

cc - Mr. Johnson
Sun Oil Co -
1608 Walnut St (3)

Archaeological Techniques

May 17, 1961

Mr. A. F. Hasbrook
Petty Geophysics Company
San Antonio, Texas

Dear Mr. Hasbrook:

Mr. Johnson, of the Sun Oil Company, and I have been discussing the development of new geophysical equipment to probe shallow depths for archaeological purposes, and as you probably know from discussions with him there have been some promising developments during the past year. I simply wanted to tell you how interested we are in this project and how during the past few weeks we've had many inquiries from archaeologists and geologists from M. I. T., Yale, Harvard, Princeton, Brown and Columbia offering to collaborate with us in developing and testing such instruments on actual sites.

Resistance equipment has been used extensively in Italy and England and we are now testing it in this country. It certainly is useful, but we all hope that some sort of acoustical equipment can be designed for archaeologists and geologists which would be much more useful for our purposes. We are currently being supported both by the National Science Foundation and Mr. McDermott, of the Texas Instruments Company and we have established a Center for such research here at the Museum. We have two young physicists and a chemist working since last fall that are concerned with dating and preservation techniques, as well as prospecting.

Mr. Johnson will be talking to you about designing and acoustical instruments and I want you to know that we are not only optimistic about the prospects for such an instrument but determined to continue in this field for sometime to come. We usually have seven or eight

major expeditions operating around the world and we feel that our field men should certainly be utilizing new electronic techniques in archaeological prospecting. It is difficult to predict what commercial aspect there might be for such an instrument, but the current interest shown by archaeologists all over the world recently makes me think that if we can develop something good it might be widely used in this field, even though naturally the number of diggers is not very great.

However, we have just discovered a small and inexpensive German resistance machine made for archaeologists which we are now buying and farming out to a number of archaeologists for testing. This at least gives some indication of the demand for such archaeological instruments.

I shall be very interested to know what you and Mr. Johnson can work out as a proposal to develop the equipment we want.

Very sincerely yours,

FR:ah

Froelich Rainey
Director

PETTY LABORATORIES, INC.

MANUFACTURERS OF GEOPHYSICAL INSTRUMENTS
AND EQUIPMENT

SAN ANTONIO 6, TEXAS

OFFICE AND LABORATORY
317 SIXTH STREET

MAIL ADDRESS
P.O. DRAWER 2061

June 6, 1961

Arch. Techn.

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

Dear Dr. Rainey:

We were pleased to receive your letter concerning the possible development of a short range seismic or sonic system for probing shallow depths in the search for archaeological ruins. This appears to be a most interesting application for geophysical methods.

As you know Mr. F. L. Johnson of the Sun Oil Company was in San Antonio several weeks ago to discuss the proposed development of the system. From his outline of the general requirements, we understand that your primary interest is in outlining masonry walls, floors etc. of ruins buried under perhaps 20 or 30 feet maximum of alluvium, as well as indicating the presence of artifacts a few feet in dimension. It appears that some type of direct display of the geophysical information is desirable; for example, the presentation could be in the form of a simulated section of the earth beneath the exploration site.

Since this is a relatively new field, considerable development and design of equipment most likely will be required. Our preliminary proposal, which should be completed in the next week or so, will outline a program divided into logical phases such as preliminary study, field experiments, development and construction of a model, field tests and evaluation.

We appreciate the opportunity to consider development of suitable equipment for this unusual geophysical application.

Very truly yours,

PETTY LABORATORIES, INC.

W. Harry Mayne

W. Harry Mayne
Vice President
Technical Services

WHM:ss
cc: Mr. F. L. Johnson

June 13, 1961

Mr. F. L. Johnson
Director, Production Research
Sun Oil Company
1608 Walnut Street
Philadelphia 3, Pennsylvania

Dear Mr. Johnson:

We are pleased to present the attached proposal for development of a Sonic Archaeological Probe along the general lines discussed during your recent visit.

As you will recall, we feel that we should obtain clearance from the Subscribers to our high frequency seismic research project, in which Sun is participating, before starting on the proposed program. There should be no difficulties in arranging such approval as soon as the program is firmed up somewhat.

We appreciate the opportunity to present this proposal, and look forward to working with you and Dr. Rainey on this interesting project.

Very truly yours,

PETTY LABORATORIES, INC.

W. Harry Mayne
Vice President, Technical Operations

WHM:ss

June 16, 1961

F. L. Johnson

Philadelphia

Mr. Jno. G. Pew

Dear Sir:

This memorandum covers our conversation of this morning concerning the proposal submitted by the Petty Laboratories Inc. for the development of acoustic methods for archeological prospecting. A copy of the Petty proposal is attached.

