AUG 9 1962

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

GS-16
Continuation of G-18571

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, effective August 1, 1962. As funds are needed to carry out the purpose of this grant, please include your funding requirement in the Monthly Cash Request Form, No. 4-49.

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, construction of facilities, installation or adaptation of equipment, as may be supported by this grant, 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, as amended, and in conformity with the other understandings reached between the Foundation and the grantee relating to this grant.

Please acknowledge receipt and acceptance of this grant and include a reference to the grant number.

Sincerely yours,

Alan T. Waterman
Director

NATIONAL SCIENCE FOUNDATION
WASHINGTON 25, D.C.

August 13, 1962

Dr. Froelich Rainey
The University Museum
University of Pennsylvania
Thirty-third and Spruce Streets
Philadelphia 4, Pennsylvania

Dear Fro:

This will inform 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.

I am sure you are familiar with the Foundation's policies with regard to reports on the project and reprints of publications resulting from the work done under the grant. If you have any questions about these or any other matters, please do not hesitate to write me.

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

Yours sincerely,

Albert C. Spaulding

Albert C. Spaulding
Program Director for
Anthropology

Enclosure

September 13, 1963

Program Director for Anthropology
and Social Sciences
National Science Foundation
Washington 25, D. C.

Dear Sir:

Copies of our final report and of publications for NSF grant GS-16 are enclosed.

Dr. Rainey and I would like to express our gratitude to the National Science Foundation for this financial support which enabled these activities to be conducted.

Sincerely yours,

Elizabeth K. Ralph

EKR/ek

Encls.

NATIONAL SCIENCE FOUNDATION
WASHINGTON 25, D.C.

September 23, 1963

Miss Elizabeth K. Ralph
Applied Science Center for Archaeology
The University of Pennsylvania
33rd & Spruce Streets
Philadelphia 4, Pennsylvania

Dear Miss Ralph:

Thank you for your final report on the work completed under GS-16 and for the accompanying reprints. We are pleased to see that so much was accomplished.

