geophysical context, Limp also stated the importance of being able to examine data at different spatial scales, wherein different problems exist. Institutional and infrastructure problems remain, such as in what department such work should be done, and how due credit should be given for satisfying the computing needs of the archaeological community.

Michael R. Waters' (Texas A&M University, College Station) talk on the "The Role of Geoarchaeology in Archaeological Research" won my [RS] personal prize for the best set of slides. (One of my pet peeves is that presentation graphics software will force addenda to the lists of how not to prepare slides; e.g., do not use dark green text on dark blue backgrounds.) According to Waters, the objectives of geoarchaeological research is to understand: 1) stratigraphy and dating; 2) natural site formation processes at both the site and regional levels; 3) prehistoric landscape reconstruction. Stratigraphy and dating, which provide a spatial-temporal framework, were geoarchaeology's first contributions to archaeology, beginning with the work of Kirk Bryan and Ernst Antevs in the Southwest from the 1920s through the 1940s. Analyses of anthropogenic site formation processes provide a behavioral context for the site, albeit one that can be disturbed before, during or after burial by natural transformation processes. Analysis of site formation processes at the regional level, such as Waters' own research in southern Arizona, includes the obvious application: sites will not be found for a particular time period if an area was undergoing active erosion at that time. Landscape reconstruction has emerged as an area of study in North America during the last decade; changes in site location patterns must be evaluated in the context of a changing landscape. In sum, geoarchaeological research aims to develop a human archaeo-ecological synthesis of climate, landscape, flora, fauna and culture.

Susan Mulholland's (University of Minnesota, Duluth), presentation on "Phytolith Analysis in Archaeology and Paleoecology" showed that a dumbbell can be a beautiful object of study, if it is the shape of a phytolith. Phytoliths are botanical microfossils formed as mineral deposits in plants, after which they are preserved in sediments and paleosols, and can also be found in coprolites, tooth plaque, pottery temper and tool edges. Phytolith studies go back to Darwins's voyage on the Beagle. Phytolith analyses show what types of plants were present, and whether their presence was natural or due to agricultural use. Phytolith studies are now aided by ^{14}C accelerator mass spectrometry dating, for which only 0.5 kg of soil are needed. Future directions will involve utilization of calcium oxylate phytoliths, and applications to plant evolution, micro-stratigraphy, site formation processes, and joint consideration with pollen studies.

Steven Shackley (University of California, Berkeley) began the second half of the symposium, presenting a paper "Gamma Rays, X-Rays, Stone Tools, and the 'Sourcing' Myth: Are We Missing the Point?" He discussed two major changes in lithic studies during the past decade: the use of the scanning electron microscope and chemical characterization. The SEM has tremendous potential in the arena of use-wear analysis, both for how stone tools were used and for determining on what materials they were used. Recently developed 'environmental' SEMs have large sample chambers that now permit entire artifacts to be examined and thus are not as destructive. Progress in this area of lithic studies is not limited by the analytical technology as much as by the need for empirical use-wear experiments.

With suitable attention to instrumental calibration and analysis of standards, the technical aspects of chemical characterization of obsidian are no longer significant problems. There still exists, however, a major problem arising from lack of adequate knowledge about sources and lack of communication between analysts and archaeologists. A chemical 'match' merely means that the artifact and proposed source can not be distinguished using available data. Only when the artifact can be distinguished from all other potential sources can a source assignment be made. This typically requires a careful statistical analysis that the archaeologist may be ill-prepared to evaluate. Even when all sources are well characterized, unknown distributional factors can produce erroneous conclusions. One example cited by Shackley was a correct 'source' assignment of an artifact to an obsidian source more than 100 km distant from the artifact's archaeological provenience. Careful mapping of geological redistribution of the obsidian revealed that it was available in alluvial material less than 20 km from the site. Such studies are rarely done by either the analyst or the archaeologist.

James Skibo (Illinois State University) presented "Food Residue and Pottery Function: A Critical Assessment," co-authored with Michael Deal (Memorial University of Newfoundland). They discussed the use of gas chromatography/mass spectrometry (GC/MS) and stable-isotope mass spectrometry to identify organic food residues such as fatty acids in pottery. They presented their own experimental data as well as data from prehistoric pottery. Post-depositional effects appear not to be as serious as originally feared. Diagnostic unsaturated fatty acids appear to be labile, but their degradation appears to be hindered by charring and by sealing within the ceramic matrix. Microbial and oxidative decompositions also yield distinctive products, allowing an assessment of diagenesis. Although fatty acid degradation and problems arising from multiple use prevent assignments of specific food components, it still appears to be possible to make some generic assignments of food groups. Data from stable isotopic analyses of organic residues place additional constraints on the types of utilized foods.

Douglas Price (University of Wisconsin) presented "Advances in Archaeological Bone Chemistry." He discussed work at the University of Wisconsin on the determination of prehistoric diets through isotopic and trace element analyses of human bone. The level of barium in human bone is proving to be a better indicator of trophic position than strontium. Moreover, it has potential for assessing the consumption of marine resources. The use of acid-washing methods is improving the ability to remove diagenetic contaminants, which have been a great hindrance to such dietary studies.

A second advancement in bone chemical analysis, conceived by J. Ericson, is the ability to identify human immigrants at archaeological sites through the analysis of strontium isotopes. Bone remodels chemically over seven to ten years and reflects the isotopic signature of the adult residence. Dental enamel of molars contains strontium retained from childhood and thus reflects strontium isotope patterns of the place of childhood residence. A test study by J. Ezzo (Statistical Research) and others was successful in identifying immigrants at Grasshopper Pueblo, a 14th century Mogollon site in central Arizona.