As I have expressed previously in conversations with you, Mr. Eckert, and Dr. Rainey, I have felt acoustic methods could provide valuable prospecting tools for archeologists. It is my belief, and that of Fred Mayes, that the experimental field work which was conducted with the Texas Instruments so-called high-resolution seismic equipment demonstrated conclusively that shallow reflections and refractions can be observed from shallow objects. It was also demonstrated that the presently available equipment designed primarily for the location of bed rock is also useful. It should be noted, however, that neither apparatus was designed for the purpose we have in mind. The fact that we did get successful indications leads me to believe that equipment tailored to the problem should provide much superior resolution, particularly in the location of relatively small objects.

I am also of the belief that the development of this equipment should be in the hands of people thoroughly experienced in seismic methods and apparatus. The apparatus must necessarily include means of generating acoustic energy, coupling it into the soil, and detecting the returning energy. Although specialists in electronics might be available at a university, an understanding of the acoustic coupling and transmission problems would most likely be lacking. This would be a severe handicap. Since the design of suitable equipment does involve research and development, I have never been of the opinion that we could find means to accomplish this without the expenditure of a sizeable amount of money.

The Petty proposal would, most importantly, increase the frequency range of the sonic energy, and would in fact determine the optimum ranges for variables we are dealing with. In fact, if I may recall to you, Sun Oil, along with six other companies, has been supporting Petty for the past two years in determining the properties of the surface layer at higher frequencies than those normally employed in seismic prospecting for petroleum. In this program they have studied frequencies as high as 5,000 cycles. For the archeological problem the range would be extended to

Mr. Jno. G. Pew

-2-

June 16, 1961

10,000 or 15,000 cycles. A considerable portion of the information developed by Petty in this joint venture will provide background information and test data which will bear directly on the archeological problem. This might be termed a "contribution" from all of the participants, such as us, who have supported the Petty research investigation.

Although the estimates submitted by Petty add to the sizeable amount to \$32,000, this expenditure should establish, once and for all, the feasibility of this method. I personally am quite convinced that a useful apparatus can be developed. I also believe that Petty's estimate of these research and development costs is not at all unreasonable. I do not know whether support at this level can be developed for this project. If not, I would have no further recommendation of my own, other than to abandon the project, and use the presently commercial equipment which is useful, but undoubtedly limited in many respects. I recommended to Dr. Rainey that the apparatus obtained by Linnington for the tests in Texas and Arizona be purchased for approximately \$1,800, and used during this summer's expedition to Italy. The use of the Texas Instruments equipment is not feasible in its present form.

Very truly yours,

F. L. Johnson

FLJ:es

Enc.

CC: Mr. S. B. Eckert (w/enc.)
~~Dr.~~ Froelich Rainey "

Archaeological
Technique

July 14, 1961

Mr. A. F. Hasbrook
Petty Geophysics Company
San Antonio, Texas

Dear Mr. Hasbrook:

I am very pleased to tell you that we have now been granted the money to proceed with the development of a sonic archaeological probe as outlined in your letter of June 13th to Mr. F. L. Johnson of the Sun Oil Company.

You may wish to draw up a more detailed contract for this research and development with the University Museum, which will be paying the bill. I am leaving for Italy today and will be away for nearly two months. The Associate Director, however, Dr. Alfred Kidder II, is in charge in my absence and is empowered to sign a contract with you under the terms outlined in your letter.

We have here a physicist trained in archaeology, Mr. Richard Linington, and an electronics expert Mr. MacLaughlin, who have now had considerable experience in this field. Mr. Linington will join me in Italy for testing various geophysical instruments there, but he will return late in the fall and I will ask him to call on you in San Antonio and to offer any assistance possible. At that time he can fill in your people there on the results of our investigation this summer and fall in Italy. Also, I am sure that Mr. F. L. Johnson will be in touch with you from time to time and we assume will be helpful to you.

Mr. A. F. Hasbrook

(2)

July 14, 1961

As you know, we are very anxious here to develop an instrument which can be used by archaeologists without any detailed technical training and one which is easily transportable. All of us here are optimistic about your proposal and trust you will develop the kind of instrument we want.

We are, of course, anxious to have you begin as soon as possible and let us know how you want payments made for the work. Please address your reply to Dr. Kidder, including any contract which you feel is desirable.

