

MASCA

Projects

ELIAS, GREECE

PRINTS



ELIAS GREVE

Fig. 4



ELIAS, GREECE

Fig. 2



ELIS, GABICE

Fig. 3



ELIS GREECE

Fig. 5



ELIS GRELLÉ

Fig. 6

RESEARCH LABORATORY FOR ARCHAEOLOGY
AND THE HISTORY OF ART

TEL. 55211

6 KEBLE ROAD
OXFORD

21st December, 1967

Miss Beth Ralph,
The College,
Department of Physics,
University of Pennsylvania,
Philadelphia 4.

Dear Beth,

Very many thanks indeed for the radiocarbon article. At a quick reading this looks to be just what we want. My only request for alteration is that the caption of figure 2 should be expanded to give an indication of what is meant by a regression curve. Does it simply mean 5 or 10 year averages?

If you are willing to expand this caption, please will you send an amended variation to Mrs, P. M. Reid, 51 Lower Belgrave Street, London S.W.1. .

Is the survey at Elis still on the cards? David Zimmerman is keen to go, and there is also a friend of his here - another American, Bob Harrison, who is also interested and willing to pay his expenses in so far as it is necessary.

With all best wishes for 1968,

Yours sincerely,



M. J. Aitken

yes, if
can stay
whole month
of May

January 3, 1968

Professor Spyridon Marinatos
Department of Archaeology
University of Athens
57, Solonos St.
Athens 143, Greece

Dear Professor Marinatos:

Thank you for your letter of October 26, 1967. After I wrote to you in September, my back condition became progressively worse so that I came flying home to have an operation. The surgeon removed part of a disc and after a few more months, I shall be much stronger than I have been for years, and fortunately, do not have to wear a warm girdle around my waist.

If agreeable with you, I shall plan to return to Elis for the month of May. In order to make the work go a little faster and also to conserve my back, I should like to bring along my two Italian assistants who have worked with me for many seasons. Unfortunately, they speak only Italian and if for this and other reasons, it would be better not to bring them, please do not hesitate to let me know. Another possibility is that I might find a young student here to bring with me.

I enjoyed working with Ilias Andreou in September, and hope that he will be able to join us in May. If I do not bring one or two people with me, perhaps, you have a young student with a strong back who could join our group. Please let me know your pleasure in this matter of assistants.

If I may trouble you for a little note written in Greek for the customs in Patras, it will not be necessary for someone to meet me there. This would be more convenient for me because it will be difficult for me to say precisely in advance what day I shall arrive, I left Italy in such haste that I shall have to gather and test the magnetometer and have my Fiat repaired when I arrive there.

[Happy New Year ^{written} in Greek]

Sincerely,

Beth K. Ralph

RESEARCH LABORATORY FOR ARCHAEOLOGY
AND THE HISTORY OF ART

TEL. 55211

6 KEBLE ROAD

MJA/CAB

OXFORD

28th March 1968.

Miss Beth Ralph,
University Museum,
33rd and Spruce Streets,
Philadelphia,
Pennsylvania,
U.S.A.

Dear Beth,

As the summer is coming on, I thought I should write and confirm that David Zimmerman and Bob Harrison are still keen to go on the Elis expedition; ~~is~~ there ~~is~~ any more news of it (e.g. are the dates fixed yet?). However, neither of them feel they can spare the time to work for more than a fortnight there, so you must balance their claims to come against other people on your list. David Zimmerman is well acquainted with proton magnetometer surveying having been on half a dozen surveys last year. Bob Harrison has no previous experience but I think you will find him a quick learner.

Archaeometry Volume 10 should be appearing around mid-April so your article will soon be seeing the light of day. We have your order for 200 reprints noted.

With best wishes.

Yours ever,

M. J. Aitken

*not fare
exp in Greece*

*↑
NSF - Grant -
Iran - Ellen - Dyson
G.W. - schedule w.
dates*

*Return Au
Proton magn. batteries
Cost ?*

4/10/1968

Giacinto Loisi
Via Amendola 12
Cassano Ionio 87011
(Cosenza) Italia

Caro Giacinto,

Mi dispiace molto, ma Prof. Marinatos m'ha scritto e Lui ha cambiato idea. Adesso Lui vuole che io sola venga in Grecia e che tutti i lavori saranno fatti con studenti greci.

E una notizia spiacevole anche per me perche preferisco lavorare con Lei e Nunzio.

Quando arrivero in Italia verso la fine d'aprile, vi prego che Lei mi dica quanto e costato il passaporto e altre cose.

Tanti saluti,

Elizabeth K. Ralph



MINISTÈRE A LA PRESIDENCE DU CONSEIL
DIRECTION GENERALE DES ANTIQUITÉS

[ELIS, GREECE]

Athens, May 18th 1968.

Dear Miss Ralph,

Something comic happened to me. I and my Secretary believed, that your letter of 10 May was mailed from Athens, where Othonos and Amalias Street cross, but no hotel Hellenis was there; till a calling of Mr. Papathanassopoulos cleared the situation.

I am sending immediately our topographer, who will be available after 3 days.

Of course, there is no objection for inviting your two assistants from England, but, if you wish to have immediately two helpers from Athens, please let Mr. Papath. to call me and I will try to send you two (female) students in order to get a first acquaintance with the magnetometer.

I try to come and see you in Elis and I hope we will see you in Athens. We are very grateful!

Yours hastily, but sincerely.

Sp. Marinatos

April 12, 1968

Miss Elizabeth K. RALPH
Museum of Applied Science
Center for Archaeology
The University Museum
University of Pennsylvania
33rd & Spruce Streets
Philadelphia, Pa. 19104
U.S.A.

Dear Miss Ralph,

Many thanks for your letter of April 5. I was very happy to read it, for it made me understand that your health is now in perfect condition.

You will be wellcome to Patras on May 2nd or 3rd; I will see that somebody be there for you.

I also wish to thank you for your idea to train some Greek students in the use of magnetometers. It will be useful, indeed. I will see what I can do about it. As to the possibility of your inspecting other sites eventually suitable for magnetometer surveys, we shall discuss it on your coming here. *I have already in mind some plans.*

Ευχαρητήρια διά τὰ ἑλληνικά σας!

Καλὴν ἀντάμωσιν (ἐγὼ ἀγαπῶ τὴν καθαρεύουσαν!)



Prof. S. Marinatos

January 22, 1968

Miss Beth K. Ralph
Museum Applied Science
Center for Archaeology
The University of Pennsylvania
33rd and Spruce Streets
Philadelphia, Pennsylvania 19104
U.S.A.

Dear Miss Ralph,

I am in receipt of your letter of January 3 and was very glad to see that your back condition is better now. I do hope you will soon completely recover and wish you a healthy and happy New Year.

You are welcome to return to Greece by May 1968 for the excavations at Elis. The question of your assistants is left up to you to be settled as you think it better.

Enclosed you will find the paper required. I trust, you will let me know at your convenience about the samples I sent you for CI4 examination.-

With best wishes,

A handwritten signature in dark ink, reading "S. Marinatos". The signature is written in a cursive style with a long horizontal stroke extending to the left and another extending to the right.

Prof. S. Marinatos

April 11, 1968

Prof. Spyridon Marinatos
Ministry to the Prime Minister's Office
General Direction of Antiquities
The Inspector General
Athens, Greece

Dear Prof. Marinatos,

I have just received Dr. Rainey's message about not bringing the Italian assistants. Therefore, I shall come alone.

I shall need two assistants to work with me, one of whom should be intelligent and strong enough to carry the instrument and batteries (about 13 kilograms) all day long. The other one, who will carry the sensor, can be a local workman. Unfortunately, my back is not yet strong enough to carry the instrument myself as I did last year.

One minor little problem is that I must sleep with a board under my mattress, but I imagine that I can find one when I arrive in Greece.

With best wishes for a Happy Easter,

Elizabeth K. Ralph

EKR/abn

April 5, 1968

Professor Spyridon Marinatos
The Inspector General
Ministry to the Prime Minister's Office
General Direction of Antiquities
Athens, Greece

Dear Professor Marinatos:

Fro Rainey has probably told you of my plans, but just to confirm them, I am writing to you directly.

I am planning to land in _____ on May 2nd or 3rd, but, with your letter of introduction, there should not be any need for some one to meet me there.

If the boat is late as it was last year, I shall plan to drive to Olympia the following day. I shall plan to bring my two Italian assistants with me -- Giacinto Loisi and Nunzio Leone -- at least, for the first few weeks. There are two students from Oxford University who would like to join me later in May, but I shall not decide about them until I am in Greece and talk to you. I would be a good thing also to train some Greek students in the use of magnetometers.

I am wondering if you would like me to inspect other sites in early June (as we discussed last September) in order to find out which ones would be suitable for magnetometer surveys in the future.

I have been studying Greek for two months, but I do not expect to be able to speak fluently.

Elizabeth K. Ralph

January 3, 1968

Professor Spyridon Marinatos
Department of Archaeology
University of Athens
57, Solonos St.
Athens 143, Greece

Dear Professor Marinatos:

Thank you for your letter of October 26, 1967. After I wrote to you in September, my back condition became progressively worse so that I came flying home to have an operation. The surgeon removed part of a disc and after a few more months, I shall be much stronger than I have been for years, and fortunately, do not have to wear a warm girdle around my waist.

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I enjoyed working with Ilias Andreou in September, and hope that he will be able to join us in May. If I do not bring one or two people with me, perhaps, you have a young student with a strong back who could join our group. Please let me know your pleasure in this matter of assistants.

If I may trouble you for a little note written in Greek for the customs in Patras, it will not be necessary for someone to meet me there. This would be more convenient for me because it will be difficult for me to say precisely in advance what day I shall arrive, I left Italy in such haste that I shall have to gather and test the magnetometer and have my Fiat repaired when I arrive there.

[Happy New Year^{written} in Greek]

Sincerely,

Beth K. Ralph

November 21, 1968

Professor Sp. Marinatos
Ministry to the Prime Minister's Office
General Direction of Antiquities
The Inspector General
Athens
Greece

Dear Professor Marinatos:

We have just received the good news that you are coming here on December 10th, and we are looking forward to your visit.

I hope that you will excuse my delay in sending the enclosed Elis report. The maps were just completed this week and I am sorry that Figure 1 is not clearer. As you can see, there are a few spaces where I have put question marks and your name with the thought that you, Mr. Papathanasoupoulos, or Mr. Andreou can supply this information. Also, for a complete report and a more careful interpretation of the magnetometer anomalies, there is a need to study the excavation reports.

I hope that we can discuss these matters during your visit here.

With best regards,

Elizabeth K. Ralph

EKR/mrb

ARCHAEOLOGICAL PROSPECTING

Cesium Magnetometer Survey, Elis, Greece

Miss Elizabeth K. Ralph, Associate Director of MASCA, has reported on the cesium magnetometer survey made at the site of ancient Elis (about 70 km from Olympia). This site presented an ideal challenge for magnetic prospecting because of its location on an alluvial plain, which consists of homogeneous non-magnetic soils, and was urgently needed because of the impending construction of irrigation canals directly through the site. As well as offering easily detectable magnetic anomalies, most of the surface now consists of farmland uncluttered by modern magnetic disturbances, with the exception of the southern edge of the area where there is a small village.

Elis lies along the banks of the River Peneus, between a hilly eastern region and a fertile, western, coastal plain. Originally settled in dispersed villages, the city was founded in 471 B.C. by bringing together many smaller groups into a large and open town.

The first tests at Elis with the cesium magnetometer were made by Miss Elizabeth K. Ralph in September 1967, supposedly in the proposed path of the large irrigation ditch. (See MASCA Newsletter, Volume 3, Number 2, November 1967.) By May 1968, the route of the ditch had been changed, and the ditch itself was already under construction. However, Greek archaeologists had

been excavating extensively in the new path of the ditch during the winter and early spring, and since many of the structures were still exposed, this helped with the interpretation of the anomalies found with the magnetometer.

In the course of seven weeks, complete grids were made over 1/2 sq. km. of the site of ancient Elis. The procedure was roughly as follows: grids varying in size from 10 by 150 to 120 by 200 meters were laid out in each field with parallel base lines marked by rows of canes. The parallel base lines were then divided into three-meter intervals marked by flags so that a man carrying the magnetometer sensing device could walk along a line between the markers. Magnetometer readings were taken at two meter intervals (as determined by paces) along these lines. The sensor man was followed by a second carrying the readout device and batteries, and a third person carrying a notebook pad. With this portable cesium magnetometer it is not necessary to pause for a reading. The operators walk steadily along the line while the man carrying the readout calls out a number (magnetic intensity reading) at every two paces which is written by the third man in the notebook oriented in the same direction as the grid laid out on the ground. For maximum precision and stability, the magnetometer was operated in the differential mode for most of the grids. That is, a second sensor was fixed at the center of the grid and attached to the other in-

struments with a long cable. This served to cancel out diurnal and other extraneous magnetic disturbances so that only archaeological remains were detected except in the proximity of magnetic modern disturbances such as reinforced concrete bridges and the new irrigation ditch where it was completed. There were also some fields under cultivation with crops which would be injured by the trampling of magnetometer crews. For this reason and due to the lack of time, not all of the areas of most interest were covered in the 1968 spring season.

The grids were photographed, reduced in scale, and located on a map of the site. These, in combination with radial survey lines made out from the regions of concentrated coverage by grids, showed that the ancient city extended over approximately 2 sq. km. Within the grids, the walls and rows of houses showed up so clearly that it appears to be possible to recreate part of the ancient city plan. Closely spaced contours found in particular grids, run east to west, and continue in adjacent grids. It is presumed that these represent rows of walls made of bricks or a combination of stones and roof tiles. These walls appear at depths, usually of less than one meter, but many extend to depths of four to five meters. The uppermost walls are predominantly Roman, but where it has been possible to observe the earlier levels, it can be seen that the Roman walls, in most cases, followed the pattern of the ones beneath.