Arleyn Simon (Arizona State University, Tempe) presented "What Archaeometry Has or Has Not Done for Archaeological Ceramic Studies." Archaeologists now have a wide array of highly powerful analytical tools. Understanding the types of data and the appropriate applications of each make possible the acquisition of complementary data sets to study ceramic technology and address social and economic questions well beyond issues of provenience. Instrumental precision and accuracy are now sufficient to control analytical sources of variation such that attention can be focused upon cultural and technological sources of variation. Current developments are not so much in the instrumental arena as in the development of theoretical principles and practical examples for choosing sampling strategies and appropriate statistical approaches. These are significantly aided by the proliferation of personal computers along with powerful statistical packages for multivariate analysis.

Jeffrey Dean (University of Arizona, Tucson) presented "Recent Advances in Archaeological Dendrochronology." Although there have not been major changes in the basic principles of dendrochronology, there have been methodological improvements such as the use of ring density instead of ring width. Multivariate methods have been developed to refine the applications of dendrochronology, augmented by the availability of appropriate software for use on personal computers. The methods have now expanded beyond Europe and the southwestern United States, and applicability has been extended into long chronologies in the 10,000 year range. In addition to conventional dendrochronological dating, methodological refinements allow broader application in other fields such as climatology. Examples include the use of dendrochronology to establish forest-fire frequencies over a 3,000-year period in Sequoia National Forest, and the dating of flood events in alluvial deposits.

R. E. Taylor (University of California, Riverside) presented "Radiocarbon Dating: Past and Future Revolutions." He discussed the three major 'revolutions' in radiocarbon chronology. The first was the initial development of the radiocarbon technique and its archaeological application (which he dates to Sept. 1, 1950, but gives no ±). Early applications included dating of bitumen from Jarmo and Jericho, dating Upper Paleolithic cave deposits, and New World applications in the Maya area.

Discrepancies between ^{14}C dates and independent archaeological evidence led to the second 'revolution,' the recognition of short-term secular variations in atmospheric ^{14}C. Adjusting ^{14}C dates to compensate for these 'wriggles' yielded refined dates that pervasively affected archaeology. More precise chronology led to the recognition that many culture traits were independently invented rather than being the result of diffusion. Refined chronology also led to improved archaeological field methods and had an impact on interdisciplinary studies.

The third 'revolution,' still very much in progress, is the development of accelerator mass spectrometry (AMS) to directly measure ^{14}C abundances. The great advantage of AMS is the small amount of required sample, less than one-million atoms being an appreciable amount. (While this is a lot of atoms by AMS standards, it still represents only 10^{-17} grams.) Many more samples and many more kinds of samples, not adequate for radiometric dating, can now be dated by AMS techniques. The ability of AMS to measure small amounts of isotopes is also opening the door to dating methods using other isotopes such as ^{10}Be, ^{36}Cl, and ^{41}Ca.

Although each speaker discussed a different archaeometric domain, many expressed, if not emphasized, common themes. The tools for acquiring high-quality data are largely adequate, whether for measuring elemental abundances at parts-per-billion levels or 'dating' infinitesimally small numbers of carbon atoms. Computational tools for analyzing complex, multivariate data sets likewise exceed our understanding of how to best use them. What is now needed is the knowledge of how to appropriately integrate existing archaeometric methods into the research designs of archaeologists. Many speakers spoke of the need for training of archaeologists in the methods of the physical sciences, and, almost desperately, for increased communication between archaeologists and physical scientists. An opinion was expressed by an enthusiastic audience that this symposium, and similar future symposia, are a significant step in this direction.

Contributed by Rob Sternberg and James Burton (addresses on back page). □

Phytolith Symposium

An SAS-sponsored symposium, "Frontiers in Phytolith Research," was presented at the 1993 Society for American Archaeology meetings in St. Louis by co-chairs Irwin Rovner (North Carolina State University) and Elizabeth Lawlor (University of California, Riverside). Abstracts are printed in the *Phytolitharien Newsletter*, 1993, vol. 7, issue 3, pp. 6-8. The papers stressed nontraditional applications of phytolith research to both methodological and systematic problems.

Several approaches to phytolith analysis are just now receiving wider exposure. "AMS Dating of Phytoliths: The Bearskin Point Example" by Christine Prior (University of California, Riverside) and Susan Mulholland (University of Minnesota, Duluth) presented the results of dating occluded carbon in phytoliths from a site where the charcoal dates are at wide variance with the cultural materials. The phytolith dates are substantially older than the associated charcoal dates. "The Formation of Phytolith (Plant Silica) Deposits: Cultural and Environmental Processes in California's Eastern Mojave Desert" by Elizabeth Lawlor (University of California, Riverside) explored the effects of formation processes on sediment phytolith assemblages (and how phytoliths can inform us about site formation). A possible phytolith signature for ricegrass (*Oryzopsis hymenoides*) processing in the Mojave Desert and Great Basin was proposed. "Phytoliths as Indicators of Subsistence: Coprolites and Features" by Linda Scott Cummings (Paleoresearch Lab) reported on silica and calcium phytoliths from contexts that inform directly about subsistence and diet. Great abundances of hooked hairs from bean pods in Anasazi coprolites indicate consumption of pods as well as seeds.