Sincerely,

Allan H. Smith
Program Director for
Anthropology

cc: Dr. Frolich Rainey

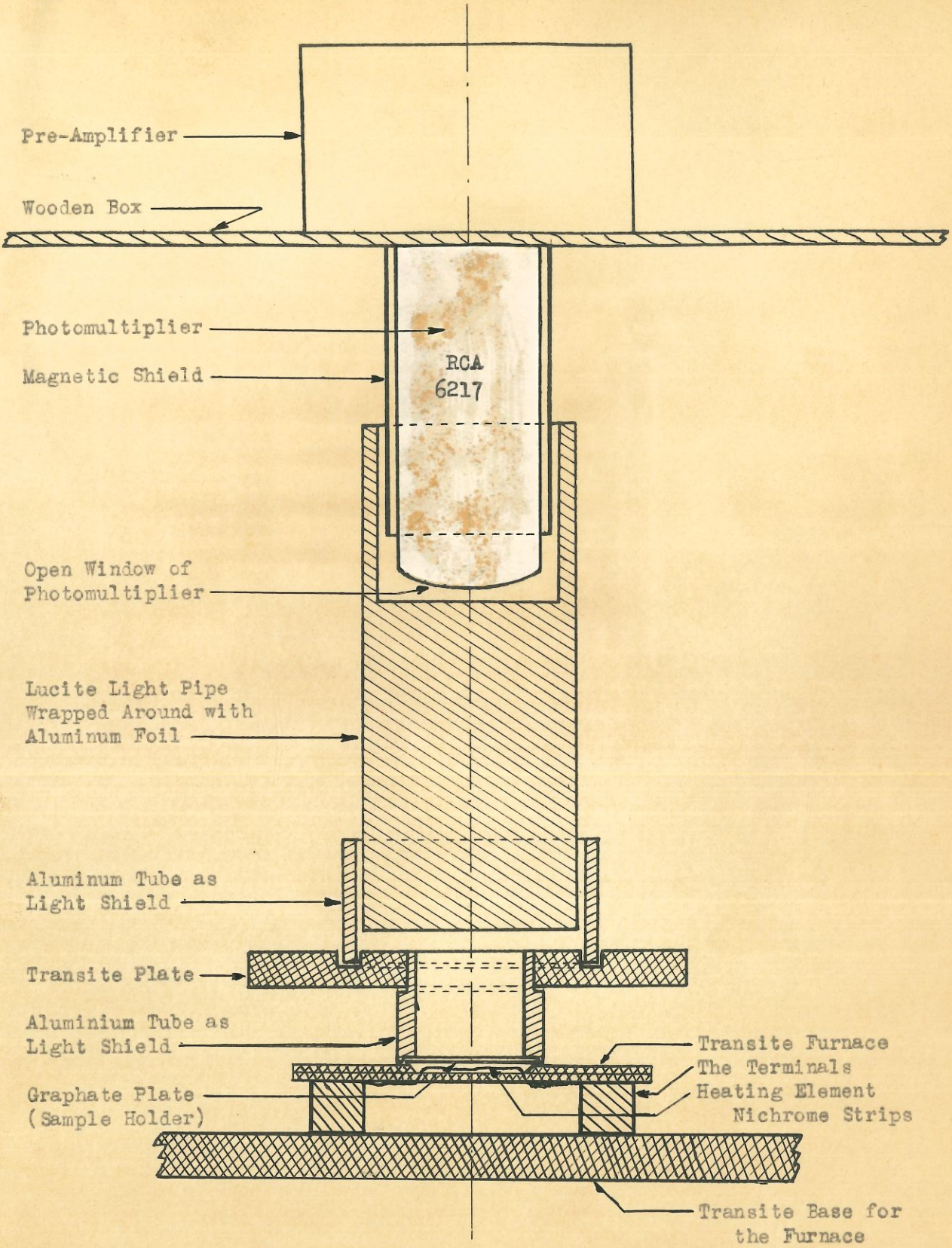


Fig. 1 Cross Section of Photomultiplier, Light Pipe, and Furnace

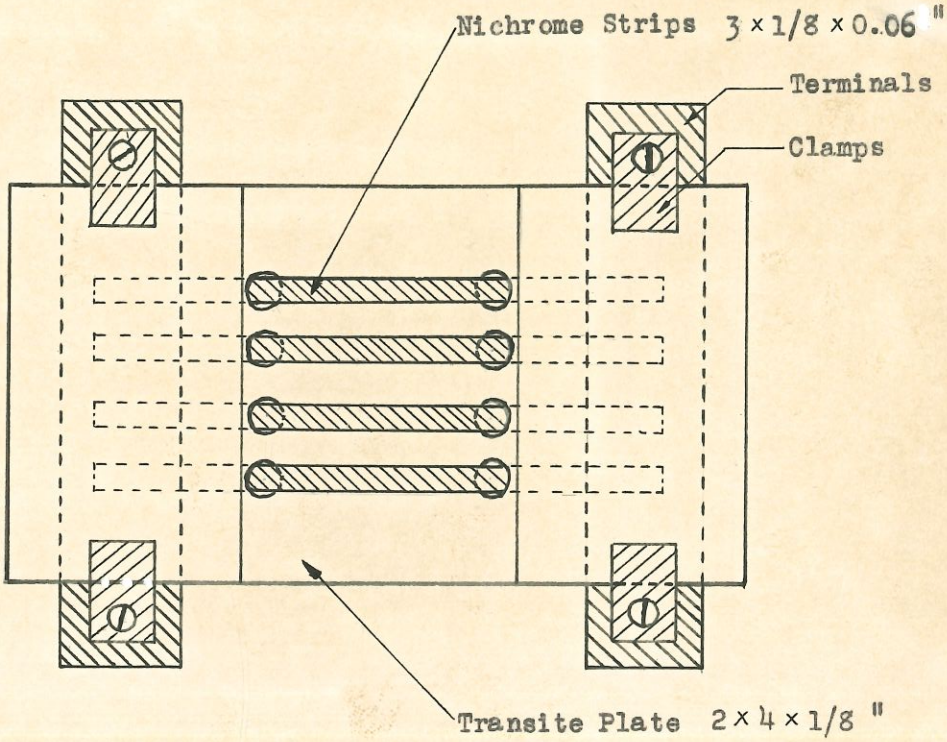


Fig. 2 Top view of the Furnace

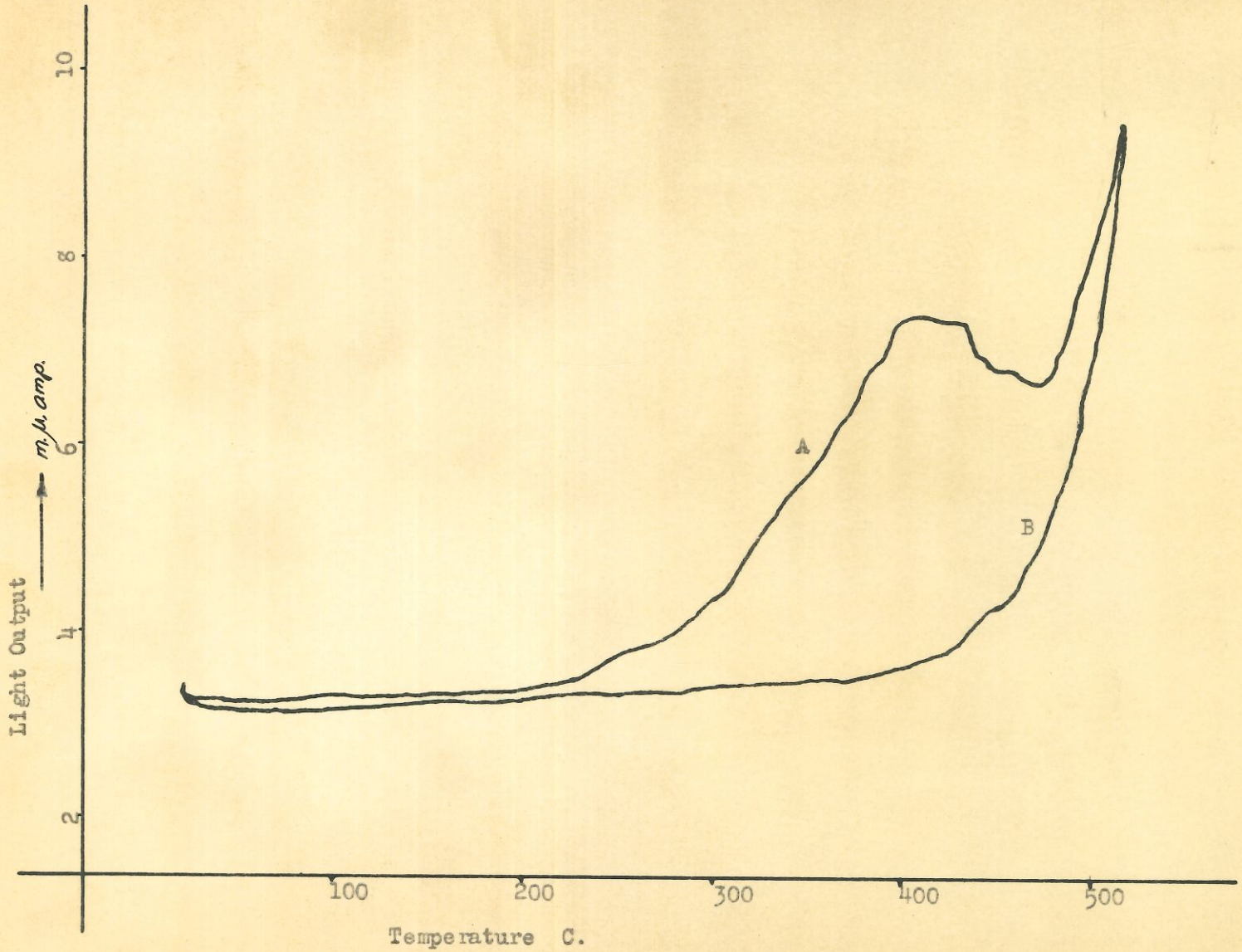
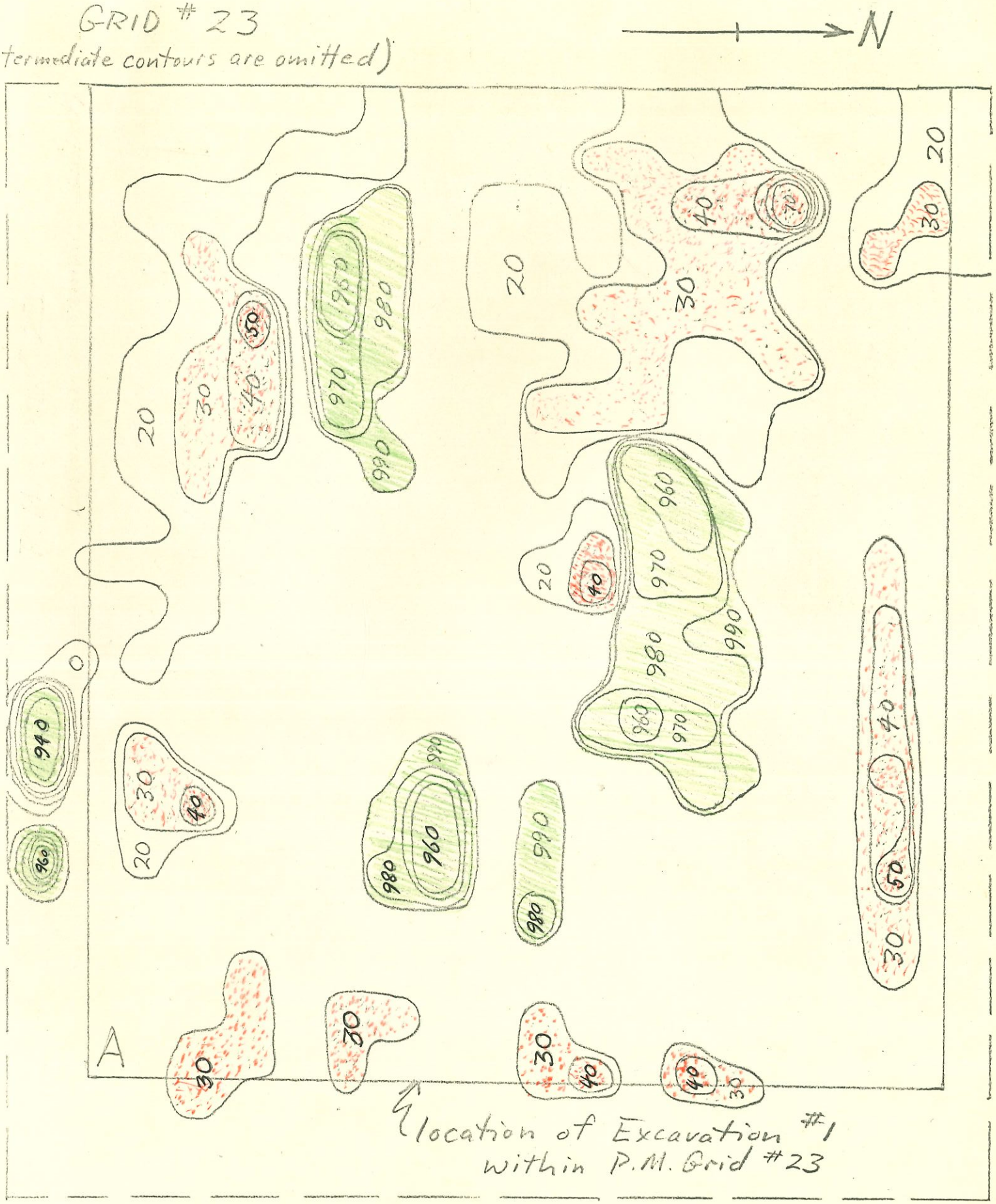


