PEABODY MUSEUM
OF
ARCHAEOLOGY AND ETHNOLOGY
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138 U.S.A.

CABLE ADDRESS: PEAMUSE
CAMBRIDGE, MASSACHUSETTS

March 3, 1965

Dr. Froelich Rainey, Director
The University Museum
University of Pennsylvania
33rd & Spruce Streets
Philadelphia, Pennsylvania 19104

Dear Fro:

Many thanks for sending me a copy of your ASCA Newsletter (Volume 1, Number 1) for February 1965. I took it home last night and was much impressed with the various items of news contained therein. Certainly much more is going on in connection with the application of scientific techniques to research in our field than most of us are aware. It is certainly good to have all this information pulled together and summarized in such admirable fashion.

In the last issue of the Proceedings of the National Academy of Sciences [redacted] (Volume 53, Number 2) for February 1965, there is an article on pp. 230-233 by a pair of physicists from the University of Arizona named Wyckoff and Doberenz. These gentlemen have been making experiements in electron microscopy on bone from the famous tar pits at Rancho La Brea. They have demonstrated that in the specimens in question collagen and other organic materials may still be present in fossil bone. Of course, it is possible that this is due to the extraordinary conditions of preservation at the Rancho La Brea locality; on the other hand, it may be that this applies to bones preserved under other types of conditions as well. It would certainly be interesting to follow this up. For this might lead to the development of a technique for obtaining reliable radiocarbon dates for bones of considerable antiquity on the basis of the amount of organic material preserved in them. Such samples have already been measured by the Gröningen Laboratory, but the figures are never quite the same as those derived from ash samples collected in the same stratum. In my opinion, the actual cause for these discrepancies constitutes a subject concerning which absolutely nothing is known either by physicists or anyone else in the C-14 business. Perhaps the Rancho La Brea material and Wyckoff and Doberenz's electron microscopy project would throw some new light on the problem.

With very best wishes,

Yours ever sincerely,

Hallam L. Movius, Jr.

506
N 19.5

HLM:ga

ARCHAEOLOGICAL INSTITUTE OF AMERICA
100 WASHINGTON SQUARE, EAST
NEW YORK, N. Y. 10003

TELEPHONE: ALgonquin 4-5710

March 16, 1965

Dear Dr. Rainey:

Thank you for sending us Vol. 1 no. 1 of the ASCA Newsletter. I hope that you also sent a copy to the A.J.A. and to Archaeology so that both publications can acquaint their readers with this useful reference source.

We are anxious to continue to receive the Newsletter; tell us if you would like a formal subscription; otherwise I shall take it that this letter suffices.

Congratulations on the Newsletter - and renewed congratulations for the work done by ASCA.

Sincerely,

Claireve Grandjouan

Claireve Grandjouan
General Secretary

Dr. Froelich Rainey
Director, Applied Science Center for Archaeology
The University Museum
33rd and Spruce Streets
Philadelphia, Pennsylvania 19104

DEPARTMENT OF ELECTRICAL ENGINEERING

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE 39, MASSACHUSETTS

April 16, 1965

Dr. Elizabeth K. Ralph
University Museum
University of Pennsylvania
Philadelphia 4, Pa.

Dear Dr. Ralph:

Many thanks for the story of your work with the Varian magnetometer in your search for Sybaris.

Please keep me informed of your most interesting work.

Good luck.

Sincerely,

Harold E. Edgerton

HEE:m

SMITHSONIAN INSTITUTION
FREER GALLERY OF ART
WASHINGTON, D. C., 20560

Cable address:
FREER, Washington, D. C.

Area Code: 202
Telephone: 381-5344

March 22, 1965

Miss Elizabeth K. Ralph
Associate Director
Applied Science Center for Archaeology
The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia, Pennsylvania 19104

Dear Miss Ralph:

I want to thank you or whoever is responsible for sending me Volume 1 of the ASCA Newsletter. It is a very good beginning and I want to congratulate all who are concerned. I hope you keep me on your mailing list so that we can cover ASCA Newsletter in IIC ABSTRACTS.

Perhaps some day I can give you a short item on the analytical work being done on archaeological material here at the Freer Gallery of Art.

Best wishes.

Sincerely yours,

Rutherford J. Gettens
Head Curator, Freer Gallery Laboratory

RJG/mla

UNIVERSITY OF FLORIDA GAINESVILLE, FLORIDA 32603

DEPARTMENT OF ANTHROPOLOGY

March 10,1965

Miss Jeannette Flamm
Applied Science Center
The University Museum
33rd & Spruce Streets
Philadelphia, Penna., 19104

Dear Miss Flamm:

The first issue of the ASCA Newsletter was a pleasure to read and fills a need of which I have long been aware. I hope that you will continue to provide this service.

I wonder if you have received or want to receive the papers of the 3rd and 4th Historic Sites Comferences. These involve some discussions of laboratory methods in conservation and preservation. These two reports were printed as Vol. 17, No. 2 (June), 1964 of The Florida Anthropologist. I expect to print the papers of the 5th Histroic Sites Conference in the same series in June of this year. Please let me know if these would be of use to you.

You might also be interested in the existance here of a glass patina dating laboratory. We are working out the technique developed by Brill and are having moderate success. In the near future we expect to be able to accept glass samples for dating from outside sources. So far we have been asking only for samples of known date to serve as checks on our technique. We have re-checked the samples from Jamestown which Brill had previously dated and have dated some samples from a number of Florida sites. The problems of protecting the fragile patina in the field and the embedding seem to have been solved.