Advances in phytolith systematics and the expansion of reference collections (which form the basis of phytolith analysis) were also reported. "Phytolith Morphometrics: The Use of Image Analysis for Morphologic and Systematic Study of Wheat Phytoliths" by Terry Ball (Brigham Young University) applied advanced techniques to the study of an important plant taxon. Confidence levels of 70-76% were achieved for a key to emmer, einkorn, and bread wheat (*Triticum* sp.). "Phytoliths in Southeast Asian Flora" by Lisa Kealhofer (Smithsonian Tropical Research Institute) reported on the analysis of 360 species in 80 families of monocots and dicots as the basis for a study of the origin of agriculture in Thailand.

The session concluded with papers addressing the interpretation of phytolith deposits in sediments. "The Use of Opal Phytolith Analysis in Paleoecological Reconstruction on St. Catherine's Island, Georgia" by William Middleton (University of Wisconsin) reconstructed the sequence of vegetation along a transect. He concluded that the formation of a pond was by cultural processes rather than natural. "Getting Down to Specifics: Phytolith Analysis in Historic Period Sites" by Irwin Rovner (North Carolina State University) showed how phytolith analysis reflects small-scale, short- term uses of residential yards, such as vegetable gardening. The approach provides data not found in documents and can expand the interpretation of historical sites.

At least seven other papers in other sessions incorporated phytolith analysis. These include: possible coca phytoliths on Peruvian human teeth (Middleton); an invited review of advances in phytolith research and patterns of plant use and discard in North Dakota (Mulholland); an invited review of advances in Andean paleoethnobotany (Deborah Pearsall, University of Missouri); possible maize phytoliths on coastal Peruvian human teeth (Birgitte Holt, University of Missouri); Early Bronze Age agricultural stress in Western Palestine (Arlene Rosen, Ben Gurion University); and complex combinations of agricultural strategies at Pulltrouser Swamp, Belize (Charles Miksicek, Biosystems Analysis).

Annual phytolith symposia at SAA are planned for the future. For more information on the 1994 symposium, call or write to Elizabeth J. Lawlor, Department of Anthropology, University of California, Riverside, CA 92521, USA; e-mail Lawlor@UCRVMS (bitnet) or lawlor@ ucracl.ucr.edu (internet); fax 909-787-5409.

For more information on phytolith analysis (including the Society for Phytolith Research), call or write to Susan Mulholland, Archaeometry Lab, University of Minnesota at Duluth, 10 University Drive, Duluth MN 55812, USA; tel 218-726-7957; e-mail smulholl@ub.d.umn.edu (internet).

Contributed by Elizabeth Lawlor and Susan Mulholland (addresses on back page). □

Geoarchaeology Symposium

Geoarchaeology was the subject of many papers and posters at the 1993 Society for American Archaeology meetings in St. Louis. The majority were included in sessions on the archaeology of particular geographic regions. The exception was the 1993 Fryxell Symposium, "Geoarchaeological Methodologies for Interpreting Prehistoric Landscapes," organized by geoarchaeologists Hajic and Bettis. In the order presented the papers were as follows. Ferring and Humphrey's "Paleoenvironmental Reconstructions Using Stable Isotope Analysis of Late Quaternary Carbonates" discussed the potential for using stable isotope analysis to reconstruct temperature changes. Asch's "Archaeological Plant Remains and Stratigraphic Interpretation" discussed the importance of understanding how plant remains accumulate. He emphasized that by restricting botanical analysis to post-field identification of only those remains associated with a definite cultural affiliation, we limit the amount of information gained. Wiant's paper, "Geological Context and Investigative Strategy at Napoleon Hollow," discussed the importance of doing cost-benefit analysis of geoarchaeological techniques and approaches. Bettis' "Buried Site Potential: Determination, Evaluation, and Suggestions for Sampling 10 Cubic Meters" emphasized the importance of tailoring archaeological survey to depositional rates. Stafford's "Applying Distributional Archaeology to the Subsurface: Some Initial Observations" emphasized the dependence of artifact density on the size of artifacts sampled. Mandel and Bettis' "Recognition of the DeForest Formation in the Midwest U.S.A.: Implications for Archaeological Research" discussed identifying the DeForest Formation at the Logan Creek site. Johnson's paper, "A Reevaluation of the 'O' Factor of Soil Formation in Terms of 'Dynamic Denudation': A Gaian Approach to Explaining Archaeological Stratigraphy and Site Evolution," reminded us of the significance of organic processes in soil and site formation. Hajic's "Holocene Landscape Evolution and the Upland Archaeological Record: Modeling and Testing" presented a dynamic model of upland geomorphic processes which was a strong antidote to the frequent assumption that the geoarchaeological contexts for upland sites are relatively static and simple to interpret. Discussant Benn looked at the papers in terms of Fryxell's vision, and discussant Brown described the session as a good fit with the Fryxell charter and an indication of how far we have come.

The other geoarchaeological papers presented at the SAA, with the exception of an overview by Waters, "The Role of Geoarchaeology in Archaeological Research," and a small number of thematic papers, were either site specific or regional in focus. The majority of thematic papers dealt with the effects of environmental stress on cultural or political continuity. These include papers by: Courty, "The Micromorphology of Abrupt Climatic Change"; Rosen, "Environmental and Agricultural Stress: Two factors in the Collapse of Late Third Millennium Societies in Western Palestine"; Possehl and Meadow's bibliographical paper, "Climate, Collapse, and Civilization in the Greater Indus Region"; and Kolata, "Tiwanaku: Origins, Impact, and Legacy." A different theoretical perspective on Bronze Age settlement patterns was shown by Wilkinson's geographically-based simulation in "Land Use Zones and Settlement Size in the Jazira Region of Turkey, Syria, and Iraq."