Fig. 3

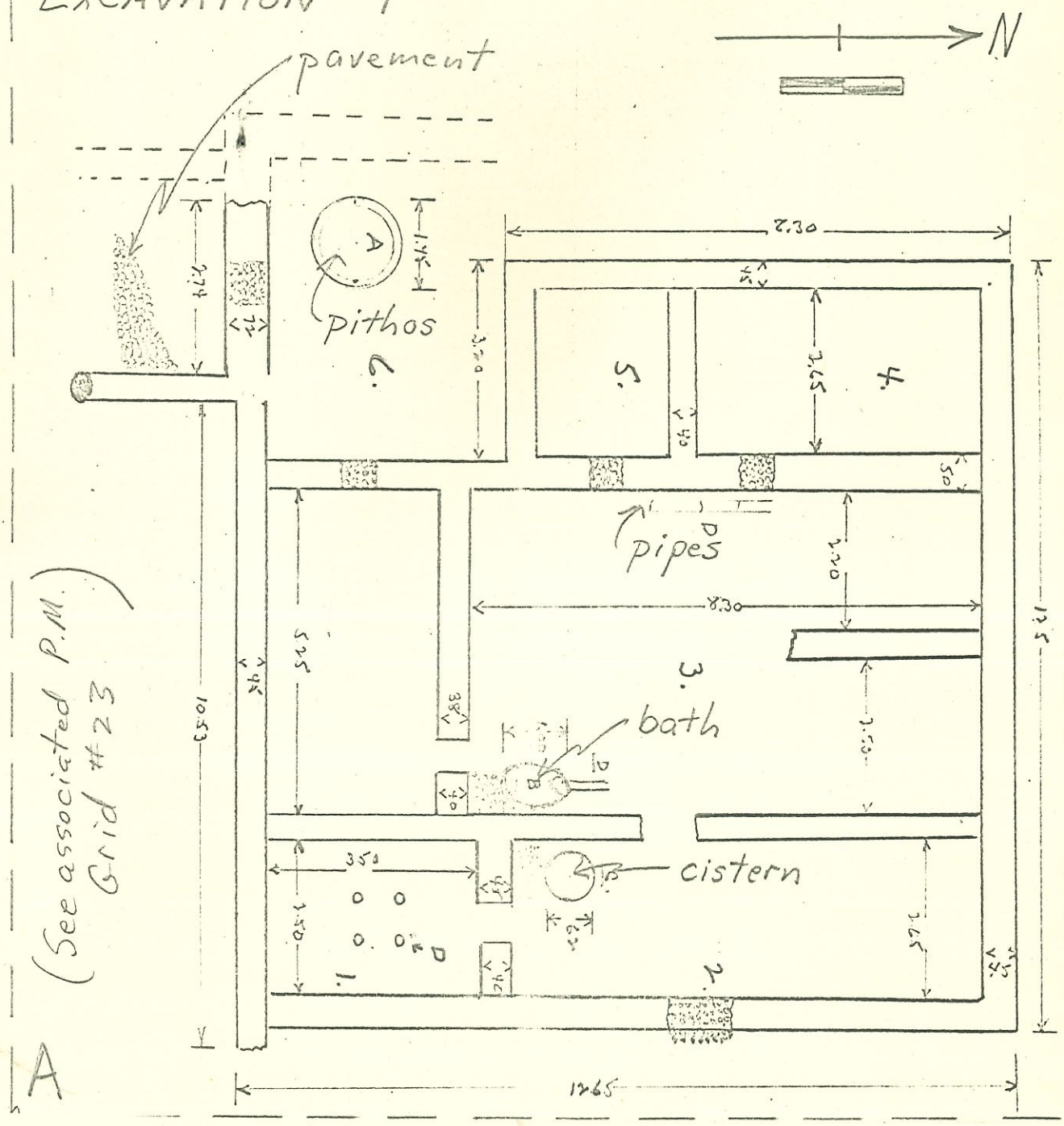
Glow Curve of 4,000 B.C. Pottery from Hotu, Iran.

