1960

Received from University Museum, 23 copies of
grant to the National Science Foundation

Ivania De Angelis

Office of Project Research and Grants

THE UNIVERSITY MUSEUM
UNIVERSITY OF PENNSYLVANIA
33RD & SPRUCE STREETS, PHILADELPHIA 4

GRANT NSF #G13256

Arch Technique

UNIVERSITY OF PENNSYLVANIA
Philadelphia 4, Pennsylvania

PROPOSAL FOR RESEARCH PROJECT

Submitted to: National Science Foundation

Title of proposal: Research and Development in New Techniques for Archaeology

Principal Investigator: Froelich Rainey Position: Director

School: Department: University Museum

Starting Date: 1 September 1960 Duration: 1 year

FUNDS REQUESTED

First Year: $ 27,870 Total: $ 27,870

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, Pa.

Date:

Approved: _____
Loren C. Eiseley
Position: Provost
University of Pennsylvania

_____
Froelich Rainey
Principal Investigator
Director, University Museum
University of Pennsylvania

Note: This is a revision, requested by NSF, of application under same title submitted 1 February, 1960.

RESEARCH AND DEVELOPMENT IN NEW TECHNIQUES FOR ARCHAEOLOGY

ABSTRACT OF PROPOSED RESEARCH

The applications of recent discoveries in atomic physics, electronics, and chemistry to new techniques for research in archaeology are now taking place at an unprecedented rate. The University Museum, in Philadelphia, has a group of men working in all the major fields of archaeology and also a physicist and a chemist employed to assist in archaeological field research. We propose to establish at the Museum a specific program to record what is now taking place in the development of these new techniques, both in Europe and America, and to improve and develop certain new techniques described below. Everything done in this field by the University Museum will be published for the use of archaeologists in general. Moreover, such a program should materially improve instruction at the University of Pennsylvania and elsewhere in the application of findings in the physical sciences to archaeology.

BACKGROUND

The development of the radiocarbon method for dating prehistoric remains has proved to be one of the most significant new techniques in archaeology, and has already altered our conception of human history. It is not perfected, however, and improvements are taking place in some 20 laboratories around the world. The University Museum, in collaboration with the Physics Department of the University of Pennsylvania, has been operating a C-14 Laboratory for 8 years, and like other laboratories, has not only improved the method but utilized the C-14 technique for research in other fields, as, for example, the study of suspected fluctuations in cosmic ray intensity. The laboratory has completed an extensive study in dating ancient remains in Middle America and finally determined the precise correlation between the Maya calendar and our own. It has also made major contributions in dating prehistoric remains in the Near East, South America, the Arctic, and the Classical World.

Research in dating prehistoric pottery (and other objects which have been heated over fires in the past) by the thermoluminescence method has also been carried out by our Laboratory with promising indications for the feasibility of the method.

For dating geologic formations and cultural remains as far back as the beginning of the Pleistocene, experiments with various long-lived radioactive elements and isotope ratios have been carried out in England and elsewhere. The decay of uranium to lead

with the emission of alphas (helium), of potassium to argon, of rubidium to strontium, and of other naturally radioactive elements have afforded numerous approaches to the problem of dating in the eras of millions and more years ago. It is hoped that other phenomena of radioactive disintegration will be discovered and applied to prehistoric archaeology.

Resistivity equipment developed primarily by the Oil Companies in the United States for geophysical prospecting ., has been very successfully adopted for archaeological prospecting in England and in Italy, but had not been utilized by American archaeologists either at home or abroad, probably because the potentialities of the technique are not understood. The University Museum has experimented recently with this equipment in Mexico and had considerable success in locating changes in strata and buried wall contours. Further experiments will be carried out at Tikal, Guatemala and at Hasanlu, Iran during this year.

In the field of chemistry, several methods of determining the relative ages of fossil bones have been developed and used successfully in England and other countries. The most notable of these are the fluorine, nitrogen, and uranium oxide comparisons. These afford ample evidence of what can be devised through the collaboration of archaeologists and chemists. Moreover, there are many other examples of the success of such collaboration in the new techniques for preserving ancient remains found in archaeological excavations.

Recent advances in this field have been confined largely to refinement of procedures and the use of newer chemical compounds. Synethic resins have been used in various ways, for example as protective coatings or as adhesives. Specific applications of methacrylates are their use as embedding media for exhibition purposes and as media for consolidating archaeological finds such as shell mounds. Rubber latex compositions have been extensively used for making molds. Ion-exchange resins have been used for removing corrosion products from metals. Epoxy resins have been used as bonding agents with excellent results, and for reproductions of structural members in architectural restorations. Polyethylene glycols and trimethyl carbinol have been used in conjunction with freeze-drying in treating waterlogged wood.

Freeze drying itself is a relatively new technique. In the identification of archaeological materials newer chemical and physiochemical methods are increasingly being used. The application of microchemical methods to the identification of pigments and metallic corrosion products is a case in point. Chromatographic analysis is also being used increasingly.

Other dating methods, such as neutron bombardment(England and U.S.) and measurements of thermo-remanent magnetism (England and France), show promise as aids to archaeological research.

The proton magnetometer has also been adopted in England for archaeological prospecting. This instrument is still in the developmental stage as far as archaeology is concerned, but may prove to be invaluable in locating buried kilns, deposits of iron implements, and even soil disturbances such as pit-fillings which have been associated with human occupation in the past.

This brief survey has been presented to illustrate the contributions of technical discoveries to archaeological research and to reveal the urgent need for more development, support and collaboration in this field, especially for the adaptation of new instruments and concepts which have been devised for other purposes.

DETAILED DESCRIPTION OF PROPOSED RESEARCH

We propose to establish in the University Museum a specific department having to do with research and development in archaeological techniques. This will be under the over-all direction of Froelich Rainey, the Director of the Museum and will be staffed by one of the archaeologists in the Museum, (or one to be employed by the Department of Anthropology, of the University of Pennsylvania), Elizabeth K. Ralph, physicist, now in charge of the radiocarbon laboratory, Eric Parkinson, chemist, now employed by the Museum, an additional physicist and a secretary. All of the curators in the Museum who are engaged in archaeological field research, will also collaborate with this department.