Sincerely,

C.H. Fairbanks

C.H.Fairbanks
Chairman

ASCA

NATIONAL MUSEUM,
P.O. BOX 266,
BLOEMFONTEIN. O.F.S.
SOUTH AFRICA.

12th April, 1965.

The Director,
Applied Science Center for Archaeology,
The University Museum,
University of Pensylvania,
33rd & Spruce Streets,
Philladelphia, Pennsylvania 19104,
U.S.A.

Dear Dr. Rainey,

ASCA NEWSLETTER.

I have just received Vol. 1, No. 1 of your Asca Newsletter and I must congratulate Miss Jeannette Flamm on the way she has prepared it. I feel pleased and honoured that you have my name on your mailing list.

Already I can make use of a number of items, which appear in this first number, for my presidential address next year to the South African Association for the Advancement of Science. The title for my address will be "The role of Applied Sciences in Archaeological Research."

As leader of a team of Archaeologists, Anthropologists, Palaeontologists and Geologists into the rich archaeological and palaeontological fields of the Orange River Basin, I can assure you that we are all concerned with all the new methods of exploration, dating, identification, and interpretation. And this is where your Newsletters can greatly assist us.

Sincerely yours,

A. C. Hoffman

DIRECTOR.

ACH/JJ.

Museum of Classical Archaeology,

Little St.Mary's Lane,

CAMBRIDGE, England.

7 April 1965

Dear Sir,

Thank you very much for sending me a copy of the first number of your ASCA news-letter. It is a most useful summary and I congratulate you warmly on it. Since we should like to receive further issues of this journal, would you please let me know what the subscription rate is?

Yours sincerely,

RM Cook

The Director,
Applied Science Center of Archaeology,
The University Museum,
33rd and Spruce Streets,
Philadelphia, Pa.
U.S.A.

CENTRE NATIONAL
DE LA RECHERCHE SCIENTIFIQUE

CENTRE D'ANALYSE DOCUMENTAIRE
POUR L'ARCHÉOLOGIE

31, Chemin Joseph Aiguier
13 - MARSEILLE 9e
Tél. Marseille (91) 76-12-20

Marseille, June 4 th 1965

Mrs E.K. RALPH
Associate Director,
Applied Science Center
for Archaeology
33rd & Spruce Streets

PHILADELPHIA 4
Pennsylvania

Dear Mrs Ralph,

I thank you for the ASCA Newsletter which you sent recently to Mrs M.R. SALOME, Head of our Paris office (your letter of April 14). This is a very useful contribution to the knowledge of new techniques in archaeological research, and I should be very grateful if you could put our Centre (Marseille) on your mailing list. Please let me know if there is any subscription fee.

In case you might wish to include in your survey not only techniques of the physical sciences, but also new methods in a wider sense, I am sending you under separate cover some reprints and pamphlets which describe our work in connection with punched cards and computers, oriented towards descriptive analysis, information storage and retrieval, automatic classifications, etc. You may extract therefrom a few lines for your Newsletter - or forget about it altogether.

Please give my regards to Dr RAINEY (whom I met in Afghanistan in 1951, I think, and in Philadelphia in 1958).

Yours sincerely,

J.C. Gardin

UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA 4, PENNSYLVANIA

Title of Proposal
Information Center and Training

Submitted to
National Science Foundation
Washington 25, D. C.

August 1, 1965

Principal Investigator:	Froelich Rainey	Position:	Director, University Museum
School:	Graduate School of Arts & Sciences	Department:	University Museum
Starting Date:	1 October 1965	Duration:	1 year

FUNDS REQUESTED

$13,072

Corporate Name of University: THE TRUSTEES OF THE UNIVERSITY OF PENNSYLVANIA
(A Pennsylvania non-profit corporation)

Contracting Office: OFFICE OF PROJECT RESEARCH AND GRANTS
3400 Walnut Street, Philadelphia 4, Penna.

Date:_____ Approved:_____
Roy F. Nichols, V.Provost

Approved:_____
Froelich Rainey, Principal Investigator
Director, University Museum

_____
Otto Springer, Dean of the College

_____
Alfred Kidder II, Associate Director, University Museum
(for Froelich Rainey)

I. DESCRIPTION OF PROPOSED RESEARCH

ABSTRACT

An Information Center has been established which contains abstracts of references to research and techniques derived from related sciences that are pertinent to archaeological and anthropological research. A few books and periodicals of specific interest have been purchased. A Newsletter with up-to-date news of research and experiments at ASCA and other centers has been initiated.

In the Information Center at ASCA we have been compiling cumulative author and subject indices of scientific techniques of value to Archaeology and Anthropology. The abstracts of articles, and references, and information on new developments which are the basic components of our files, are culled from many publications of diverse fields. We have found that techniques and developments in other fields, particularly the physical sciences, are frequently pertinent to archaeological research, but that this applicability is either not known, or often not recognized by archaeologists.