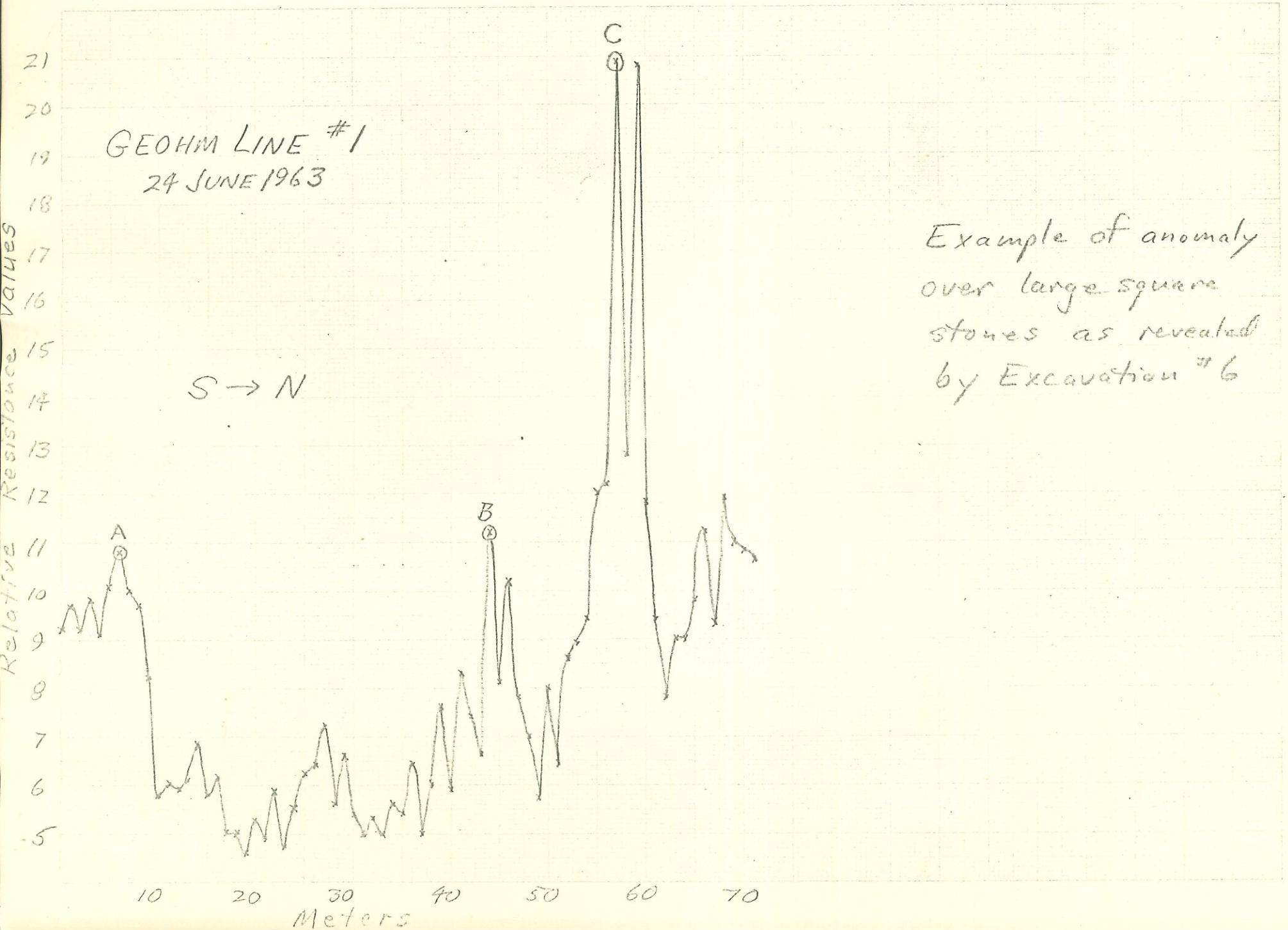
PROTON MAGNETOMETER
GRID # 23
(Intermediate contours are omitted)