Research proposed during the next two years is defined under the following four divisions.

1. Development of "Underground Explorer". Archaeologists in England and in Italy have successfully adapted resistivity equipment to archaeological prospecting. They are also working on a proton magnetometer for similar purposes. No one, to our knowledge, has utilized a sonar detector in archaeology. In discussions with research engineers of the Sun Oil Company laboratories, we have come to the conclusion that the resistivity instrument, the proton magnetometer, and a sonar detector can be developed in one instrument for underground exploration by the archaeologists. We have assurance that men in the Sun Oil Company laboratories will advise our group in designing such an instrument and will guide them to the industrial firms now producing the necessary parts. The design of this new instrument will be under the joint direction of Elizabeth Ralph, a physicist now employed by the University of Pennsylvania, and a physicist to be employed. We believe that with the assistance of the Sun Oil Company laboratories and the equipment now available, that this new instrument could be developed and proven on the sites of the University Museum's current excavations during the coming year.

2. The Establishment of an Information Center on New Techniques. Research in various techniques applicable to archaeology is now proceeding in many institutions in the United States and Europe. Moreover, many research laboratories in the

United States are developing apparatus and methods which may be applied to archaeology. We propose to build up a card file containing all information available on what is being done, by whom, and where. For example, we wish to know not only what archaeologists are working with resistivity equipment, but what industrial companies are producing the equipment and what research laboratories are developing similar equipment which might be applied to archaeology. We wish to know just what such laboratories as that in the University of London are doing with identification and preservation methods. Also, we propose to file lists of laboratories with facilities available for materials (wood, etc) identification. All of this data will be available to other archaeologists in this country.

3. Development of Thermoluminescence Method for Dating Pottery and Other Fired Objects. The thermoluminescence method is theoretically possible because of the presence in clays (and other earth compounds) of traces of uranium and thorium. The alpha particles emitted by these radioactive elements bombard the other constituents of the clays and raise electrons to metastable levels. When heated, these electrons drop back to their normal states with the emission of photons. The firing of the pottery is then the starting point of excited electron accumulation. In the laboratory, a fragment of a potsherd can then be reheated and the photons detected; the longer ago the firing, the greater the light intensity. The rate of bombardment can also be measured with an alpha detector, and with both known, it may be possible to work out a time scale for dating pottery, etc.

This method was proposed in 1953 by Farrington Daniels (University of Wisconsin) and has only recently been pursued by George C. Kennedy (University of California, Los Angeles), by our laboratory, and others. At the University of Pennsylvania, initial experiments have revealed that both the photons and alphas in 5000 year old pottery are detectable, and some knowledge of the problems involved has been acquired. This work will also be under the direction of Miss Ralph.

4. Expansion of Chemical Laboratory. At present there is in the University Museum a Chemical laboratory for preservation and identification of archaeological objects. We wish to extend the usefulness of this laboratory as funds permit, and would devote most of the $750. requested under Chemicals and Supplies for this purpose.

PROCEDURE

With a grant from the NSF the University Museum could employ an additional physicist to assist the physicist and the chemist now on the staff. Moreover, these scientists, who would be working in the physical and chemical sciences could assist the archaeologists in compiling all the relative information on what is now being done in the field by other individuals and institutions. The secretary to be employed with this grant would be primarily concerned with compiling a card catalogue of these developments under the direction of the archaeologists, assisted by graduate students now employed by the University Museum.

Also with a grant from the NSF, the University Museum could expand its present chemical laboratory in the Museum to include a few more facilities.

The additional physicist and Miss Elizabeth Ralph with possibly the assistance of an extra part-time graduate student employed by the University of Pennsylvania would then expand the research with the thermoluminescence method and also begin work with the laboratories of the Sun Oil Company in the designing and development of the new "Underground Explorer." In both of these developments they would have the advice and assistance of the archaeologists in the University Museum, who are now engaged in active field research, and members of the physics department. New techniques developed under this program can be proven in the field with any of the Museum expeditions in large part at Museum expense. It is assumed that the "Underground Explorer" could be developed and proven within approximately one year since many parts of this instrument are now available.

The card catalogue of information on current research and techniques would be available to all other archaeologists in this country and the Museum would undertake to publish the results of its research in this field.

FACILITIES

Facilities already available at the University of Pennsylvania for this research are the radiocarbon laboratory and the small chemical laboratory at the University Museum. Also there is space in the University Museum to install a considerably expanded laboratory for this program. Moreover, the departments of Chemistry, Physics, and Electrical Engineering in the University as well as the industrial laboratories in the vicinity of Philadelphia can be utilized at least in an advisory capacity to develop these techniques for archaeology.

The University of Pennsylvania under this proposal would, of course, be paying the salaries of the Principal Investigator, together with that of the Chief Chemist, Chief Physicist, the archaeologists and all of the curators and field researchers who would be consulting on this project.

PERSONNEL

Short biographical sketches and bibliographies of the Principal Investigator and other professional personnel are attached.