All literature published since 1955 has been intensively surveyed, but outstanding contributions, regardless of date, are included. A partial list of the periodicals read regularly by the staff of the Information Center is as follows:

PERIODICALS:

American Anthropologist

American Antiquity

American Journal of Archaeology

American Journal of Science

American Numismatic Society, New York

American Society for Metals, Review of Metal Literature

Annals of the New York Academy of Science

Antiquaries Journal

Antiquity

Archaeological Journal

Archaeological Newsletter

Archaeology

Archaeometry

Archeologia

Bollettino dell'Istituto Centrale del Restauro

Bulletin de correspondance hellenique

Cahiers Archeologiques

Chemical Abstract

Council for Old World Archaeology, Bibliographies and Surveys

Curator

Current Anthropology

Geochimica et Cosmochimica Acta

Geoexploration

Geographical Review

Geological Society of America, Bulletin

Geophysical Abstracts

Geophysics

Hesperia

Institute of Archaeology, University of London, Bulletin

International Council of Museums, News

International Institute for Conservation, Abstracts and News

Jahrbuch des deutschen archaologischen Instituts

Journal of Geophysical Research

Journal of Glass Studies

Journal of Near Eastern Studies

Journal of the Iron and Steel Institute

Journal of the Society of Glass Technology

Metallurgical Abstracts

Museum

Museums Journal

Nature

The Physical Review

Physical Review Letters

Physics Abstracts

Proceedings of the Prehistoric Society

Review of Scientific Instruments

Revue Archéologique

Science

Science Abstracts

Scientific American

Southwestern Journal of Anthropology

Studies in Conservation

Textile Research Journal

The United States National Museum, Annual Reports

The abstracts we write include reports of analyses, dating methods, field studies and conservation methods, and these, as well as information from unpublished material and letters, and our own research work, and instrument surveys, form the comprehensive reference-file library of techniques appropriate to archaeological research. Also included are correspondence and experimental notes concerning various types of equipment and their recent applications, and entries applicable to C-14 dates which supplement the IBM (Radiocarbon Dates Assoc., Inc.) cards and provide leads to dates that appear in archaeological journals. The following is a listing of subject headings in the files:

Aerial Prospecting-Photography

Amber Studies

Analytical Techniques, General

Archaeological Summaries and Survey Reports

Astronomical Information, Solar Radiation

Bone Analyses

Botanical Information

Ceramic Studies

Chemical Analysis

Climatology

Conservation-Restoration

Dendrochronology

Drills

Ecological Information

Field Methods of Preservation, in field

Field Survey Techniques (Land Sea Air)

Fission Track Dating

Fluorine Dating

Gas Analysis

Geochemical Methods

Geological-Geophysical Methods (Geochronology)

Geological Information

Geophysical Information

Glacial Information

Glass Analysis-Information

Gold, Copper, Bronze Studies

Gravity Surveys

History of Technology

Infra-red Analyses

Magnetic Dating (Paleo,Archaeo, Remanent)

Magnetic Surveying

Magnetometers for Field Surveying

Magnetometers for Vector-Intensity measurements

Magnetometers, Helium

Magnetotelluric Variations

Marine Sediments

Metal Detectors

Metallurgy Studies-Analyses

Metallurgy: Chemical analysis

Metallography

Microstructure Studies

History of Metallurgy

Castings, Studies

Wrought materials

Metallic corrosion

Microscope Studies, Binocular Electron, etc.

Malacology

Neutron Activation Analysis

Obsidian Dating

Other Radioactive Dating Methods

Patination

Petrographic Studies

Photography and Photogrammetry-Information

Physical Anthropology

Pigments-Information

Pollen Dating-Analysis

Potassium-Argon Dating

Radiocarbon

Radiocarbon Laboratory Methods

Radiographic Measurements

Radiological Methods-Techniques of Dating

Resistivity Surveying

Seismic Studies

Shell Analysis Information

Soil Analyses

Sonar

Sonic

Spectrometer, Mass
Spectrometry-Analyses
Statistical Treatments
Stratigraphy Studies
Textile Studies-Analyses
Thermoluminescence
Trace Element Analyses
Tritium Dating
Ultrasonic Measurements
Underwater Archaeology
Varve Analysis-Information

The subject index provides major categories captioned according to subjects, and within it the cards are filed alphabetically by author's name. In case of joint authorship, the principal author is the capitalized name found on the author's cards. Whenever an entry is pertinent to several classifications, a card has been placed in all subsidiary categories, noting the principal category, that in which the summary of the article may be found. The author index includes title and source of article, date of publication, and where it may be found. Instrument surveys accomplished with the proton magnetometer and earth-resistivity equipment and other instruments are also filed--whether they have been conducted by the ASCA staff or other expedition groups. These are placed according to the type of survey and are cross-referenced to the instruments used as well as to the geographic location of the tests.

It has been our experience that the above described organization of the Information Center, although using a hand file system, has been simpler and more useful to the archaeologists and other interested persons who use the materials, than an elaborate IBM system. The organization is closely related to that used in libraries and a person can find without assistance, the information for which he searches.

A few examples of the utility of the files are as follows:

1) An archaeologist using the file for a pollen analysis study can go directly to that particular suject heading or, if the specific site is known principally for the ceramics found and analysed, there will be a cross-reference in the ceramic file to pollen analyses taken from peat from that site.

2) A medical doctor became interested in the study of tissue mummification and found, within a few minutes, much material to assist him in his research.

3) A professor working on the history of metallurgy has found information contained in several of our abstracts and references which he had not previously seen or found in other bibliographies.