Very best wishes and good luck on this development,

Most sincerely,

FR:ah

Froelich Rainey
Director

*file -
Archaeol,
Technique*

*c.v. -
Petty
Lab*

September 5, 1961

Mr. W. Harry Mayne
Petty Laboratories, Inc.
San Antonio 6, Texas

My dear Mr. Mayne:

I look forward to receiving further word from you in connection with a contract for the development of the sonic probe . Dr. Rainey wrote me from Italy that he hoped that this would soon come to pass, and I am grateful to you for letting me know that things are progressing.

Sincerely yours,

Alfred Kidder, II
Associate Director

AK:ad

PETTY LABORATORIES, INC.

MANUFACTURERS OF GEOPHYSICAL INSTRUMENTS
AND EQUIPMENT

SAN ANTONIO 6, TEXAS

LABORATORY
STREET

MAIL ADDRESS
P.O. DRAWER 2081

August 29, 1961

Dr. Alfred Kidder II
Associate Director
The University Museum
University of Pennsylvania
Thirty Third and Spruce Streets
Philadelphia, Pennsylvania

Dear Dr. Kidder:

We were very pleased to hear from Dr. Rainey that a decision has been made to proceed with development of the sonic archaeological probe.

During the past few weeks we have been considering some of the possible approaches to the initial experimental phase of the program. As indicated previously to Dr. Rainey and Mr. F. L. Johnson, we have much interest in this shallow exploration problem and look forward to working closely with you on the program.

A more detailed contract for the research and development is in preparation and will be submitted shortly for your consideration.

Very sincerely yours,

PETTY LABORATORIES, INC.

W. Harry Mayne

W. Harry Mayne
Vice President
Technical Services

WHM:ss

PETTY LABORATORIES, INC.

MANUFACTURERS OF GEOPHYSICAL INSTRUMENTS
AND EQUIPMENT
SAN ANTONIO 6, TEXAS

MAIL ADDRESS
P.O. DRAWER 2061

OFFICE AND LABORATORY
317 SIXTH STREET

October 3, 1961

Dr. Alfred Kidder, II
Associate Director
The University Museum
The University of Pennsylvania
33rd and Spruce Streets
Philadelphia 4, Pennsylvania

Dear Dr. Kidder:

Attached please find initial draft of the contract covering development of a seismic archaeological probe for your exploration.

Work under this contract would follow the proposal previously submitted, copies of which are included for reference.

If you find this contract acceptable please execute and return one copy for our files, so we may proceed with the program.

If any changes should be desired, please indicate the desired revisions for our consideration.

We appreciate the opportunity of considering this project, and will be looking forward to working with you in the development of a useful tool for this exploration technique.

Very truly yours,

PETTY LABORATORIES, INC.



W. Harry Mayne
Vice President
Technical Service

WHM:ss

October 6, 1961

Mr. W. Harry Mayne
Vice President, Technical Service
Petty Laboratories, Incorporated
San Antonio 6, Texas

Dear Mr. Mayne:

Thank you very much for the draft of the contract and the copy of the proposal. The only thing that concerns me about it, is that under the terms of schedule A, it would seem that the project would be terminated financially in a rather short time, and I am wondering whether we could in fact expect to have a working model completed for the thirty-two thousand dollars we have raised.

Dr. Rainey will be back next week and I think it might be best for me to wait until his return. However, I am turning over your material to some people here who know the problem technically and if they advise me to sign the contract, I shall certainly do so. In the meantime, many thanks for your cooperation.

Sincerely yours,

Alfred Kidder II
Associate Director

AK:ad

Bill Tackman

Memo: to Dr. Rainey

Subject: Petty Laboratories, Inc. Proposal for Sonic Archaeological Probe

Comments: by McLaughlin and Ralph

(Phases listed below refer to Petty Co. Estimated Time and Cost Schedule)

Phases I and II would be duplication of studies already made by Linington and McLaughlin. (See McLaughlin's interim report).

Phase I -- frequency is determined by size of object sought. For examples, at 5000 cycles, objects with dimensions of one foot may be seen; smaller ones, at higher frequencies, etc.

Phase II -- experiments with existing low frequency continuous wave equipment are not conclusive enough to be useful. Must use pulse technique. Literature has been surveyed for information re coupling (to ground) at higher frequencies and none exists.

Phase III -- no miniaturization planned. Result would be a truckload of bulky equipment. The main problems which McLaughlin has licked are those of miniaturization.

Phase IV -- better to start with McLaughlin's portable (20 lbs.) working model; then see what the next problems are. Field experiments with transducers and their development are needed.

