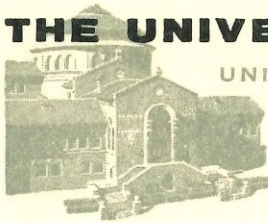


# THE UNIVERSITY MUSEUM



UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS  
PHILADELPHIA 4, PENNSYLVANIA

CABLE ADDRESS "ANTIQUE"  
TELEPHONE: EVERGREEN 6-1241

Archaeological  
Techniques

Tikal, Guatemala.  
31st March 1961.

Dear Dr. Rainey,

Enclosed you will find my "letter" from England giving brief details of the Texas work. I have tried to make it self explanatory, without making it too obviously a 'put up job', however I feel that the result may appear slightly stilted. It should I hope be suitable for the purpose envisaged.

So far I have not been able to get any real results here at Tikal, this is mainly because I had to spend the first few days mending the seismic equipment, then rebuilding the time break system. It now works with the aid of a piece of paper and pencil as part of the circuit. Also the magnetometer caused some trouble. Or rather Tikal has caused the trouble as it seems that the local magnetic field is quite unusual. As a result I had to alter some of the initial circuitry, and I will not be able to tell if all is finally well until some extra components arrive. Dr. Kidder has a list of what is required, and I feel fairly certain that I will be able to use the magnetometer in the end.

This weekend the universal Easter holiday has not helped either, so that I will not be able to continue my preliminary testing until next week. However I am still fairly hopeful of obtaining some useful results within not too long a time.

On looking over my draft for the grant proposal I discovered a few ~~typig~~ typing errors, in particular in my Curriculum Vitae; these are :-  
for emanations read excavations in Experience line 2, for rout read road in Publications line 1, delete VI in Publications line 2.  
Also in the previous report, the last sheet, the I should be replaced by ' before Geophysics in line 3 under section 8.  
I hope that no further trouble has arisen over this matter, and that the grant proposal will go through smoothly as planned.

I am now settling down rather more to the change of climate, at first the heat proved very trying, in fact I managed to run up a temperature of over 102 on the first night. So far I am glad to say that I have not suffered too badly from the insects. However I feel that it would take a long time for me to become completely used to living in the jungle.

I hope that you and your family are all well. I also hope that I will still be able to return with the interesting results promised.

Yours sincerely,

*Richard*

R.E. Linington.

As from :-

## THE UNIVERSITY MUSEUM



UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS  
PHILADELPHIA 4, PENNSYLVANIA

CABLE ADDRESS "ANTIQUE"

TELEPHONE: EVERGREEN 6-1241

London, England.  
5th March 1961.

Dear Dr. Rainey,

Enclosed you will find a few brief notes on some of the results of our work using the commercial geophysical equipment. These results are basically the same as those I used in my paper to the conference on Geophysical Prospecting Methods in Archaeology yesterday. The conference appeared to be very interested in our research project, and there was a general feeling that the work should definitely be continued, especially as no one else seems to be attempting this approach at the moment. Most of the present activity seems to be concentrated on resistivity and magnetic methods, although quite a lot of interest has been shown in electromagnetic methods, especially for the location of metal objects. Gravity, as I had reported before, does not seem to be very feasible for normal work. I will show you my notes of the conference when I return.

As to the enclosed results I should perhaps point out that of the total time spent on this stage of the project, that is from 9th Jan. to 25th Feb., much of the time was spent in arranging for suitable test sites, preparing equipment, and of course evaluating the results. The work fell into two main parts; firstly using a full High Resolution set of equipment the Texas Instruments team and I tried out several test sites near Dallas. We used large simple objects, all modern in construction, for example concrete bridge abutments, spillways of a local reservoir, and even parts of the main sewage works. These objects were chosen as the Texas Instruments geophysicists thought that one would be lucky to notice the difference caused by objects even as large as these using the existing equipment. After this first stage was completed we had a general meeting at which everyone present expressed their great surprise at the relative success of the results so far. In the light of this it was thought worth while to proceed directly to try out the existing equipment on sample archaeological sites.

The second stage in the work took place in Arizona on sites near Tucson and Globe. Again I had the same team from Texas Instruments, with in addition a smaller piece of equipment, which I had managed to get on loan from a firm in Minnesota. The firm concerned had very kindly agreed to contribute the instrument free of cost for the period of testing.

Just before I left Texas we had a further meeting to discuss the results so far. It was agreed that further work appeared very worth while, in particular I feel it would be worth trying out some seismic equipment at Tikal with the other survey work. With this in mind I have contacted a firm in Houston, Texas, and should have a reply soon. As to the continued work with Texas Instruments, this depends partly of course on the extension of our grant, however I hope that they will be willing to make a separate grant of their own towards the work, which is of necessity rather expensive.

I hope that this hurried letter gives enough details for the present. I will be returning early next week in any case.

Yours sincerely,

*R. E. Linington*

RIE: Linington.

'Normal refraction profile'

In order to clarify the results given on the sheet overleaf, this ~~is~~ brief description of the type of record normally obtained for a simple strata series, is given.

For a stratified situation as below (fig 1); if a percussive energy source is used to generate shock waves in the earth, then these energy waves will travel out from the shock point in all directions. Of these shock waves only those that are in some way deflected from their original path stand a chance of returning to the surface. In practice it is found that such deflections can occur when the waves pass from one medium to another in which the wave velocity is different. Then for the wave to return to the surface the angle of incidence of the wave at the boundary of the medium, and the change in velocity must have certain critical values. In particular the underlying medium must have a higher wave velocity. In practice this is almost always the case for near surface conditions. Thus several possible wave paths can exist from the shock source to a given point on the ground surface. In general the travel times along these paths will be different. Then if one considers only the first wave to arrive back at the surface, for points close to the shock point this will obviously be that wave which travels directly under the surface of the ground. However for greater distances, as the velocity in the lower layers can be much larger than for the surface layer, it can occur that a refracted wave travelling via the deeper layer can arrive before the surface layer. It is then found that the graph of time interval between shock occurrence and the first wave arrival will consist of a series of straight line portions as in fig 2, each portion corresponding to first arrivals coming from progressively deeper layers. This very common form of profile is the normal refraction profile.

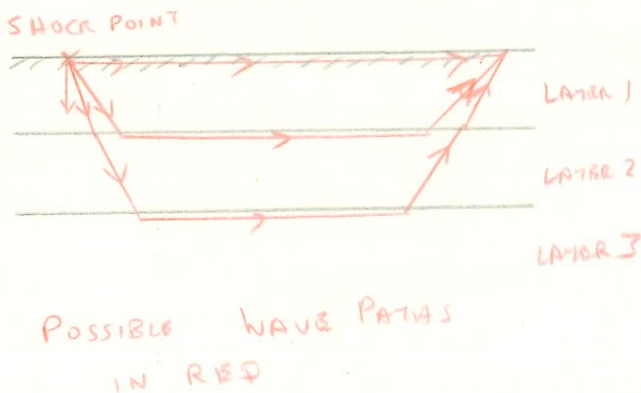


fig 1

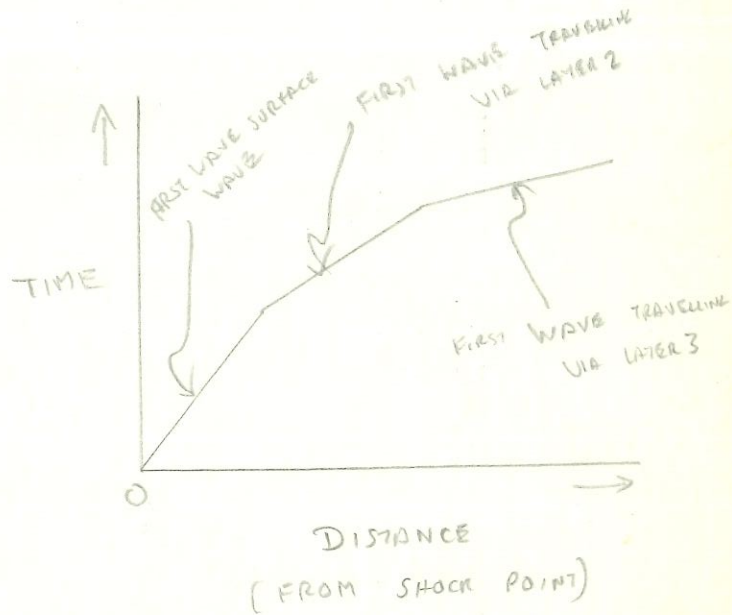


fig 2

Field testing in the Dallas area, Texas, 16th to 30th Jan.  
Results from Lewisville test site, 26th to 30th Jan.  
-----

The test feature consisted of a filled trench originally dug to about 6ft in depth and approximately 4ft wide and 15ft long. The trench had been dug into sandy deposits, and had been filled with gravel, which had been rammed to give a consolidated fill. The relatively recent construction of the feature, in connection with commercial geophysical testing of equipment, made it likely that the observed effect of the feature would appear as a time delay.

Profiles shot next to the feature showed that three distinct velocity layers occurred. These presumably correspond to the surface soil, sandy deposit and harder rock in order of increasing depth. On the diagram the postulated geological section is shown with the graph of the normal profile below in black.

Three sample profiles are shown over the feature for shot points close to, at a medium distance and far away from the feature. These are given in red. The position of the object for each shot point is marked below the profiles. It is seen that in each case a marked time delay occurs.

Field testing in Arizona, 11th to 20th Feb.  
Results for Tucson, University Indian Ruin, 14th Feb.  
-----

Several profiles were taken across adobe walls and floors. Of these some were inconclusive, probably as the nature of the adobe fill is very similar to the surrounding soil.

In the example given a profile was shot across an exterior adobe wall and adjoining floor. This showed a velocity reversal which must be due to a horizontal difference between the adobe and the natural undisturbed soil. In this case the adobe appeared to have a lower velocity than the soil.

Results for Globe, Gila Pueblo, 15th and 16th Feb.  
-----

Several profiles were taken across boulder built stone walls. These were normally standing up to heights of 4 to 5ft where excavated. In the area tested the walls had not been excavated, however their line could be traced from surface indications. The areas between the walls was filled with a mixed soil and tumbled boulder fill. The site was underlain by a solid hard pan layer.

It was found that complex effects occurred depending on the relative positions of shot point and wall. At large distances most of the energy appeared to travel through the hard pan.

In the examples given; no. 1 close to the wall shows a time decrease caused by the wall, no. 2 also shows this, with however less certainty, and with the presence of a velocity reversal before the wall, finally no. 3 shows only a slight time decrease at the wall. In addition no. 3 shows a very large time delay in the area before the wall. In view of the size of this feature excavations were made at this point showing that the effect had been caused by a mass of boulders. The effect was probably caused by complex interference effects between the different travel paths, and illustrates the complexity of the problem.