4) On the basis of information received from ASCA's files, dendrochronological results concerning the central Anatolian plateau have been sent to the Institute of Archaeology in Moscow. And, in order to gain permission to core ancient Cedars of Lebanon, the Information Center sent articles to Lebanon about coring techniques and results of dendrochronological correlation and analyses,--whereby permission to core a series of ancient Cedars was granted.

In February 1965, the Information Center at ASCA issued its first newsletter (enclosed). It was hoped that this publication would stimulate individuals and laboratories to forward to ASCA news of their most recent work, so that we may place it in our files and future newsletters, and thereby help to establish contact between laboratories doing similar or related experiments.

The response to the ASCA newsletter has been overwhelmingly favorable. Sixty-two letters have been received and many contain news

items or short reports of recent work for the next issue of the Newsletter. Copies of a few of the letters are attached.

A course entitled "Problems in Archaeology" which includes lectures and field work with instruments and other techniques is offered by B. Wailes, Assistant Professor of Anthropology. The students in tnis course make extensive use of the card files in the Information Center.

The Information Center,itself,now that a considerable volume of data have been collected, is becoming more useful to members of the staff, students, and visiting scholars. We are asking for funds to continue this work and for the publication of two Newsletters per year.

II. Facilities

A room in the University Museum has been provided and equipped with file cabinets, desks, and bookshelves. The services of all of the libraries of the University are available for reference material. The office of Printing and Duplicating makes printing done inexpensively look "expensive". For addressing and mailing of Newsletters,the free services of Museum guards are available.

III. Personnel

Personnel are as follows:

Dr. Froelich Rainey, Principal Investigator, Director, University Museum, Director, ASCA

Miss Elizabeth K. Ralph, Associate Director of ASCA

Miss Jeannette M. Flamm, Research Assistant of ASCA

IV. BUDGET

Information Center and Training*

Salaries		
Research Assistant, full-time	$6,000	
Student Assistant, part-time	$2,400	
Total salaries		$8,400
Employees benefits (8.4% of salaries)		$ 706
Equipment and Supplies		
Books and periodicals	$ 500	
Office supplies	$ 100	
Duplicating costs - xerox, etc.	$ 100	
Printing costs (ASCA Newsletter 2 issues per year, 1500 copies each)	$ 387	
Postage (including ASCA Newsletter) Folding, etc. is done free of charge by Museum employees	$ 100	
Total, equipment and supplies		$1,187
Travel-conferences, museums, and other research centers		$ 600
Total, direct costs		$10,893
University of Pennsylvania overhead (20% of direct costs)		2,179
TOTAL		$13,072

*The course entitled "Problems in Archaeology" offered by B. Wailes, Assistant Professor of Anthropology, is supported by the Department of Anthropology.

V. Current Support and Pending Applications

A. Current Support

1. Field Expeditions

a. Onion Portage, Alaska, 1965 Season, NSF Grant to Brown University, approximately $30,000. (F.Rainey, Principal Investigator for summer 1965).

b. F. Rainey - directs the expeditions to Sybaris which are supported by privately raised funds.

2. Radiocarbon Laboratory

a. Univ. of Penna. annual support = $28,000. This includes salary of E. K. Ralph.

b. C-14 measurements of Known Age Samples, Dec. 1964 to 1966, NSF GP-3778, $24,950 annually (E. Ralph, Principal Investigator).

3. ASCA

Dating of Pottery by Thermoluminescence, Sept.1964-1965, NSF GS-566, $20,000. (F. Rainey, Principal Investigator, E. Ralph, Faculty Associate, M. Han, Research Chemist).

4. Dept. of Metallurgy in collaboration with ASCA

Research in Metallurgy and Archaeology, Aug. 1965-1967, NSF P-17186, $12,800 annually (R.Maddin, Principal Investigator, E. Ralph, Faculty Associate).

B. Pending Applications

1. Continuation of Dating of Pottery by Thermoluminescense Sept. 1965-1966, to be submitted to NSF, $16,826 requested, (F. Rainey and E. Ralph, Principal Investigators. M. Han, Research Chemist).

2. Development of Rubidium (or Alkali Vapor) Magnetometer for Archaeological Prospecting, Oct. 1965-1966, to be submitted to NSF, $24,000 requested (F. Rainey, Principal Investigator, E. Ralph, Faculty Associate).

3. Information Center and T r a i n i n g, Oct. 1965-1966, to be submitted to NSF, $13,132 requested, (F. Rainey, Principal Investigator, E. Ralph, Faculty Associate, J. Flamm, Research Assistant). (Present proposal).

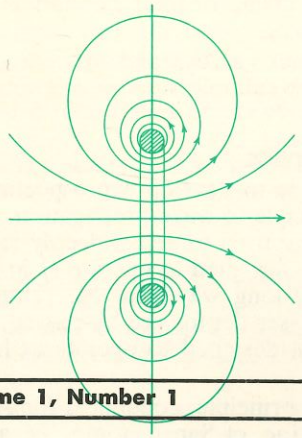
These proposals are not being considered nor will they be submitted to other possible sponsors while they are being considered by the NSF.