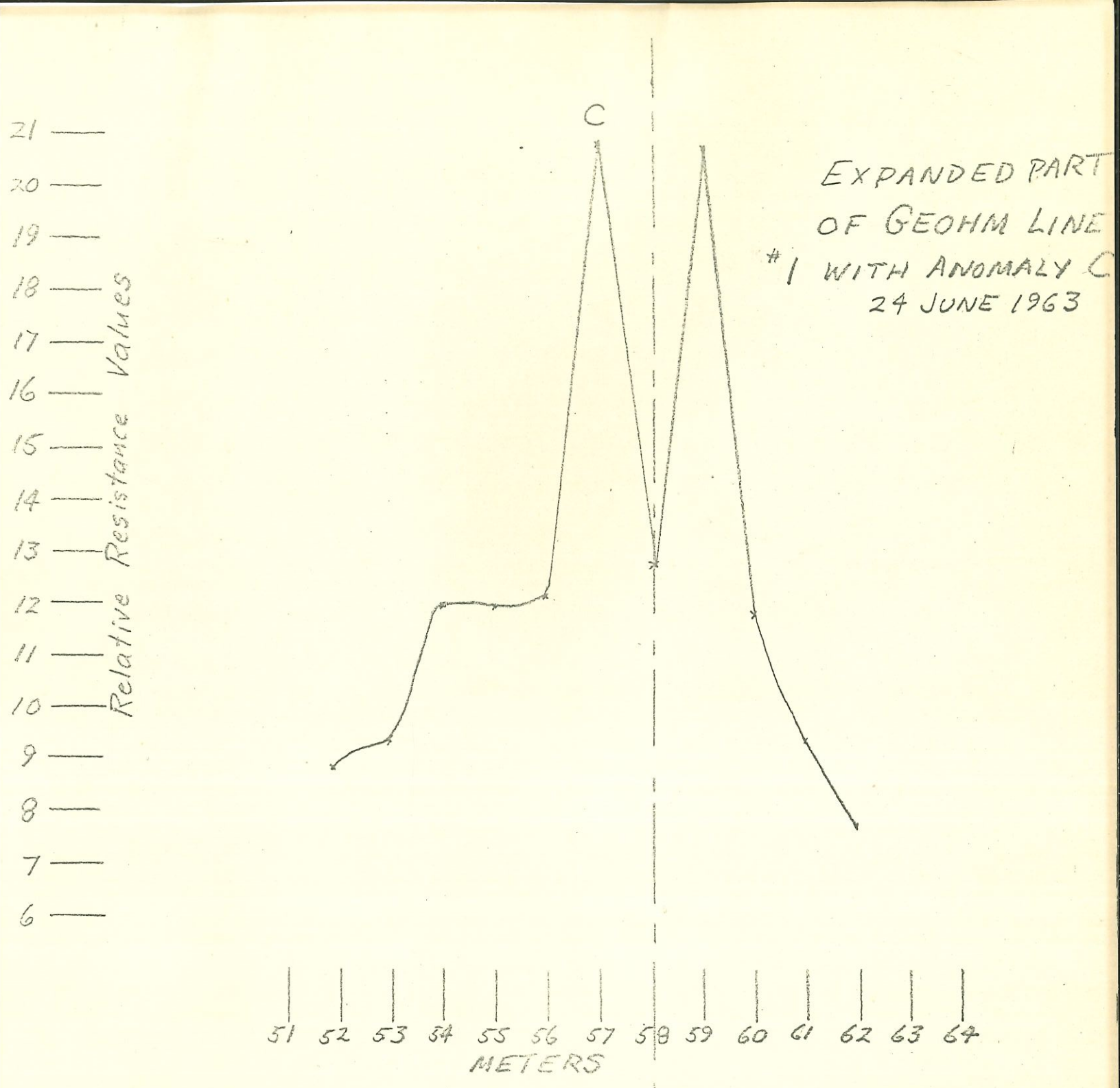
SCALE: 1CM = 1M

EXCAVATION #1



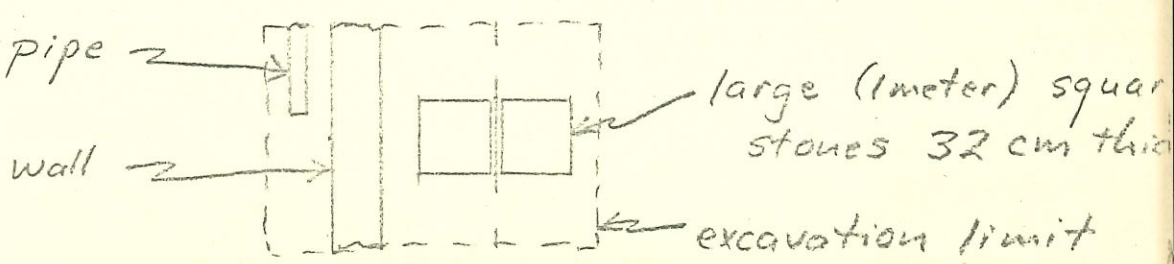


Example of anomaly over large square stones as revealed by Excavation #6



EXPANDED PART OF GEOHM LINE #1 WITH ANOMALY C
24 JUNE 1963

EXCAVATION #6



SCALE: 1cm = 1M

8/62 Reduced Budget

BUDGET

Salaries		
Research chemist, Mark Han	$ 6600	
Research assistant, full-time	5000	
Research assistant, part-time, information center	3000	
Research assistant, part-time	2000	11600
Total salaries	16600	2000
Employee benefits (8.3% of salaries)	1378	1128
Equipment		
Underground Instruments -- continuation of sonic device development including ground coupling and transducer problems and development of more sensitive metal detectors	10000	5000
Information center	500	
Books, references, periodicals		
Laboratory projects		
Thermoluminescence recorder, etc.	3000	
Vickers projection microscope	3500	
Special study costs -- emission ~~microscope, ole~~ spectrograph, electron microscope, mass spectrometer, etc. service charges	2000	
Expendable supplies and materials and small apparatus	2500	2000
	21500	7000
Travel		
Technological site review, 3 people to Near East	5000	
Other instrument tests	1500	
Collaboration with and trips to Texas companies	500	
	7000	1500
TOTAL	46478	
Overhead, 20%	9296	
GRAND TOTAL	$55774	23,228 / 4,646 / 27,900

Called Dr. Spaulding 8/21/62 E Ralph

Reasons

Saving money

caution - archae. world

Title - their mistake

Spaulding/away Aug. 25 → Sept. 24th, 1962

2.00
40
50
2000

ASCA - Budget

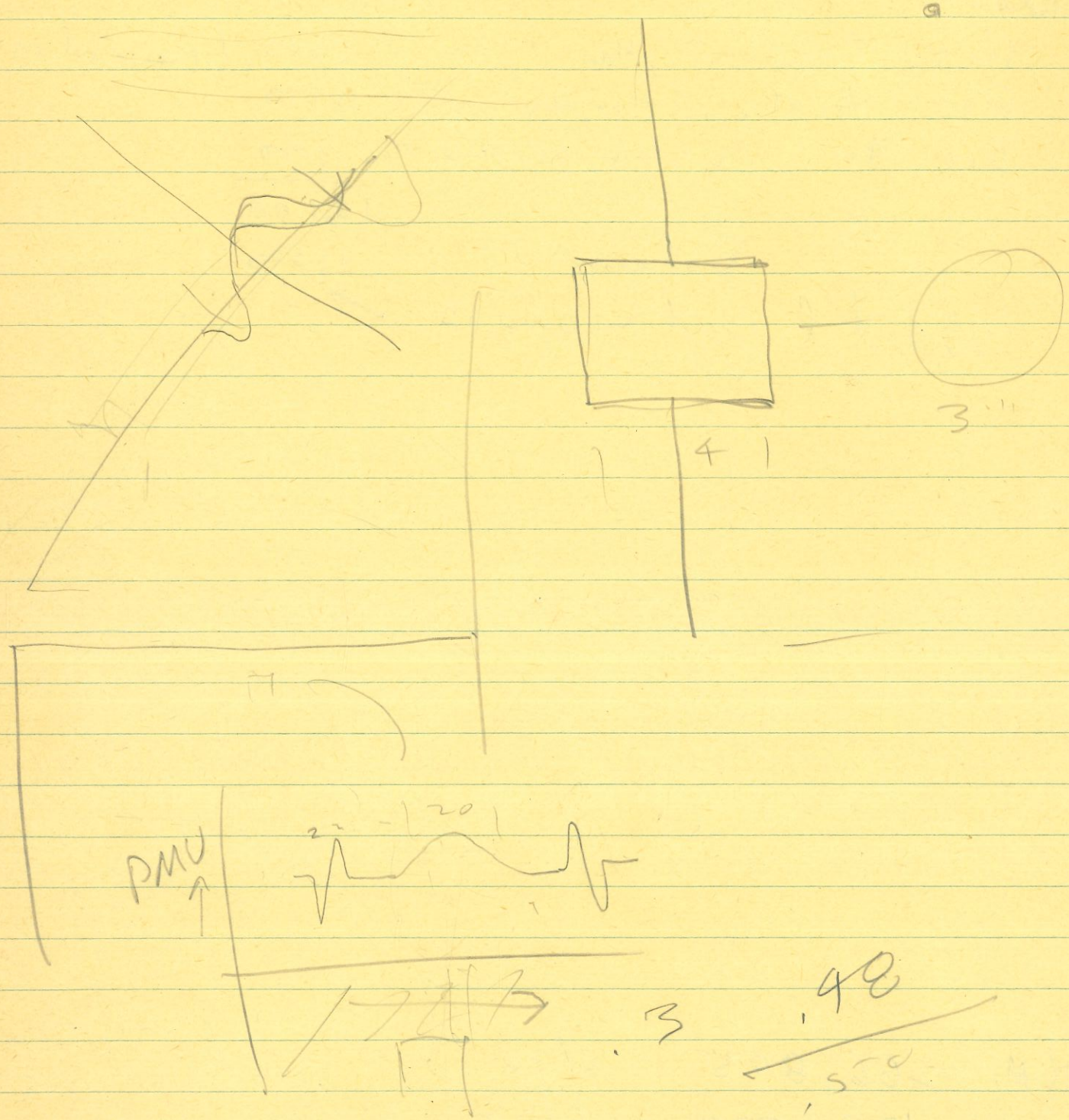
9/5/62

Salaries

Res. Chemist, Han	6600 (raise of 10%)
Res. Asst., ½-time, Ham	2500
Res. Asst., ½-time, data & files, Ham	3000
	12,100
Balance =	1,500

addit'l part-time assist →

H.M. 266,895 6/30
120,000 6/27


PMU
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[Aug. 13, 1962]

Arch Techniques

UNIVERSITY OF PENNSYLVANIA
Office of Project Research and Grants
Digest of Terms of Contract or Grant for Research Project

CONTRACT NO: NSF-GS-16
ACCOUNT CODE NO: 4-10100-3-6226
SPONSOR: Nat'l Science Fdn.
TITLE: Research on Archaeological Techniques.
DURATION OF CONTRACT: 8/1/62 to 7/31/63

PRINCIPAL INVESTIGATOR: Dr. Froelich Rainey
UNIVERSITY DEPARTMENT: University Museum
TYPE OF CONTRACT: Grant
AMOUNT OF CONTRACT: $27,900
OVERHEAD: 20% of cost ($4650)

REPORTS, INVOICES: Scientific Reports: Comprehensive Final
Financial Reports: 6 Mo. interim; Final

BUDGET: A University budget covering these funds should be prepared and submitted through regular channels.