Dr. Froelich Rainey, Principal Investigator
Miss Elizabeth K. Ralph, Chief Physicist
Mr. Eric Parkinson, Chief Chemist

List of Collaborating Archaeologists

Dr. Alfred Kidder II-South America
Dr. Linton Satterthwaite-Mesoamerica
Dr. William Coe-Mesoamerica
Dr. Rodney S. Young-Classical
Dr. Roger Edwards-Classical
Dr. Ellen Kohler-Classical
Mr. Robert H. Dyson- Middle East
Dr. Rudolf Anthes-Egypt
Dr. Carleton S. Coon-Middle East
Dr. Samuel Noah Kramer-Sumerology

DR. FROELICH RAINEY, CURRICULUM VITAE

JANUARY 27, 1960

PERSONAL HISTORY:

BIRTH: June 18, 1907, Black River Falls, Wisconsin

WIFE: Penelope Lewis Rainey

CHILDREN: Penelope, Jr. Age - 19
Pamela Age - 16

EDUCATION:

University of Chicago, Graduated in 1929, Ph. B. in English

Yale University, Graduated in 1935, Ph. D. in Anthropology

American School in France-Pre-historic Archaeology, 1930

POSITIONS HELD IN THE PAST:

Professor of Anthropology, University of Alaska 1935 - 42

Financial Grants in Aid for Research at American Museum 1934 - 42

Assistant Professor of Anthropology at the University of Puerto Rico, 1935

Director of Quinine Mission in Ecuador 1943 - 44

State Department:

Foreign Service Officer assigned to Berlin 1945 - 46

Office of Transport and Communications in charge of inland transportation 1946 -47

Consultant, State Department 1948 - 1952

U. S. Representative to International Rhine Commission. 1949

ANTHROPOLOGICAL RESEARCH IN WEST INDIES AND ALASKA

DIRECTOR, UNIVERSITY MUSEUM, UNIVERSITY OF PENNSYLVANIA - 1947 to present

ACTIVITIES:

Prof. of Anthropology - University of Pennsylvania

Chairman, Organizing Committee, 29th International Congress of Americanists, 1940
Philadelphia Committee on Foreign Relations

Treasurer, Society for Applied Anthropology 1947 - 1950

Carbon 14 Committee

Chairman, Committee on International Relations in Anthropology 1951 - 1956

American Anthropological Association, Executive Committee 1951

Moderator of Television Program WHAT IN THE WORLD

President, International Congress of Anthropological and Ethnological Sciences, 1956

Foreign Policy Research Institute 1954 to present

Chairman, Science Planning Board, 21st Century Exposition Seattle, Washington

BIBLIOGRAPHY OF PUBLICATIONS
OF FROELICH RAINEY
DIRECTOR, UNIVERSITY MUSEUM
1959

"Archaeology in Central Alaska," ANTHROPOLOGICAL PAPERS OF THE AMERICAN MUSEUM OF NATURAL HISTORY, Volume XXXVI, Part IV, New York, 1939

"Eskimo Prehistory: The Okvik Site on the Punuk Islands," ANTHROPOLOGICAL PAPERS OF THE AMERICAN MUSEUM OF NATURAL HISTORY, Volume 37, Part IV, New York, 1941

"The Ipiutak Culture at Point Hope, Alaska," AMERICAN ANTHROPOLOGIST, Volume 43, No. 3, July - September, 1941

"Puerto Rican Archaeology," THE NEW YORK ACADEMY OF SCIENCES-SCIENTIFIC SURVEY OF PUERTO RICO AND THE VIRGIN ISLANDS, Volume XVIII, Part I, New York, February 13, 1940

"The Whale Hunters of Tigara," ANTHROPOLOGICAL PAPERS OF THE AMERICAN MUSEUM OF NATURAL HISTORY, Volume 41, Part 2, New York, 1947

"Native Economy and Survival in Arctic Alaska," APPLIED ANTHROPOLOGY, Volume 1, No. 1, October - December, 1941

"Ipiutak and the Arctic Whale Hunting Culture," by Helge Larsen and Froelich Rainey, ANTHROPOLOGICAL PAPERS OF THE AMERICAN

BIBLIOGRAPHY (CONT'D)

MUSEUM OF NATURAL HISTORY, Volume 42, New York, 1948

"The Museum Takes Inventory," BULLETIN, UNIVERSITY MUSEUM, Volume 15, No. 4, Philadelphia, 1950

"The University Museum, Its Collections and Expeditions, " FAIRMOUNT PARK ART ASSOCIATION, 78th Annual Report, Philadelphia 1950

"The Arctic as a Strategic Area," THE GENERAL MAGAZINE AND HISTORICAL CHRONICLE, Volume LIV, No. 1, Philadelphia 1951

"Eskimo Archaeology in 1950" BULLETIN OF THE NATIONAL RESEARCH COUNCIL-PROCEEDINGS OF THE ALASKAN SCIENCE CONFERENCE OF THE NATIONAL ACADEMY OF SCIENCES, NATIONAL RESEARCH COUNCIL, No. 122, April 1951, Washington, D.C.

"The Significance of Recent Archaeological Discoveries in Inland Alaska, "AMERICAN ANTIQUITY, MEMOIRS OF THE SOCIETY FOR AMERICAN ARCHAEOLOGY, Volume XVIII, No. 3, Part 2, Utah, 1953

"AFGHANISTAN," BULLETIN, UNIVERSITY MUSEUM, Volume 17, No. 4, Philadelphia, 1953

"Tradition and Change," BULLETIN, UNIVERSITY MUSEUM, Volume 18, No. 4, Philadelphia, 1954

"The New Museum, " BULLETIN, UNIVERSITY MUSEUM, Volume 19, No. 3, Philadelphia, 1955

"Problems of American Archaeology," Published in Russia 1958

"Archaeology in the American Arctic," Published in Russia, 1958

"The Vanishing Art of the Arctic," Expedition Winter 1959 Volume 1, No. 2

"Radiocarbon Dating in the Arctic," American Antiquity Volume 24, No. 4, April, 1959, p. 365 - 374

CURRICULUM VITAE

NAME: Elizabeth Ralph (Beth)

RESIDENCE: Box 357, Woosamonsa Road, Pennington, N. J.

BIRTH: February 5, 1921, Trenton, N. J.