Applied Science Center for Archaeology

THE UNIVERSITY MUSEUM • UNIVERSITY OF PENNSYLVANIA

33rd & SPRUCE STREETS • PHILADELPHIA, PENNSYLVANIA 19104

Froelich Rainey, Director • Elizabeth K. Ralph, Associate Director



ASCA Newsletter

Volume 1, Number 1 February, 1965

ASCA (The Applied Science Center for Archaeology) has been established at the University Museum in Philadelphia to experiment with and to develop new techniques in archaeological research. With ten to fifteen archaeological expeditions operating annually in the field, the Museum is naturally concerned with all new methods of exploration, dating, identification, and interpretation. In addition, during the present-day period of rapid technological advance, it is the purpose of ASCA to investigate techniques developed in other fields, primarily those of the physical sciences, that may be adapted for archaeological research. This new program was initiated by Dr. Froelich Rainey and has been supported in part by the National Science Foundation. The radiocarbon laboratory, initiated also by Dr. Rainey, and constructed and run by Miss Elizabeth K. Ralph since 1951 continues to operate and is now part of the ASCA program. It is located in the Department of Physics, University of Pennsylvania, and its direction is assisted by Mr. Robert Stuckenrath.

The initial projects of ASCA have been the use and development of instruments for archaeological prospecting, the investigation of new dating methods, the possible new applications of established dating methods, investigations of various analytical methods, and the establishment of an information center.

The ASCA NEWSLETTER, reporting on current developments in the field of techniques will be issued periodically for archaeologists and other interested persons. It is prepared by Miss Jeannette Flamm of the information center of ASCA. This center attempts to cover current literature on the subject and to keep in touch with those who are doing related research. In order to make this newsletter more effective, we urge all those engaged in work concerning new techniques applicable to archaeology to send notes, reports, and articles to ASCA.

ARCHAEOLOGICAL PROSPECTING

INSTRUMENTS: MAGNETIC DETECTION

The Research Laboratory for Archaeology and the History of Art, Oxford, England, formed in 1955, under the direction of Drs. E. T. Hall and M. J. Aitken, has pioneered in developing techniques to assist the archaeologist in locating buried structures and remains.

The Elsec proton magnetometer (manufactured by the Littlemore Scientific Engineering Co., Littlemore, Oxford, England) is among the first "nuclear" prospecting instruments to have been developed especially for archaeological purposes. The surveys made with it in England; in Enkomi-Alasia, Cyprus; Alcudia, Majorca; Alpompé, Portugal; and elsewhere have proved that many important archaeological features may be detected by means of magnetic contrasts—that is, if a buried structure is more magnetic than the surrounding earth, or vice versa, the magnetometer will find it. The Oxford laboratory has reported on the use of the Elsec proton magnetometer for the detection of pottery kilns, pits in the interiors of hill-forts, and in tracing ditches. The Laboratory has also developed a proton gradiometer and a new fluxgate gradiometer. The immediate advantage of the fluxgate over either of the proton free-precession instruments is that its readings are continuous. Reports on work by the Laboratory, including specific surveys conducted with the various instruments used on different sites, appear in its annual publication, *Archaeometry*.

The Rheinisches Landesmuseum in Bonn is now equipped with a complete electronics shop and laboratory. Dr. Irwin Scollar has designed a special digital differential proton magnetometer which is used by the field teams of the Bonn museum and has been sold and licensed to various other institutions. Further development there is concentrated on automatic recording of magnetic survey results for computer processing of very large sites.

During the past four years, surveys with the Elsec portable proton magnetometer have been conducted by members of the ASCA staff. These have been carried out at both archaeological and historical sites, 15 in all, in 6 different countries. Among these the most comprehensive program has been the search for the ancient Greek city of Sybaris in southern Italy. In addition to the challenge of finding this site of former luxury and fame, the plain of Sybaris affords an ideal testing ground for instruments based on the principle of magnetic detection. Remnants of the Classical periods—that of the 6th century B.C. Sybaris, the later Greek Thurii, and the subsequent Roman Copia Thurii—have been buried by meters of homogeneous alluvial clay that is very slightly magnetic.

As a result of the surveys conducted for three years (in collaboration with the Lerici Foundation of Rome) it was apparent that buried structures of sufficient mass which extended upward to within one to three meters of the

surface could readily be detected with the proton magnetometer. Drilling and test excavations have revealed, however, that these are Roman, or, in some cases, Roman on top of Greek structures. Very few definite finds of less massive, deep, and presumably, Greek walls, however, were made with the proton magnetometer. Therefore, our attention was directed toward the more sensitive optical absorption magnetometers.

Rubidium Magnetometer

With the kind cooperation of Mr. Lee Langan and Mr. Sheldon Breiner of Varian Associates, experiments were conducted with various configurations of the Varian V-4938 rubidium magnetometer. (Instrument Special Products, Varian Associates, 611 Hansen Way, Palo Alto, California, U.S.A.) Preliminary tests were made at Fort Lennox, Ile-aux-Noix, Canada in May 1964 before the more extensive ones on the plain of Sybaris in October. The rubidium magnetometer is more sensitive than the proton magnetometer because of the fact that for a given magnetic change, the resultant change in frequency—the property that the instrument detects—is 100 times greater. The two types of magnetometers detect this information in different ways, both of which, however, are based upon energetic movements within atoms. The proton magnetometer is so named because protons in the alcoholic detector bottle (after an initial "upset" with an artificial magnetic field supplied in a surrounding coil) gyrate at speeds that are proportional to the earth's magnetic field. The basic principle of the rubidium and of other optical absorption magnetometers is that, due to the Zeeman effect, the energy levels become split into various sublevels whose separations are dependent upon the total intensity of the ambient magnetic field. To detect this proportional splitting, optical pumping is required. The operation of optical pumping involves the excitation of electrons into metastable states by the absorption of appropriate electromagnetic radiation. When "pumping" is completed, redistribution of the pumped electrons to lower levels is accomplished by stimulation from a radio frequency corresponding to the difference in energy between the split levels. For the isotope Rb^{85} the resultant frequency change due to the separation between sublevels is 100 times greater than the precession frequency of the protons for a unit change in magnetic intensity.