Regional perspectives included: Woods and Hajic's "Archaeological Significance of Recent Geomorphological Investigations in the Northern American Bottom;" Hajic's "Late Quaternary Change in the Central Mississippi River Valley;" and Moeller and Hoffecker's "A Geoarchaeological Analysis of Hydropower Operation Effects on the Green River in Utah and Colorado." Two papers dealt with Delaware Valley geoarchaeology, Schuldenrein's "The Geomorphic Background to Prehistoric Occupation of the Central Delaware Valley," and LaPorta's "Structural and Stratigraphic Models Applied to the Great Valley Sequence: The Elucidation of a Prehistoric Mining District." Three papers dealt with geoarchaeology of the Susquehanna River Basin: Coppock, Braun, and Pollock's "Island Geomorphology Within the Main Stem Susquehanna River and its Implications for the Occurrence of Deeply Buried Archaeological Sites"; Vaunt and Rollins' "Genetic Stratigraphy, Climatic Change and Paleosol Development Within the Susquehanna River Drainage Basis"; and Taylor's "Correlating Archaeological Stratigraphic Data with a Genetic Stratigraphic Framework in a Dynamic River Basin: Implications for the Study of Settlement and Cultural Stratigraphy."

Site specific papers included Marino's "Stable Isotope-based Paleoenvironmental Reconstruction at Pendejo Cave," Sather's "Geoarchaeology of the Norton Paleoindian Bonebed in Stratigraphic History and Assemblage Definition," and Linse's "Room Use and Disuse: Deciphering the Depositional Record at Burnt Mesa Pueblo and Penu Kunaete, New Mexico."

Relatively few papers were methodological. The few that were included the "Holocene Geology as an Aid in Archaeological Survey: An Example from the Upper Mississippi Valley," by Artz and Bettis, and McKinney's "Uranium Series and ESR Dating of Tooth Enamel, Methods in Conflict: The Uranium Uptake Debate."

In addition to the above there were several very interesting posters with geoarchaeological themes. William Johnson dealt with a significant problem in cultural resources management in his "Archaeological Research in Contaminated Areas: Plutonium Valley at the Nevada Test Site." Michael Waters, John Giardino and James Parrent's "Geoarchaeological Investigations of St. Ann's Bay" and Michael Collins, Paul Goldberg, and C. Britt Bausman's "Interdisciplinary Investigations of Paleoindian Occupations at the Wilson-Leonard Site, Texas" illustrated the importance of geoarchaeological research. Kathleen Morrison's "Microscopic Charcoal and Land Use: Lake Sediments and Regional Burning," Kim Bartolotta's "Characterization of Archaeological Sediments by Laboratory Techniques," and Paul Takac, Michael Collins, and Wulf Gose's "The Archaeomagnetic Investigation of Burned Limestone Rocks: An Interpretive Technique," presented geoarchaeological techniques.

Contributed by Robin L Burgess (address on back page). □

Announcement

New Cesium Magnetometer

EG&G Geometrics has introduced a portable cesium magnetometer. The G-822L is a very sensitive, continuous-reading total field magnetometer useful for a wide variety of archeological search and mapping applications.

The G-822L has advantages over both proton-precession and fluxgate magnetometers. Where proton-precession magnetometers take readings at intervals of a few seconds, the cesium-based G-822L reads continuously, allowing surveys to be conducted while in motion. An archaeologist can survey an area five times as fast with the G-822L, while logging data at 20 times the density of a proton magnetometer. The G-822L is also much more sensitive to small magnetic effects than a proton precession magnetometer, but does not exhibit orientation errors as do fluxgate magnetometers.

The G-822L has an RS-232 port to interface the magnetometer to an external computer. Magnetic readings are provided 10 times per second for automatic data storage. Software is available from EG&G Geometrics for logging the data on the computer, and for plotting magnetic contour maps of the survey area. The combination provides a very efficient means to create a magnetic map of a site to identify artifacts with subtle magnetic properties (such as fired brick, stone, and small objects containing iron).

EG&G Geometrics has application notes available describing the use of magnetometers for archaeological surveys.

For more information, contact Ross Johnson, EG&G Geometrics, 395 Java Drive, PO Box 3497, Sunnyvale, CA, USA; tel 408-734-4616; fax 408-745-6131. □

The G-822L magnetometer

Meeting Announcements

International Symposium on Archaeometry

The 29th International Symposium on Archaeometry will take place in Ankara, Turkey, 9-14 May 1994. The scientific sessions will be held at the National Library (change of venue from previous announcement), Ankara.

Approximately 350 responses to the first circular have been received of which 250 listed intent to submit one or more papers.

Single sessions of oral presentations will be held every day from 9 May through 13 May. Special time slots will be allocated for sessions of poster presentations which will be important parts of the Symposium.

The following scientific sessions will be included: 1) Prospection; 2) Geoarchaeology; 3) Dating of organic materials; 4) Dating of inorganic materials; 5) Study of human remains; 6) Mathematical methods and data management; 7) Ancient technology and provenance of metals, non-metals (ceramic, glass, stone, plaster, cement, pigments), and organics. A full day theme session on "Science in Anatolian Archaeology" with invited contributions as well as submitted papers will be held.

In addition to the scientific program, various social activities are planned; we expect to have receptions at the Anatolian Civilisations Museum, Ankara, and at Middle East Technical University (METU). The symposium dinner will be arranged at Eymir Lake of METU. Sightseeing arrangements to various archaeological sites such as Capadocia, Firgian Region and Hittite Region, are expected to be done.

A travel service will be available to arrange for the least expensive travel for special sightseeing arrangements. Hotel reservations have been made at a number of hotels at rates starting at approximately $30 per room.