Phase V -- with experience gained with McLaughlin's working model, alternate possibilities are as follows:

- 1) Have Petty Co. work on the problem -- approach by different people might have value. (McLaughlin's special circuits, etc. will be patented by him).
- 2) Have McLaughlin make an improved model with higher resolution -- possibly an expanded scale with a J-scope.
- 3) Attack problem using a different basic principle of wave transmission.

General Comments:

Petty Co. proposal is a long-term project. Result, as presently planned, would be some heavy equipment that wouldn't necessarily do the job that's needed.

If it is decided to make a contract with the Petty Co., the following should be specified:

Equipment designed and built

- 1) Object of project -- namely, to locate archaeological objects such as ...
with dimension ranges of ...
and to determine variations in soil to depths of ... ft. and for distances of ... , and so forth.

2) Specify that equipment use pulse technique (not continuous wave).

3) Specify that resulting working model be portable, capable of being carried by one man.

E.K. Ralph
October 11, 1961

cc. G. McLaughlin

Techniques

December 20, 1961

Mr. W. Harry Mayne
Vice President, Technical Service
The Petty Laboratories, Inc.
San Antonio, 6, Texas

Dear Mr. Mayne:

My sincere apologies for the long delay in writing to you regarding the research and development program for the sonic archaeological project which I received from you in October. It so happened that I had just then returned from Italy and was about to sign the contract and return it to you when we got an offer from another company to do all of the research free of charge. But then they have been backing and filling for two months now and we have all decided that we should go ahead with the Petty Company as stated in your contract of October 3. However, there is one small modification of that contract in Section 2, Number 3 referring to unlimited licenses, which we have modified. We are developing these instruments for the use of archaeologists in general and therefore have modified this section so that not only we at the University Museum but other archaeologists in other institutions will have the right to use without charge any method, process, or system originating out of this research. That is, we wish the right to make this available to archaeologists in general for their own research although we agree that commercial uses are outside our interest. We would be pleased of course to have you manufacture instruments for this use by archaeologists.

We hope that in spite of this long delay that you are prepared to go right ahead with this research. An electronics man from our Physics department here has developed a high-frequency seismic instrument which he is now testing and I wonder at this point if we should not get this instrument out to you and perhaps cut some corners in the kind of research program you have laid out here. I would very much appreciate it if you would let me know about the timing on this research and about the instrument we have at hand.

Most sincerely,

Froelich G. Rainey
Director

FR:ad

*Archaeological
Techniques*

Contract

*in
Safe*

January 25, 1962

Mr. W. Harry Mayne
Petty Geophysical Engineering Company
San Antonio 6, Texas

Dear Mr. Mayne:

Thank you very much for your letter of January 11 enclosing a signed copy of the contract for the development of the archaeological seismic equipment. I have just arranged with Mr. F. L. Johnson to meet him in San Antonio on the 7th or 8th of February so that we can talk with you and with Mr. Hasbrook about this program. One of us will let you know specifically the day when we can be there and we hope it will be convenient for you to meet with us there at that time.

Most sincerely,

Froelich Rainey
Director

FR:ad

PETTY GEOPHYSICAL ENGINEERING COMPANY

INCORPORATED 1925

SEISMIC · GRAVITY · MAGNETIC SURVEYS

CAPITOL 6-1393 · P. O. DRAWER 2061

SAN ANTONIO 6, TEXAS

HARRY MAYNE
VICE PRESIDENT

January 11, 1962

Dr. Froelich G. Rainey
Director, The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia 4, Pennsylvania

Dear Dr. Rainey:

The contracts regarding the development of the sonic archaeological probe have been received and one executed copy is enclosed for your files.

Your confidence in assigning this program to us is greatly appreciated and we are looking forward to an interesting and fruitful association.

As indicated earlier, we wish to advise the participants in our high frequency seismic research program of this project, and if possible, obtain their approval for an interchange of pertinent information between the two programs.

While this is in process, it should be quite advantageous to proceed with consideration of the device developed by your physics department, and we will be awaiting further information from you concerning it.

Mr. Arthur F. Hasbrook will be assigned overall responsibility for this program and will consult with you concerning further activities.

We thank you again for this contract and are proceeding as indicated above.

Very truly yours,

W. Harry Mayne

W. Harry Mayne

WHM:bw
Enclosure

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Production Research
Assoc.
Richardson
7-8
Sun oil
Revised
7-16
Halle

*Archaeology
Techniques*

January 30, 1962

Mr. W. Harry Mayne
Petty Geophysical Engineering Company
San Antonio 6, Texas

Dear Mr. Mayne:

I have just talked to Larry Johnson on the phone and we have arranged to meet at the Petty Geophysical Company about ten o'clock on Friday the ninth of February. I hope this is satisfactory to you.