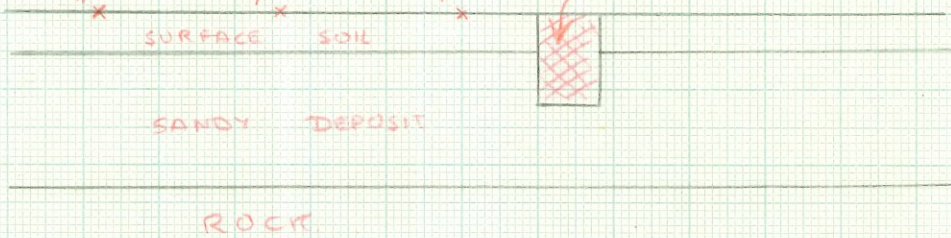
POSITIONS OF SHOT POINTS #10

#7

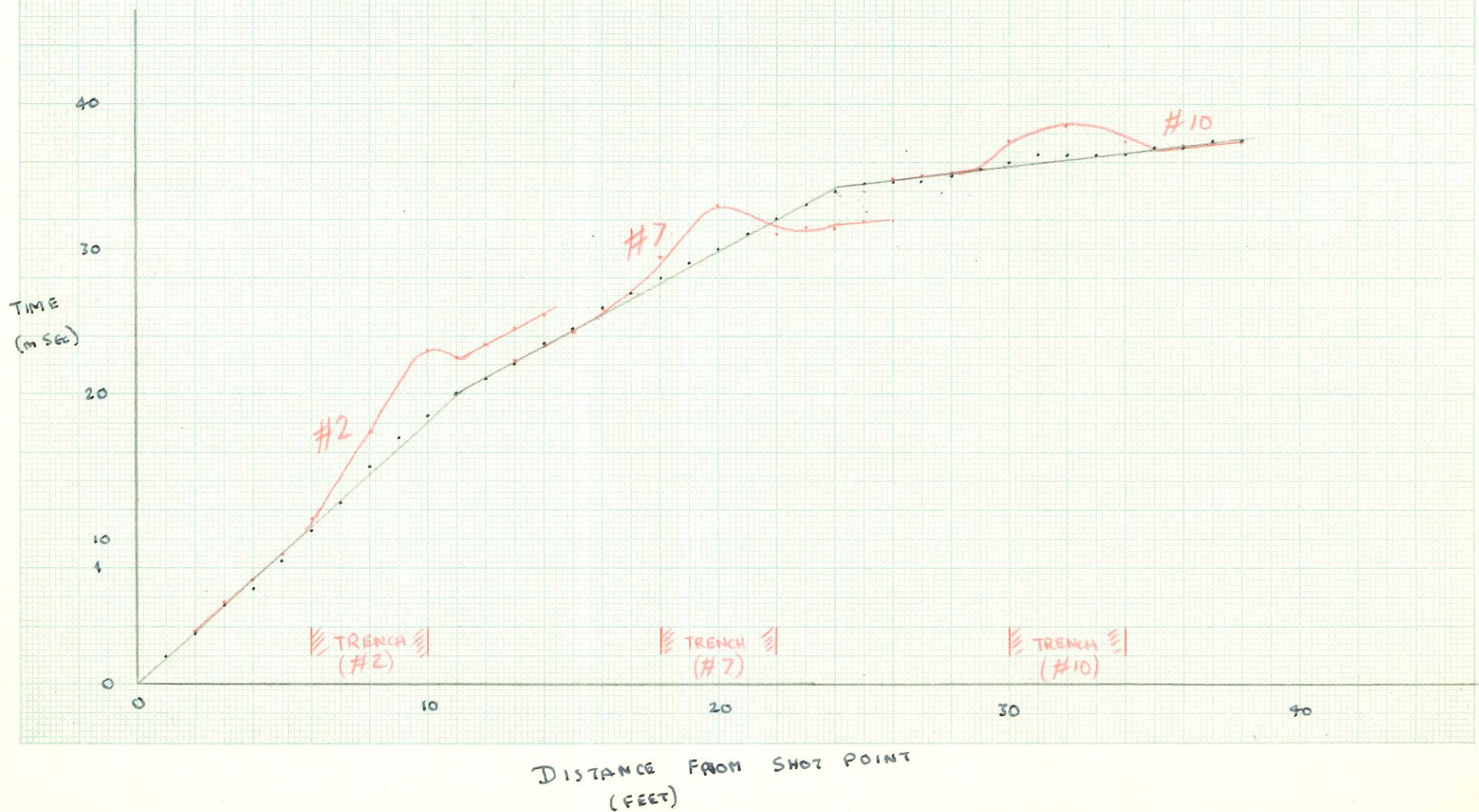
#2

TRENCH

LEWISVILLE  
(TEST SITE).



0 10 FEET

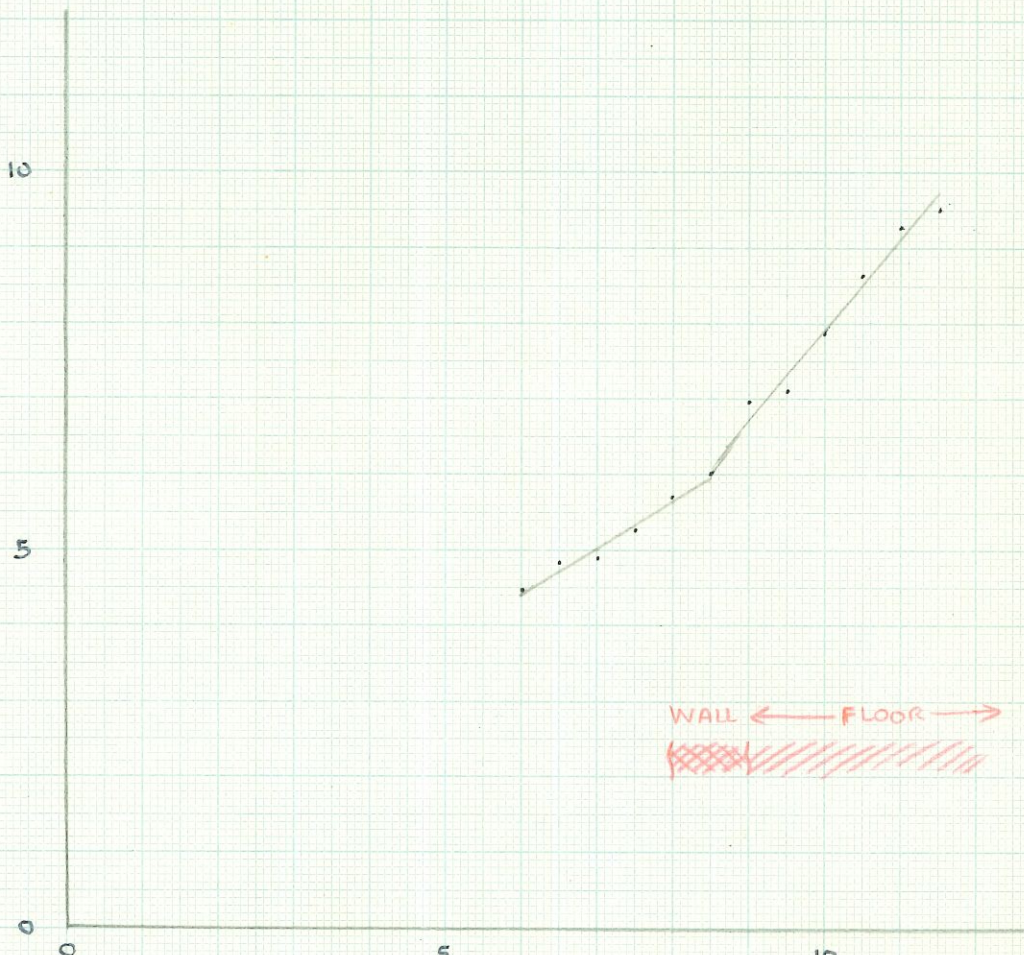


TUCSON.

APPROXIMATE SECTION.



TIME  
(m secs)





WALL ← FLOOR →

DISTANCE  
(FEET)

GLOBE.

TIME  
(in secs)

  
AREA OF BOULDERS

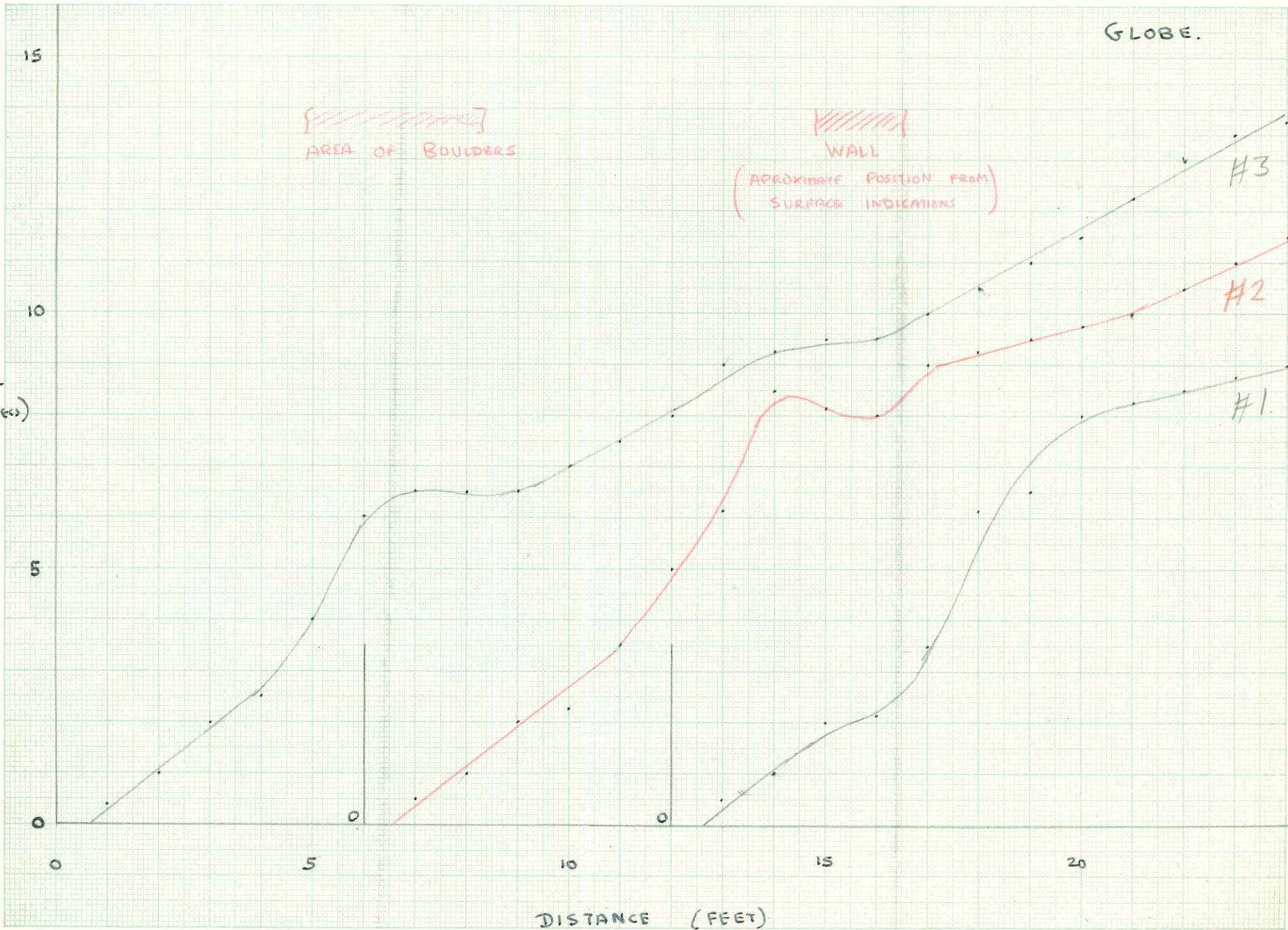
  
WALL  
(APPROXIMATE POSITION FROM  
SURFACE INDICATIONS)

#3

#2

#1

DISTANCE (FEET)



*Archaeological  
Techniques*

April 5, 1961

Mr. Richard Linington  
El Proyecto Tikal  
El Peten, Tikal  
Guatemala

Dear Richard:

Mr. McDermott telephoned as soon as he returned to Dallas and told me that they had decided out there that we should get a University to develop our sonic apparatus because he felt that his own men were not sufficiently interested in archaeological instruments to spend the time on them. He said he, himself, was very much interested in the whole thing and would send us his personal contribution. He said he was surprised that we had paid them anything and that he meant to do this himself. He recommended getting in touch with a geophysicist at Penn State.