The symposium organizers hope to provide limited financial aid to qualifying applicants in the following categories: 1)Archaeometry researchers from Turkic Republics; 2) Archaeometry students (from Turkey and abroad); 3) non-Turkish researchers who can prove financial hardship and who plan to submit significant research papers. All those interested in financial aid should request application forms from the symposium correspondence address until October 1, 1993.

Details on the social program, hotels, travel, sightseeing, etc., will be mailed in February 1993 to everyone who received the second circular, together with the symposium registration forms and the preliminary symposium program.

The symposium organizers are soliciting abstracts of papers. Abstracts should be submitted in English to the symposium correspondence address by those wishing to present a paper. The length of the abstract should be between 200-300 words and must be sufficiently informative to allow a fair evaluation by the section convenor. Four copies of the one-page abstract must be received by December 1, 1993. The abstract should clearly list: the title, the author(s), affiliations(s), the abstract. References, if used, should be in the format of the journal *Archaeometry*. In a cover letter, please indicate the name and address of the corresponding author. All abstracts will be reviewed by a session convenor who will make recommendations for acceptance of the paper and whether the paper should be presented in the oral or in the poster sessions.

The papers in the symposium will be published.

For further infromation, contact:

Ay Melek Özer, Archaeometry 94, METU, Department of Physics 06531, Ankara, Turkey; tel 90-4-02101000/3273; fax 90-4-210-12-81.

International Conference on Tree Rings, Environment, and Humanity: Relationships and Processes

Tree-ring data are used to address an increasing range of scientific questions that span many disciplines. The 1994 International Conference will offer an opportunity for individuals interested in tree-ring research to meet and discuss current progress and future directions of dendrochronology. The theme of the conference, Relationships and Processes, stresses the contributions of tree-ring research to understanding environmental and cultural processes. The conference will address aspects of the past and future Earth, including its physical, biological, and social systems. Invited papers will assess the contribution of dendrochronology to recent advances in a wide range of disciplines. Contributed papers will present research results, case studies, and methodological innovations. Participation by students and young scientists is especially encouraged and supported.

The International Conference will be held at the Hotel Park Tucson in Tucson, Arizona, USA on 17-21 May 1994 and will be hosted by the Laboratory of Tree-Ring Research at The University of Arizona. The five-day program will be organized into paper and poster sessions on Tuesday, Wednesday, Friday, and Saturday with Thursday devoted to elective activities including day-long field trips and workshops offered by the Tree-Ring Laboratory and optional activities of individual choice.

Dendrochronology-related field trips will be offered by individual subscription on a first-come-first-served basis. A three-day trip (14-16 May) to the Grand Canyon

(Southwestern environmental variability) and a four-day trip (13-16 May) to the Colorado Plateau (Southwestern archaeological sites) will precede the conference, and a four-day trip (22-25 May) to the White Mountains of California (bristlecone pine) will follow the meeting.

Interested individuals are invited to submit tentative paper and poster titles by 30 June 1993. A second communiqué that includes session topics and a call for abstracts will be mailed in August. Abstracts will be due in mid-October. A preliminary program and registration packet will be distributed in late November 1993.

Registration fees are $150 for regular participants and $50 for students. The regular fee includes a reception, coffee breaks and lunches during the meetings, a conference program, and abstracts of the papers and posters. Registration at the Hotel Park Tucson includes breakfast. Elective field trips and workshops will be subscribed separately.

Please send tentative paper and poster topics, program suggestions, names and addresses for the Conference mailing list, and requests for additional information on the conference to:

International Tree-Ring Conference, Laboratory of Tree-Ring Research, Building 58, University of Arizona, Tucson, Arizona 85721, USA; tel 602-621-2191; fax 602-621-8229.

15th International Radiocarbon Conference

Date, Location and Accommodation

The 15th International Radiocarbon Conference will take place on August 15-19, 1994 in the Royal Scottish Academy of Music and Drama, Glasgow, Scotland. It is preceded by LSC 94, "Advances in Liquid Scintillation Spectrometry" from August 8-12, in the same venue.

Accommodation has been arranged in local hotels and student residences, all within walking distance of the Academy. Further details of the accommodation options and a booking form will be circulated early in 1994.

Programme

The scientific programme will have sessions on archaeology, advances in beta-counting techniques, accelerator techniques, calibration, current environments, reconstruction of past environments, and general topics. There will be poster and oral sessions, and, in compliance with our stated intention, no main Conference session will be held in parallel.

Workshops

A number of workshops have been planned for the weekend preceding the main Conference. Workshop topics are: ^{14}C in Soils (Dr. D.D. Harkness, NERC Radiocarbon Laboratory, NEL Technology Park, East Kilbridge, Glasgow G75 0QU; tel 44-3552-60037; fax 44-3552-29829); , Archaeology - Dating Re-colonisation After Glaciation (Dr. E.M. Scott, Department of Statistics, University of Glasgow, Glasgow G12 8QW, Scotland; tel 44-41-339-8855 x5125; fax 44-41-330-4814); Carbon in the Oceans (Mr. B.F. Miller, NERC Radiocarbon Laboratory, NEL Technology Park, East Kilbridge, Glasgow G75 0QU; tel 44-3552-60037; fax 44-3552-29829); Past Global Change (PAGES) (Dr. D.D. Harkness); the Third International Radiocarbon Intercomparison (TIRI) (Dr. E.M. Scott); Liquid Scintillation Techniques (Dr. G. Cook, SURRC, East Kilbridge, Glasgow G75 0QU, Scotland; tel 44-3552-23332; fax 44-3552-29898); Volcanology - Tephra Studies and Radiocarbon Dating (Dr. G. Cook); and AMS Sample Preparation (Mr. B.F. Miller). Separate registration will be required for the workshops. Abstracts of 400-500 words should be submitted to the convenors listed above.