The two weeks in Italy with the rubidium magnetometer were experimental ones, both in regard to the application of a more sensitive detector and to how it could be improved for archaeological applications. We learned that a given area could be surveyed, at least four times more rapidly than with our proton magnetometer, and that buried structures which produced anomalies of only three gammas or less could be detected with the rubidium magnetometer. In this case, on the plain of Sybaris, the deeply buried structures were at depths of 4-5 meters.

MAGNETIC AND RESISTIVITY DETECTION

Fort Lennox, Ile-aux-Noix, Quebec Province, Canada

At a summer training and survey program sponsored by the Canadian Government (Department of Northern Affairs and National Resources) at Fort Lennox, Ile-aux-Noix, Quebec Province, both magnetic and resistivity detection were used by ASCA. At this historic site where structures are not buried deeply, there was reasonable correspondence between the two methods. An earth resistivity instrument, the Gossen Company's Geohm (Erlangen, W. Germany, and sold in the USA by National Electronics, Box 1237, Sheridan, Wyoming) was the optimum instrument for finding the walls which were at shallow depths, but the proton magnetometer best indicated regions of disturbances, and located the hearth foundations of some of the earlier structures. The walls of a hospital, for example were found to within three inches of their location as were graves and buried iron objects.

We are glad to conduct surveys and instruct others in the use of instruments at suitable sites as our schedule and funds available allow.

DEVELOPMENT OF SONIC DEVICE

Efforts have been made to develop a prospecting instrument based on the principle of wave propagation. Since most seismic instruments are used to detect deeply located geological features they are designed to operate at low frequencies with consequently long wave-lengths. Thus, archaeological materials at lesser depths are by-passed. The need for a sonic instrument designed to operate at higher frequencies was indicated.

Experiments with this principle, conducted for ASCA by the Petty Laboratories, Inc. of San Antonio, Texas, indicated that the optimum frequency for archaeological purposes is of the order of 600 cycles. It is hoped that at these frequencies an instrument will detect reflections from relatively small objects or anomalies. The higher the frequency, however, the greater are the losses in intensity due to attenuation and more stringent are the requirements for ground coupling. Only a small portion of the energy starting out from a given source will reach a given distant point. Because of these and other problems further investigation is needed on initial power requirements, the variation of attenuation with frequency, the effect of soil composition, and the severe problem of coupling the sound source to the ground without excessive losses.

A new sonic instrument that may help to overcome some of these difficulties is being constructed for ASCA by Mr. Grey MacLaughlin (MacLaughlin Electronics, Perkiomenville, Pa.) in collaboration with Dr. Frederick Romberg and other members of the Geophysical Service Division of Texas Instruments (Dallas, Texas).

UNDERWATER TECHNIQUES

Use of Submarine in Underwater Archaeology

The "Asherah," a two-man submarine designed and built for the University Museum by the Electric Boat Division of General Dynamics, was taken to Turkey in 1964 for experimentation during the fifth season of underwater excavation directed by Dr. George Bass of the University Museum. The submarine is capable of operating at depths down to 600 feet for periods of two to ten hours depending upon the speed used. Two motors, mounted on the sides of the hull, which may be rotated 360 degrees, provide excellent maneuverability and allow the vessel to direct precisely a suction hose or mechanical arm. It is possible for the pilot or observer to communicate with divers outside the submarine, which facilitates the direction of excavations. One of the primary purposes of the submarine, however, the search for unknown ancient wrecks, was not attempted in the 1964 season because of the unreliability of the electrical circuits. The "Asherah" is 16 feet long, weighs four tons, has six viewing ports, and a top speed of four knots.

Underwater Photogrammetry

After the promising results obtained from experiments in 1963 to map wrecks in three dimensions by stereophotography with fixed cameras, attempts were made to map from the two-man submarine by means of cameras. A pair of aerial-survey cameras, with underwater housings and stroboscopic flash units (built by the Illinois Institute of Technology Research Institute, 10 West 35th St., Chicago 16, Illinois) were mounted on a frame attached to the "Asherah." Correcting lenses were used to compensate for the index of refraction of water which had caused some

difficulty in determining elevations in the past. Two ancient wrecks, one lying in 140 feet of water, and the other in 90 feet, were mapped completely in a few hours; the resultant photographs are now being developed into maps at the International School of Photogrammetry in Delft, Holland. The savings in time and effort are indicated by the fact that in 1961 it took fifteen divers over a month to map only one wreck in 120 feet of water using standard surveying and measuring methods. This new mapping technique will also be of use to fields other than archaeology.

AERIAL PHOTOGRAPHY

The Rheinisches Landesmuseum in Bonn reports that they have chartered a light plane, equipped with aerial cameras and distortion correction equipment. A pilot is under contract and flights are being made at regular intervals throughout the year. A darkroom technician, an archivist, and a photographer complete their aerial survey group. In four flying years, over 700 new sites have been found. The aerial photographs have been assembled and catalogued and are now in the process of being published.