Johnson thinks that they discovered something they want to develop themselves without exposing information. I talked with Jack Pew and Mr. Eckert yesterday and we tentatively agreed that Mr. Pew and I would see McDermott in Dallas on the 26th, but Pew is writing him first. The contribution from McDermott has not yet arrived. I have written the fellow in Penn State saying that we would like to talk to him when you get back. This is all a most peculiar business.

The National Science Foundation turned us down on the Chronometric Center. I talked with Al Spaulding by 'phone this mornin g and he said he, himself, did not push it very hard because he expected us to apply on our Techniques Center the first of May and I gather he felt he could not get both grants. Also, I felt that in conversation with him that your detailed reports on Dallas, Tucson, and Tikal will be very important. Beth is going ahead with thermoluminescence so I think we have something to add on that. I hope you get the spare parts we sent. By the way did you order another German resistance apparatus, I forgot to ask before you left?

Very best wishes,

FR:ah

Archaeological  
Techniques

May 5, 1961

Mr. Richard Linington  
El Proyecto Tikal  
El Peten, Tikal  
Guatemala, C. A.

Dear Richard:

I just have yours of April 24th, delivered by Linton and am very pleased to learn you are getting results, even though the new percussion instrument is not working. However, since you are getting results there, it seems wise to go on working for a while, even though it may delay the development of new equipment which is one of the most important reasons for getting our grant from the Science Foundation.

Mr. Pew and I had a lengthy discussion with Mr. McDermott last Thursday and there seems no doubt now that he does not wish to involve his people in the designing of this high frequency equipment. He thinks it can be more easily and quickly done in the University. I told him we would go ahead here.

Beth has talked to electronics people and the physics people here and will see the man at Penn State either this week, or next. Then we will go ahead in either one place or the other, trying to develop a source and a ground couple which can be used with the H. R. equipment belonging to G. S. I. Mr. McDermott says that he thinks you can operate this equipment and he will see that you get it for testing when we have developed a high frequency source. I hope this can be in Italy this summer.

We now have requests for advice and equipment from Harvard, Yale, Brown, Princeton and Columbia so I'm trying to set up a meeting here at the Museum on June 1st, expecting you to be back at that time so that you can explain the results of your experimental work at Tikal and the use of the instruments. We have ordered two more German resistance

gadgets so that we can farm them out to various expeditions during the next few months and at least get these people using electronic instruments. Could you finish up your work there in time to report in to Romberg and Mayes , in Dallas, and then get here in time for the meeting on June 1st. I'm expecting to leave for Italy on June 9th and wesshould work out our future plans between the time of your return and my leaving.

Incidentally, Mr. Johnson soon will talk to Mr. Pew about contracting with another firm in Texas to develop the kind of instrument he thinks is possible and will propose that the Pews put up \$25, 000. to do this. I have no idea how this will work out, but we certainly can't rely on it.

I hope you've got used to the heat in Tikal and that you are having an interesting time there. Satterthwaite was very enthusiastic about your results and it looks to me as if you have got some good concrete proof of the resistance method in that field. By the way, Beth is getting on with the thermoluminescence investigation and Ham is doing quite a job on the Information Center. Although, we didn't get the money from the Science Foundation for the Chronometric Center, I've decided to dig up some money from our own Museum Research funds to send Bannister to Gordion and thus get the thing started in any case.

Very best wishes,

FR:ah

Froelich Rainey  
Director

4/6/61

Tikal  $17^{\circ} 13.3' N$

$89^{\circ} 38.5' W$

$\approx 270^{\circ} 21.5' E$

Geomagnetic Total Intensity

1945  $\approx 0.45$  cgs-unit [oersteds]

Secular change  $\approx -20 \gamma$  per yr.

$.45 \text{ oe} - 16 \times 20 \times 10^{-5}$

$- 3.2 \times 10^{-2}$

$\therefore 1961 = 0.42$  oersteds

Magnetic Intensity -  
Secular Changes

Archaeological  
Techniques

Kidder  
File

# THE UNIVERSITY MUSEUM



UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS  
PHILADELPHIA 4, PENNSYLVANIA

CABLE ADDRESS "ANTIQUE"

TELEPHONE: EVERGREEN 6-1241

El Proyecto Tikal,  
El Peten,  
Guatemala.  
24th April 1961

Dear Dr. Rainey,

The survey work here is progressing very satisfactorily, although at first rather slowly. I am afraid that all of the equipment developed faults during the journey. These were none of them very serious, however they had the result that I had to spend several days checking the instruments. This delay, followed by the Easter break, caused the inevitable postponement of the start of the survey work until about the 3rd April. Since then the work has carried on fairly smoothly.

At the moment both the resistivity equipment and the magnetometer are working well, however the seismic apparatus is not functioning. Soon after Dr. Kidder left I managed to find the trouble in the magnetometer, this was a good thing as your package of components has only arrived this morning.

So far I have mainly concentrated on testing the resistivity equipment. Tests with the magnetometer show that it is not of much use in the main areas of excavation, partly owing to the great concentration of iron objects imported onto the site during the course of the excavations. The resistivity equipment has proved to give surprisingly good results on the excavated area of the acropolis, and I was able to predict the position of buried masonry construction with some accuracy. Tests were run at two different stages of the excavation, and some 1500 readings taken. I also tested the use of the method for accurate location of bedrock, mainly on the North Terrace; again the results seem to agree very well with the known depths found by excavation. Apart from several small tests the other main item of resistivity surveying has been on Temple I. I have put in a great deal of effort in an attempt to throw some light on the internal structures, however I am not so happy about the results obtained. It is quite possible however that I can predict the approximate height of an earlier structure within the present pyramid structure. I hope to try to confirm this interpretation with the seismic apparatus, assuming I can manage to get it back into working condition.

Work with the magnetometer has so far been far more limited, in all I have taken about 900 readings. It appears probable that away from modern disturbances, especially in the form of iron laminae, the instrument could still be of great use, if only from the much faster speed of operation. I thus hope to be able to survey quite a large area as soon as sufficient undergrowth can be cleared.

At the moment it is still difficult to predict how long it will necessary to stay here. However I aim to stay to complete several types of survey, so that we can give the instruments the full field test originally agreed upon.

Although it is not possible to include very many details of the results so far I will give a few ~~examples~~

examples from my results to show more definitely how the work is progressing

As far as the Texas situation is concerned I hope that your trip to Dallas, if it has still proved necessary, shows some success. However I really do wonder if we will ever sort this matter out finally. I still do not see how we could have approached the work with Texas Instruments in a different manner; however I do hope that nothing in my share of the negotiations can be considered to have caused any trouble. Perhaps a financial contribution from McDermott to work elsewhere than with Texas Instruments would be a better solution than attempting to continue work under the present uncertain conditions. In any case I feel that the support of Sun Oil could go a long way to help clarify the situation.

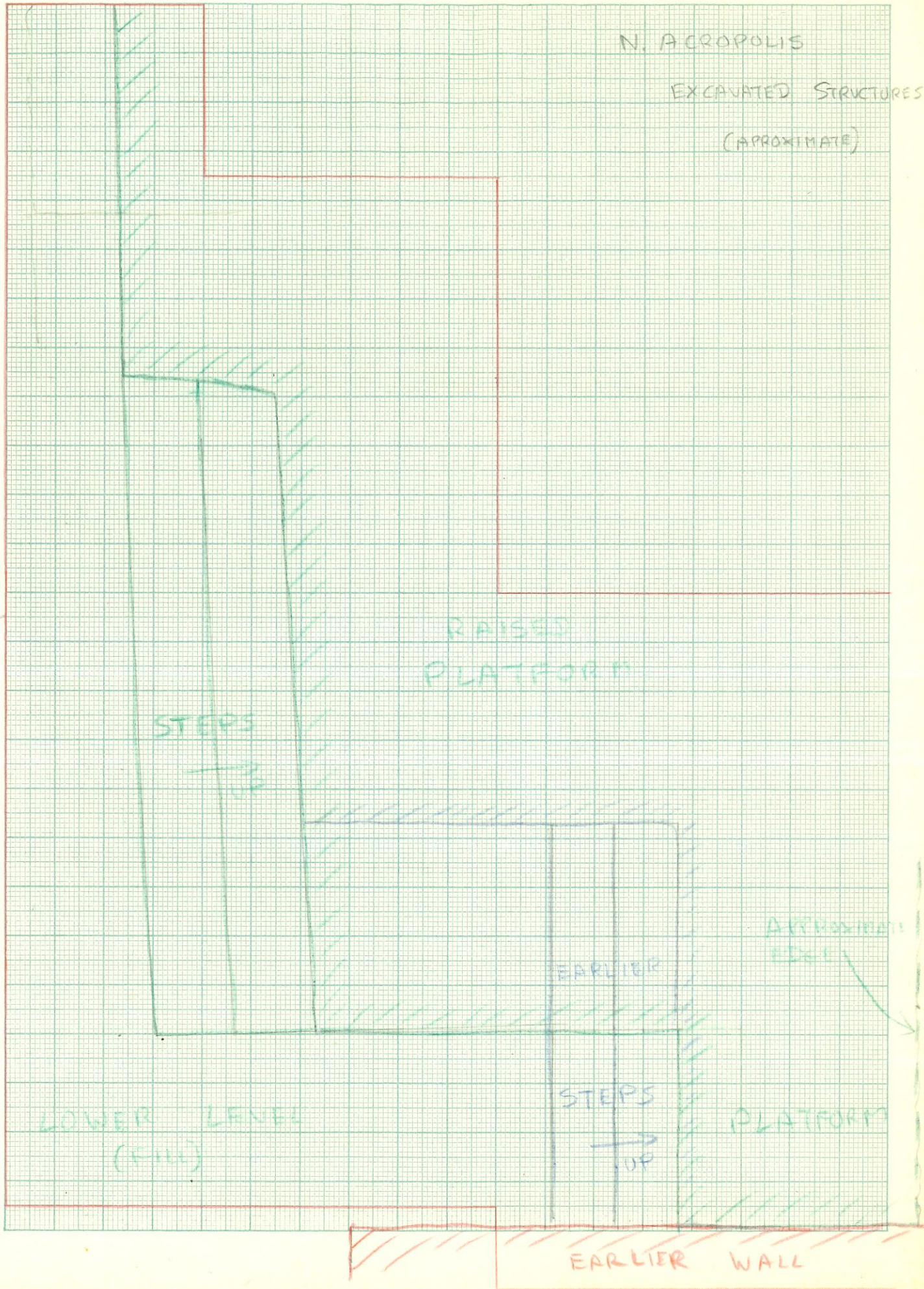
I am sorry to hear that the Tree Ring grant was rejected, especially after so much work was done on preparing for the projected work. However in any case if some serious work is projected on thermoluminescence it is probably better not to have too many projects starting at once.