This observation is important for the interpretation of the magnetometer anomalies. Because brick walls consist entirely of fired clay, they tend to be more magnetic than walls made of a mixture of stones and fired ceramics such as the Greeks used in the 5th and 4th centuries B.C. (The firing of clay causes the inherent magnetic dipole moments, which are normally random, to be lined up in one direction--that of the earth's field at the time of firing. Consequently, the overall field is more homogeneous and more magnetic).

The final plan of the city is not complete. However, this survey is an example of the reconstruction of the plan of a Greek city by means of magnetic contouring. It demonstrates as well that it is now possible to map a good part of a large ancient city and to find its limits, within 8 weeks. Certainly, much more was detected in these weeks than had been uncovered or suspected during 60 years of intermittent excavations.

Magnetometer Survey at

Ancient Elis, 1968

by

Elizabeth K. Ralph

MASCA, University Museum

University of Pennsylvania

Philadelphia

One of the main activities of the Applied Science Center for Archaeology, at the University Museum, University of Pennsylvania, has been the use and development of instruments for archaeological prospecting. As a result we are now equipped with sensitive portable magnetometers for the detection of buried features which are of interest to archaeologists. With this capability in mind, Professor Sp. Marinatos asked our Director, Froelich Rainey, for our assistance at the site of Ancient Elis.

Elis, leading city of the second largest province (Elis) of the Peloponnese, lies along the banks of the River Peneus, between a hilly eastern region and a fertile, western, coastal plain. Originally settled in dispersed villages, the city was founded in 471 B.C. by bringing together many of these smaller populations into a large and open town. It played a minor role in ancient politics, generally amenable to Spartan policies, and preferring quiet country life. It was, however, noted for its horses and high-quality flax and achieved its greatest fame as administrator of the important sanctuary of Olympia and president of the Olympic games. These quadrennial competitions, one of the greatest of Panhellenic festivals, were traditionally reputed to have begun in 776 B.C.

Elis control was definitely established by about 572 B.C. and was maintained into the Roman era.

The site of the ancient city has long been known, and some of the later Roman structures are observable as brick and stone fragments scattered over an area three to five kilometers in circumference. Excavation was begun by the Austrians in 1910-14, resumed in 1931-2 and again, in a joint Greek and Austrian campaign, in 1960. As a result, the theatre had been found, but little was known about the location of other important features of pre-Roman Elis, nor of its city plan, nor of its precise boundaries. In the mid-1960's, it became urgent to learn as much as possible about ancient Elis in a very short time, because of the impending construction of irrigation canals directly through the site. (This construction is part of the Dam project which will furnish irrigation to

?
Prof.
Marinatos

Because of this urgency and because of its location on an alluvial plain, which consists of homogeneous non-magnetic soils, it presented an ideal challenge for magnetic prospecting. Also, fortuitous was the fact that in the 5th and 4th centuries B.C., the builders used many fragments of roof tiles in the construction of their walls. Roof tiles and bricks are much more magnetic than unfired

clay or stone and, hence, are readily detectable in a region that is normally magnetically quiet. As well as offering easily detectable magnetic anomalies, most of the surface now consists of farmland uncluttered by modern magnetic disturbances, with the exception of the southern edge of the area where there is a small village.

The first tests at Elis with our cesium magnetometer¹ were made in September 1967, supposedly in the proposed path of the large irrigation ditch. When I returned in May 1968, I found out that not only had the route of the ditch been changed, but that it was already under construction. However, Ilias Andreou and students, under the direction of George Papathanasoupoulos, Director of the Olympia Museum, had been excavating extensively in the new path of the ditch during the winter and early spring. Since many of the structures were still exposed, this helped with the interpretation of the anomalies found with the magnetometer.

1 This cesium magnetometer is the Model V-4920 Precision Portable Magnetometer which was developed by Varian Associates (Palo Alto, California) especially for the University Museum. The principal of operation and its capabilities are described by E.K. Ralph, F. Morrison, and D.P. O'Brien Geoexploration, V. 6 (1968) p. 109-122.

In the course of seven weeks, complete grids were made over 1/2 sq. km. of the site of ancient Elis. The procedure was roughly as follows: Grids varying in size from 10 by 150 to 120 by 200 meters were laid out in each field with parallel base lines marked by rows of canes. The parallel base lines were then divided into three-meter intervals marked by flags so that a man carrying the magnetometer sensing device could walk along a line between the markers. Magnetometer readings were taken at two-meter intervals (as determined by paces) along these lines. The sensor man was followed by a second carrying the readout device and batteries, and a third person carrying a notebook pad. With this portable cesium magnetometer it is not necessary to pause for a reading. The operators walk steadily along the line while the man carrying the readout calls out a number (magnetic intensity reading) at every two paces which is written by the third man in the notebook oriented in the same direction as the grid laid out on the ground. For maximum precision and stability, the magnetometer was operated in the differential mode for most of the grids. That is, a second sensor was fixed at the center of the grid and attached to the other instruments with a long cable. This served to cancel out diurnal and other extraneous magnetic disturbances so that only archaeological remains were detected except in the proximity of magnetic modern

disturbances such as reinforced concrete bridges and the new irrigation ditch where it was completed. There were also some fields under cultivation with crops which would be injured by the trampling of magnetometer crews. For this reason and due to the lack of time, not all of the areas of most interest were covered in the 1968 spring season.

After the completion of each grid in the field, the pages of the notebook were pasted together to form a grid map composed of magnetic readings. The next step was to draw in contours of equal magnetic intensity just as one would draw in a survey of land elevations. In this case, however, the "hills" and "valleys" are anomalies representative of archaeological features.

At Elis it was soon apparent that we were detecting lines of structures and possibly parallel rows of structures. Since the original individual grids, made at a scale of 1:200 were too large to put together to form a composite picture, even on the floor of a large room, the next step was to have them photographed and reduced in scale. Also, since an adequate land map of the area was not available, it was necessary to have landmarks such as roads and the corner stakes of the grids surveyed in order to record their physical locations. When this was completed and drawn to a scale of 1:1000 and the magnetometer grids reduced to

this same scale, a composite picture could be formed. This is shown (in ~~very much~~ reduced scale) in Fig. 1. The estimated limits of the archaeological zone were determined by prospecting rapidly in radial lines out from the areas covered by grids. This zone, shown in part by wavy lines in Fig. 1, covers approximately 2 square kilometers.

In Fig. 1 one sees definite rows of anomalies, many of which are parallel and run predominately in the east-west direction. (Note that the map is not oriented in the north-south direction). This is particularly true on the flat regions of the plain. Unfortunately, in this two-dimensional plot, one cannot visualize the land contours as well. Two areas of higher ground were covered. To explain this, let us take a short "guided tour." Starting from the Modern Expedition Houses, we walk midway between the Modern Main Road and the Theater Excavation in a southwesterly direction. Here, we are on a small "plateau" from which we look down to the Theater Excavation, but up to the hills to the east across the main road. We continue walking in the same direction over the crest of this "plateau" and soon look down upon the flat plain. We descend onto it as we reach the more pronounced anomalies in Fig. 1. We have now traversed an area of rather "jumbled" anomalies, the

directions of some of which conform to the contours of the hill.

Next, we continue south on the flat plain, cross several lines of pronounced anomalies, and turn due east, possibly along the path of an ancient street (between two long parallel anomalies). After crossing the Modern Main Road and walking for 1/2 km, ^{we arrive at} the eastern Modern Minor Road and here we are on a higher hill just below the highest hill of the region on which there is a small church (see Fig. 2). Again, we see more confusing anomalies and some conforming with the contours of the hill.

In both of these hill regions we note that there are fewer pronounced anomalies as well as the fact that they do not form definite patterns. It is most likely that since the ground is higher, structures were buried less completely or less deeply and that destruction and reuse of building blocks by succeeding generations was much more probable.

3. Prof. Marinatos
Perhaps, the results of previous
excavations will help with
the explanation of these anomalies.

Let us now return to the extensive area of the plain where the anomalies form more consistent patterns and where the exposed excavations of 1967 and 1968 assist in their interpretation. In all of the excavations, both the larger ones southeast of the Modern Main Road (Fig. 3) and those made in the path of the irrigation canal (narrow strips parallel to the Main Road, (Figs. 4 and 5), one sees a profusion of walls running both east-west and north-south. They appear at depths, usually of less than one meter, but many extend downward to depths of four to five meters. The uppermost walls are predominantly Roman, but where it has been possible to observe the earlier levels, one notes that the Roman walls, in most cases, followed the pattern of the ones beneath. This is illustrated in Fig. 6 where one sees a Roman wall on top of and directly in line with a 4th century B.C. wall.

This observation is important for the interpretation of the magnetometer anomalies. Because brick walls consist entirely of fired clay, they tend to be more magnetic than walls made of a mixture of stones and fired ceramics such as the Greeks used in the 5th and 4th centuries B.C. (The firing of clay causes the inherent magnetic dipole moments, which are normally random, to be lined up in one direction - that of the earth's field at the time of firing. Consequently, the overall field is more homogeneous and more magnetic).

To return to the problem of the interpretation of the magnetometer anomalies, it is likely that the most pronounced ones — those represented by very closely spaced contours such as shown in Fig. 7 — are caused by Roman bricks. If we assume, however, that the Roman builders followed the original 5th and 4th century B.C. grid plans, then it may be that these anomalies reflect part of the city plan of pre-Roman Elis.

In order to see this more clearly, part of ancient Elis has been reconstructed in Fig. 8 on the basis of the anomalies shown in Fig. 1. In Fig. 8 the hatched areas represent the regions of pronounced anomalies. We may safely assume that these hatched areas reflect concentrations of structures such as rows of houses back-to-back, and that the original streets were in the blank areas between these. We note that many of these on the plain are in parallel east-west lines, and that the predominant spacing between them is approximately 60 meters. One exception is area "A" where the usual structure at 60-meter intervals does not appear. An optimistic thought is that area "A" represents the location of one of the three enclosed gymnasia reported by Pausanias.² (Frazer, Pausanias' Description of Greece VI. xxii.1-5).

Another striking feature of this "city plan" is that of the structures in region "B"^{which} do not conform to the grid plan. Since these are on the side of the city which is closest to the present bed of the river, however, there may be a natural explanation for the directions of this group of walls.

If these few interpretations are correct and if the blank areas between rows of houses do truly represent streets, then we may repeat our "guided tour", but this time, walk with assurance along the streets of ancient Elis, one of which will surely bring us to the agora.

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1966-1967, pg. 11, 1967-1968, p. 12, following.

Bulletin de correspondance hellenique.

Fasti Archaeologici.

Figure Captions

Fig. 1. Cesium Magnetometer grids located on the map of of the site. Contour lines in the grids represent regions of equal magnetic intensity.

Fig. 2. View eastward from the Modern Main Road with the highest hill in the background.

Fig. 3. Large excavation east of the Modern Main Road viewed from the north.

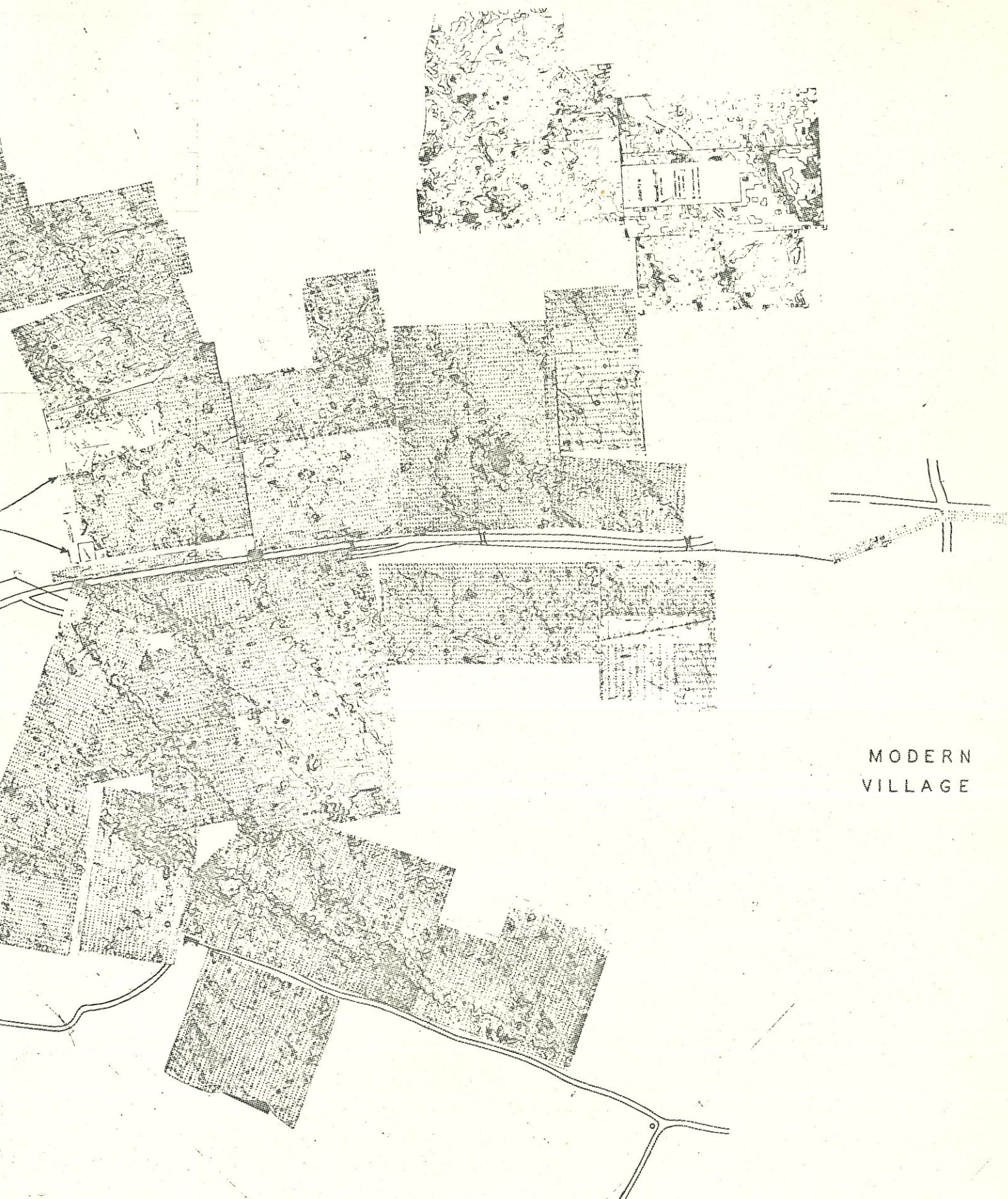
Fig. 4. Excavation in the path of the irrigation canal west of the Modern Main Road.