Evening and Social Activities

There will be a welcoming reception at the Academy on the evening of Sunday, August 14 during which time the Conference registration desks will be open. A civic reception, given by the City of Glasgow, will be held on the Tuesday evening. On Wednesday afternoon there will be a trip to the City of Edinburgh, and if possible, an evening visit to the world famous Edinburgh Festival Military Tattoo. The Conference dinner will be held on Thursday evening in Glasgow's Royal Concert Hall.

Post-conference Tours

Plans are under way for post-conference tours of the Scottish Highlands and Islands, taking in the scenic towns of Pitlochry, Oban and Inverness.

Delegates should note that the Edinburgh Festival takes place at the same time as the Conference and a programme will be sent with the final circular.

Abstract

Deadline for submission of abstracts is 31 December 1993. Abstracts should be double-spaced and 400-500 words in length. Margins should measure 3.5 cm on all sides. Submissions on diskette as WORD, WORD-PERFECT or ASCII files preferred. Include the title, author(s) and full address(es) at the top, telephone, telex and fax numbers, and e-mail address, and send to The Secretariat. Indicate preferred session, and whether oral or poster presentation is preferred.

The Secretariat c/o Mrs. M. Smith, Department of Statistics, University of Glasgow, Glasgow, G12 8QW, Scotland, UK; tel 44-41-339-8855 x5024; fax 44-41-330-5094; e-mail Gata24@UK.AC.Glasgow.VME □

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., "15(1):2" for volume 15, number 1, page 2.

* Dec. 1-3. British Museum XVII Classical Colloquium: Archaeological Research in Roman Britain. London. Keeper of Greek and Roman Antiquities, British Museum, London WC1B 3DG, UK; fax 071-323-8355.

* Dec. 2-3. Conservation and the Antiquities Trade. London. Helena Jaeschke, Secretary, UKIC Archaeology Section, 3 Park Gardens, Lynton, Devon Ex35 6DF, UK.

* Dec. 2-4. British Association for Near Eastern Archaeology, 7th Annual Meeting. Manchester. Charles Burney, Department of Archaeology, University of Manchester, Oxford Road, Manchester, M13 9PL, UK.

* Dec. 13-16. 15th Annual Conference of the Theoretical Archaeology Group. Durham. TAG Organizing committee, Department of Archaeology 46 Saddler Street, Durham, DH1 3NU, UK.

Dec. 27-30. 95th Annual Meeting of the Archaeological Institute of America. Washington DC. AIA, 675 Commonwealth Avenue, Boston, MA 02215, USA. Symposia include: Problem-solving in Mediterranean archaeology. 16(2):21.

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* Jan. 5-9. Annual Meeting, Society for Historical and Underwater Archaeology. Vancouver, British Columbia. David V. Burley, Department of Archaeology, Simon Fraser University, Burnaby, BC, V5A 1S6, Canada.

* Jan. 5-9. 15th Indo-Pacific Prehistory Association Congress. Ubon Ratchathani, Thailand. Dr. Peter Bellwood, Department of Prehistory and Anthropology, ANU CPO Box 4, Canberra ACT 2601, Australia.

Feb. 2-4. Fifth Australian Archaeometry Conference. Armidale, New South Wales. Nick Cook, Department of Archaeology and Palaeoanthropology, The University of New England, Armidale, NSW 2351, Australia; tel 067-73-2860; fax 067-73-2526; email ncook@metz.une.edu.au. A series of special discussion sessions and workshops for archaeologists on various methods and sampling is intended.

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

Feb. 27-March 4. Pittcon '94: The Pittsburgh Conference & Exposition on Analytical Chemistry and Applied Spectroscopy. Chicago. Alma Johnson, Program Secretary, The Pittsburgh Conference, 300 Penn Center Boulevard, Suite 332, Pittsburgh, PA 15235-5503, USA; tel 412-825-3220. Symposium topics include: elemental mass spectrometry; advances in fluorescence; surface mass spectrometry. Abstract deadline: 3 Aug. 1993.

* Feb. 28- Mar. 4. Archaeological Curation and Collections Management. Washington, DC. The George Washington University, Division of Continuing Education, Center for Career Education and Workshops, 2020 K Street NW, Suite B-100, Washington DC 20052, USA; fax 202-293-2650.

* March-April. Cultural Resource Management, 1993-94. Reno, Nevada. Cultural Resource Management, Division of Continuing Education/048, University of Nevada, Reno, NV 89557-0024, USA. Courses include: Faunal Analysis, March 9-11, $325, registration deadline 2/9/94; Geomorphology in Archaeological Analysis, April 5-9, $525, registration deadline 3/7/94; Geographic Information Systems in Archaeology, April 18-19, $250, registration deadline 3/21/94.

March 1-4. 7th Australasian Remote Sensing Conference. Melbourne. 7th ARSC, Conference Secretariat, PO Box 29, Parkville, Victoria 3052, Australia; tel 613-387-9955; fax 613-387-3120; e-mail 7arsc@-dar.csiro.au . Paper synopsis: 16 July 1993.

April 2-6. Association of American Geographers Annual Meeting. San Francisco. Association of American Geographers, 1710 16th Street NW, Washington DC 20009, USA; tel 202-234-1450.

April 4-11. William Robertson Smith Congress. Aberdeen. William Johnston, Department of Hebrew and Semitic Languages, University of Aberdeen, King's College, Old Aberdeen AB9 2UB, Scotland, UK.