EDUCATION: (dates, schools, degrees)

Wellesley College, B. A. 1938 - 1942
University of Pennsylvania, M. S. 1949 - 1951

EXPERIENCE: (past to present)

August 1942 - 1949, Jr. Electronics Engineer, then Chemist, then Assistant to Chief Radio Engineer, then Project Engineer at Foote, Pierson and Company and Kearfott Manufacturing Company, Newark, N. J.
September 1, 1951, Carbon 14 Technician, University of Penna. 1955, Research Associate Carbon 14 Laboratory

MEMBERSHIPS IN SCIENTIFIC ORGANIZATIONS:

American Association for the Advancement of Science
Sigma Xi - Chapter Member 1956

OTHER ACTIVITIES:

Field Hockey trips to South Africa and South Rhodesia, 1950
Australia and New Zealand and Fiji, 1956
C-14 Lab. visits and Field Hockey trips to British Isles, 1953

PUBLICATIONS:

Ralph, E. K. 1955 - "University of Pennsylvania, Radiocarbon Dates I", Science, 121, 149 - 151
Coon, C. S. and Ralph, E. K. 1955, "Radiocarbon Dates for Kara Kamar, Afghanistan, University of Pennsylvania, II, Science, 122, 921 - 922
Ralph, E. K. 1956, "C-14 Dating," Penna. Archaeologist, 26, 27-31
Ralph, E. K. 1957, "Age is no longer a Secret", Wellesley Alumnae Magazine, 41 - 142 - 143

Rainey, F. G. and Ralph, E. K. 1959, "Radiocarbon Dating in the Arctic", Volume 24, No. 4, April 1959 p. 365 - 374, American Antiquity.

Ralph, E. K. 1959, "University of Pennsylvania, Radiocarbon Dates III," Amer. J. Sci. Radiocarbon Supplement, Vol. 1, p. 45 - 58.

Ralph, E.K. and Stuckenrath, R., 1960, "C-14 Measurements of Known Age Samples," Nature (Oct. 15, 1960)

Satterthwaite, L and Ralph, E.K., "New Radiocarbon Dates and the Maya Correlation Problem, American Antiquity, in press

CURRICULUM VITAE

NAME: A. Eric Parkinson

RESIDENCE: 210 Ashurst Avenue, Secane, Pa.

BIRTH: (date and place) December 1, 1906, Leeds, England

WIFE OR HUSBAND: Magdalene (married in June, 1942)

EDUCATION: (Dates, Schools)

Graduated from West Philadelphia H. S., 1925
University of Pennsylvania, 1925-30 Degree of B. S. in Chemistry

EXPERIENCE: (past to present)

Chemist, Pennsylvania Hospital, Philadelphia, 1930 - 34
temporary research fellowship, Harrison Laboratory, U. of P.
February - June, 1934
Chemist, Continental - Diamond Fibre Co., Bridgeport, Pa.
1935 - 1946
Chemist, University Museum, August 1, 1946
Keeper of Collections, July 1, 1948

OTHER ACTIVITIES:

Stamp collecting
traveling - traveled in Western, Northern, and Central Europe
May - October, 1937

PUBLICATIONS:

"Estimation of Aldehydes by the Bisulphite Method; An Improved Procedure", with E. C. Wagner, Ind. and Eng. Chem., Anal. Ed., Volume 6, p. 433, 1934

"Heat Resistance of Laminated Plastics", with E. O. Hausmann and G. H. Mains, Symposium on Plastics, Phila., District Meeting, A. S. T. M., February 1944

"The Preservation of Cuneiform Tablets by Heating to a High Temperature", The Museum News, Volume 27, No. 17, March 1, 1950

BUDGET (Period 1960 - 1961)

Salaries	
Physicist	$10,000.
Secretary	3,000.
Employee Benefits (7.5% of Salaries)	975.
Other Expenses	
Parts and equipment to develop "Underground Explorer"	5,000
Chemicals and supplies	750
Laboratory installation	2,000
Travel (for collaboration with British labs and Sun Oil Co.)	1,500
SUB-TOTAL	23,225
Overhead 20%	4,645
TOTAL	$27,870

JUN 13 1960

Dr. Gaylord P. Harnwell, President
University of Pennsylvania
Philadelphia 4, Pennsylvania

Research Grant NSF-G13256

Dear Dr. Harnwell:

I am pleased to inform you that the sum of $27,900 is hereby granted by the National Science Foundation to the University of Pennsylvania, for the support of "Research on Archaeological Techniques," under the direction of Froelich Rainey, University Museum, for a period of approximately one year. This grant will be paid on or about two weeks from date of this letter, in full.

It is a condition of this grant that it may be revoked in whole or in part by the Foundation after consultation with the principal investigator and the grantee, except that a revocation shall not affect any commitment which, in the judgment of the Foundation and the grantee, had become firm prior to the effective date of the revocation; and that funds not committed by the grantee prior to the conclusion of the work contemplated under this grant shall be returned to the Foundation.

It is a further condition of this grant that disposition of patent and other rights in any inventions or discoveries made or conceived during the research shall be the responsibility of the grantee; that the grantee shall give the Foundation reasonable notice of application by the grantee or other person or institution for a foreign or domestic patent on any such invention or discovery; and that upon application for any patent on any such invention or discovery, the patentee shall grant the Government an irrevocable, royalty-free, nonexclusive license for use of such invention or discovery for governmental purposes.

The Foundation desires that this grant be administered in general accordance with the Foundation's policies for research grants as stated in "Grants for Scientific Research," January 1960, and in conformity with the other understandings reached between the Foundation and the grantee relating to this grant.

Please acknowledge receipt at your earliest convenience.

Sincerely yours,

Alan B. Waterman
Director

NATIONAL SCIENCE FOUNDATION

WASHINGTON 25, D.C.

June 15, 1960

Dr. Froelich Rainey
Director, University Museum
University of Pennsylvania
Philadelphia 4, Pennsylvania

Dear Fro:

This will confirm our previous conversation informing you that your proposal entitled "Research on Archaeological Techniques" has been approved by the National Science Foundation in the amount of $27,900 for a period of approximately one year. In order that you may acquaint yourself with the conditions of the grant, a copy of the grant document is enclosed.