Fig. 5. Excavation in the path of the irrigation canal east of the Modern Main Road.

Fig. 6. Roman wall on top of 4th century B.C. wall made of stone blocks in large excavation east of the Modern Main Road.

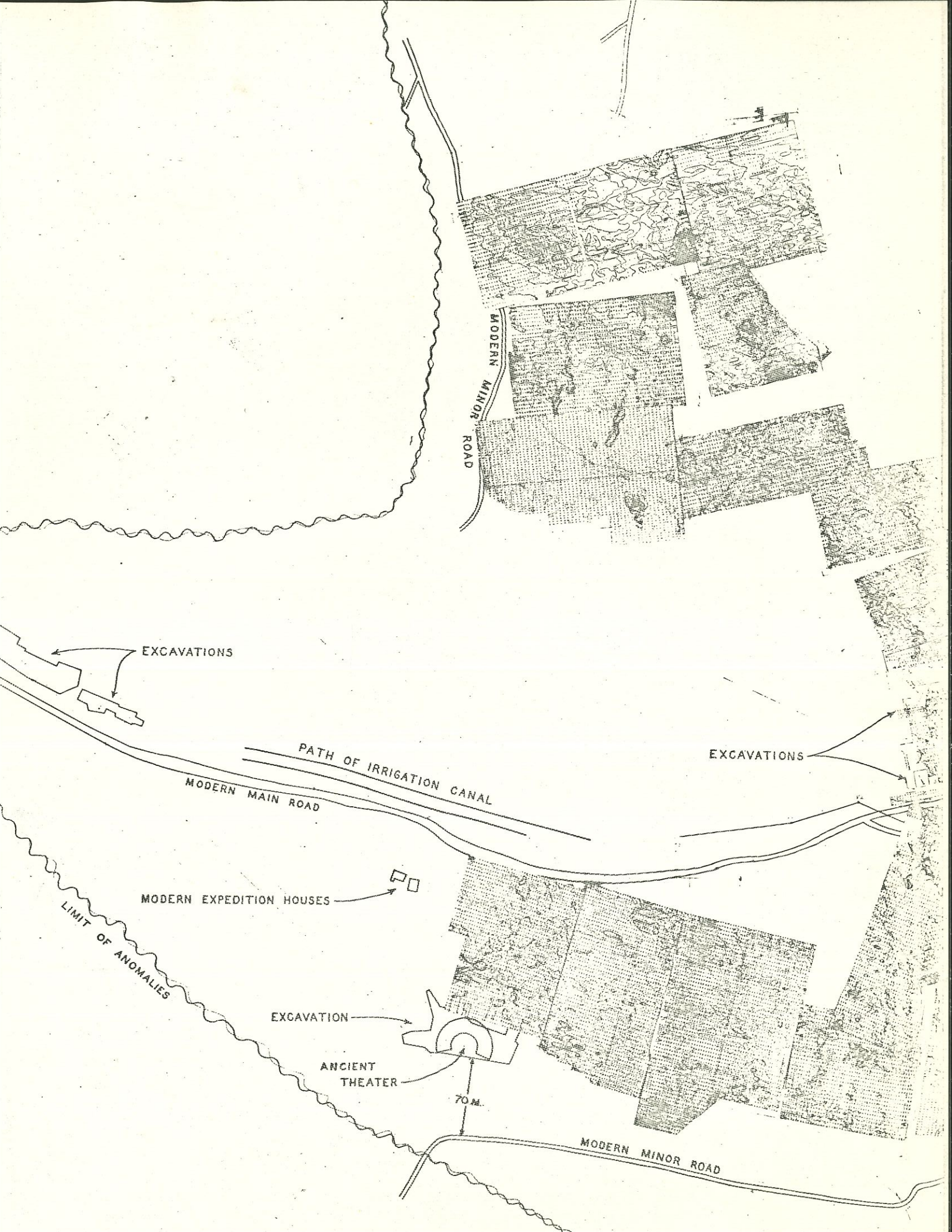
Fig. 7. Example of cesium magnetometer grid with lines of closely spaced contours representative of rows of structures. This grid was made in region "B" of Fig. 8 and shows two walls converging to form a large "V". Magnetic contours are drawn at intervals of 10 units. Each unit is approximately equal to 0.5 gamma.

Fig. 8. Reconstruction of part of ancient Elis based on magnetometer contours shown in Fig. 1. Hatched area⁵ represent the regions of pronounced anomalies.