TRAVEL: To be authorized by: Dr. Rainey Per Diem $_____ on a quarter day basis or, actual subsistence not to exceed $_____ per day if supporting receipts accompany claim.
Automobile reimbursement: 10 ¢ per mile.

SPECIAL BUDGET INSTRUCTIONS ATTACHED

APPROVALS: Prior approval must be obtained for subcontracts and purchase orders that fall in categories checked below:

_____ Insurance.
_____ Exceed $500., $1,000.
_____ Involve research or development.
_____ Provide for building alteration or construction.
_____ Overtime pay.
_____ Foreign purchases.
__X__ ~~Travel to Scientific Meetings~~ and all foreign travel. Federal transportation taxes may not be paid with grant funds. Exemption certificates available at Comptroller's office.

Not in budget submitted

EMPLOYEE BENEFITS: 8.3 % of salaries and wages should be budgeted for Employee Benefits.

PUBLICATIONS: Copyrighted material shall carry byline granting sponsor royalty-free right of reproduction and shall acknowledge sponsor's support. __X__
4 copies of reprints of each publication to NSF.

PATENTS: Any patentable invention to be reported to sponsor. __X__

PROPERTY: Title to property purchased with sponsor's funds rests with University Accurate records must be kept of all non-expendable items purchased with contract or grant funds.

OTHER: For payment use monthly cash request for no.4-49. Funds not committed prior to conclusion of project to be returned to NSF. NSF to be informed of contemplated major deviations from budget estimates.

NOTE: Accounting Code 4-10100-3-6226 has been assigned to this project. Please use this number on all requisitions, invoices, etc. to be charged against these funds.

DISTRIBUTION: File
Comptroller, Attn: Miss Rennard, w/cy contract
Principal Investigator ✓
~~Dean~~
Purchasing

OFFICE OF PROJECT RESEARCH AND GRANTS

Rev
561

IMPORTANT NOTICE CONCERNING UNIVERSITY BUDGETS

In order that a clear picture of the actual costs of sponsored research projects might be obtained, the following procedures should be used in the preparation of budgets covered by contracts and grants.

On the "Current Expense and Equipment" page of the University Budget, on the line in the overhead section labelled "Full" Rate", the overhead costs of the project are to be entered. These must be in an amount equal to 50 per cent of all salaries and wages included in the budget.

If the overhead allowance provided by the sponsor is less than 50 per cent of salaries and wages, the difference will be shown as a contribution from the University. Steps will be taken by the Office of Project Research and Grants to secure an appropriation from University funds to cover this contribution.

The following illustrates the procedure outlined above. In this example it has been assumed that the salary budget amounts to $10,800 and that 15 per cent overhead on $11,900 of total direct expenses has been allowed by the sponsor.

CURRENT EXPENSE AND EQUIPMENT page of budget

Code No.	Current Expense		Expl. Ref. No.	Amount Approp. Current Year	Amount Propos. for Next Year
8940	Overhead:			XXXXX	XXXXX
	"Full" Rate (50% Salaries)	$5,400		XXXXX	XXXXX
	Less: Univ. Contr.	3,615		XXXXX	XXXXX
	Overhead Allowed				1,785

This procedure was established in January 1958 to implement an action of the Trustees. It is not intended in any way to curtail research efforts of the faculty, nor is it indicative of any intent on the part of the University to reduce its contribution toward the cost of research programs. The procedure was developed to assure that indirect costs of our various programs will be more clearly recognized and more appropriately distributed.

F. Haydn Morgan
Director

NSF GRANT GS-16

Activities of the Applied Science Center for Archaeology

September 1962 - September 1963

Final Report - September 1963

by Froelich Rainey, Director
and Elizabeth K. Ralph, Associate Director

I. Development and use of instruments for underground exploration.

A. Development of sonic detector.

Experiments with the MacLaughlin prototype, both last year and again this year in Italy, indicated the necessity of obtaining more basic information concerning the behavior of sonic waves in earth before the design of a satisfactory instrument could be achieved. The reasons for this are that waves with frequencies higher than the usual seismic (greater than 200 cps) are attenuated much more severely in earth than in liquids and gases, media in which they have been used successfully. And, it is more difficult to couple waves of higher frequencies into the earth efficiently. It is necessary to go to these higher frequencies, and consequently shorter wavelengths, in order to detect the relatively small archaeological features at shallow depths.

Fortunately, through the kind cooperation of the Petty Laboratories and a contribution ($32,000.) for this work by the Sun Oil Company, these basic experiments were conducted this year. First of all, a requisite test site was constructed near the Petty Laboratories in San Antonio, Texas. This in-

cluded geophones and "anomalies" (concrete blocks 1 meter in diameter) planted at various depths. Measurements made with a 25 w speaker then indicated that 600 cps was the best "compromise" frequency of operation. Above 600 cps the attenuation increased sharply, but this frequency is sufficiently high to enable one to "see" walls and foundations of the order of 1 cubic meter. Subsequently, experiments have been made with a variety of transducers. Through the kind cooperation of Prof. Harold Edgerton of M.I.T., experiments were conducted with one of his Pinger systems and with his 1000 WS Boomer. The output of the 12 KC Pinger was undetectable (due to attenuation) at distances greater than 70 cm. Also, even though the Boomer had a resonant frequency of 600 cps and was more powerful than considered necessary, it transmitted a spectrum of frequencies and the lower ones of the order of 350 cps and less masked the higher components. These tests indicated also the need for more efficient ground coupling even for the comparatively low 600 cps frequencies, and for a narrow band frequency output. One plan, presently being tried, is to mount a Boomer or other power source on a large steel plate designed to be resonant at 600 cps.

At the same time, experiments are continuing with Barium Titanate crystal transducers, and the indications are that with improvements in the ground coupling, increased power (approximately 25 Kv) to drive the crystals, and with a larger assembly of crystals (possibly 75 cm, approximately the wavelength), sufficient gain will be obtained to detect transmission up to 6 meters and to see reflections from objects buried at depths of 2-1/2 to 3 meters. This is less than our ultimate goal of detecting walls, etc. buried at depths of 8 or

more meters, but would still be a very useful instrument for locating features at intermediate depths. It would provide not only detection but also a measure of depth.

The NSF contribution during this year toward this project has provided travel funds for E. Ralph to participate in and to help to accelerate the experiments in Texas. Also, the test apparatus includes the detector of the MacLaughlin prototype and other components built both by MacLaughlin and the Petty Co. engineers. These have enabled experiments to be conducted with continuous and with pulsed waves, various amplifiers and associated filters, and to be detected both by oscilloscopic and oscillographic means.

B. Field Use of Instruments -

These instruments include the Oxford proton magnetometer, resistivity instruments (Gossen Co. Geohms), seismograph (Geophysical Specialities Co.), and various metal detectors, drills and probes.

The most prolonged field surveys (April through June) were conducted again in southern Italy in the course of the search for Sybaris. This was a continuation of the work described in the publications listed. The difference this year was that work was conducted in the hills as well as on the plan. Even though walls were found at shallow depths in the hills, it was difficult for work with the proton magnetometer because the earth in the hills was highly magnetic and in many places had been disturbed by plowing, etc. However, even though some "anomalies" proved to be merely mixed earth, many house foundations were located with the proton magnetometer and some with the geohm. An example of each is included. The geohm was used under power lines where the magnetometer would not function, but necessitated, of course,

a much more time consuming operation for covering the large areas required in the search for Sybaris.