You may also be interested in the Foundation's policy with regard to reports from research projects which it supports. We like to have a short informal annual report at the termination of each grant year, and at the expiration of the grant, a relatively comprehensive final report of the accomplishments of the project. It is helpful if reports contain a bibliography of published articles resulting from the research, and it is also desirable that the final report include a listing of personnel who have participated in the research. This listing should contain the status of each person, i.e., whether graduate student, technical assistant, professional associate, and so forth.

We would appreciate it very much if you would provide us with three reprints of each publication resulting from the work done under the grant as soon as such reprints are available. If in the course of the research any unusually significant results are obtained, we, of course, are interested in learning of these as they occur.

If you have any questions about these or any other matters, we would be pleased to try to answer them.

May we wish you the best of success in your research program.

Yours sincerely,

ACe

Albert C. Spaulding
Program Director for
Anthropology

Enclosure

June 18, 1960

Dr. Albert C. Spaulding
Program Director for Anthropology
National Science Foundation
Washington 25, D. C.

Dear Al:

Many thanks for yours of June 16th, advising me of the grant of $27,900. for the archaeological research in techniques. It came at just the right time, because at Oxford, working with their techniques research group there, I decided to bring over a young physicist named Linington, who has been working with them and to put him full time on the job of developing our new acoustical apparatus in collaboration with the Sun Oil Company and I also worked with Lerici, in Rome, and he will probably send one of his physicists over here in January, at his own expense. Also, I have worked out a deal with the Italians to combine all three of us, British, Americans and Italians on some experimentation, in Italy, during the late winter. The NSF money is enough to get us cracking, but I'm still going to have to get financial support from some Oil Company to do the kind of electronic designing we expect. However, we are going to try to do the major job in one year and if we really have something dramatic to show you, I will be back again with a request next spring.

Nubia is a hell of a place , the average temperature was about 120 degrees and about twelve or fifteen nations will be in there scrambling for sites. As you know, we got our Amendment in the Mutual Security Act and Ambassador Reinhardt, in Cairo, with me, cooked up a scheme for how counterpart funds should be used. I will be presenting our scheme to Wilson, Brew, Smith and Manell in the latter's office, in Washington, on Tuesday. If you are interested I'll be at the Cosmos Club Monday and I can give you a run-down of what we propose.

Regards,

FR:ah

Froelich Rainey

March 28, 1961

Dr. William E. Benson, Program Director
Division of Earth Sciences
National Science Foundation
Washington 25, D. C.

Dear Dr. Benson:

The reprints of the Maya calendar dating project have arrived and I have enclosed six copies.

The sealing of our laboratory rooms is now in process and is expected to be completed within two weeks. Then we shall be busy with the rebuilding for we had to remove everything except the steel shielding from the rooms.

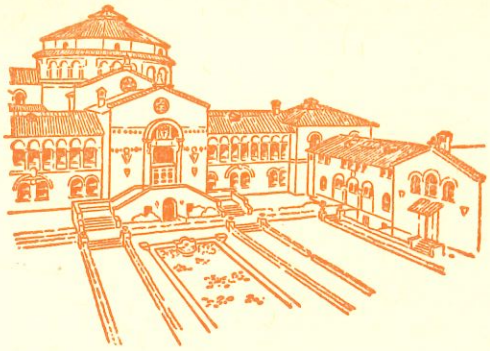
In the meantime we have "come to roost" in the Museum and are working on the tree-ring analyses of our sequoia sections and various other techniques and projects.

With best regards,

Elizabeth K. Ralph

EKR/eh

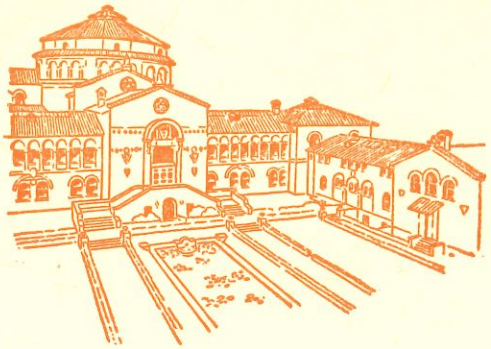
file tech. prop



THE UNIVERSITY MUSEUM
UNIVERSITY OF PENNSYLVANIA
33RD & SPRUCE STREETS, PHILADELPHIA 4
CABLE ADDRESS "ANTIQUE" TELEPHONE: EVERGREEN 6-1241

NSF-G-13256. Summary of expenditure as of 27th June 1961.

Laboratory furniture and fittings.			
143 Furniture.		83.00	
144 Delivery of 143.		11.00	
232 Venetian blind.		15.00	
232 Floor tiles.		79.00	
505 Cabinets.		185.90	
505 Slide case.		19.95	
505 Carafe set.		15.25	
551 Wood and pilaster.		58.33	
583 Cabinets.		148.60	
585 Wood.		48.80	
682 Transite.		7.06	
683 Electrical fitments.		421.72	
698 Venetian blinds.		59.00	
912. Stools.		94.50	
		1247.11	1247.11
Laboratory and field equipment.			
586 Ohmyst meter.		137.50	
590 Geohm resistivity meter.	~~83x78~~	83.78	
458 Proton magnetometer.		2325.76	
655 Heater.		16.30	
857 Calculating machine.		152.95	
892 Lab. supplies.		5.09	
1119 Duo-Spectranal.		575.00	
103 Refund of deposit on 458.	34.43		
		3261.95	3261.95
860 Geohms.	190.00		
940 Fuses.	32.00		
1118 Seismograph.	1675.00		
1159 Drill.	3125.67		
	5022.67		
Supplies and books.			
270 Books.		112.73	
380 Geophysics.		187.25	
781 Book.		8.75	
899 Subscription.		5.80	
900 Books.		10.80	
953 Subscription.		1.25	
1110 Book.		3.00	
1111 Graph paper.		14.85	
		~~344.43~~	344.43
1129 Graph paper.	9.60		