MODERN
VILLAGE

Fig. 1



EXCAVATIONS

EXCAVATIONS

MODERN EXPEDITION HOUSES

EXCAVATION

ANCIENT THEATER

70 M.

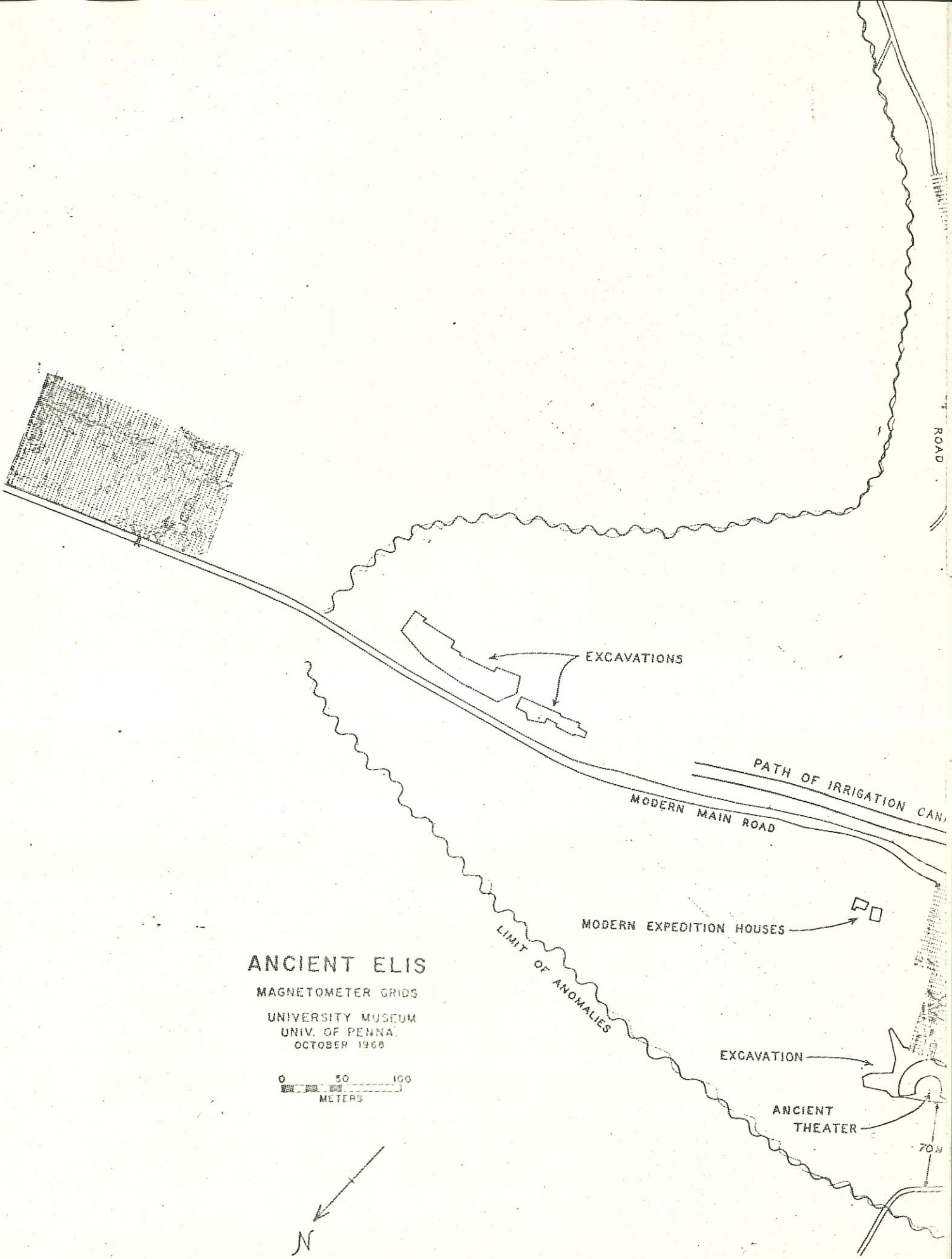
MODERN MINOR ROAD

MODERN MAIN ROAD

PATH OF IRRIGATION CANAL

MODERN MINOR ROAD

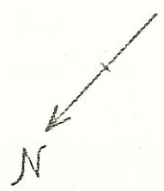
LIMIT OF ANOMALIES



ANCIENT ELIS

MAGNETOMETER GRIDS

UNIVERSITY MUSEUM
UNIV. OF PENNA.
OCTOBER 1968



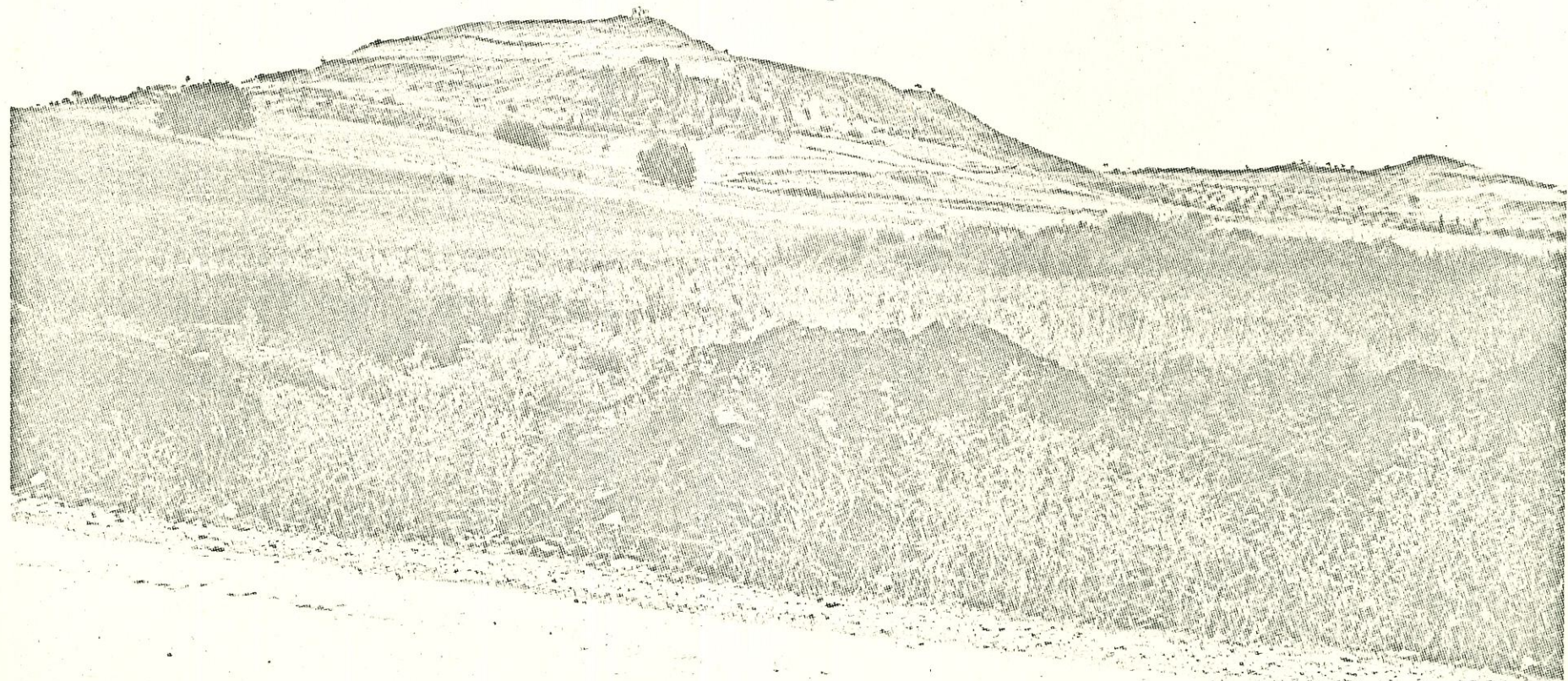


FIG. 2

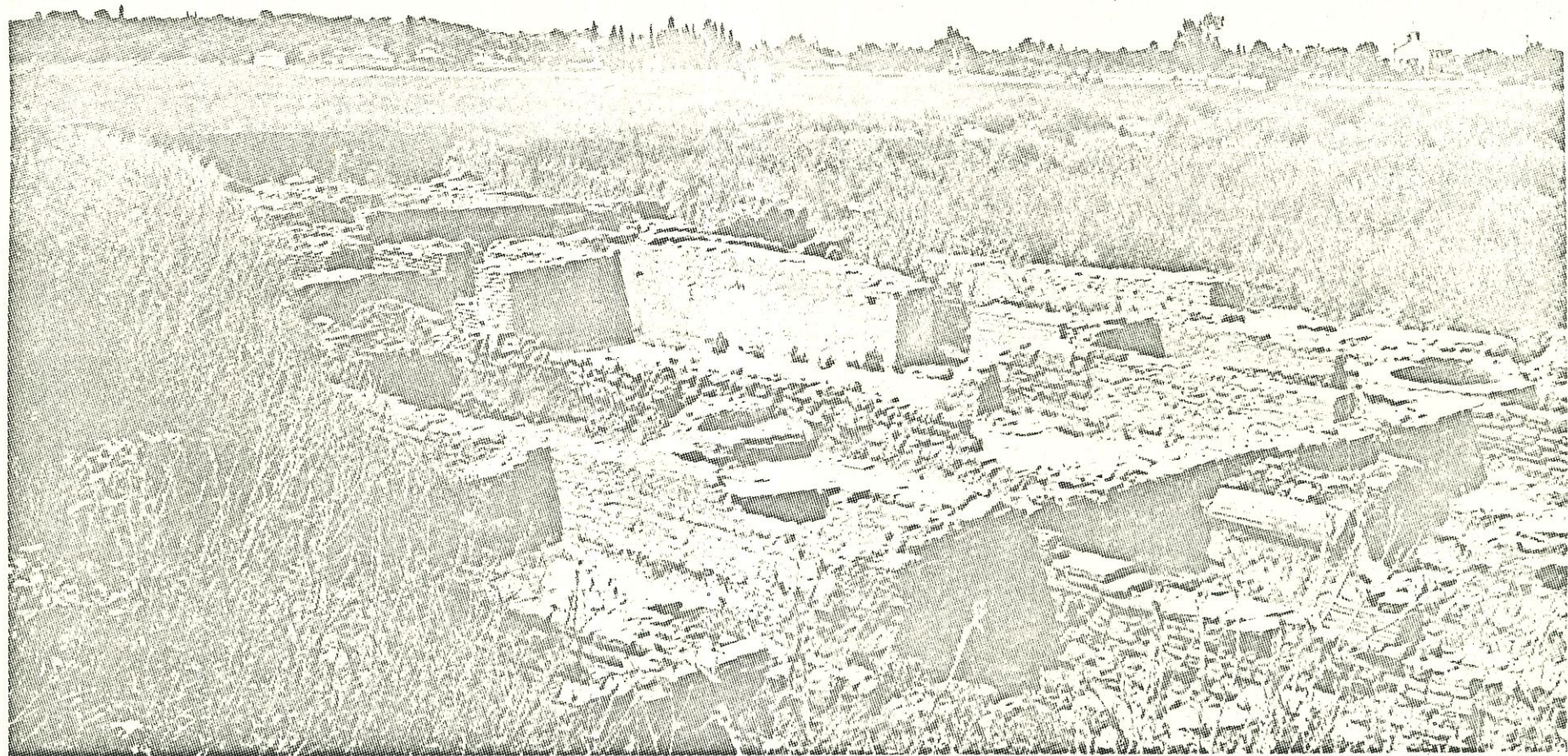


Fig. 3

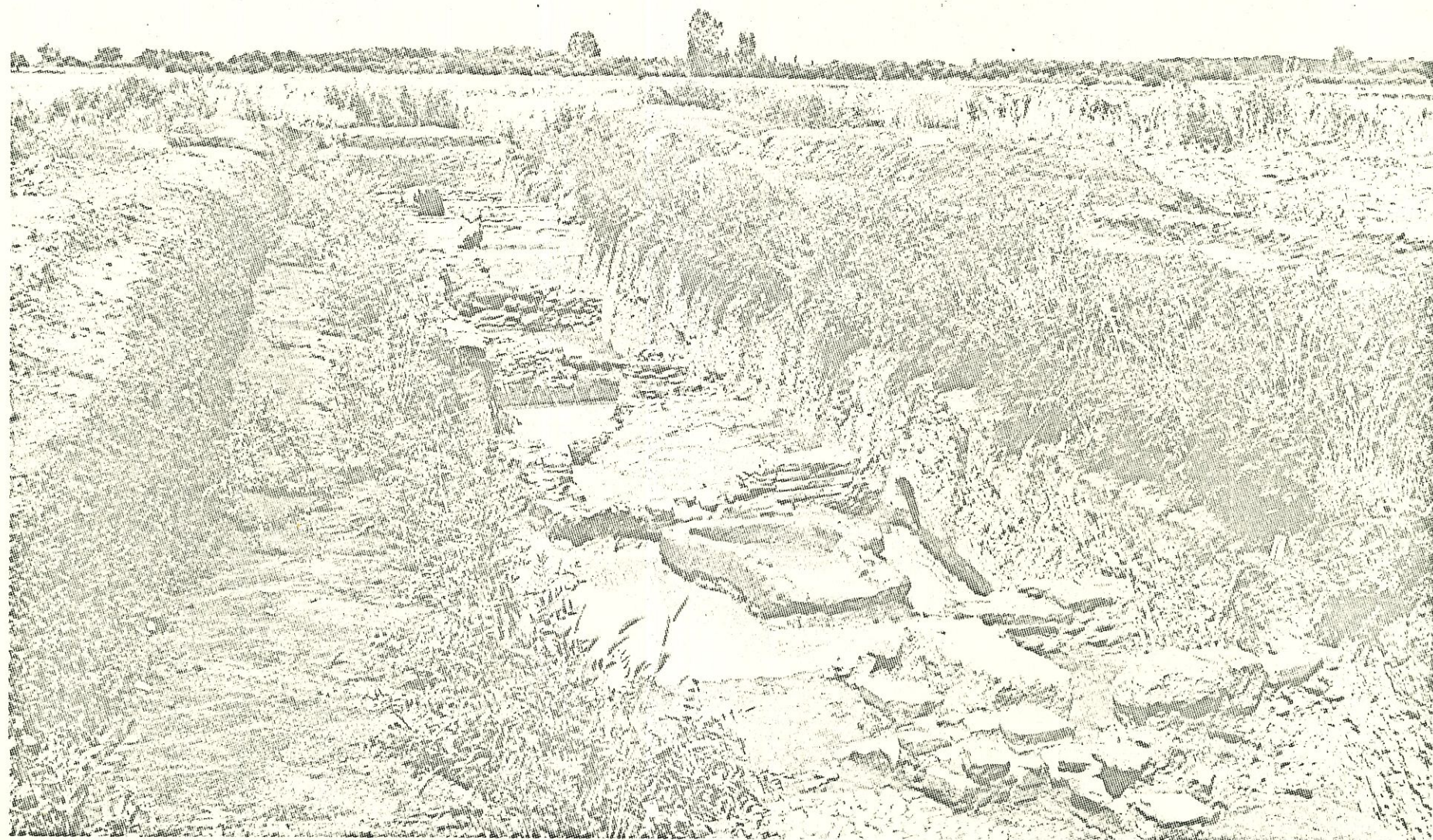


Fig. 4



FIG. 5

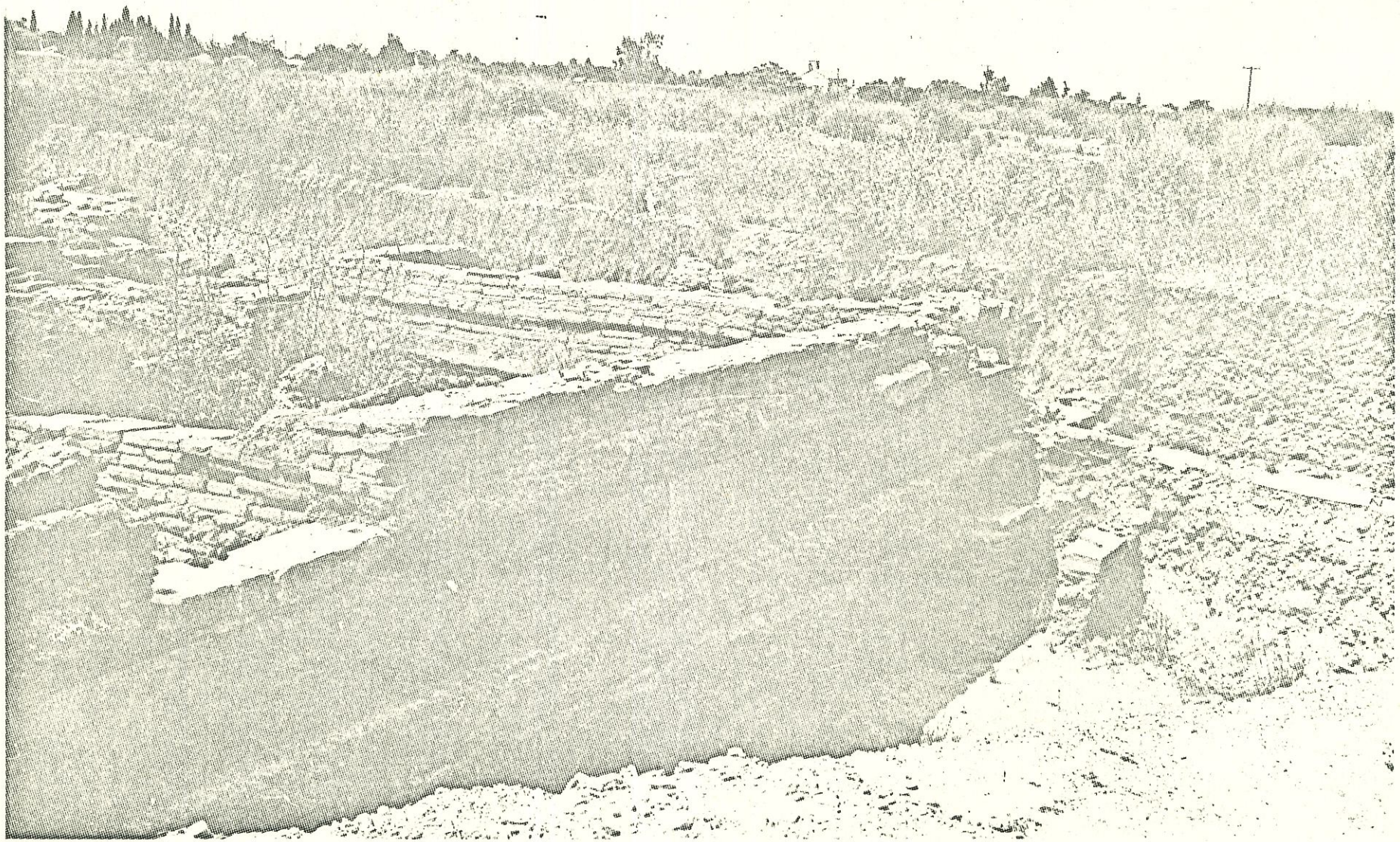


Fig. 6

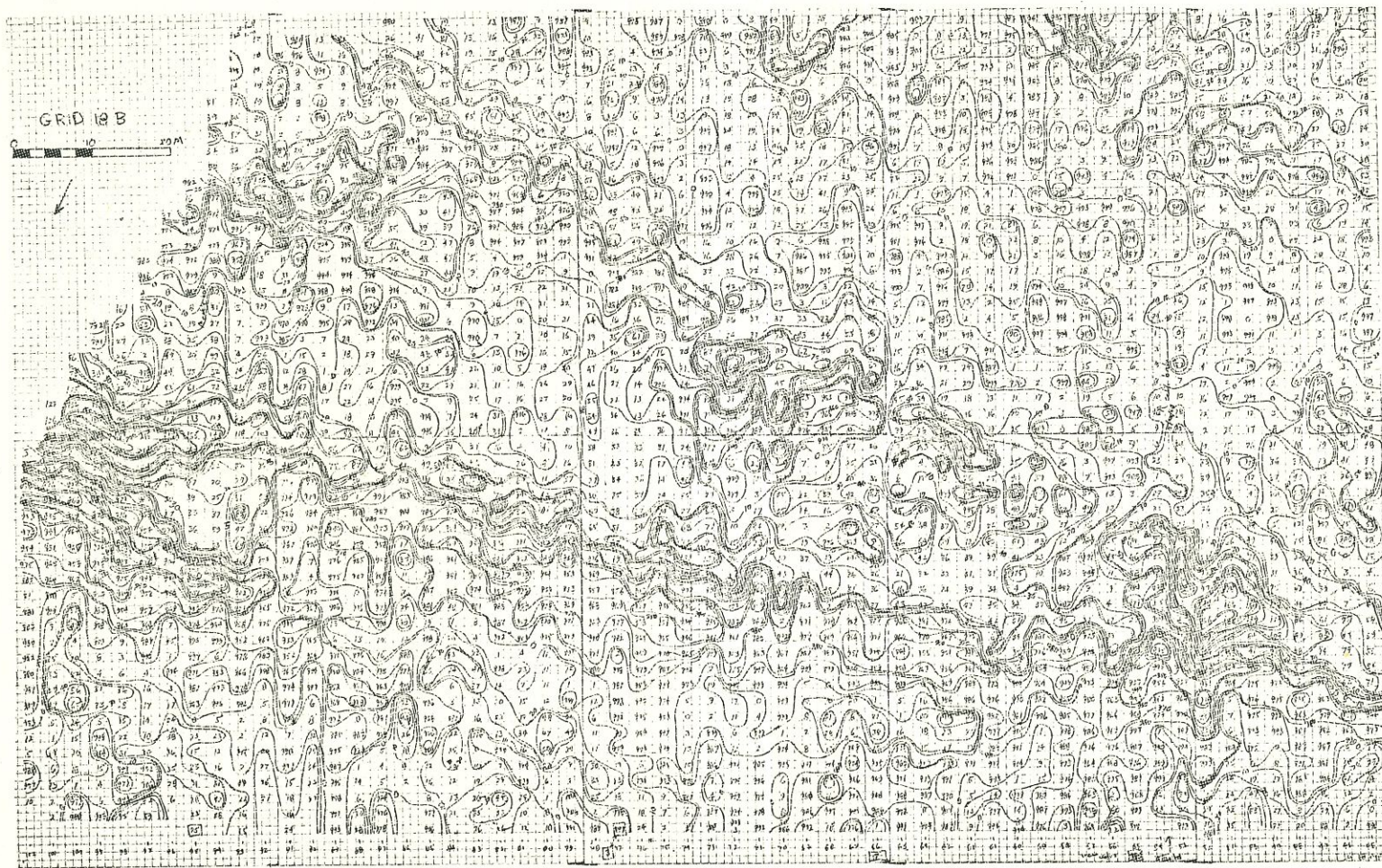


Fig. 7

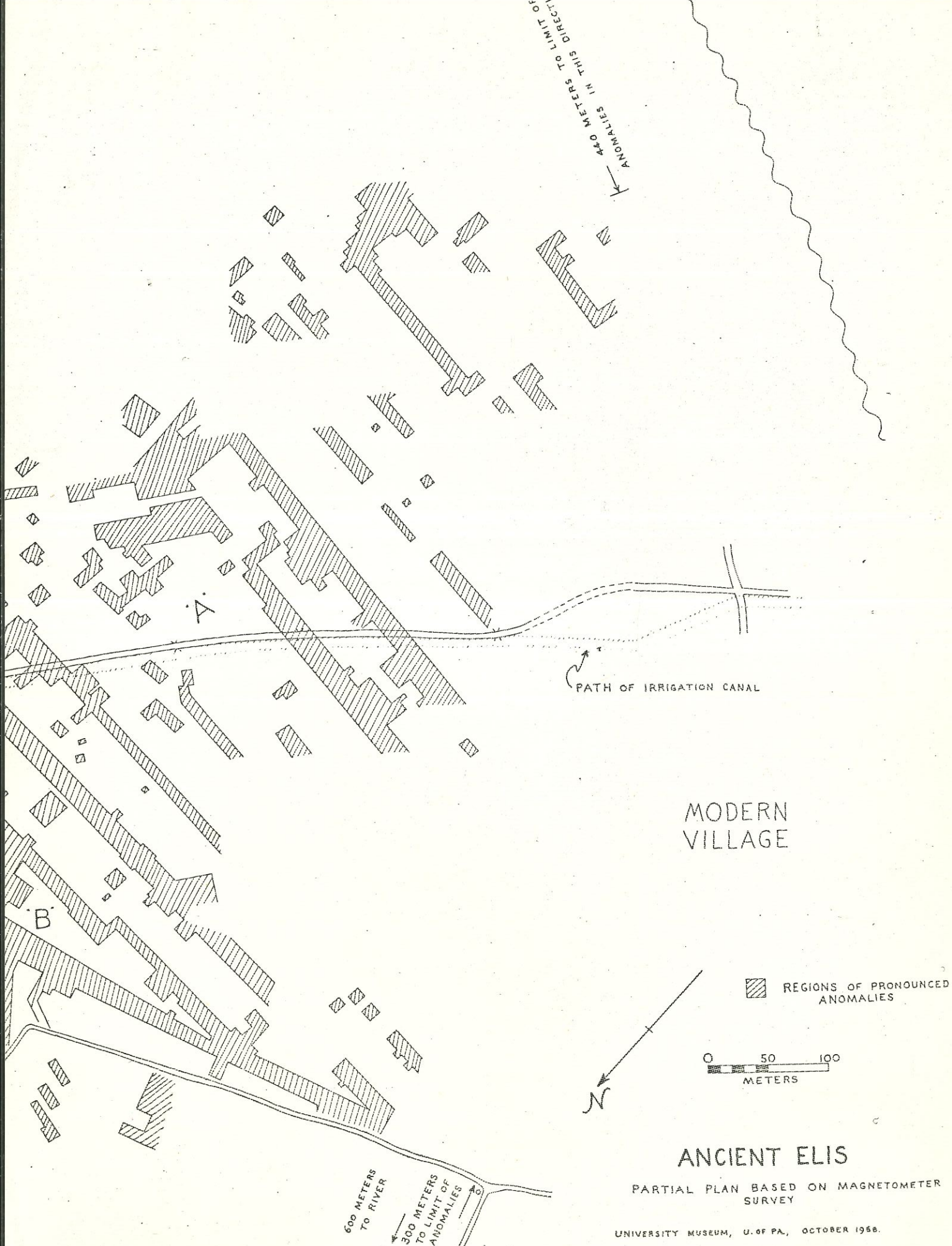
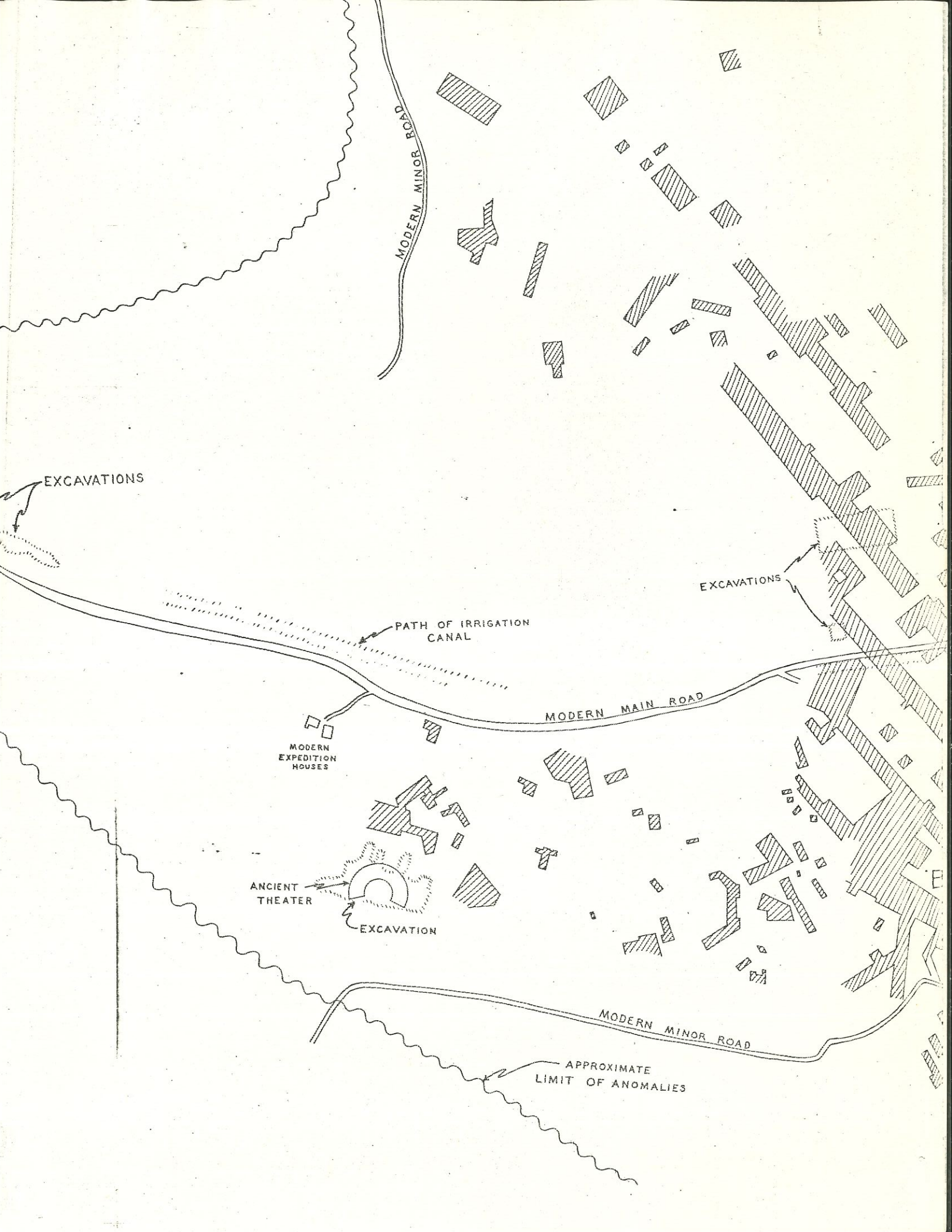


Fig. 8



Old Readout 49-116 #93

5/5/68

Sensor #93

44456

Instrument Tests

#90

44459

Need -
scale
scissors

Pos. A

Pos. B

Diff

49-544 #90

Rb

55 --- variable

11:45 #90

#93

00005.0

12:05

" 4.2 ± 0.1

12:10

#90 44455.6 ± 0.1

49-544-#93 44453.3 ± 0.1

12:15 Rb
49-538 #55

with Old Readout - single 603 - - ± 200

~~Readout~~

New Readout & sensor #90

1:28

80001

80,000

79,999

5/12/68

Grids 7 & 8 not located on map
(too far north)

Grid 17 - on top of hill

Grid 25 - on way to top of hill

5/6/58 Q3 & Q4 - both in path of canal (W of road) where it had been excavated to 0.5 - 1 meter. Sensor at shoulder height

5/7/58 Q5 - in excavation trench N canal excavation, E of road. Sensor at shoulder height.

Q6 - E of road, S of Q5 & N of Q1 & Q2 (1967)
Sensor - normal ht.

Q6 ~ 75 x 150 M - 4 hrs. after warm-up (3 men)

5/8/68 Q7 NE of Expedition headquarters where reservoir is planned
New battery; 9-12, 2:20 - 3:30 (24v) (after 12 hrs. fast chg.)
Old black battery