DATING TECHNIQUES

DATING POTTERY BY THERMOLUMINESCENCE

Thermoluminescence, which is caused by radiation damage, is a potential method for dating pottery. The amount of light output observed when a small powdered piece of pottery is reheated is representative of the accumulated radiation damage, and is related to the amount of time which has elapsed since the original firing of the pottery. This light output, which is due to the emission of photons as the pottery is heated, arises because electrons have been pushed into metastable levels as the result of bombardment by radioactive particles (primarily alphas) from traces of uranium, thorium, etc. in the clays. For age determination, therefore, the rates of bombardment must also be measured. Also, various corrective factors must be determined due to the variations in susceptibilities and other properties of clays. The ASCA laboratory is now getting results from measurements of photons emitted with heating of sherds, and rates of alpha bombardment that are beginning to show some correspondence with age.

Series of pottery samples from the Solduz Valley in Iran, dated through associated charcoal samples which had been dated previously in our Radiocarbon Laboratory, have been analyzed by ASCA research chemist Mark Han. The method is not yet perfected and more experimentation is necessary before all of the basic problems are resolved.

During the past two years of experiments with thermoluminescence, ASCA has been in close correspondence with the Research Laboratory for Archaeology and the History of Art at Oxford, England, where they are engaged in a similar study of thermoluminescence. Their progress and further discussions of the problems involved are described in the following articles: Tite, M. S. and Waine, J., 1962, Thermoluminescent Dating: A Re-appraisal, *Archaeometry,* Vol. 5, 53-79; Aitken, M. J., Tite, M. S., Reid, J., 1963, Thermoluminescent Dating: Progress Report, *Archaeometry,* Vol. 6, 65-75.

NEW STUDIES IN DENDROCHRONOLOGY

Bristlecone Pines

Dr. Charles W. Ferguson (from the Laboratory of Tree-Ring Research at the University of Arizona, Tucson, Arizona, now under the direction of Dr. Bryant Bannister) reports that the master tree-ring chronology for bristlecone pines from the White Mountains of California-Nevada has been greatly strengthened by data from two aspects of the project developed during the past year. First, the bulk material available for study in the form of cross sections of fragments from long-dead trees has provided a quality of record that was not possible to obtain with the limited supply of material available from small-diameter samples taken by increment borers. Secondly, the collection of bristlecone pine specimens has been expanded. The resultant additional regional chronologies, while shorter, have supported the White Mountain chronology in the 2,000-year interval of overlap. The laboratory is striving to provide a known chronology for bristlecone pines that will extend backwards in time beyond 4,000 years.

Dendrochronology and C-14 Dating

The dendrochronology studies undertaken by ASCA, under the direction of Dr. Henry Michael, have been with sequoia and bristlecone pine sections of very long "runs." In part these studies are based on the dendrochronological dating worked out by the Laboratory of Tree-Ring Research in Tucson. As a result of this collaborative effort, samples of known age will soon be available which may help to determine the small changes in the atmospheric inventory which have occurred in past times and to elucidate their basic causes. (See preliminary report by Ralph, E. K., Michael, H. N., and Gruninger, J., Univ. of Penna. Date List VII, *Radiocarbon,* in press.)

First Application of Dendrochronology in the Near East

A pilot project initiated by ASCA at Gordion, Turkey, has been completed with the cooperation of Dr. Bryant Bannister of the Laboratory of Tree-Ring Research. Dr. Bannister has been able to establish an 804-year floating chronology for the central Anatolian plateau. (His paper on this was read at the 7th International Congress of Anthropological and Ethnological Sciences, Moscow, Aug. 3-10, 1964.) The study indicates that climatic conditions may have been suitable for the establishment of master tree-ring logs for Anatolia and surrounding regions. The cedars of Lebanon and other woods imported into Egypt may provide materials for the extension of a tree-ring chronology into the period of the early Egyptian dynasties. This program will be conducted in conjunction with C-14 dating.

Tree-Rings and Regional Storm Circulation Patterns

A study of tree-rings from A.D. 1650 to 1920 made by Dr. Harold C. Fritts of the Laboratory of Tree-Ring Research at the University of Arizona, shows that in western North America there are two areas of dendroclimatic homogeneity: (1) the Southwest and (2) the Northwest. These two areas are divided by the mean path of winter storms. Crossdating is good within each of these two groups but rather poor between groups. On the other hand, crossdating is exceptionally good in the east-west direction from California to Colorado which is an area parallel to the mean storm track.

Tree-Rings and the Navajo Land Claim Study

Mr. M. A. Stokes has completed the 12-year study of the Navajo Land Claim specimens submitted to the Laboratory of Tree-Ring Research at the University of Arizona, the dates of which may be found in the *Tree-Ring Bulletin,* Vols. 25 and 26.

Physiology of Trees

The physiology of trees being studied at the Tree-Ring Research Laboratory at Macalester College, St. Paul, Minnesota (under the direction of Dr. Waldo S. Glock) while not having direct bearing on archaeological dating, may eventually provide a basis for the solution of some of the difficult problems that are encountered with bristlecone pines. In addition to the work being done on tree growth and uniformity among growth layers of the ponderosa pine, the current work centers on some 1300 of the increment

cores taken from pondersosa pine in the Flagstaff region of Arizona. A complete photographic record is being prepared at the laboratory of all anatomical features encountered and of growth-layer pattern types and subtypes.