As to the German resistivity equipment, I had Gloria Albany send off an order to the firm concerned before I left Philadelphia.

Finally I hope that you, and your wife and family are all well, and I look forward to returning with the promised series of interesting results as soon as I have completed obtaining them.

Yours sincerely,

Richard .



N. ACROPOLIS

RESISTIVITY SURVEY  
(CONTOURS)  
PART OF ONLY.

LOW



1 METER

LOW

HIGH

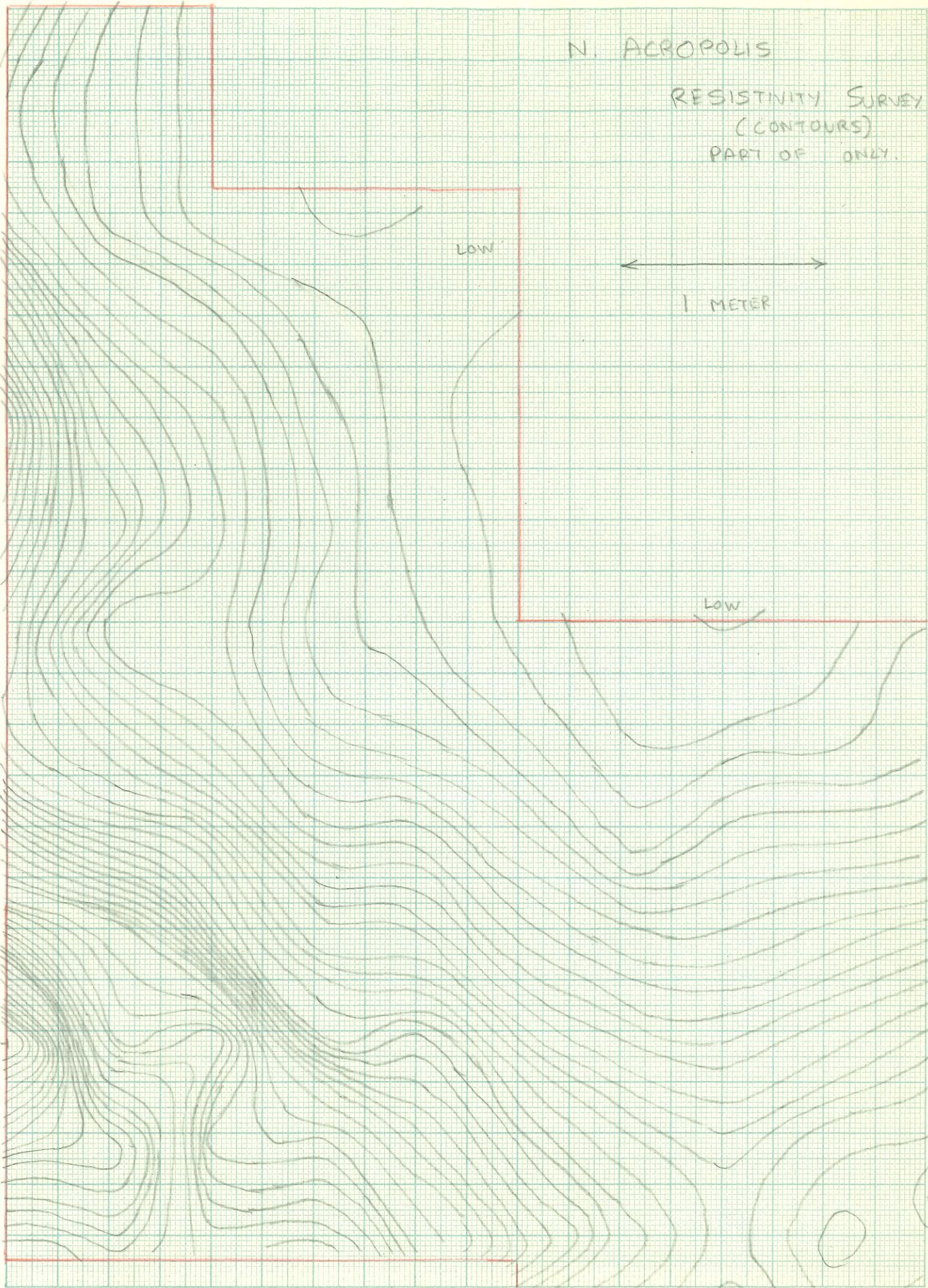
LOW

1+16H

359-14B  
MADE IN U.S.A.

10 X 10 TO THE CM.  
KEUFFEL & ESSER CO.

K&E



NORTH TERRACE - VERTICAL SOUNDING

R42

EQUIVALENT RESISTANCE

0 4 5 6 7 8 9 10 11

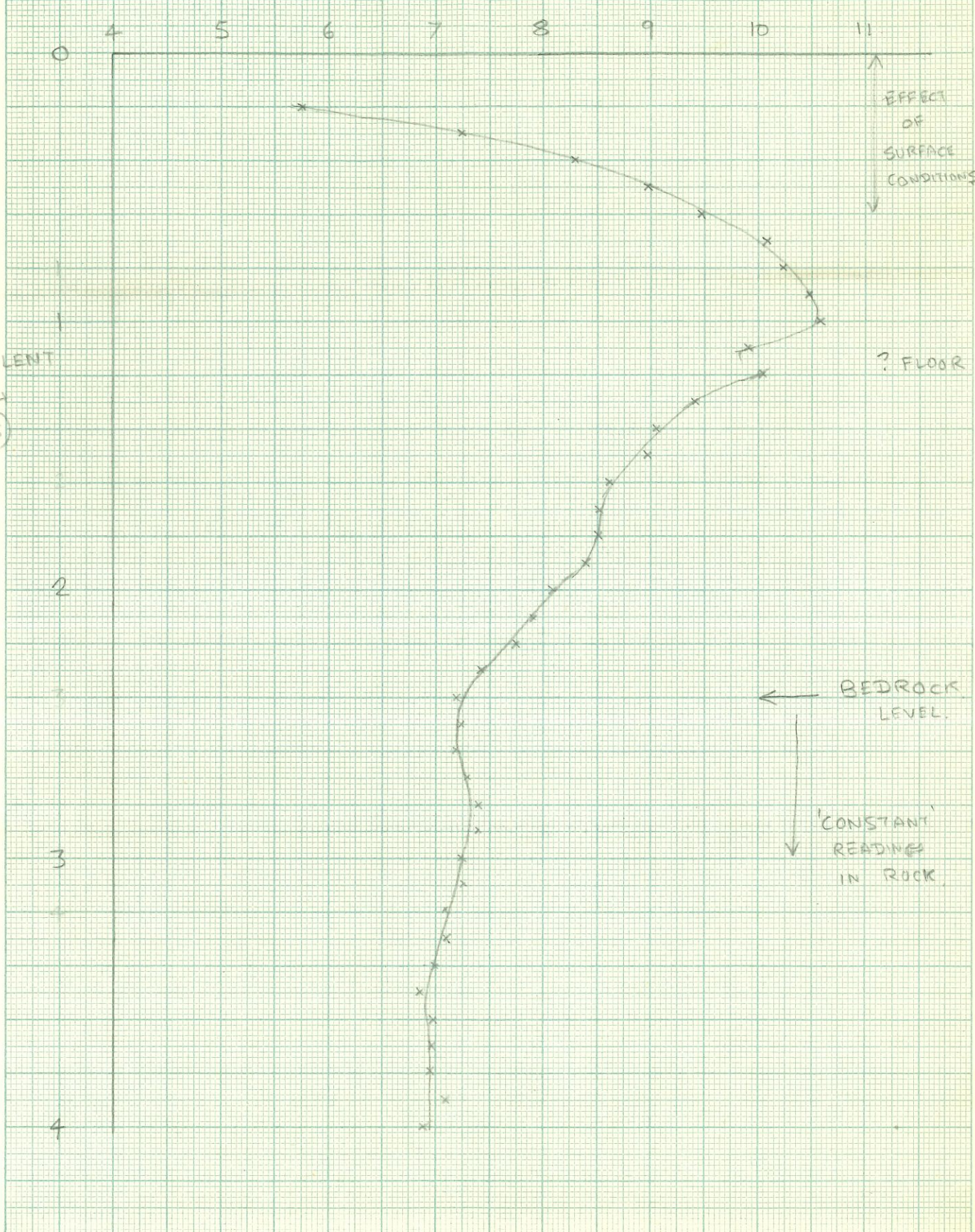
EFFECT OF SURFACE CONDITIONS

EQUIVALENT DEPTH (METERS)

? FLOOR

BEDROCK LEVEL

'CONSTANT' READINGS IN ROCK



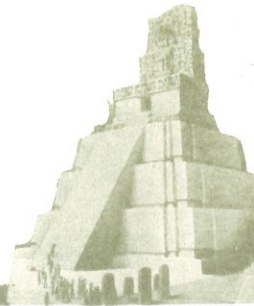
## THE TIKAL PROJECT

PROYECTO TIKAL, TIKAL, EL PETEN, GUATEMALA, C. A.

CABLE: "PENTIK" VIA TROPICAL RADIO

THE UNIVERSITY MUSEUM, UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD & SPRUCE STREETS, PHILADELPHIA 4, PENNSYLVANIA



March 7, 1962

Miss E.K. Ralph,  
c-14 Laboratory,  
Dept. of Physics,  
University of Pennsylvania.

Dear Beth:

Many thanks for your letter of Feb. 28th which arrived on today's plane. I'm glad you received the Fairservis sample and will include it in the Near East series. It will add to our discussion. Send me some of your new dates on a postcard sometime if you think of it. By the way did you ever try to use bat dung? It ought to work oughtn't it? I mean couldn't we date the final abandonment of our palace for example by the deepest dung on the floor level? This is Structure 10 (5D-52) on which you did the wood lintels.