5/9/68 Q8 along road on S side. Grid 12 m wide.
Sensor at shoulder ht.
Start opposite expedition houses

Q9 ~ 111 x 150 M; continuation of Q6 east

Test of red earth from Q8 - no magnetism

5/10/68 Q6 22 Q10 - S of Q6, starting at road and continuing past line of Q1

5/11/68 Q11 - small grid connects Q10 & Q1; includes small road beside Q1

5/13/68 Q12 - North of Q6 & Q9 - in area with two excavations of previous years - grid went crooked with land lines.

5/14/68 Q13 - In field w tomatoes, corn, etc., S of Q10
Q14 - " " onions, between Q13 & Q11
Q15 - West of road - in fields with tomatoes - one sensor only! opposite Q13, Q10, & Q6.

5/15/68 Q16 - West of road - in fields with lemon trees and onions
One sensor only!

5/16/68 Q17 - On top of hill overlooking Elis (with small church)

5/16 * 5/17 Q18 A E of small road several fields west of main road - large field with no crop.

5/20 Q18 B - continuation of 18A
(2 1/2 days total for Q18)

5/21/68 Q19 - North of Q18, between it & old irrigation ditch
(1/2 day)

- 5/22 Q20 - S. of Expedition House, betw. road & theatre
5/23 Q21 - W of Q 20
5/24 Q22 - W of Q 21
5/25 " "
Q23 W of Q 22
Q24 S of Q 23
5/29 } Q25 on high ground to right of small road
5/30 } [5/31, rain, to Athens; 6/1 Thompson & Zimmerman arrived] that leads to top of hill
6/3 Q26 - below Q18, toward river
6/4 Q27 - south of Q25, sloping down from Q25
6/5 Q28 - south of Q27, leading down to flat area.
6/6-8 Q29, 30, 31, 32 - all in same area
6/10 Q33 - Δ between excavations on W side
of main road
6/10 Q34 - W of Q33 & N of Q15
6/11, 12 Q35 - N of Q34
6/12 - Limits

North end G 6 17 line 14

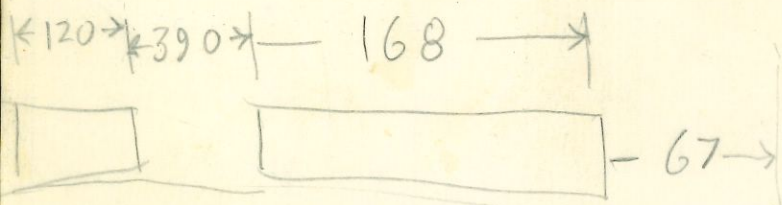
of topsoil

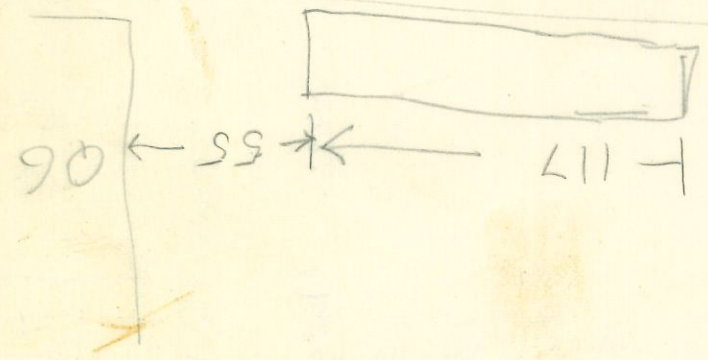
Test of samples from hilltop with church 5/13/68