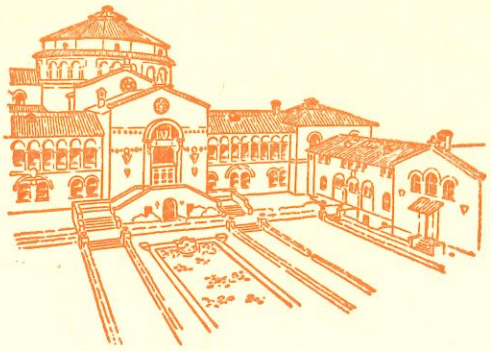
THE UNIVERSITY MUSEUM

UNIVERSITY OF PENNSYLVANIA

33RD & SPRUCE STREETS, PHILADELPHIA 4

CABLE ADDRESS "ANTIQUE" TELEPHONE: EVERGREEN 6-1241

Travel and freight charges.			
113 Linington.		300.00	
278-82 Expenses.		500.00	
289 Dallas.		90.70	
609 Bannister.		300.00	
645 Texas.		181.40	
647 Duty.		52.43	
704 Bannister.		26.92	
742 Rainey.		161.71	
762 Duty.		343.96	
783 Air freight.		16.88	
804 Expenses, England trip.		350.00	
808 Expenses.		500.00	
861 Air freight.		16.13	
889 Air freight.		6.86	
907 Tikal.		275.20	
1122 Parkinson.		49.23	
1147b Insurance		23.32	
1170 Air freight		77.96	
		3272.70	3272.70
Physics block charges.			
? Inventory.		41.55	
Stockroom.		12.86	
Machine shop.		143.26	
Physics of metals.		72.00	
1067 Metal rods.		51.55	
Inventory.		16.21	
Machine shop.		22.04	
Storeroom.		14.08	
1045 Inventory.		17.61	
Surplus.		.20	
1047 Machine shop salaries.		14.94	
Batteries.		4.94	
1149 Machine shop salaries.		411.63	
		841.09	841.09
Salaries.			
Linington.	8x458.33	3666.64	
Linington.	4x458.33 1833.32		
Carson.	24.00 & 10.50	34.50	
Employee benefits.		143.00	
Overhead.		451.00	
		4295.14	4295.14



THE UNIVERSITY MUSEUM
UNIVERSITY OF PENNSYLVANIA
33RD & SPRUCE STREETS, PHILADELPHIA 4
CABLE ADDRESS "ANTIQUE" TELEPHONE: EVERGREEN 6-1241

G.S.I. work 815 G.S.I.		3799.00	3799.00
Contract overhead.		4650.00	4650.00
Petty cash. 954		1.57	1.57
Total expenditure to date.			21712.99
Outstanding expenditure.	6865.59		6865.59
			28578.58
Initial grant.			27900.00
Excess of expenditure over grant.			678.58
Other expenses (estimated)	80.00		80.00
Estimated deficit.			£758.58

R.E. Linington.

PRESERVATION COPY: 04/24/2014

THE UNIVERSITY MUSEUM
THE UNIVERSITY OF PENNSYLVANIA
THIRTY-THIRD AND SPRUCE STREETS
PHILADELPHIA 4, PENNSYLVANIA

Dr. Albert C. Spaulding,
Programme Director for Anthropology,
National Science Foundation,
Washington 25, D.C.

10th August 1961

Dear Dr. Spaulding,

Enclosed you will find a report on the final progress to date under NSF G 13256, Research and development in new techniques for archaeology. Dr. Rainey has asked me to send you this semi-formal report at this stage as we will both be absentfrom the country for most of the fall.

I understand that Dr. Rainey has already sent you a copy of the financial statement I prepared in June. Most of the estimated items have now been official billed, and the final position is almost exactly as stated previously. That is we managed to exhaust the grant with about $800 being carried over as expenses to the new grant.

I hope that the enclosed information will prove satisfactory

Yours sincerely,

R.E. Limington.

PRESERVATION COPY, 06/20/2014

THE UNIVERSITY MUSEUM

THIRTY-THIRD AND SPRUCE STREETS
PHILADELPHIA 4, PENNSYLVANIA

10th August 1961.

Report on research under NSF G 13256; Research and development in new techniques for archaeology.

Previous reports.

1. A brief report covering initial progress was made on 12th Nov. 1960

2. A full report covering the period up to 15th April 1961 was given in connection with the application for the continuation of the above grant.

The present report will thus only cover in detail work subsequent to April 1961, as well as outlining possible future progress.

Research up to August 1961.

1. Field survey methods ("underground explorers").
In addition to the resistivity equipment and the proton magnetometer reported upon previously, the museum has purchased two further resistivity equipments, and a seismic instrument for near surface surveying. The extra resistance equipments will allow of the field testing of this survey method at several different museum excavations enabling results to be obtained under widely differing conditions. The new seismic instrument, a Geophysical Interval Timer from Geophysical Specialties Inc., Minnesota, is similar to the device used in Arizona in connection with the work undertaken in cooperation with Texas Instruments, as outlined in a previous report.

During March and April an extensive programme of field tests was carried out at Tikal, Guatemala. Surveys were undertaken in connection with all the main areas of excavation, as well as in areas where excavation is planned for next season. It was discovered that of the three methods tried the resistivity method was most successful under the jungle conditions. However, it was also thought that an improved seismic device could prove of great value.

Dr. L. Giddings has completed tests with both resistivity and proton magnetometer instruments on several sites in Alaska, also a second resistivity instrument is being used by Dr. R. Young at Gordion, Turkey. At the present no details of the results of their work are avaliable.

An extensive programme of further field testing in Italy will be carried out during September to November 1961. This work is being organised in cooperation with the Fondazione Lerici, which has several years experience in surveying on Italian archaeological sites. In connection with this work, in order to aid correlation between the survey results and the deposits concerned, a portable power-operated drill has been purchased. This should

greatly increase efficiency for surveying large areas.