These two instruments were used in July at Navan Fort, near Armagh, N. Ireland on and around the prehistoric mound at this site. Surveys with the magnetometer indicated that the earth over possible passageways and entrances had not been disturbed in recent years. In a bog near the site, various anomalies were found. Excavations, to be continued next year, will help to illuminate the causes of these.

A search for natural copper ore deposits, the source of metal for Indian tribes, was conducted at Isle Royal, Lake Superior, Michigan in June. Results obtained with the Fisher M-scope metal detector, the seismograph, and a geohm indicated various spots where deposits may exist.

In August, surveys made at the Louisbourg Fortress, Louisbourg, Nova Scotia with the proton magnetometer, a geohm, seismograph, and metal detector found the following probable anomalies:
In the Chapel, approximately 10 graves (found as magnetic regions with the magnetometer due to the greater susceptibility of disturbed soil), buried construction features or fallen walls. (geohm, high resistance areas), and bed rock 4 feet deep (seismograph change of velocity) were indicated. In one of the embankments, a possible tunnel was detected with the magnetometer and the anomaly, confirmed with geohm readings. In the Terreplein area, 2 or 3 buried cannon or other large iron objects were found with both the proton magnetometer and the metal detector. Because of extensive excavations now in process and to be continued for several years and because of the presence of a variety of buried architectural and other features, this site provides a good testing ground for the instruments.

II. Experiments with the Dating of Potsherds by the Thermoluminescence Technique.

For the determination of the requisite glow curves, significant improvements in the design of the rapid-heating furnace and the arrangement of light-pipes and shields have been achieved by M. Han. A cross-sectional diagram showing the arrangement made for measuring the glow curve of a sample being heated rapidly by the furnace (or the heating element) under the sample holding disk is shown in Fig. 1. The photomultiplier is situated on top with its open window facing the sample, and is separated by a solid lucite light pipe, to prevent the heat produced by the furnace from reaching the photomultiplier. The pipe is wrapped with aluminum foil, which serves as a reflector for the passing light, then electrical tape is wound around the foil as an external protector of the light pipe. The path from the sample to the photomultiplier is made completely light-tight from external sources, so that only the minute amount ~~visible~~ of light that is emitted from the sample, when it is being heated up to several hundred degrees centigrade in a very short time is being detected by the photomultiplier and recorded.

Figure 2 illustrates the construction of the furnace. An A.C. current of 100 amperes is applied to the nichrome strips. The heat produced by the furnace is used to heat a thin graphite disk 0.04" thick and 1&15/16" in diameter, on which the sample is placed. The disk is located 1/8" above the nichrome strips. To measure the temperature of the disk; a thermocouple is inserted beneath the disk, its output fed into the X-axis of a X-Y recorder. The output from the photomultiplier after amplification is fed into the Y-axis, and the glow curve is so obtained. Experimental results ~~of~~ with a 4,000 B.C. sample of pottery gave a glow curve as shown in Fig. 3. Curve A

indicates the sample heated from room temperature up to 500°C. The peak in output occurs around 400°C. Curve B indicates the same sample, after primary heating, reheated again under the same conditions. The sharp increase in the output of the photomultiplier around 500°C, is due to heat radiation emitted by the disk, when heated up to this high temperature. The difference between the two curves shows, however, that the significant portion of the glow curve has been detected before the onset of heat radiation.

It is planned now to make a series of quantitative measurements to determine the reproducibility of this arrangement with one type of sample, and then to begin measurements of samples of different ages. Concurrently, rates of alpha emission, as a measure of the rate of this small irradiation damage, are being determined.

III. Chemical Analyses and Experiments

A. Emission Spectrograph

With the kind cooperation of the Department of Physics at Drexel Institute, several analyses with their emission spectrograph were made by M. Han. They are as follows:

1. Gold objects from the Near East, Russia and Central America were analyzed; qualitative results of elements present were obtained.
2. A series of copper ingots and copper-tin alloys from a sunken ship off the coast of Turkey excavated by George Bass, University Museum, were analyzed. Trace elements present in each individual sample were reported as a comparative study of the samples.
3. Several amber samples from different localities were analyzed by this method. Differences in trace elements among the given samples were noticed. A further study of this problem is scheduled as follows:

a. Sample of the same locality; to determine the variations in composition among one group.

b. Determination of variations among groups; then use this approach to the problem of determining the source areas of ambers as a means of tracing trade and migration routes.

4. Samples collected from several bronze jars and bone containers from Hasanlu were analyzed. The materials inside the jars as well as the ones from a few broken bone containers appeared to be earth-like. Qualitative results showed the materials containing lead, magnesium and aluminum in large amounts with other elements as traces in most of the samples. It is known in ancient times that compounds of the above elements were used as cosmetics. This may provode information about the usage of these jars and the bone containers.

B. Use of the Fisher Dual Spectranal from Aug. 1962 to Sept. 1963.

During the past year the Spectranal has continued to be useful in making qualitative analyses without going through the whole scheme of wet analysis, in proving the presence or absence of minor constituents in a specimen containing a known or suspected major constituent, and in identifying traces which might have been difficult to prove by chemical tests. Sometimes identification could be made without further separation after the sample had been taken into solution; in other cases preliminary chemical separations were necessary.

The following is a resumé of work by E. Parkinson in which the Spectranal was used:

1. A sample from a spearhead from Beisan was analyzed to check a quantitative analysis made outside the Museum in 1932. The check analysis confirmed the presence of copper (major), iron and zinc, and the absence of tin, showed calcium and magnesium, not reported previously but probably contained in the "corrosion product, etc.," and failed to verify the presence of lead, arsenic and silicon, which in very small amounts might not be detected by the Spectranal.

2. During an investigation of thirteen earthy specimens from the Museum Site at Gordion analyses were made of the ignition residues of seven samples. Iron, calcium and magnesium were identified in all seven, copper in five, lithium (probably traces) in five and phosphorus in one, and there were doubtful identifications of strontium, lithium, sodium and thallium in two or more. Aluminum was identified chemically in one. Also the analysis of ash from a piece of charcoal from one specimen showed that it contained calcium, magnesium, lithium and and possibly thallium. Another specimen was analyzed without ignition by wet chemical analysis supplemented by spectroscopic identification of some elements.

3. Chips from the surface of a haematite weight from a Bronze Age shipwreck looked somewhat metallic. Analysis showed the presence of iron, calcium and copper with possibly traces of magnesium, strontium and thallium, from which it was concluded that the surface layer was essentially a calcarious incrustation contaminated with copper salts and intimately mixed on its under surface with haematite.

4. In the course of a quantitative analysis to determine the amount of copper and tin in fragments from a Classical site the Spectranal was used to identify other elements in a siliceous residue from the impure tin oxide; iron, calcium, magnesium and lithium were found.

5. Analysis of a white pyramidal-shaped button from Hasanlu showed that magnesium was the major metallic constituent, with iron and copper and traces of calcium, barium, potassium (by chemical test on a separate sample), lithium and possibly zinc. Quantitative determinations of silica and the magnesium were made and it was concluded that the specimen was a magnesium silicate similar to sepiolite.