Gr No.	No.	Top of sensor	Under Sensor	Rotated beside	
2	4	24	20	17 - 20	brown
5		19	19	19	tan (sandy)
3	5	21	19	18 - 19	brown
4	1	19	19	19	"
1	5	18	19	19	"

contained pc. brick w/ cen³

bird's nest

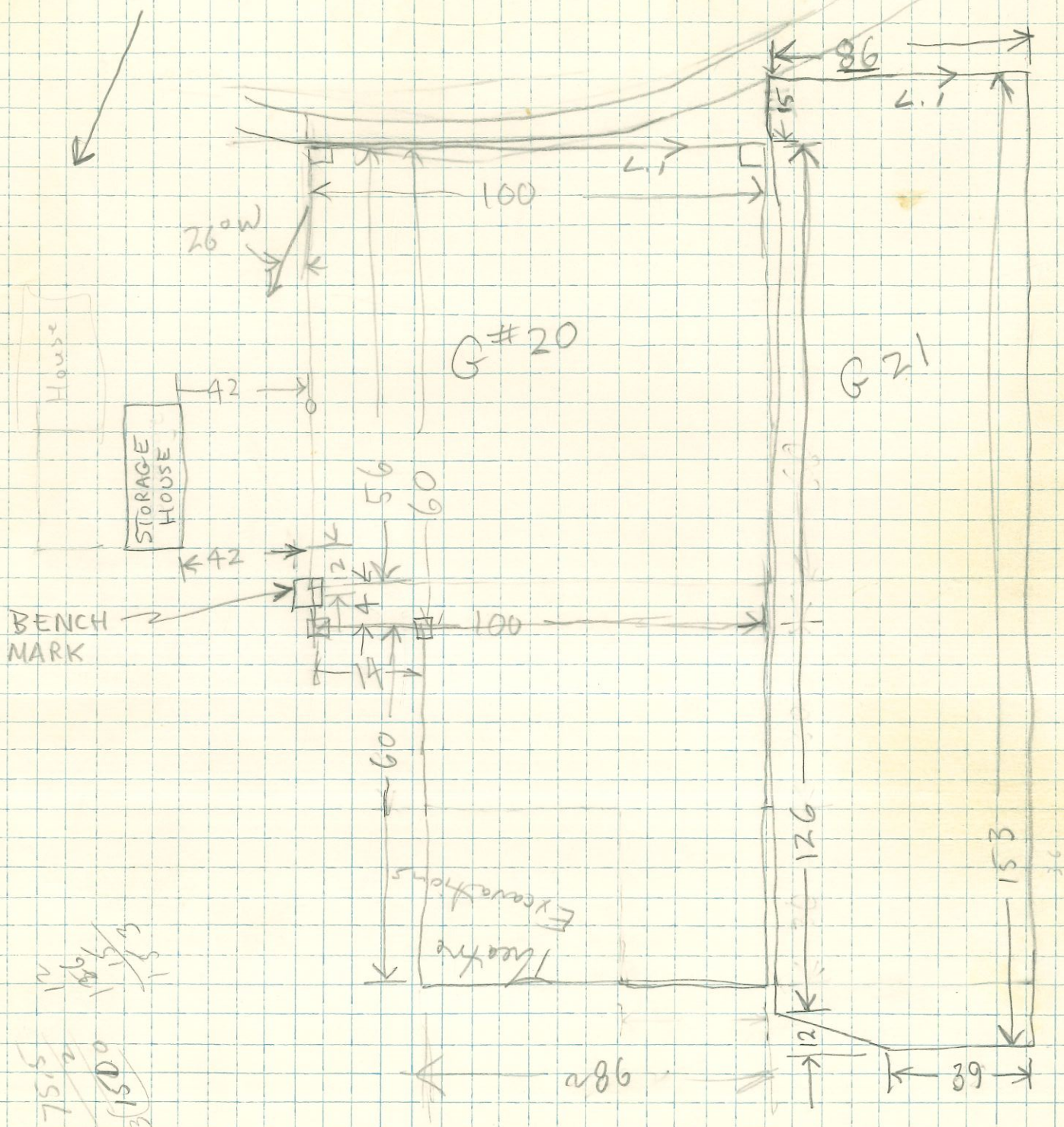


$$\frac{120}{31} = 8.9$$


$$\begin{array}{r} 59.75 \\ \hline 2.2 \\ \hline 11950 \\ \hline 11950 \\ \hline 131450 \end{array}$$

$$\begin{array}{r} 390 \\ \hline 110 \\ \hline 280 \\ \hline 163 \\ \hline 117 \\ \hline 957 \\ \hline 22 \end{array}$$

$$\begin{array}{r} 64 \\ \hline 110 \\ \hline 160 \\ \hline 213 \\ \hline 279 \\ \hline 369 \end{array}$$



$$\begin{array}{r} 19.5 \\ 19.2 \\ \hline 0.3 \\ 0.390 \end{array}$$

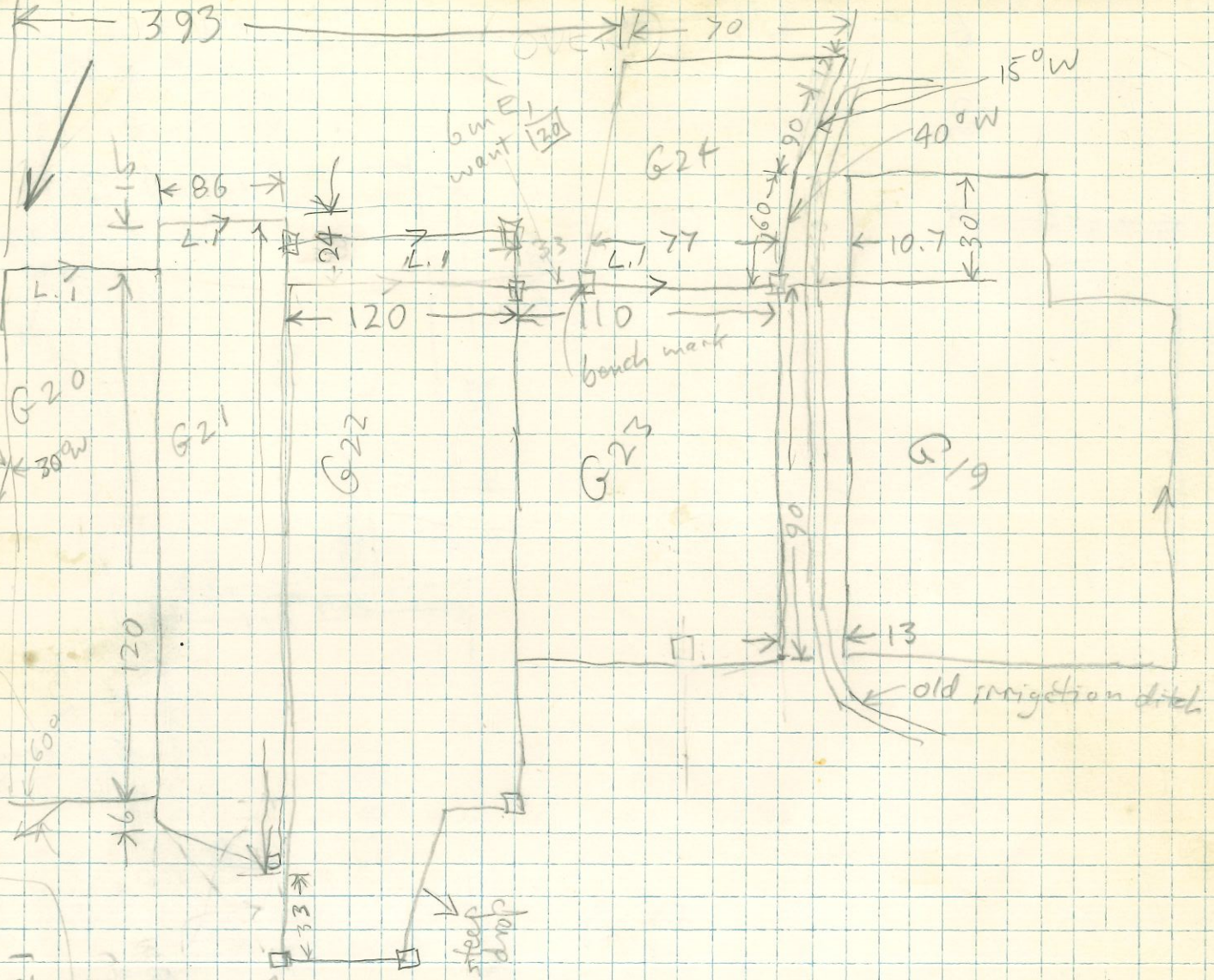
$$\begin{array}{r} 75.5 \\ 16.0 \\ \hline 15.3 \\ 15.3 \end{array}$$

$$\begin{array}{r} 140 \\ 15 \\ \hline 2 \\ 11 \\ 11 \end{array}$$

See Book IV for G 22 ff.