2. Development of improved seismic surveying method.
As a result of the field tests carried out in collaboration with Texas Instruments it was decided to attempt the construction of a simple high frequency seismic device. In view of the complex design problems this phase of the work is being carried out by an electronics specialist connected with the University of Pennsylvania. Preliminary work appears encouraging, and it is expected that a prototype device should be ready for field testing by the end of 1961.

In addition to the above development work considerable financial support has been promised from various oil company interests in order to sponsor a full investigation of the possibilities of improved seismic devices. In view both of the lack of knowledge about the general problems involved, and of the complex design requirements, such work would probably be mainly undertaken by commercial geophysical interests in Texas. Full cooperation is however expected from the University Museum, especially with respect to field testing.

3. Theoretical studies on field surveying methods.
Preliminary tests with model techniques of resistivity problems have shown promise, and it is hoped to undertake a much fuller study early in 1962. In general a geat deal of work still appears to be necessary in the study of near surface conditions, especially under the special type of conditions found on archaeological sites.

4. Information center on techniques.
A part time graduate student has been employed since July 1961 in a literature search covering the techniques field. From this an extensive card index file is being prepared. The select library is also being extended.

5. Thermoluminescence dating.
It is hoped to continue preliminary studies as reported previously.

6. Extension of museum chemical laboratory.
The 'Spectramal' spectroscopic analysis instrument has proved to be of great value in improving upon the rapid analysis of archaeological specimens. Further investigations with this and other analyses methods are planned.

A full investigation of the possible uses of the Vickers Projection Microscope , as mentioned in the last report, is being undertaken.

7. Student training in techniques.
A course in archaeological techniques for graduate students is being considered for possible establishment during 1962.

For item 8 see below.

~~8. Conferences attended during 1961.~~
~~R.B. Lindington attended a weekend conference on surveying methods in~~ London, March 1961. A.E. Parkinson ~~attended a conference on conservation~~ of ancient bronzes in ~~Washington~~, June 1961, and is due to attend a ~~several week long conference on conservation methods in Rome, Sept. 1961.~~

9. Publications.
Rainey published a brief account of the general aims of the ~~-amme~~ in Bulletin of the Philadelphia Anthropological Society,

Dr. A. Kidder II commented on the possible uses of surveying methods in South America, reference as for Rainey.

An article on the uses of surveying methods in connection with salvage archaeology by R.E. Linington is to be published in Archaeology, Dec. 1961.

R.E. Linington,

Research associate in archaeological techniques,

University Museum, Philadelphia.

8. Conferences attended during 1961.

R.E. Linington attended a weekend conference on surveying methods in London, March 1961. A.E. Parkinson attended a two day conference on the conservation of museum objects at the conservation center, New York University in April, 1961, and a three day seminar on technical studies of ancient metal artifacts in Washington, June, 1961. He is also due to attend the I.I.C. week long conference on conservation methods in Rome, Sept., 1961.

A conference meeting was held at the University Museum, June, 1961, to report both on scientific survey methods, and on the survey results from Tikal, Guatemala.

RESEARCH AND DEVELOPMENT IN NEW TECHNIQUES FOR ARCHAEOLOGY

ABSTRACT OF PROPOSED RESEARCH

The continuation and extension of the research programme initiated during 1960-61 under research grant NSF G 13256. Details of the proposed programme for 1961-62 are given below.

SUMMARY OF PROGRESS DURING 1960-61

A brief report on the initial development of the project was given to the NSF on 12th Nov. 1960. A copy of this report is appended to this application.

The general progress of the project can be summarised as below.

1. R.E. Linington, a physicist and archaeologist from Oxford University commenced work in Sept. 1960 as Research Associate in Archaeological Techniques of the University Museum. Close contact has been maintained with the existing museum chemical laboratory and with the Radio Carbon laboratory, as well as with the collaborating archaeologists of the staff of the University Museum.

2. Establishment of field survey methods. New resistivity equipment, seismic equipment and a proton magnetometer have been purchased. These instruments, with suitable modifications for archaeological usage, were extensively tested at Tikal, Guatemala in conjunction with the University Museum's excavation programme. This work was undertaken immediately prior to the submission of this application, so that preliminary interpretation of the results is as yet incomplete, however it is apparent that the tests have given some very useful information on both the possible usage of the methods on this type of archaeological site, and also on the general interpretive problems involved in such surveys.

3. Development of a new survey method. Extended testing was undertaken with commerical high-resolution seismic equipment in conjunction with Texas Instruments (Geophysical Services Inc.) Help was also received from Sun Oil Company and the Texas Research Foundation, Dallas, Texas. Preliminary field testing in the Dallas area proved sufficiently successful for a second series of tests to be made on selected archaeological sites in Arizona. From the results of these tests it has become obvious that, although much more work is required, in particular using energy sources other than the normal percussive ones, the general position over the development of the new survey method is very satisfactory. Such a method should be of great use in archaeology as it would be applicable in cases where the existing methods can not be used. A report on the results of the seismic tests was given by R. E. Linington at a conference in London on archaeological prospecting in March 1961. In connection with this work Texas Instruments have already contributed considerable technical help and financial aid; the exact amount contributed is difficult to estimate however probably is not less than $10,000. It is also hoped that Texas Instruments will provide a grant to enable further development work to be carried out using their laboratory facilities.

4. Establishment of museum methods. Little further work has been attempted other than that reported previously.

5. Improvement of existing chemical facilities. An ultra-sonic decontamination unit has been added to the chemical laboratory.

6. Information center and technical library. The technical library has been started, especially with regard to geophysical literature. Work on the basic card reference system dealing with archaeological techniques has commenced, with a graduate assistant of the museum working part time.

7. Thermoluminescence

BACKGROUND AND AIMS OF RESEARCH

A full background to the proposed research was given under the application for NSF G 13256. A summary of the basic aims of the research is repeated below.