I think you are probably right about being able to do the same work in Philadelphia. But we will miss seeing you at Tikal.

Peter Harrison and I are rushing through a report for you on the West Plaza which will probably go out at the same time as this letter under separate cover.

Re Jarmo be your own judge. My own inclination would be that given the confusion that at present exists in the dating that unless I were going to run a new and separate series with enough raw material to establish what I considered a firm date of my own I would steer clear of it. I mean which dates will you choose out of the several thousand year range as relevant to your three poor quality samples? But make your own choice.

Glad to hear the Science article finally made the grade. I was wondering whether it was out yet. Also glad to hear that you think it is o.k.

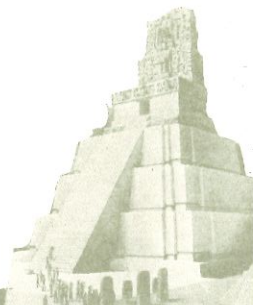
We are burrowing along - running very hard to keep thinking up things for people to do in order to keep the staff of 16 and 103 men busy!

Good Luck with Independence Hall etc.

R.H. Dyson, *Bob*  
Field Director.

## THE TIKAL PROJECT

PROYECTO TIKAL, TIKAL, EL PETEN, GUATEMALA, C. A.  
CABLE: "PENTIK" VIA TROPICAL RADIO  
THE UNIVERSITY MUSEUM, UNIVERSITY OF PENNSYLVANIA  
THIRTY-THIRD & SPRUCE STREETS, PHILADELPHIA 4, PENNSYLVANIA



April 3, 1962

Miss Elizabeth K. Ralph,  
C-14 Laboratory,  
University of Pennsylvania.

Dear ~~Mr~~ Beth:

Your letter of March 21st at hand. You will be gone to Italy when this reaches Philadelphia but I am sending it anyway just for the record.

Re: Resistivity report. The scale on Fig. 1 is in meters and may be worked out by measuring between the A and I line or between two points on either line which are marked at 2 meter intervals as I recall. In any case A 45 is 5 meters from A 50 etc. Sorry the scale got left off - I was tracing from the big map (which didn't have one either but we had the stakes in the plaza in position). Figure 2 has a standard scale of 1:20 cms. No one including Linington in his memo ever told us the spacing of the electrodes.

I cannot understand your reference to closely spaced contours to the right of the A line btw 48 and 51 meters. The map doesn't go right of the A line to any extent. In any case Fig. 1 shows where we dug so why ask me if we were digging there? Anyway, where?

Glad to hear you included the techn. review of sites in a grant proposal. I think it would be an interesting study.

Sorry the resistance wasn't useful for your talk. Hope you are enjoying Italy - I know you will.

Cheers.

Robert H. Dyson, Jr.,  
Field Director.

ASCA

Dr. Rainey  
Fortney  
Wendell

I. Identification of charcoals

The majority of charcoal samples from Tikal that have been analyzed by the U. of P. Radiocarbon Laboratory have been identified by the Forest Products Laboratory, Madison, Wisconsin. The procedure has been to select a small sample of charcoal from each charcoal bag scheduled for radiocarbon analysis. There is no assurance that each small sample submitted to Madison is in fact representative of the total range of materials contributing to the total excavated sample. Secondly, the results obtained from Madison are often inconclusive. Various samples submitted have been identified as pure pine, while the majority are identified simply as hardwood. In most circumstances, pine is favored for radiocarbon analysis because the growth time-span of pine is considered to be less than the growth spans of "hardwoods." In many instances it is necessary, in order to rationalize the C14 results, to have a precise identification of a sample identified as "hardwood." It is zapote, logwood, or what? There is good reason to doubt that the Madison laboratory is equipped to undertake the following program of analysis:

A. Each excavated sample from Tikal should be submitted in its entirety to an expert for complete identification, if possible. Ideally, the expert would spread out the sample, using proper radiocarbon precautions (contamination, etc.), and separate the charcoal botanically, repackaging the sample subsequently in accordance with the botanical identifications. This procedure will do away with the problem of having to remove samples for identification from charcoal collections that are already on the borderline of adequate weight for C14 analysis. The procedure would allow a review of the total excavated sample, rather than a small part which may not be representative. The information gained would allow Project personnel to make valuable conclusions regarding behavior in construction, cooking, vandalism, and so forth. With such data, charcoal could be submitted to the C14 laboratory in as fully controlled a manner as is now possible. The procedure, moreover, would provide those concerned directly with the ancient environment with a unique source of information.

II. Determination of "best sample growth error"

In submitting lintel and vault beam zapote samples, an attempt is always made to utilize samples most distant from the growth centers of the beams (cf. Satterthwaite and Ralph, 1961). Here we are concerned with charcoal which usually occurs in pieces too small to allow such controls. If we were to submit an excavated lot of charcoal that was identified as pure zapote wood, and assuming the deposition of this charcoal followed closely on the cutting of the zapote(s); we would have to assume that the C14 result would be ~~XXXXXXXXXXXXXX~~ roughly median in terms of the growth span of the tree or trees. The result was then be ~~XXXX~~ a number of years earlier than the deposition of the charcoal, or at least the cutting and killing of the tree(s). If the submitted sample was wholly or largely growth center wood, the result would be still older. Data are obviously needed on the life spans, ideally maximum, of Tikal fauna present in excavated samples. What is required is

Fig 334 -  
see table

a table of maximum life spans of pine, logwood, etc., and any other woods present in the excavated structures. A few steps in this direction are suggested:

A. A program of measuring diameters of zapote and other potentially significant trees with the swath cut by Mandelstam and Maier (ca. 70 years ago (Temple I to Temple IV; cf. Peabody and British Museum photographs)). There probably are trees to be accepted but generally anything in this area has grown up since that cutting. Careful work could provide such figures as: X-inches of growth diameter can be achieved in 70 years.

B. A program of core drilling of trees of maximum diameter wherever they may occur about Tikal, in order to locate growth center samples. These could be submitted to a lab. If a 1000 years of growth was present in a particular tree, the analysis should indicate it. However, if only a century of growth was present, analysis might produce equivocal but still quite significant results. The real problem would be to locate by horizontal drill the growth center. Cross-sections on ancient zapote lintel beams do show on occasion a growth center displaced eccentrically to one side.

C. Submit samples from the growth centers of beams previously analyzed using wood post distant from the growth centers. Theoretically, this work would be done on only the largest lintel beams for which sections are obtainable.

The results of one or more of these steps might provide a means of roughly translating diameter or radius into time (i.e., an inch of radius in a zapote is gained in 20 years). Assuming that zapote is the slowest growing tree that was anciently utilized at Tikal, such data on it alone would provide a maximum growth rate limit on all other woods appearing archaeologically.

W. R. Coe  
Tikal Project  
Jan. 1963

Beth Tschunig  
CR Tikal

January 31, 1963

Dr. C. L. Lundell  
Executive Vice President and Director  
Texas Research Foundation  
Renner, Texas

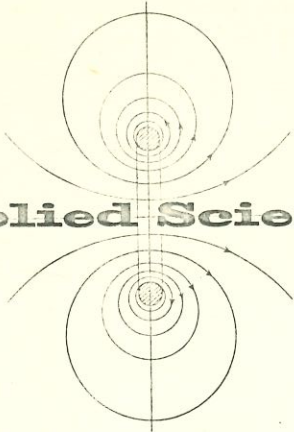
Dear Dr. Lundell:

Beth ~~Ralph~~ is just back, and tells me she has had an interesting and productive conference with you about Tikal. Of course you know all about our problems of Radiocarbon dating in Tikal, and the urgent necessity of straightening out the question on Zapote wood. I just want to add my word urging you to get back down to Tikal to help out in this matter, this winter. I expect to be there between the 10th and the 20th of February, and would enjoy giving you a hand in any way I could during that time. Also, I would very much appreciate your help and advice on how to get the Government to take over maintenance of the place. As you know we are going to pull out in 1965, and we simply must get them started.

Very best wishes,

Froelich Rainey  
Director

FR/vv



## Applied Science Center for Archaeology

Arch. *D. Rainey*  
Techniques *RL*

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Froelich Rainey, Director EVERgreen 6-7400 (Area code 215)  
Elizabeth K. Ralph, Associate Director  
EVERgreen 6-0100 Ext. 8168 (Area code 215)  
Cable Address "Antique"

March 11, 1964

Dr. William Coe  
Tikal Project  
Peten, Guatemala

Dear Bill:

Herewith the complete list of dates for the Tikal series submitted October 2, 1963.

Two dates are listed for each sample. One of these is based upon a half-life value of 5568 years, the Libby value, as used for publication in Radiocarbon and for comparison with dates of prior samples and other laboratories. The second date is based upon a half-life value of 5730 years, a more realistic and more recent value.

The tolerances quoted for each date include the combined statistical counting errors of the individual sample counts and background and calibration counts, but do not include the half-life error.

Sincerely,

Robert Stuckenrath, jr.  
Radiocarbon Laboratory

cc: Dr. Rainey  
Dr. Kidder  
Dr. Satterthwaite

		5568 half-life	5730 half-life
P-750.	12P/151. Coe Sample No. 1. Charcoal from what seems to be occupation and household trash pertaining to earliest North Acropolis occupation found within present limits of tunnels and trenches; associated with Eb sherd material, pertaining to earliest known Tikal ceramic complex; community of which this trash was a part was eventually leveled, and formal floors and ceremonial construction begun. Hardwood.	588 $\pm$ 53 B.C.	665 $\pm$ 55 B.C.
P-751.	12P/164. Coe Sample No. 2. Charcoal from dark ash-banded fill of a multi-chambered chultun sealed by fills, floors, and constructions providing all samples except P-750 and P-759; associated sherd material is mixed, but latest material is identifiable as belonging to the Chuen ceramic complex. Hardwood. NaOH pretreatment.	219 $\pm$ 52 B.C.	284 $\pm$ 54 B.C.
P-752.	12P/143. Coe Sample No. 3. Charcoal from ballast of "Wood" floor which turns up to "Nick" structure (cf. P-753); Chuen ceramic association, although mixed with earlier materials. Leguminosae. NaOH pretreatment.	207 $\pm$ 52 B.C.	272 $\pm$ 54 B.C.
P-753.	12P/152. Coe Sample No. 4. Charcoal from "Nick" structure fill, mixed with many lumps of painted burned architectural plaster; charcoal may also be from earlier construction; ceramic associations as in P-752. Manilkara.	118 $\pm$ 52 B.C.	178 $\pm$ 54 B.C.
P-754.	12P/138. Coe Sample No. 5. Charcoal from carefully segregated fill of "Heck-Teck" platform, the earliest large-scale North Acropolis found; overlies "Nick" structure (cf. P-753); ceramic associations mixed, but Chuen at latest. Bursera. NaOH pretreatment.	67 $\pm$ 52 B.C.	128 $\pm$ 54 B.C.
P-755.	12P/120. Coe Sample No. 6. Charcoal from what seems to have been a fire pit (scorched wall, ash, flint, etc.), sealed by a semicircular addition to front of "Heck-Teck" platform (cf. P-754). Hardwood. NaOH pretreatment.	275 $\pm$ 55 B.C.	342 $\pm$ 57 B.C.
P-756.	12P/116. Coe Sample No. 7. Charcoal from "Lock" level fill, down to bedrock, south of "Heck-Teck" platform; level believed to consist of foundation materials for "Wood" floor at the latest, and thus "pre-Heck-Teck" (cf. P-754). Manilkara.	114 $\pm$ 52 B.C.	176 $\pm$ 54 B.C.