$$\begin{array}{r} 16.0 \\ 15.0 \\ \hline 1.0 \\ 1.38 \end{array}$$

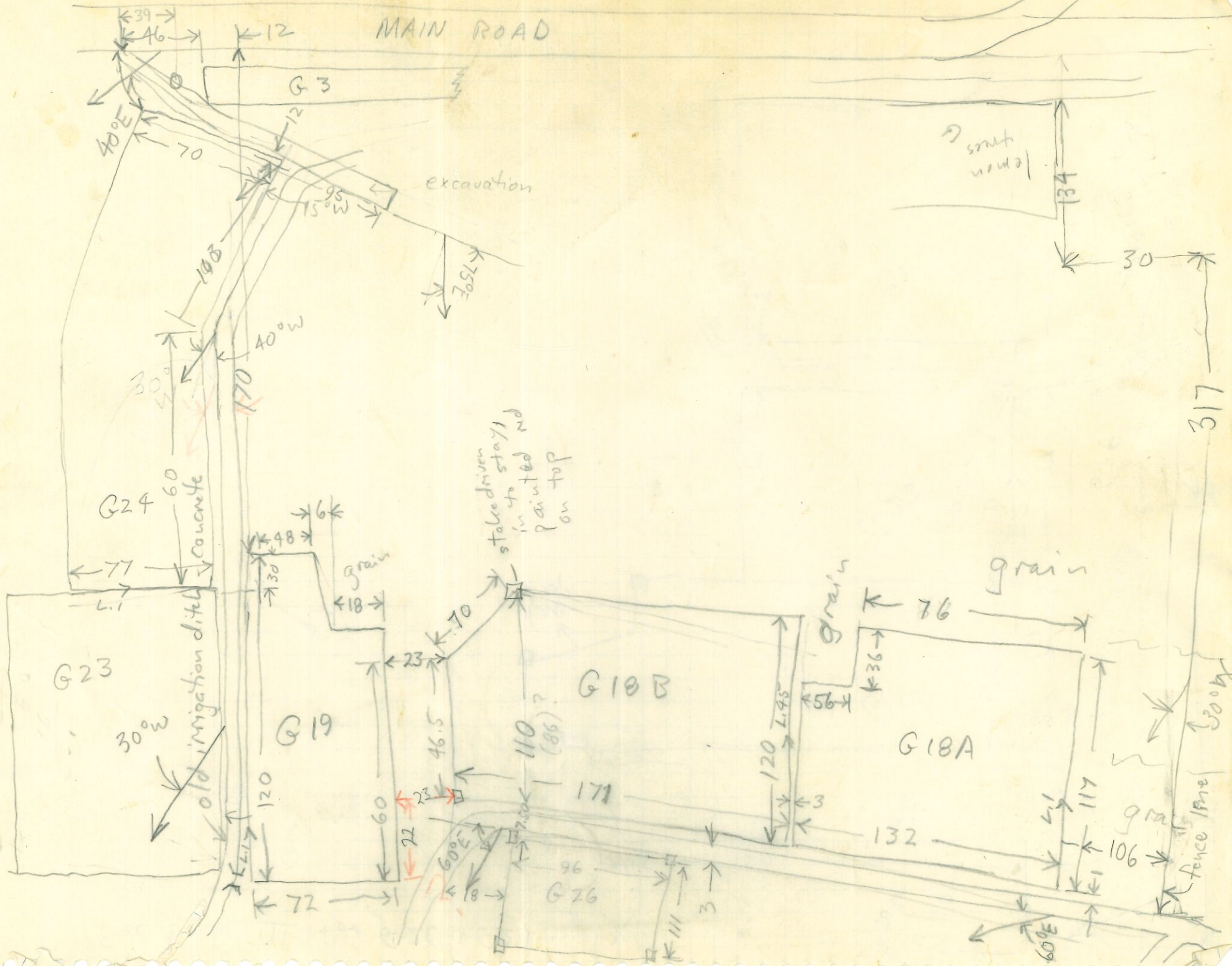
See Book III for G20 & G21

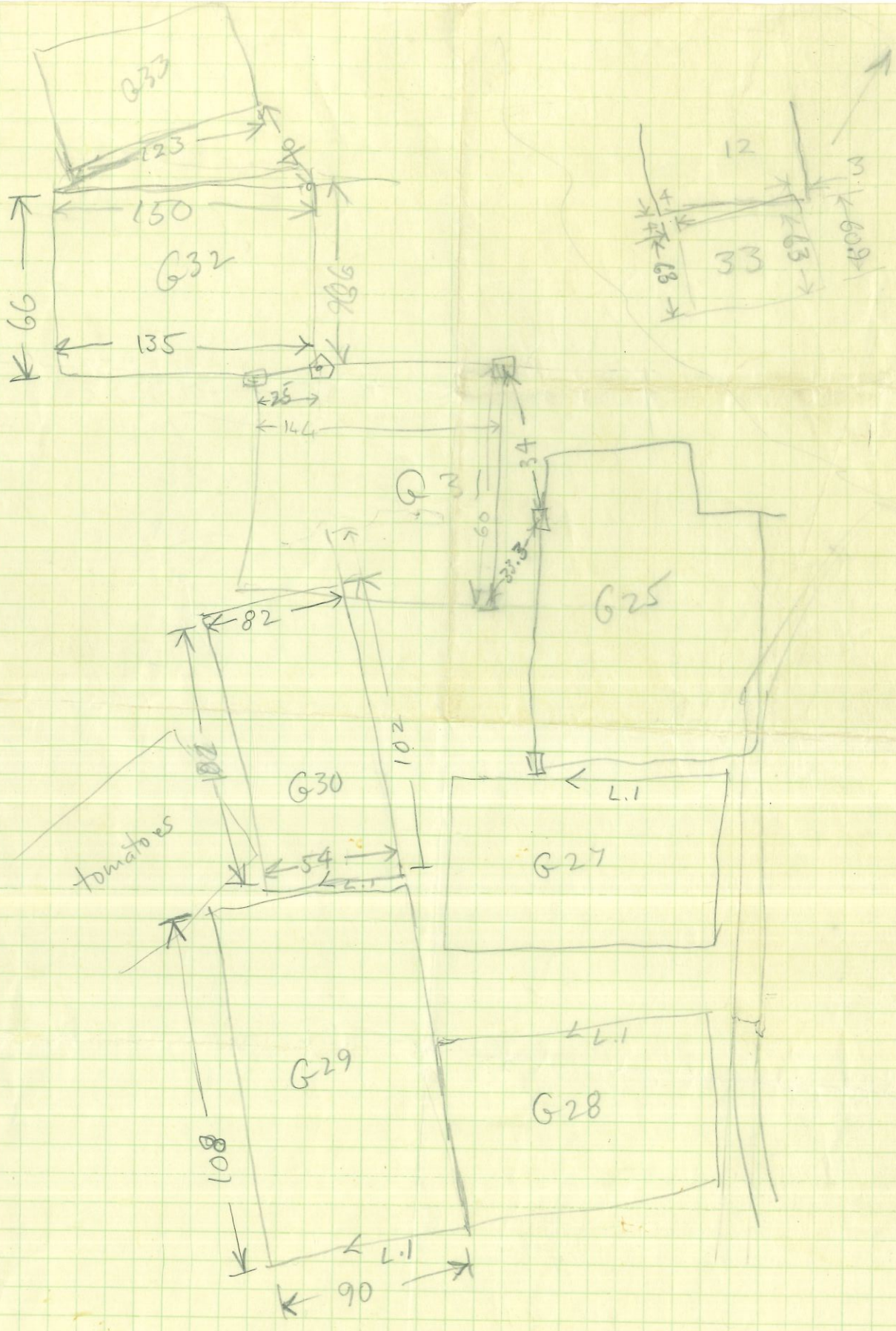


$$\begin{array}{r} 110 \\ 33 \\ \hline 77 \end{array}$$

$$\begin{array}{r} 86 \\ 22 \\ \hline 177 \end{array}$$

393







Q18

High ground

theatre

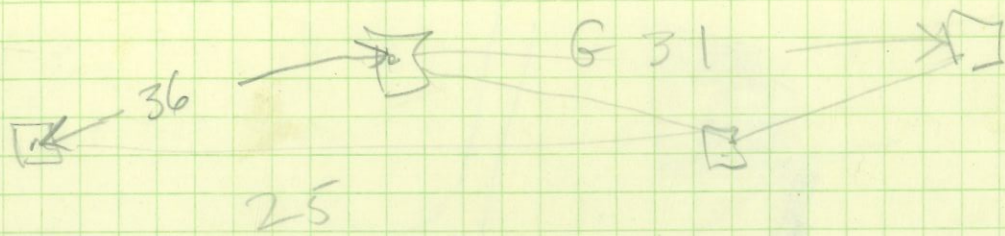
70

180
Δ = 18

300 m
very little

river

Limit



$$\begin{array}{r} 87 \\ 2 \\ \hline 174 \end{array}$$

next village



nothing

nothing

small anomalies

200
120
120

Last G

to church

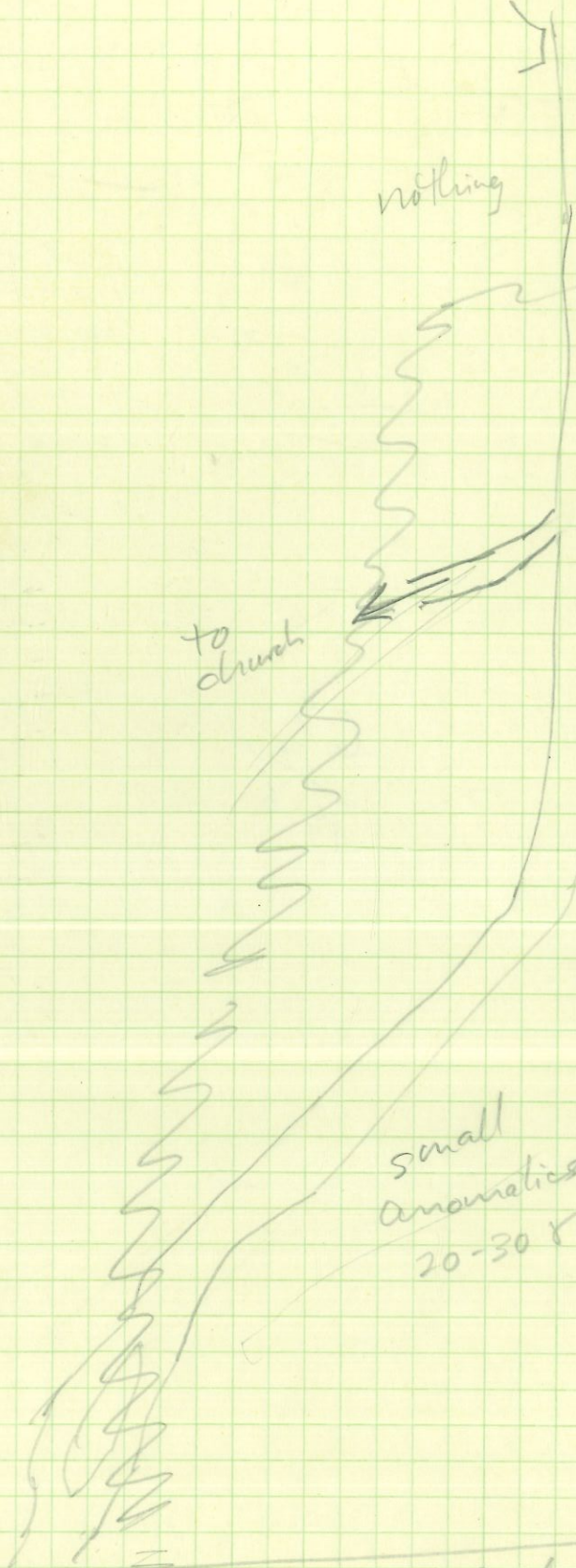
G25

small anomalies
20-30 r

G7

Main Road

small anomalies



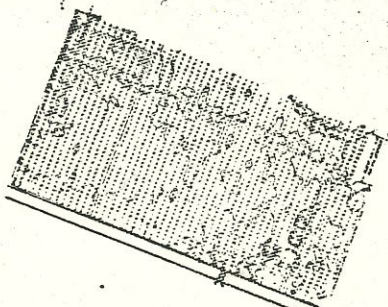
$$\begin{array}{r} 632 \\ \hline 126 \end{array}$$

Need -

E of G # 1

Cont. of G # 18 wall

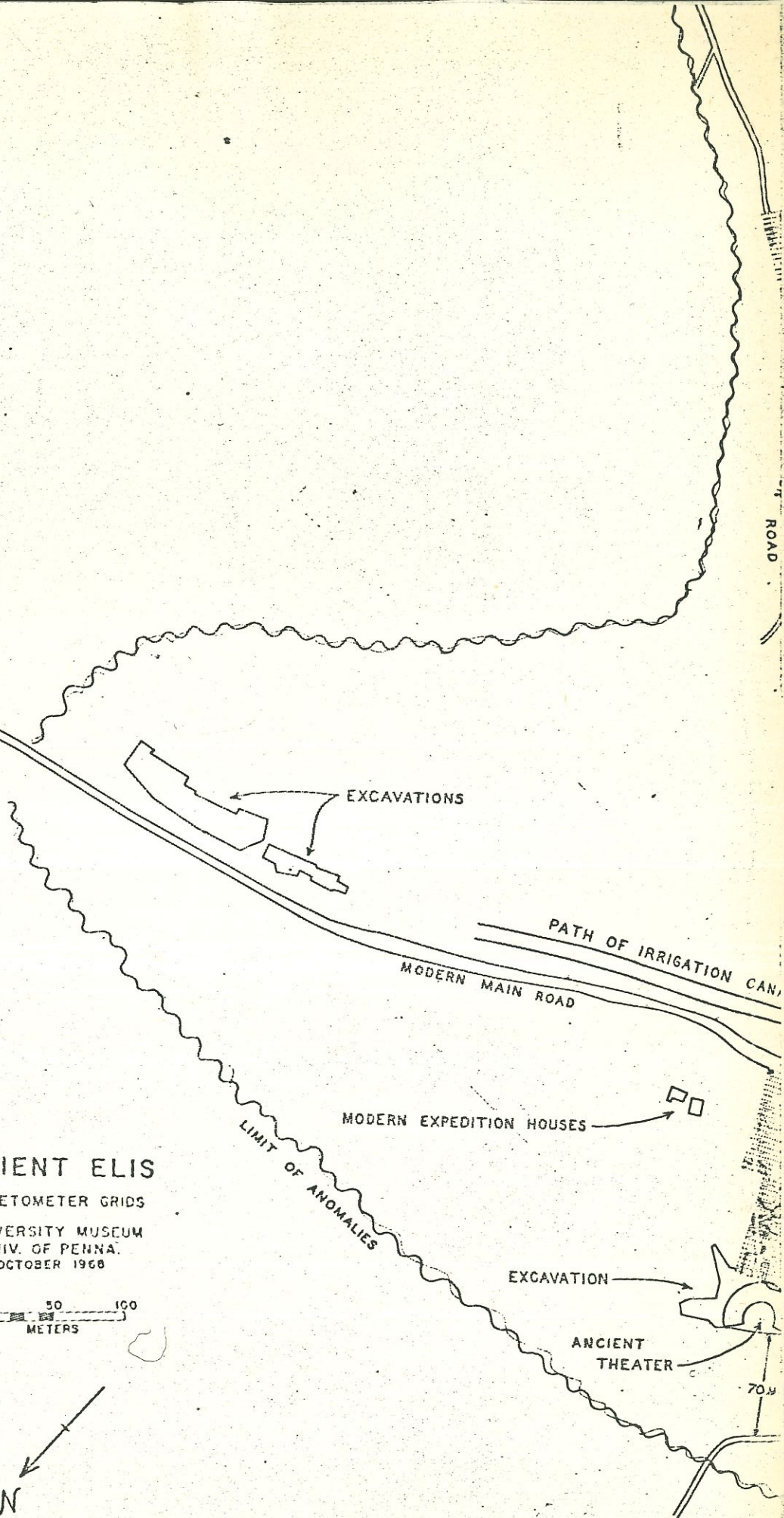
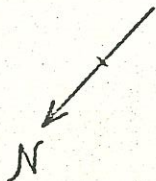
City limits