The number of scientific techniques applied to archaeology, and also those techniques in allied fields which could be applicable to archaeology, have increased rapidly during the last few years. Most of this development has occurred in Europe, especially in England, although some work has been done in the U.S.A. The aim of the University Museum project has been to set up a center, not only for the use and development of specific techniques, but also for recording information and for teaching over the whole range of possible techniques. In particular the center aims to concentrate on prospecting methods for locating buried archaeological features, on dating methods, and on methods of analysis and conservation of museum objects. The latter two subjects conveniently allow of full collaboration with the existing Radio Carbon and Chemical laboratories respectively. At the present botanical and soil analysis problems are not being treated as these can be more adequately covered by existing specialist institutions. Data relevant to these methods will however be collected as proves convenient, in connection with the information center aspect of the project.

DETAILED DESCRIPTION OF THE PROPOSED RESEARCH, 1961-62

1. Continued development work on the new seismic survey method. It is hoped that much of the development costs of this aspect will be met by Texas Instruments. Despite this considerable expenditure will still be necessary, especially in connection with field work and travel.

2. Improvement of existing survey methods, in particular over the interpretive problems encountered. This aspect of the work would involve some laboratory work with field tests in various geographical areas.

3. Laboratory studies including the use of model techniques, in particular with reference to resistivity surveying.

4. Extension of the technical library and information center. A part time graduate assistant would be hired specifically to undertake much of the work involved in the information center. An extension of the technical library to cover conservation methods and dating methods is envisaged.

5. Establishment of a basis for possible teaching courses in techniques.

6. Expansion of chemical facilities. This work, including the possible purchase of spectroscopic equipment for rapid analysis purposes, would come under the existing museum chemical laboratory.

7. Improvement of dating methods. In particular further development of the thermoluminescence method of dating is envisaged. This work would mainly be undertaken by the existing Radio Carbon laboratory.

PROCEDURE

The NSF grant to the university museum would be used to pay the salaries of R. E. Linington and possibly two part time assistants. The grant would also cover the proposed research programme outlined above. It appears likely that a considerable amount of the grant would have to be used for travel both in the U.S.A. and abroad.

FACILITIES

In addition to the existing Chemical laboratory and the Radio Carbon laboratory, office and laboratory space is now in existence in the University Museum. A considerable amount of installation of permanent fixtures has been made including improved lighting, shelving and working space.

The archaeological staff of the museum would continue to collaborate as proves necessary. The University of Pennsylvania would, of course, continue to pay the salaries of all personnel connected with the project, other than those mentioned above; in particular this includes the museum chemist, Mr. A. E. Parkinson and the staff of the Radio Carbon laboratory.

PERSONNEL

Short biographies and bibliographies of Dr. Froelich Rainey, Director of the University Museum, Miss Elizabeth K. Ralph, head of Radio Carbon laboratories, and Mr. A. E. Parkinson, Museum Chemist were attached to the previous application. A short biographical sketch of R. E. Linington, Research Associate in Archaeological Techniques, follows.

R. E. LININGTON - CURRICULUM VITAE

March 24, 1961

PERSONAL HISTORY:

BIRTH: June 8, 1936, Bromley, Kent, England

EDUCATION:

Oxford University, Honours Degree in Physics 1960

EXPERIENCE:

Instructor and Specialist in Radar, Royal Air Force, 1955-57

Director of excavations for Oxford University Archaeological Society, 1959-60

Director of geophysical surveys at five excavations 1958-60

President, Oxford University Archaeological Society 1960

Research Associate in Archaeological Techniques, University Museum, September 1960

PUBLICATIONS:

The Roman road from Alchester to Dorchester, Oxoniensia XXIV (1959)

Contributions of Physics to Archaeological Salvage, Archaeology (forthcoming)

Editor of publications of Oxford University Archaeological Society 1959-61

BUDGET (Period 1961-1962)

SALARIES		
R. E. Linington	$6,500	
Part time assistants	3,000	
Employee Benefits (7.8% of salaries)	741	
OTHER EXPENSES		
Travel and field testing	3,500	
New seismic survey method	5,500	
Laboratory installation, equipment and maintenance	2,000	
Extension of library and data center	1,000	
Dating methods (thermo-luminescence)	1,500	
Chemical laboratory	1,500	
Sub-Total		$25,241
Overhead 20%		5,048
Total		$30,289

Report on the progress of the project for the development of new techniques for archaeology at The University Museum University of Pennsylvania, Philadelphia

November 12, 1960

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1. Personnel.

R. E. Linington, a physicist from Oxford University, England, arrived at the museum the beginning of September, and has commenced work on the project.

2. Expansion of existing chemical laboratory facilities.

In collaboration with the museum chemist, Mr. A.E. Parkinson, the potentialities of the ultra-sonic cleaning method were investigated. Tests were made using the apparatus at the National Parks Service laboratory, Philadelphia. An instrument has been ordered for the museum.

3. Establishment of field survey methods.

Improved resistivity equipment, and a proton magnetometer have been ordered.

4. Development of a new survey method.

Extensive consultations have been held with industrial geophysical interests; in connection with this R.E.L. spent a week in Dallas, Texas. It appears possible that development work in Texas can be envisaged. In addition existing geophysical publications and journals have been studied.

5. Establishment of museum methods.

A beta-ray back scattering device has been set up and preliminary testing completed. The instrument is mainly of use for the non-destructive investigation of surface coatings on museum objects. Work is continuing to improve the accuracy and the application of the method.

6. Thermoluminescence.

Work has started in cooperation with Miss E. Ralph on further preliminary studies.

7. Establishment of an information center.

An extensive file and card index system covering all aspects of scientific applications to archaeology have been started. Contact has also been made with several other laboratories in Europe.

8. Technical library.

A technical library covering scientific applications to archaeology has been started . This library will also include selected material from related studies. A set of the journal 'Geophysics' has been purchased.

9. Future plans.

i. Further work as detailed under items 4 to 8 above.
ii. Field tests with field survey equipment at Tikal, Guatamala in connection with the established University Museum projects.
iii. Field testing in Italy in conjunction with the Lerici foundation.
iv. Visits to European research centres.

R.E. Linington,
University Museum