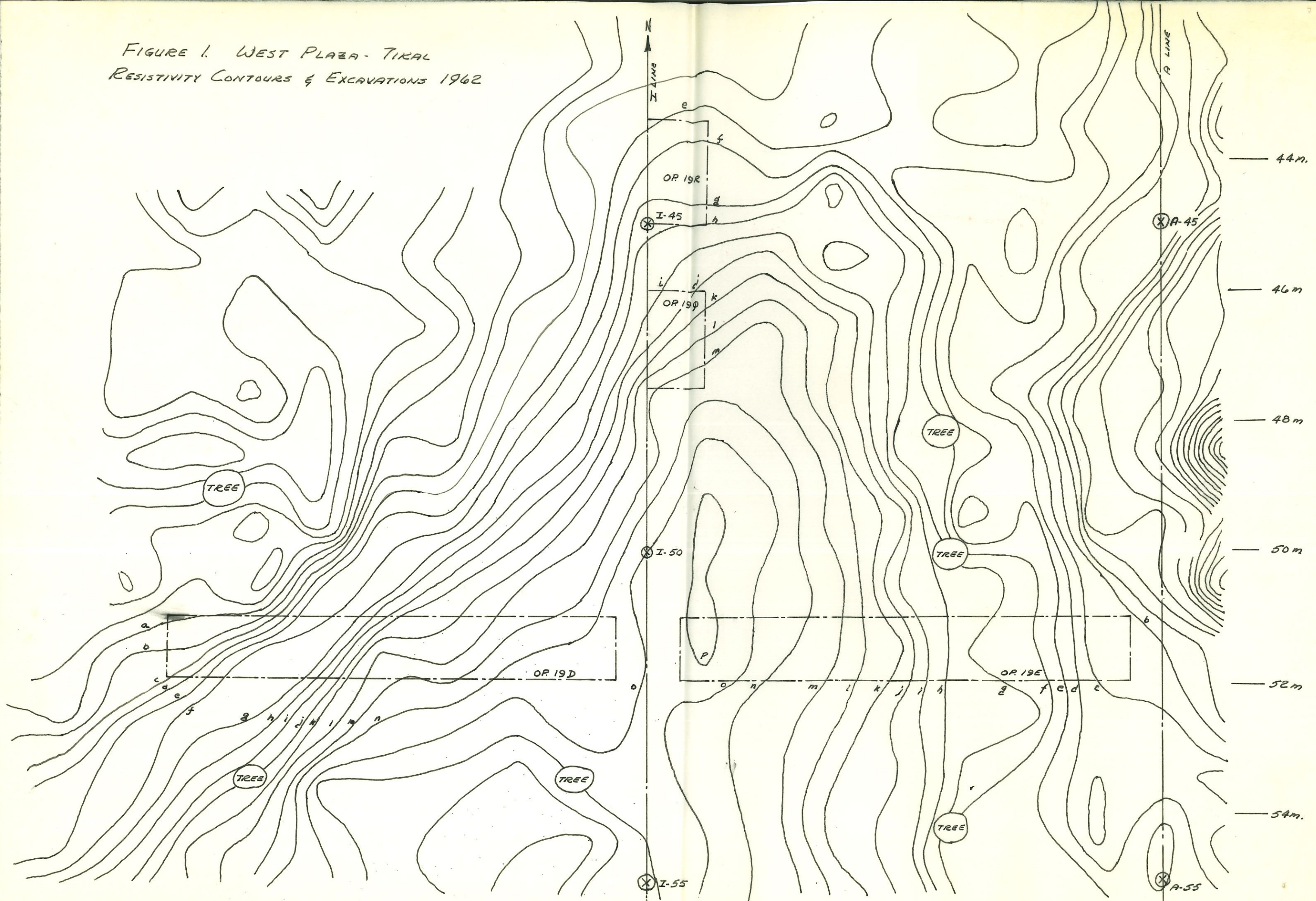
		5568 half-life	5730 half-life
P-757.	12P/114. Coe Sample No. 8. Charcoal concentrated on surface of "Lock" level immediately south of "Heck-Teck" platform and beyond semicircular addition (cf. P-755); with some ash but no evidence of in situ burning; deposition just prior to construction of "Hoot-Will" platform which overlies "Heck- Teck" platform; result to be compared with that of P-758. Bursera. NaOH pretreatment.	A.D. 20 $\pm$ 51	38 $\pm$ 53 B.C.
P-758.	12P/89. Coe Sample No. 9. Charcoal from fill of "Hoot-Will" platform, stratigraphically the latest of the features involved in this series. Hardwood. NaOH pretreatment.	90 $\pm$ 53 B.C.	152 $\pm$ 55 B.C.
P-759.	71F/57. Coe Sample No. 10. Charcoal from midden buried be- neath feature excavated in Op. 71F; charcoal scattered in midden producing excellent example of Tzec complex sherds, and underlying by more than a meter the deposits referable to the Chuen ceramic complex. Note that this sample was approximately ten percent undersized in terms of counter filling pressure.	456 $\pm$ 47 B.C.	529 $\pm$ 48 B.C.
P-768.	12G/46. Coe Sample No. 11. Charcoal from fill over Burial 125. Associated with Cimi (Proto- Classic) ceramics. Burial pit through "Wing" floor and sealed by "Wizz" patch and patched stair of "Lucky" structure. Charcoal could derive from burning of perishable material building on "Lucky" platform (heavily charred); deposition of charcoal immediately follows fire and occurred in connection with refilling the cut for Burial 125. Charcoal occurred largely in form of small lenses in fill and was associated with charred red-painted plaster that had come from ripping out the burned "Lucky" stair. Manikkara. NaOH pretreatment.	A.D. 173 $\pm$ 45	A.D. 119 $\pm$ 46

The selected series is largely made up of samples from the North Acropolis (Samples Nos. 1-9). Eb occupation is represented by Sample No. 1 (P-750), while the following Mamon-related Tzec (not isolated yet on the Acropolis) by Sample No. 10 (P-759), and the subsequent early Chicanel-affiliated Chuen complex by all remaining samples. The following Cauac complex was provisionally dated in a prior series as occurring around 0 A.D. (P-535).

Chuen is expected to date from about 200 to 100 B.C., while Tzec would go back to around 500 B.C. Keeping in mind ceramic cross-ties with the multi-date Chiapa de Corzo sequence, Culbert suggests a date of around 800 B.C. for Eb remains.

All the samples are to some degree problematical as to their origins (their provenience is a matter of record). Each, however, should provide an "upper limit" date that will serve to put a time limit on the deposition of the sample, later than which it could not have been deposited.