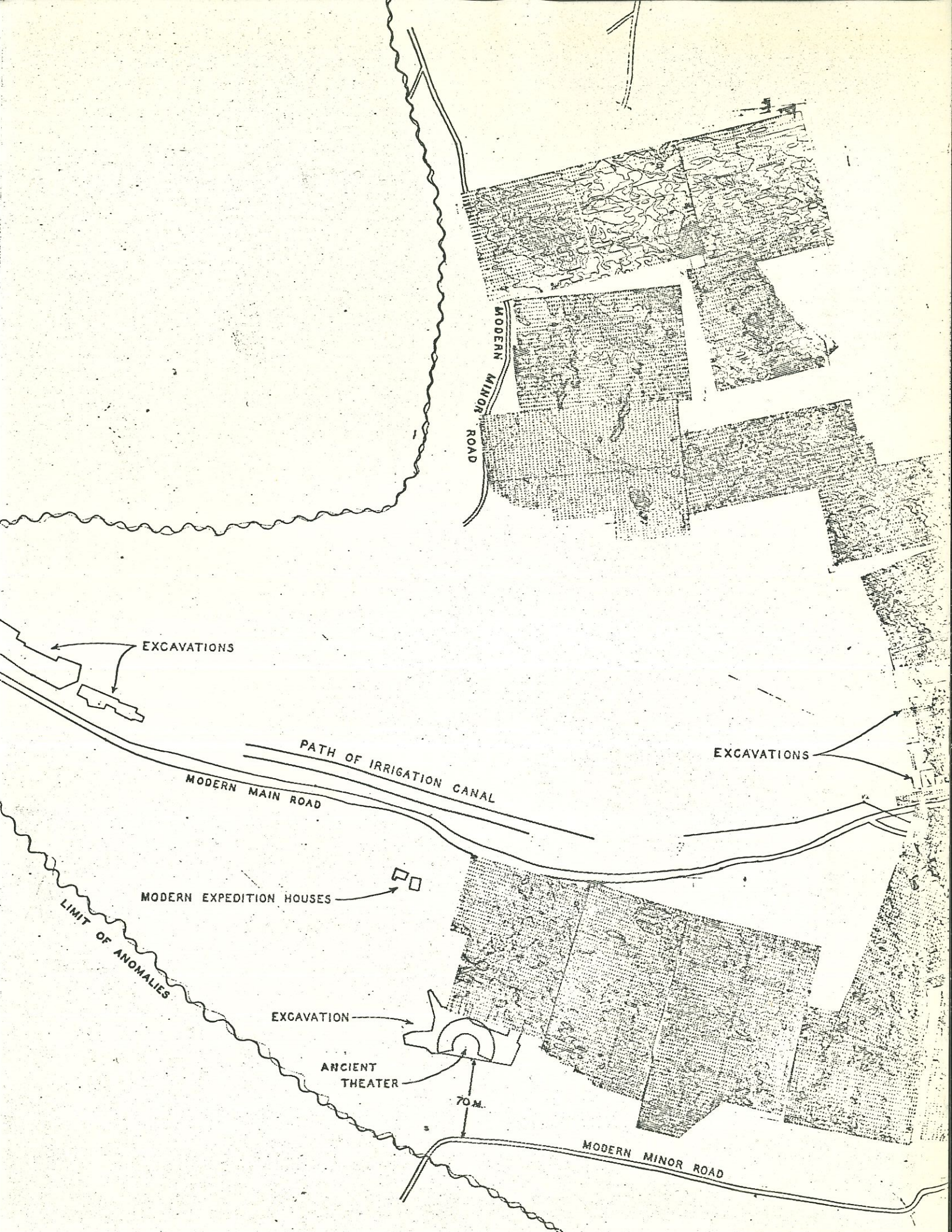


ANCIENT ELIS

MAGNETOMETER GRIDS

UNIVERSITY MUSEUM
UNIV. OF PENNA.
OCTOBER 1968





EXCAVATIONS

EXCAVATIONS

MODERN EXPEDITION HOUSES

EXCAVATION

ANCIENT THEATER

70 M.

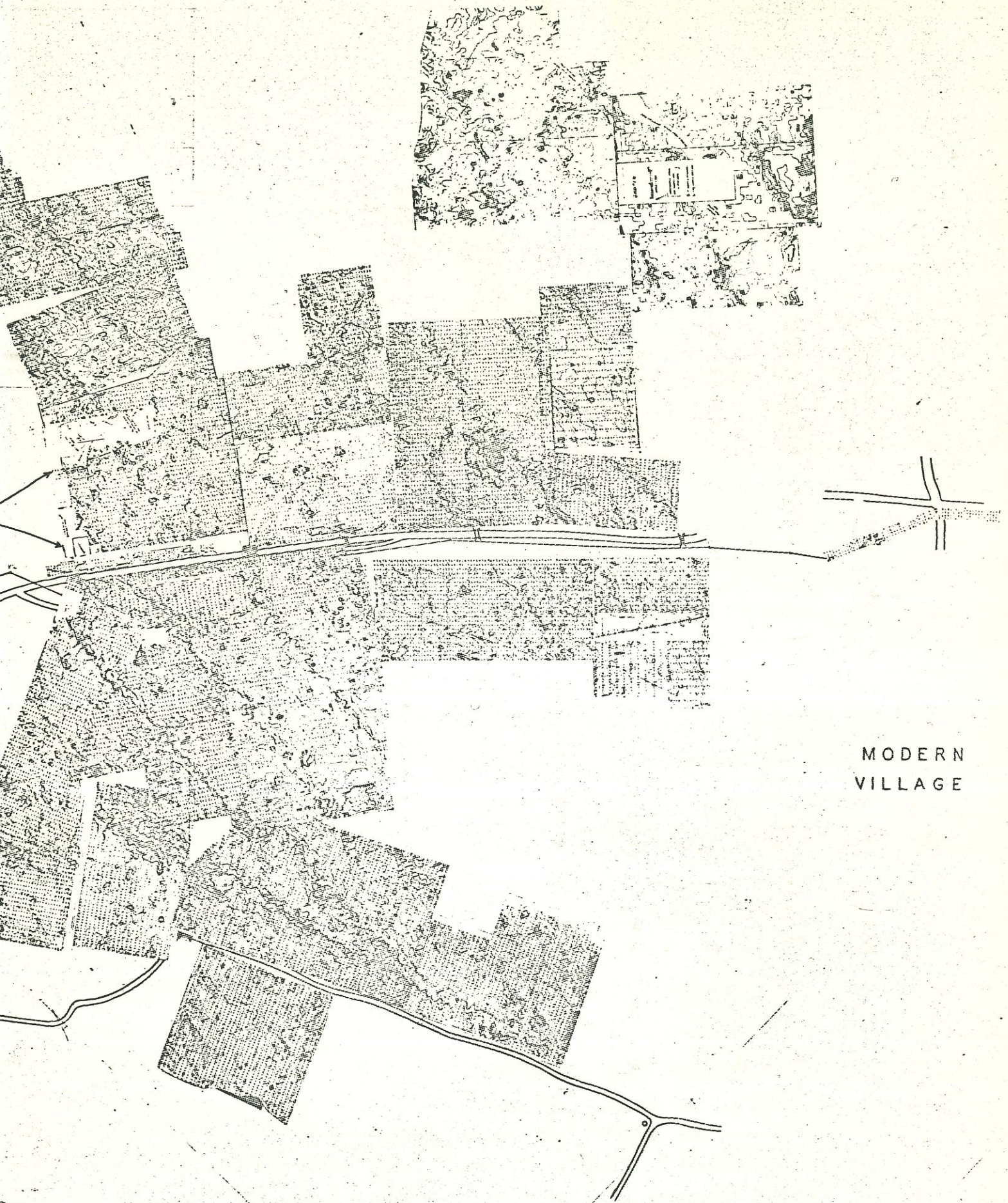
MODERN MINOR ROAD

MODERN MAIN ROAD

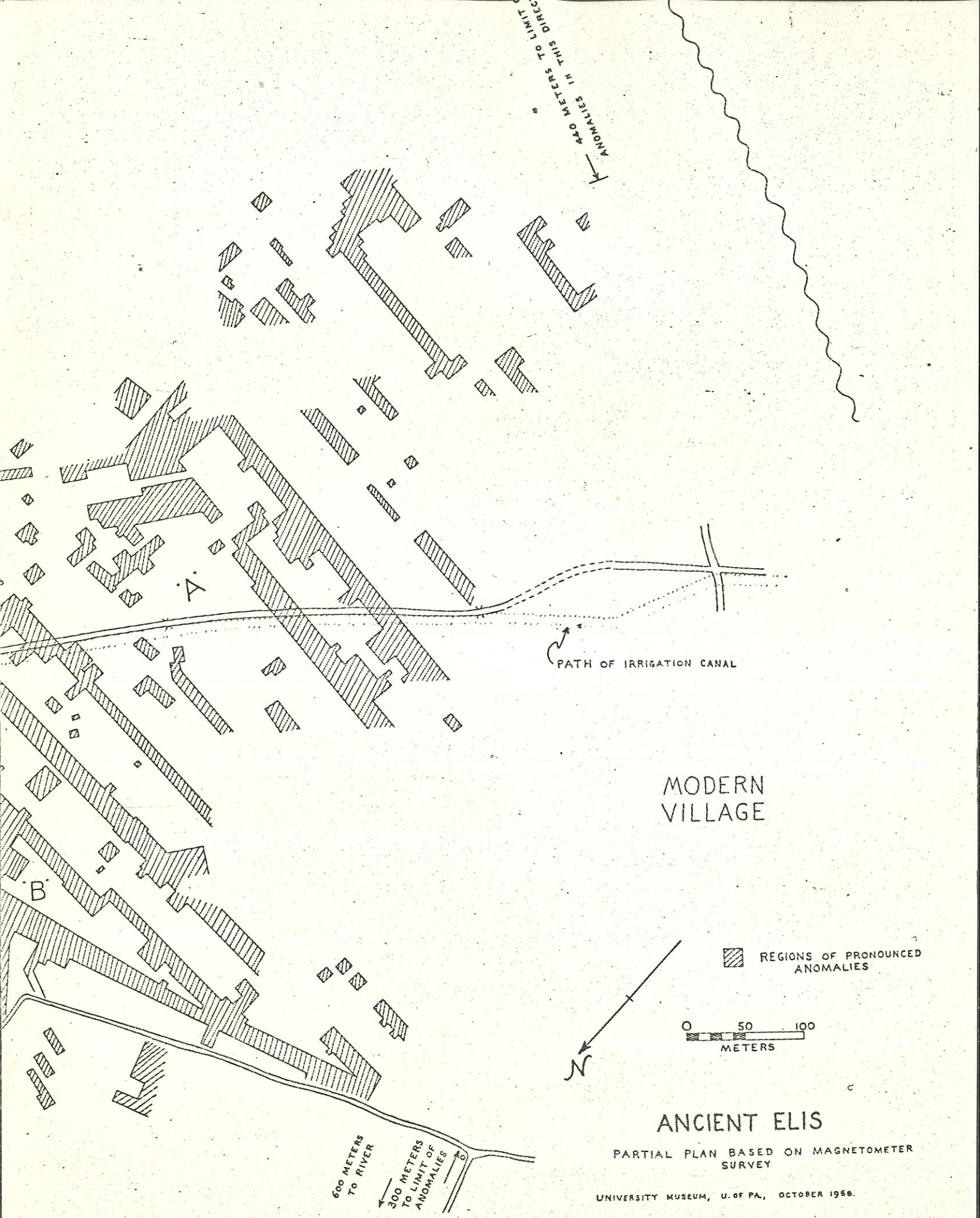
PATH OF IRRIGATION CANAL

MODERN MINOR ROAD

LIMIT OF ANOMALIES



MODERN
VILLAGE



ANOMALIES IN THIS DIRECTION
 400 METERS TO LIMIT

PATH OF IRRIGATION CANAL

MODERN VILLAGE

REGIONS OF PRONOUNCED ANOMALIES

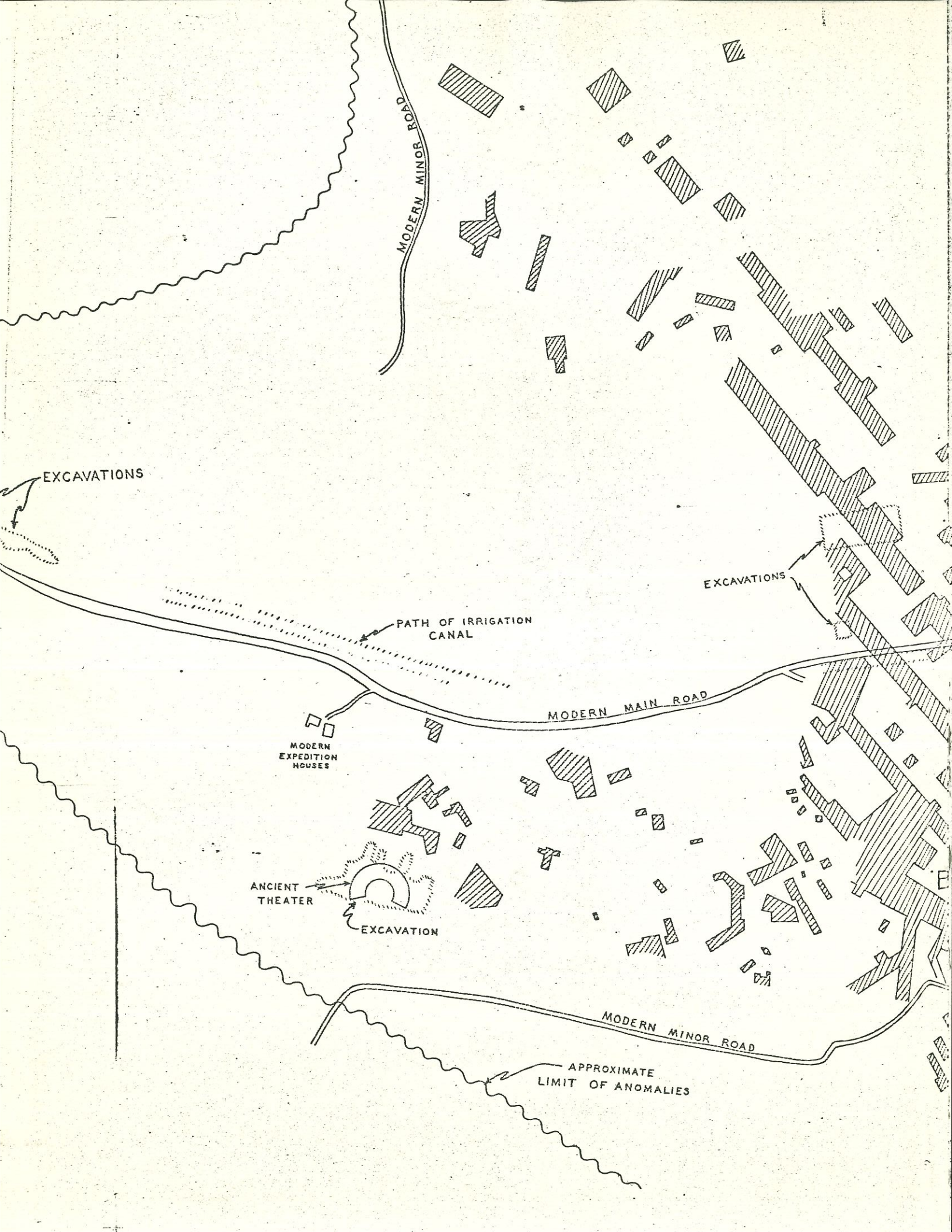
0 50 100
 METERS

ANCIENT ELIS

PARTIAL PLAN BASED ON MAGNETOMETER SURVEY

UNIVERSITY MUSEUM, U. OF PA., OCTOBER 1958.

600 METERS TO RIVER
 300 METERS TO LIMIT OF ANOMALIES



MODERN MINOR ROAD

EXCAVATIONS

PATH OF IRRIGATION CANAL

EXCAVATIONS

MODERN MAIN ROAD

MODERN EXPEDITION HOUSES

ANCIENT THEATER

EXCAVATION

MODERN MINOR ROAD

APPROXIMATE LIMIT OF ANOMALIES