6. A heavily corroded metallic specimen from La Compania Site near the coast of Ecuador presented an unusual problem because the apparently completely oxidized core had a silvery coating on each side, which in turn was covered by heavy copper corrosion. Several attempts to determine the composition of the three distinct layers were not entirely successful because it was not possible to separate the very thin silvery layer completely from the core and the overlying corrosion, but a number of analyses identified copper as the major element in the corrosion layer, with calcium, magnesium and sodium, while silver, gold and copper were found in the core and the silvery layers. From these results it was concluded that the specimen was originally

a gold-silver alloy containing a large amount of copper, with the surfaces enriched by removal of the copper to the extent that when corrosion occurred the surface layers remained substantially unchanged.

7. Two samples of a glassy material from Hasanlu, consisting of porous, greenish-black brittle lumps, were found to contain silica, iron, aluminum, small amounts of calcium and magnesium and traces of copper, lithium and zinc. The silica, iron and aluminum were identified chemically and semi-quantitative determinations were made of these. While no definite conclusion could be reached on the basis of the results, it was thought likely that the specimen was a glaze residue in which the iron caused the dark color.

8. In a sample from an iron spearhead from Hasanlu the only metals detected besides iron were calcium and magnesium in traces and possibly a trace of copper. Small amounts of carbon and silica were found by chemical methods.

9. A sample from the iron blade of a bronze-handled dagger from Hasanlu was analyzed quantitatively with the object of determining the amount of iron, carbon and silica present, and during the course of the analysis there was obtained a very small precipitate which was thought to be magnesium ammonium phosphate. Spectroscopic examination confirmed the presence of magnesium and phosphorus and indicated a trace of calcium.

10. A small corroded object of indeterminate shape from Hasanlu was accepted as bronze, but after reduction and removal of corrosion products it appeared to be silver. Analysis of some of the reduced corrosion showed the presence of silver and copper, so either the object is a silver-copper alloy or the corrosion product of the silver was contaminated with copper. Zinc, calcium and magnesium, which were also detected, undoubtedly came from the zinc and sodium hydroxide used in the reduction.

11. A bracelet from Beisan had been catalogued for many years as bronze, but after it was cleaned this appeared doubtful. Analysis of a small fragment showed that it contained silver, gold and copper, therefore the metal is electrum containing copper. Zinc, calcium and magnesium which also were detected were probably absorbed during the cleaning in zinc and sodium hydroxide solution.

12. Some metal fragments from Beisan were listed in the catalogue file as electrum but looked like silver; analysis of a sample proved that it contained gold as well as silver and copper, therefore it is electrum containing copper.

13. A soft metallic inclusion in the mineralized core of an object from Hasanlu appeared to be lead. Analysis of a small fragment confirmed this and failed to detect any other element.

14. Some material clogging a spout from an Etruscan vessel was thought to be possibly organic residue from the original contents of the vessel, but analysis showed aluminum and a large amount of silica, with copper, iron, calcium and a trace of magnesium which were identified spectroscopically. There was little or no organic matter and no chloride nor sulphate, so the material was a siliceous mixture which had nothing to do with the original contents of the vessel. In an analysis of what was thought to be patina from the flange of the spout, copper, iron, calcium, magnesium and zinc were identified, and there was only a small acid-insoluble residue, so that this material differed from that in the spout. The zinc probably came from paint which it was later found had been used on the support on which the spout had been mounted.

The following metallic specimens were all from Hasanlu:

15. A bead tentatively identified as antimony was found to be lead containing a trace of barium. The barium may have come from barium carbonate in the corrosion layer, which was probably basic lead carbonate.

16. Analysis of an antimony button confirmed that antimony was the major constituent but also showed the presence of calcium, magnesium and barium and indicated traces of copper, zinc, strontium, lithium and thallium or zirconium, some of which could have come from corrosion products.

17. Antimony was confirmed as the major constituent of another button, or bead, which also contained minor amounts of copper, calcium and magnesium and possibly traces of zinc, strontium, lithium and thallium or zirconium.

18. An S-shaped link was found to be silver containing smaller amounts of gold and copper and a trace of calcium.

C. THE ELECTROGRAPHIC KIT

This was purchased in October, 1962, primarily for the purpose of determining the composition of metal objects from which samples could not be taken for analysis. The kit was tested with various metals for which it was applicable but so far has been used only once with an unknown metal. This was a golden coating on parts of a Yoruba figurine, in which the presence of zinc and silver was indicated.

D. SPOT TEST OUTFIT

Some of the reagents in this outfit, also purchased in October, 1962, have been used to make check tests on minute samples. For example,

acridine hydrochloride reagent confirmed the presence of zinc in the golden coating on the Yoruba figurine (cf. above), and presence of copper was shown by a test using benzoin-α-oxime (spectroscopic examination of a drop of acid solution also detected copper and zinc). On the other hand, silver could not be confirmed and gold was not detected, so the coating was evidently brass. Benzoin-α-oxime also was used in the quantitative estimation of the copper in fragments of a copper-tin alloy from a Classical site.

E. THE ULTRASONIC DECONTAMINATOR

This continued to be used for cleaning operations as described in last year's report. One operation which may be mentioned was the cleaning of the Yoruba figurine mentioned above. It was covered with a heavy, sticky waxy coating colored green by corrosion products. Soaking in xylene softened the waxy coating which was then loosened and largely removed by ultrasonic cleaning in hot water containing Oakite 24. As usual, the cleaning had to be finished manually, but the ultrasonic operation saved much time and labor.

IV Reference Material

Recent books, periodicals, reprints, etc. of techniques applicable to archaeological research, but not readily available in nearby libraries were purchased or obtained. Short abstracts of articles considered useful but not essential or practical to obtain were recorded in the ASCA card files as started during the previous year. Even though this work was curtailed due to lack of funds, this very small reference facility is now being utilized more and more by students, research workers, and faculty members - both resident and visiting scholars.

V. Publications

Rainey, F., Electronics to the Rescue in the Search for the Lost City of Sybaris: Discoveries by a Joint U.S. - Italian Expedition - Part I. The Illustrated London News, Vol. 241 (Dec. 8, 1962), pp. 928-931.

Rainey, F., Engineering Devices Used in the Excavation of the Lost City of Sybaris: Discoveries by a Joint-U. S. - Italian Expedition - Part II. The Illustrated London News, Vol. 241 (Dec. 15, 1963), pp. 972-974.

Brown, D. F., In Search of Sybaris: 1962. Expedition, The Bulletin of the University Museum of the University of Pennsylvania, Vol. 5 (Winter, 1963), pp. 40-47.

Ralph, E. K. Search for A City Buried 2700 Years. Wellesley Alumnae Magazine, Vol. 47 (July 1963), pp. 283-285, 310.

Rainey, F., The Applied Science Center for Archaeology. Fellow Newsletter of the American Anthropological Association, Vol. 4 (June, 1963), pp. 3-4.

Carson, H., Seimic Survey at Harper's Ferry. Archaeometry, in press.