April 11-13. International Conference, Wetland Archaeology and Nature Conservation. Bristol, UK. Margaret Cox, Somerset Levels & Moors Archaeologist, Department for the Environment, Somerset County Council, County Hall, Taunton TA1 4DY, UK; tel 0823-255416; fax 0823-334343.

April 11-15. Materials Research Society, Spring Meeting. San Francisco. Materials Research Society, 9800 McKnight Road, Pittsburgh, PA, USA; tel 412-367-3012. Symposium: Materials Issues in Art and Archaeology IV.

* April 13-18. 3rd International Conference, The Birth of Metallurgy. Sanmenxia City, China. Prof. T. Ko, Institute of Historical Metallurgy, University of Science and Technology, Beijing 100083, China; tel 861-2019944; fax 861-2017283.

April 18-24. 59th Annual Meeting, Society for American Archaeology. Anaheim, California. Society for American Archaeology, 1511 K Street NW, Washington DC 20006, USA; tel 202-223-9774.

* April 25-29. European Geophysical Society, XIX General Assembly. Grenoble, France. EGS Office, Postfach 49, Max-Planck-Str. 1, 37189 Katlenburg-Lindau, Germany; tel 49-5556-1440; fax 49-5556-4709; e-mail EGS@LINMPI. DNET.GWDG.DE . Symposia include: Geophysics and the ancient environment (S. Papamarinopoulos, convenor). Abstract deadline: 1 Jan. 1994.
* May 5-8. 1994 International Congress on Medieval Studies; symposium of Medieval Metal and Metallurgy. Kalamazoo, Michigan, USA. Dr. Alan Stahl, American Numismatic Society, Broadway at 155th Street, New York, NY 10032, USA; tel 212-234-3130; fax 212 - 234-3381.

\+ May 9-14. Archaeometry 94: 29th International Symposium on Archaeometry. Ankara. Prof. Dr. Ay Melek Ozer, Middle East Technical University, Department of Physics, 06531, Ankara, Turkey; fax 90-4-210-12-81. See announcement, this issue.

* May 16-18. Geological Society of Canada, Annual Meeting. Waterloo, Ontario. Geological Association of Canada, Department of Earth Sciences, Memorial University of Newfoundland, St. John's Newfoundland, A1B 3X5 Canada. Sessions include: Techniques for reconstructing Quaternary paleoclimates. Abstract deadline: 1 Dec. 1993.
* May 16-20. Materials Issues in Art and Archaeology IV. Cancun, Mexico. James R. Druzik, The Getty Conservation Institute, 4503 Glencoe Avenue, Marina del Rey, CA 90292, USA; tel 310-822-2299; fax 310-821-9409.
* May 17-21. International Conference on Tree Rings, Environment, and Humanity: Relationships and Processes. Tucson, Arizona. International Conference on Tree Rings, Laboratory of Tree-Ring Research, Building 58, University of Arizona, Tucson, AZ 85721, USA; tel 602-621-2191; fax 602-621-8229. See announcement, this issue.
* May 25-29. 20th Annual Conference and Pre-Conference Training Workshop, International Institute for Conservation - Canadian Group. Toronto. Abstracts due by Dec. 31, 1993. Iona McCraith, IIC-CG Conference '94, Toronto Area Conservation Group, PO Box 956, Station F, Toronto, Ontario M4Y 2N9, Canada; tel 416-327-1521; fax 416-327-1999.

May 30-June 4. International Rock Art Congress. Flagstaff, Arizona, USA. 1994 IRAC - ARARA, PO Box 65, San Miguel, CA 93451-0065, USA; tel 805-467-3704; fax 800-467-2532. Symposia tentatively planned include: Preservation and conservation; Advances in dating techniques; Archaeoastronomy. Symposia proposals: 1 Aug. 1993; abstract deadline: 1 Oct. 1993.

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.

June 12-16. Fifth International Conference on Ground Penetrating Radar. Kitchener, Ontario. GPR '94, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada; tel 519-885-1211; fax 519-725-8720. Abstract deadline: 15 Nov. 1993.

* June 19-22. American Quaternary Association (AMQUA), 13th Biennial Meeting. Minneapolis. Limnological Research Center - AMQUA, University of Minnesota, 310 Pillsbury Drive S.E., Minneapolis, MN 55455-0219, USA. Theme: Data and models in Quaternary research. Field trips include: Archaeological sites in southern and southwestern Minnesota.

June 19-24. American Nuclear Society Annual Meeting. Atlantic City, New Jersey. ANS, Meetings Department, 555 N. Kensington Avenue, La Grange Park, IL 60525; tel 312-352-6611.

July 5-9. 7th International Specialist Seminar on Thermoluminescence and Electron Spin Resonance Dating. Krems an der Donau, Austria. Norbert Vana, Atominstitut, Schuttelstrasse 115, A-1020 Vienna, Austria.

July 10-16. 15th International Congress of Soil Science. Acapulco, Guerrero, Mexico. Dr. Roberto Nulez, Colegio de Postgraduados, Centro de Edafología, Km. 34, Carretera México-Texcoco, Montecillo, C.P. 56230, México; tel 52-595-557-1; fax 52-595-4-57-23.

* Aug. 8-12. LSC 94 - Advances in Liquid Scintillation Spectrometry. Glasgow. LSC 94, c/o Dr. G.T. Cook, Scottish Universities Research and Reactor Centre, East Kilbridge G75 0QU, Scotland, UK; tel 44-3552-23332; fax 44-3552-29898. The aims of the conference are to promote and encourage the free exchange of information on liquid scintillation spectrometry and related scintillation techniques. Abstract deadline: Dec. 1993.
* Aug. 15-19. 15th International Radiocarbon Conference. Glasgow. The Secretariat c/o Mrs. M. Smith, Department of Statistics, University of Glasgow, Glasgow, G12 8QW, Scotland, UK; tel 44-41-339-8855 x5024; fax 44-41-330-5094; e-mail Gata24@UK.AC. Glasgow.VME. See announcement, this issue.