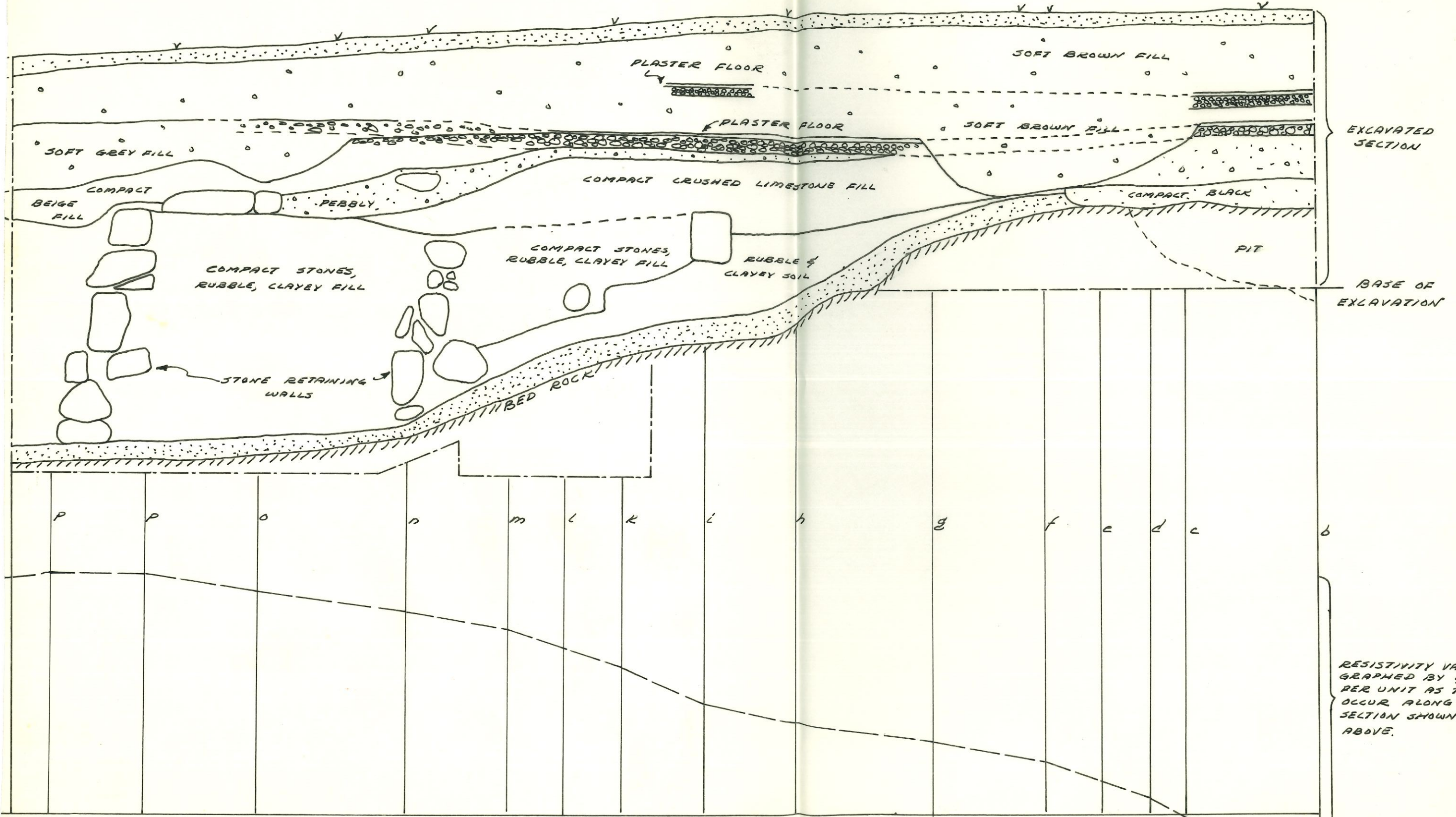
FIGURE 1. WEST PLAZA - TIKAL  
RESISTIVITY CONTOURS & EXCAVATIONS 1962



WEST PLAZA: OP. 19E

NORTH SECTION

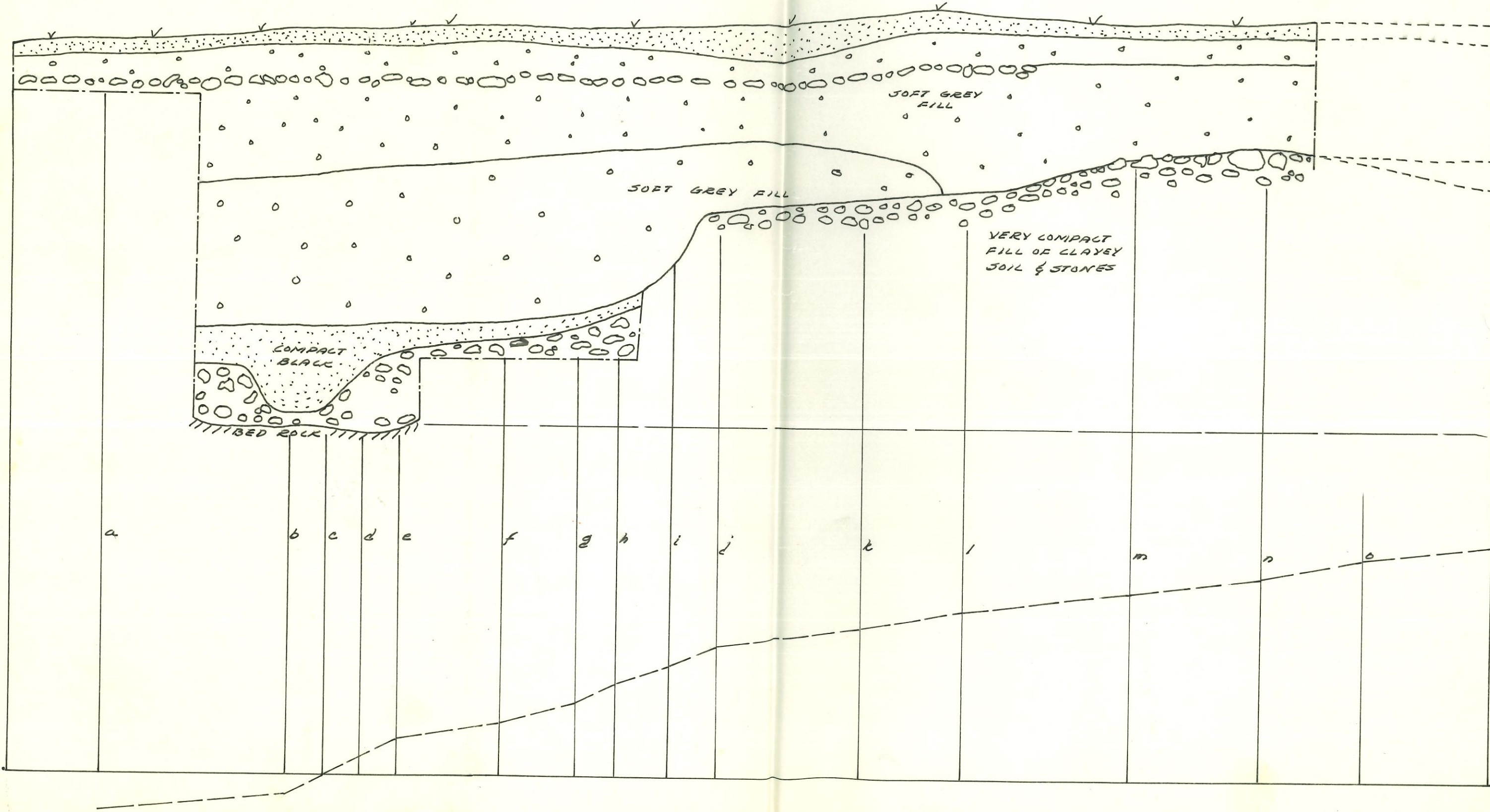
SCALE 1:20



WEST PLAZA OP. 19D

NORTH SECTION

SCALE 1:20



Resistivity readings produced a resistance contour map of the West Plaza which showed distinct anomaly structures with suggested steps. Trenching across this anomaly showed a buried mass of compact deposits and retaining walls resting on bedrock. We conclude that the resistivity readings produced a map reflecting a major change in compaction from upper loose to lower compact deposits but did not indicate bedrock. Several types of deposits combined to create the compaction surface. Retaining walls buried in the compact materials were not differentiated by the readings. By testing an area depth values for groups of resistance lines may be established and used in reading the map as a guide to the location of deeper superficial deposits (or conversely to indicate a buried compact mass). Identification of buried masses as to component material depends upon excavation.

March 11, 1

A SHORT REPORT ON EXCAVATIONS IN THE WEST PLAZA AT TIKAL  
UNDERTAKEN IN CONJUNCTION WITH THE USE OF RESISTIVITY EQUIPMENT:

Robert H. Dyson, Jr. & Peter Harrison

During the 1961 season at Tikal, Mr. Richard Linington of the ~~Center for~~ <sup>Center for</sup> Applied Science, in Archaeology at the University Museum in Philadelphia, made extensive tests at the site of Tikal using various geophysical methods. One of the areas chosen was the West Plaza which lies immediately west of the North Acropolis and main center of the site. This area was chosen as it was relatively flat, and had produced pre-Classic Chicanel sherds from deep in the fill. It was hoped that buried structures dating to the pre-Classic period might be located first without digging, and then later excavated.

Drawing upon a memorandum submitted to the Project by Mr. Linington in August of 1961 which outlines the work carried out from March 29th to May 17th, 1961 we may state the following. <sup>2872</sup> Readings were made with a Geohm resistivity instrument ~~totalling 2872~~. A strip 12 meters wide by 110 meters long with a projection 12 meters by 20 meters to the west was surveyed. Two lines of survey pegs were laid out (Figure 1, lines A and I) at five meter intervals running north-to-south, eight meters apart east-to-west. North-south lines of readings were taken over the whole area. East-west readings were taken over all but the northern 30 meters.

The results of the work were plotted on a map in the form of a contour diagram showing the resistance values (Figure 1). On the resulting diagram, reproduced in part here, it was assumed that the low resistance features ~~are~~ <sup>were</sup> most significant. The most striking  $\phi$  of these was an anomaly lying in the I50 general area of the map. This anomaly showed "clustering" of lines as if ~~in~~ <sup>over</sup> a stepped down ~~structure~~.

structure. While Linington was unable to ascertain whether the measurement reflected a rise in bedrock or a hole in the ground he, nevertheless, concluded that a "Large scale survey shows very interesting patterns of resistance features, with a reasonable chance of correlation with archaeological features."

During February and early March of 1962 the Tikal Project undertook to include the resistivity problem in its excavation program aimed at a general study of the West Plaza area. ~~XXXXXXXXXXXX~~ The approach to the problem was made in two stages: first, direct trenching across the major anomaly; second, selection of specific resistance contours over known depths of deposit in the trenches and testing these lines at other points to see whether the contours could be converted to a depth scale.

For the trenching two trenches were laid out across the anomaly in an east-west direction running from I50.5 west seven meters to P50.5 and from A50.5 seven meters west to H50.5. The trenches formed a ~~row~~ *line* east and west lying between north-south lines 51 and 52, being a meter wide. These trenches were part of a wider system of study and consequently are designated Operation 19D and 19E (viz. Figure 1). Trench 19E was carried to bedrock throughout its length; trench 19D was only carried to bedrock in one section although most of the trench <sup>has at present been</sup> ~~was~~ carried down to the heavily compacted materials beneath for much of its length. The resulting sections, drawn along the north side of the trench, are shown in Figure 2. Below the sections is drawn a graph with the resistance contours placed ~~where~~ they occur in the ~~north~~ section of the trench shown above. The resistance contours are graphed arbitrarily using a one centimeter unit in order to show the shift in value.

The trenches excavated show several important features. First, there is a pronounced slope in bedrock, which is a compact soft limestone, from the east to the west. It is immediately apparent by com-

paring the resistivity graph that there is no correlation between the resistance contours and the profile of the bedrock. We, therefore, necessarily conclude that the readings do not reflect the bedrock surface. Secondly, it is equally clear from the stratigraphy involved in these two sections, as well as <sup>in</sup> a third <sup>Trench</sup> further west, that the West Plaza area in this location has grown from east to west through the accumulation of successive roughly built retaining walls of limestone blocks holding a fill of dense dark grey clayey earth and stones and pebbles. These fills are exceedingly compact and require heavy pick-work to disengage. The general profile of this compact mass indicates some relationship to the resistivity graph. This relationship is particularly clear in the section of Op. 19D (Figure 2, left) where the general fall in the graph from east to west follows a similar fall in the compaction surface of clayey earth and stone fill. At the time of writing this fill had not been excavated to bedrock, but given the over-all section of both trenches there is little doubt of its essential nature. An examination of the section of Op. 19E on the other hand shows no such clearcut parallel. The compact materials rise slightly in the center of the section and drop slightly at either end. The drop ~~at~~ the east end of the graph may perhaps be accounted for in part by the presence of a pit in the bedrock which occurs in the trench but not in the section (where it is represented dotted in). It must be noted, however, that this pit and the shallow stratum immediately overlying it are composed of ~~the same~~ <sup>a</sup> compacted dark grey clayey soil and stones, <sup>similar to that</sup> ~~as~~ already seen in the compact surface of Op. 19D. It is, however, a separate deposit which, while appearing similar to the naked eye, may well have distinct qualities in terms of moisture, density, etc. In summary then, the comparison of the section of Op. 19E and the expected contouring as represented by the resistivity contours was less satisfactory, with the crest of

the resistance graph~~y~~ being displaced somewhat to the west of the crest of the more dense materials in the section. An evaluation of this circumstance in relation to the readings and calculations of the resistance equipment is beyond our abilities at present in Tikal.

In both sections the upper strata consist of soft grey soils with small pebbles and occasional patches of lime plaster floors. This upper zone of perhaps an average of a meter below the present surface is normally subject to much disturbance through root action, falling trees, etc. It is distinctly less compact than the compacted masses underlying it as described above. There seems little reason, therefore, to conclude that these strata taken individually have much effect on the resistivity readings. The significant differences, both in the field physically and apparently on the resistance graphs, would seem to fall between the upper less dense zone and the lower compact material, (with bed rock forming a third distinct division which in the present instance did not enter into the final result in any significantly visible way).

In order to ascertain whether or not the main conclusion indicated by the preceding data was valid, namely, that the resistance contours measured a significant difference in compaction at varying depths below surface, two additional test blocks were made. These were laid out along the I line to the east and measured a meter by a meter and a half each in area. Op. 19Q was located from I46 to I47.50, and Op. 19R from I45 to I43.50, between lines H and I. As seen on the map (Figure 1) <sup>resistivity</sup> lines i-m passed through Op. 19Q and e-g through Op. 19R.