IDENTIFICATION TECHNIQUES

THE OXFORD RESEARCH LABORATORY FOR ARCHAEOLOGY AND THE HISTORY OF ART has reported the use of the following techniques in the chemical analysis of archaeological objects. For details of specific applications see *Archaeometry,* Vols. 1-6.

Coins, Glass, Pottery (Glazes)

An instrument for x-ray fluorescence has been built; it requires a reasonably large area of a specimen. This technique, which is non-destructive, is used with coins, glass, and pottery (particularly pottery glazes). Large specimens also can be accommodated. For analysis of specimens which are either too big (e.g., pictures) or where no large area for analysis is available, a milliprobe x-ray spectrometer has been developed. It is particularly suitable for archaeological specimens, and areas as small as 0.1 mm. square can be analyzed accurately.

Inclusions in Metal, Organic Objects

For areas below 0.1 mm. square, as small as 1 micro square, an electron beam x-ray scanning microanalyzer is used. The quantitative analysis of inclusions in metals or organic objects, cross sections of paint layers, and the surface enrichment of buried metals are some of the problems being studied at Oxford with this instrument.

Coins, Gold, Silver

Neutron activation analysis is used for coins and precious metals when the extraction of the material for optical spectrometric analysis is ruled out and analysis by the x-ray fluorescence technique might give misleading results due to surface corrosion effects.

Metals, Glass, Ceramics

Where a small sample may be taken from the object (by drilling or scraping) and the laboratory is interested in the minor or trace elements, the technique of optical emission spectrometry is used.

Glass, Glazes

By measuring the "backscattering coefficient" from a glass or glaze with the Beta-Ray Backscatter Detector, it is possible to estimate the approximate lead content of surface layers—on the assumption that no other high atomic number elements (tin being the most likely) are present. This non-destructive method has been used in the investigation of glass and glazes of porcelain wares.

THE CONSERVATION CENTER OF THE INSTITUTE OF FINE ARTS AT NEW YORK UNIVERSITY, under the direction of Mr. Sheldon Keck, has been engaged in various research projects covering materials of concern to archaeologists. The center has reported work on:

Soil Environment and Recovered Ceramics

The chemical and mineralogical compositions of sherds recovered from a necropolis at Samothrace, Greece are being determined. The soil environment that surrounded the sherds is also being analyzed. The sherds were recovered from two different soil types that are within twelve feet of each other in the necropolis. The effect of the different environments on the sherds is being sought. (Sheridan and Dusenbery)

Composition of Ancient Wool

The chemical composition of wool from Coptic, Paracas and Inca-period garments is being determined. Preliminary analyses show that, in comparison with modern sheep and llama wool, the ancient wool contains very little sulphur and about 80% of the expected total nitrogen. The ancient wool molecule has been considerably degraded. Viewed in polarized light under the microscope, the fibers do not appear to have less crystalline areas than modern wool. (Sheridan and Delacorte)

Wall Paintings and Their Environment

The effect of different atmospheric environments on the appearance and composition of various types of wall paintings is being studied. The surfaces of a large number of ceramic tiles have been coated, simulating wall paintings, with various pigments, media and ground materials. The spectral reflectance curves of the finished surfaces have been measured. The tiles are now being placed in controlled atmosphere chambers where the effects of different levels of humidity and various industrial air pollutants are being sought. (Majewski)

Spectral Reflectance Curves and Paintings

The practical value and the most useful techniques of recording the spectral reflectance curves of designated areas of painting are being determined for use in the conservation of paintings. The curves now being recorded are those prior to removal of old varnish (or outer protective coating), after cleaning of the painting surface and after varnishing the cleaned surface. The value of total reflection, specular reflection, and reflection from below the surface is being determined. (Keck)

Mechanism of Corrosion of Buried Metal

The corrosion layers present on various Alexandrian coins have been analyzed by the techniques of metallography and x-ray diffraction, and the sequence and relative amounts of the several species present are studied to provide insights into the age, environment, and history of the coin. It is planned to extend these studies to other classes of metal objects. (Alexander and Lewin)

Deterioration of Exposed Stone and Frescoes

Chemical and physical studies of the mechanism of the deterioration of exposed surfaces under the influence of moisture, acidic pollutants in the atmosphere, and biological agents are under way. Means of arresting or inhibiting these processes by suitable chemical treatment of the surface are being investigated. (Lewin)

SOIL PHYSICS

The Rheinisches Landesmuseum in Bonn has undertaken a study of soil physics to aid them in their geophysical and aerial surveys. Results concerning the physical mechanism behind the production of crop sites have been obtained for important soil types in their area. These studies have helped to define where and when survey flights may be made. A study of the magnetic properties of standard soils in the Rhineland has been completed and further work will be devoted to the detection of vanished wooden objects in "difficult" soils.

This museum's chemical laboratory, in addition to solving problems of conservation and excavation of iron objects, has recently installed a 250,000 volt x-ray machine. This was placed in a special radiation-shielded room for the investigation of metal and other finds prior to removing them from the earth blocks in which they arrive.

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References to information concerning the instruments used by ASCA, and other archaeological dating methods and techniques have been gathered by Miss Jeannette Flamm. Also indexed are reports of analyses, field studies, and conservation methods. The Center is collecting books and publications in this field and would apperciate receiving reprints. The purpose of the compilation of the files at ASCA is to facilitate research work and to provide information that is often difficult to find. These facilities are open to all archaeologists.