\+ Aug. 21-26. 14th International Sedimentological Congress. Recife, Brazil. 14th International Sedimentological Congress, Caixa Postal 7801 Cidaded Universitaria, 50739 Recife PE Brazil; tel 081-271-82-40.

* Aug. 23-27. Xth Congress of the International Federation of the Societies of Classical Studies. Quebec City. X Congres de la FIEC, Cabinet du Doyen, Faculte des Lettres, Universite Laval, Quebec City, Quebec G1K 7P4, Canada.

Sept. 16-18. Science and Archaeology: A Multi-Disciplinary Approach to Studying the Past; sponsored by the SAS. Cambridge. Robert H. Tykot, Archaeometry Laboratories, Harvard University, Cambridge, MA 02138, USA; tel 617-496-8991; fax 617-495-8925; e-mail Tykot@HUSC4.Harvard. Edu. 16(2):21.

* Sept. 22-24. Symposium: Application of Scientific Methods for Investigating Coins and Coinage. London. Miss K. Havercroft, Department of Conservation, The British Museum, London WC1B 3DG, UK; tel 44-(0)71-323-8223.
* October. Cities on the Sea Symposium. Nicosia, Cyprus. Stuart Swiny, Director, CAARI, 11 Andreas Demitriou, Nicosia 136, Cyprus; fax 357-2-461-147.

Oct. 4-7. Annual Meeting German Geological Society. Heidelberg, Prof. Th. Bechstadt , Geologisches-Paläontologisches Institut, Ruprecht-Karls-Universität, Im Neuenheimer Fald 234, D-6900 Heidelberg, Germany; tel 49-(0)62-21-56-55-31.

Oct. 24-27. Geological Society of America, Annual Meeting. Seattle, Washington. Geological Society of America, 3300 Penrose Place, Boulder, CO 80301, USA; tel 303-447-2020.

Nov. 3-5. Imaging the Past: Electronic Imaging and Computer Graphics in Museums and Archaeology. London. Dr. Peter Main, Department of Scientific Research, The British Museum, Great Russell Street, London WC1B 3DG, UK; tel 44-71-323-8959; fax 44-71-323-8276; e-mail EZBMPLM@UK.AC.ULCC .

Nov. 30-Dec. 2. American Anthropological Association, Annual Meeting. Atlanta, Georgia, USA. American Anthropological Association, 1703 New Hampshire Avenue NW, Washington DC 20009, USA; tel 202-232-8800.

* Dec. 4-11. Third World Archaeology Congress, New Delhi, Shri M.C. Joshi, Director General, Archaeological Survey of India, Janpath, New Delhi 110011, India; tel 91-11-3014821; fax 91-11-3019821. □

Funds (continued from p. 9)

identified specialist or for the services of existing analytical facilities (such as the Oxford Radiocarbon Accelerator Unit and the Sheffield Environmental Facility). It is open to all archaeologists, archaeological scientists and archaeological conservators resident in the United Kingdom, and provides grants up to a maximum of £5000. The closing date is December 31 each year. Further information from: Miss J.A. Leitch, Assistant Secretary (Research Grants), British Academy, 20-21 Cornwall Terrace, London NW1 4QP, UK, tel 44-(0)71-487-5966, or from the SBA Coordinator Sebastian Payne, Ancient Monuments Laboratory, English Heritage, 23 Savile Row, London W1X 1AB, UK, tel 44-(0)71-973-3378, fax 44-(0)71-973-3001, who acts as coordinator for FASA and would be pleased to give more information and to advise on applications. It should be noted that this fund is not intended to provide normal site post-excavation costs.

From the Science-Based Archaeology Newsletter, Number 6, January 1993.

Smithsonian Institution Materials Analysis Fellowship

Fellowships are available for research in residence at the Conservation Analytical Laboratory on studies dealing with the application of techniques of the physical sciences to problems in anthropology, archaeology, and in the history of art, culture, and technology. The fellowship is available at either the pre-or postdoctoral level, to persons who have completed all coursework and examination for the Ph.D. Applicants who received the Ph.D. within seven years of January 15, 1994 are eligible to apply for postdoctoral fellowships. Applications will also be accepted from persons with a degree or certificate of advanced training in the conservation of artifacts or art objects. The fellowship is tenable for no more than twelve months and no less than six months. Twelve months is the usual period of appointment. January 15 is the deadline for receipt of completed applications.

CAL Post-Doctoral Fellows, 1976 To Present

M. James Blackman, Ph.D. Ohio State University
Suzanne DeAtley, Ph.D. University of California, Los Angeles
Albert Jornet-Marginet, Ph.D. University of Fribourg, Switzerland
Marilyn Beaudry, Ph.D. University of California, Los Angeles
Julian Henderson, Ph.D. University of Bradford, England
Emlen Myers, Ph.D. State University of New York, Binghamton
Rita Wright, Ph.D. Harvard University
Nancy Benco, Ph.D. State University of New York, Binghamton
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James K. Feathers, Ph.D. University of Washington
S. Terry Childs, Ph.D. Boston University

For application forms please contact: Materials Analysis Fellowship Coordinator, Conservation Analytical Laboratory, Smithsonian Institution, Washington DC 20560, USA. □

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