In Op. 19Q the upper soft grey and pebbly fill rested upon a stratum of beige colored, relatively compact crushed rocky material. The stratum is a northward extension of that seen in the section of Op. 19E (Figure 2, right) <sup>where it is</sup> ~~and~~ marked "compact beige fill" ~~in that diagram~~. The upper surface of this fill is encountered in Op. 19Q at

an average depth below surface of about <sup>90</sup>~~ninety~~ centimeters. At a deeper level, averaging about 110 centimeters below surface, large blocks of stone ~~and stones~~ begin to appear mixed with the fill. The <sup>compaction</sup> level along the west section of the operation which marks the top of this fill is relatively even. It is crossed by five resistance contours which give the effect of a slope on the map. By looking at the section of Operation 19D (Figure 2, left) we ~~may~~ see that these same lines cross the section along a relatively level <sup>compaction</sup> surface there also. This <sup>compaction</sup> surface is approximately one meter below <sup>actual</sup> surface - which measurement compares well with the similar situation in Op. 19Q. It is immediately suggested that the surface of this more compact material underlying the upper softer levels is <sup>the level</sup> being indicated by the resistivity readings. It is further suggested that given a <sup>resistivity</sup> contour map such as the one we have at hand, and a major test to identify the depths of the material being measured, that such a map may then be used as a rough ~~contour map~~ <sup>guide to</sup> which indicates the relative depth below surface of <sup>more compact</sup> ~~the looser surface~~ deposits. There is no indication that there is any way <sup>further</sup> to differentiate the composition of these various deposits.

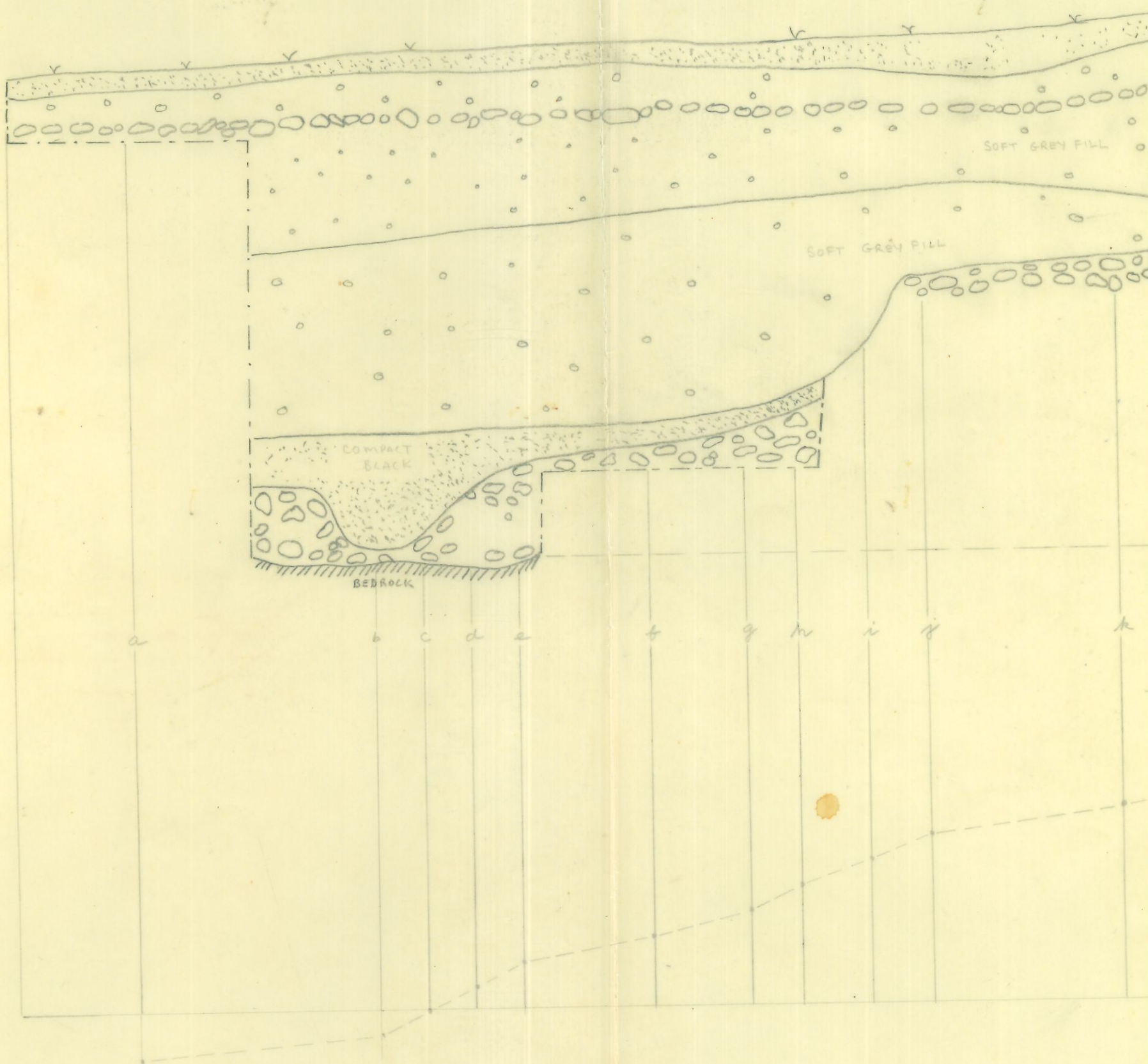
Op. 19R, however, presents a problem. Again the change in material from soft grey fill to the beige colored fill occurs essentially at a depth of 90 to 100 centimeters. The beige fill in this instance is not so homogeneous as in 19Q having some lenses of grey soil in it. The occurrence of stones begins at a depth of 110 to 130 centimeters, or somewhat lower than 19Q. Three resistance lines cross the operation. These same lines occur on section 19D lying <sup>over</sup> ~~along~~ a relatively level surface, but at a depth of 1.60 meters. ~~This is thus~~ <sup>there is</sup> a relative difference in depth between the lines of 19D(e,f,g) and 19D(i-m) of nearly a half meter. There is also a relative difference between 19R(e,f,g) and 19Q(i-m) but only on the order to 10-20 centimeters. There is a difference in the absolute depth of 19(D) ~~over~~ 19R of at least 30 centimeters if

Thus the same resistance lines give a reading for a compaction surface 1.60 meters deep in the case of 19D while only 1.30 meters or less in 19R. Remembering the displacement visible in the readings of 19E one wonders whether a similar effect is present here. Excavation has not proceeded far enough to tell as yet. In any case it is apparent that 19R lies somewhat deeper than 19Q in terms of distance below surface of the more compact materials and there is therefore a greater depth value for lines e,f,g than for lines i-m as seen in these two operations. This differential is borne out in Op. 19D where lines e-g reflect a deeper compaction surface than do lines i-m. It seems probable then, with adequate additional trenching that an approximate value in depth could be worked out for groups of these resistance lines that would allow the contoured map to be used as a guide to deeper superficial deposits.

Electrode spacing believed to  
be 1 - meter. ∴ only 1-m.  
depth was "seen" by  
instrument

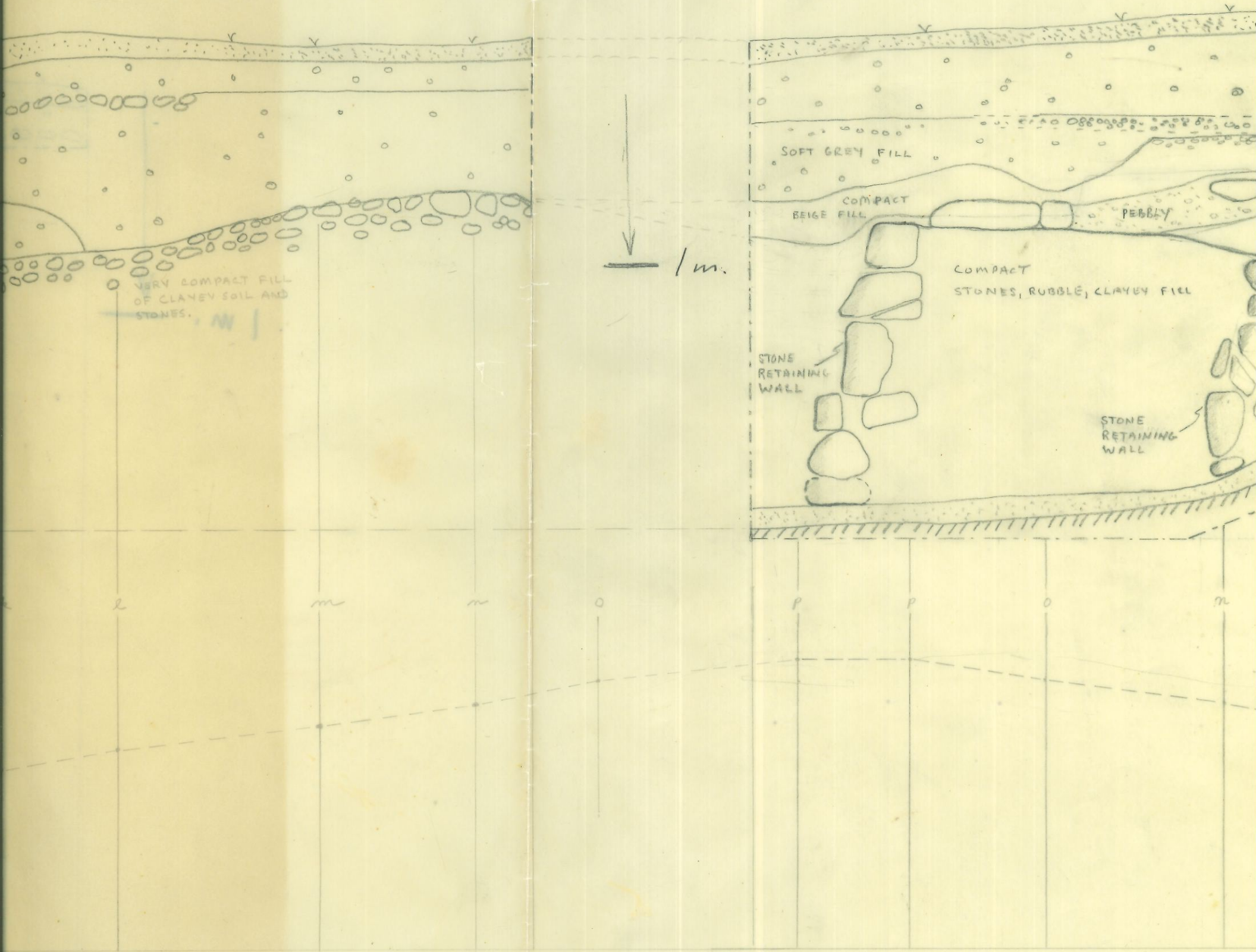
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WEST PLAZA: OP 19D  
NORTH SECTION

Scale 1:20



WEST PLAZA: OP 19E

NORTH SECTION

SCALE 1:20