He will be coming over from Dallas and I will be coming up from Guatemala. We hope then to go over with you the problems involved in our research program for underground archaeology. I expect this meeting in San Antonio will be very helpful to all of us.

With best wishes,

Froelich Rainey
Director

FR:ad

March 22, 1962

Mr. W. Harry Mayne
Petty Geophysical Engineering Company
San Antonio 6, Texas

Dear Mr. Mayne:

I am just now off for Sybaris in Italy with the sonic device built by MacLaughlin and with other instruments such as the gradiometer, resistance apparatus, and so on. We should be working in Sybaris for at least two months and possibly through June. If at any time you feel that it would be useful for Mr. Hasbrook to make actual field tests of archaeological sites, I would highly recommend Sybaris. As we discussed when I was in San Antonio, we have ideal conditions at that site and know a lot about it so that we have the best possible control for experimental work. My address at Sybaris will be, Via Ginnasio 6, Cassano Ionio, Cosenza, c/o Enrico Mueller.

In my absence, Dr. Alfred Kidder, the Associate Director is in charge here, and any correspondence to the Museum should be directed to him. We all hope things are going well with your experimental work and do let us know if there is anything we could do to assist.

With best wishes,

Sincerely,

FR:ad

Friedrich Rainey
Director

PETTY LABORATORIES, INC.

MANUFACTURERS OF GEOPHYSICAL INSTRUMENTS
AND EQUIPMENT
SAN ANTONIO 6, TEXAS

OFFICE AND LABORATORY
317 SIXTH STREET

*Arch
Tech*
MAIL ADDRESS
P.O. DRAWER 2061

22 May 1962

Mr. F.L. Johnson
Director of Production Research
Sun Oil Company
1608 Walnut St.,
Philadelphia 3, Pennsylvania

Re: Sonic Archaeological Probe
Development for University
Museum, Philadelphia

Dear Mr. Johnson:

Attached is a brief description of our proposed "General Approach to Initial Field Experiments" relating to the Sonic Archaeological Probe Development. Preliminary measurements are underway and preparations are being made for field propagation tests at our test area near San Antonio.

Very truly yours,

PETTY LABORATORIES, INC.

By: *W. Harry Mayne*

W. Harry Mayne
Vice President
Technical Services

WHM/pp

cc: Mr. Fred Mayes

Dr. Froelich Rainey ✓

Arch Teckmeyer

June 14, 1962

Mr. W. Harry Mayne
Petty Geophysical Engineering Company
San Antonio 6, Texas

Dear Mr. Mayne:

I am just now back from Italy and I am sorry to say that the sonic device constructed by McLaughlin here did not function. This was a great disappointment to us because we were looking for structures lying six meters deep on the plain of Sybaris and our proton-magnetometer will pick them up at a depth of no more than three and a half meters. The resistance equipment also did not function because our structures were lying about four-meters under the water table. Miss Ralph will give you full details on the work with the sonic device when she returns in the fall, but I write you now to urge that you step up the research there as much as possible so that we may again experiment with some high-frequency instrument at Sybaris next season. I am returning to Italy next week to complete this season's work and to arrange for the next season there.

In spite of the difficulties with our instruments we believe we have found Sybaris and that the work will proceed there as soon as possible.

We have your report on the general approach and I certainly am pleased to see this. We hope that things go well and that you will have success with the kind of instrument we very badly need.

Sincerely yours,

Froelich Rainey
Director

FR:ad

PETTY GEOPHYSICAL ENGINEERING COMPANY

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SEISMIC · GRAVITY · MAGNETIC SURVEYS

CAPITOL 6-1898 · P. O. DRAWER 2061

SAN ANTONIO 6, TEXAS

W. HARRY MAYNE
VICE PRESIDENT

July 30, 1962

Arch Techn
File

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

Dear Dr. Rainey:

Enclosed are three copies of our initial Summary of Activities,
May - June, 1962, on the Archaeological Probe development.

Very truly yours,

W. Harry Mayne

W. Harry Mayne

WHM:bw

Enclosures

cc: Mr. F. L. Johnson
Sun Oil - Philadelphia

Mr. Fred Mayes
Sun Oil - Dallas



INCORPORATED 1932

P. O. DRAWER 2061 • SAN ANTONIO 6, TEXAS

512 CAPITOL 6-1393 • CABLE: PETTYCO

August 10, 1962

file Petty

Dr. Froelich Rainey
 The University Museum
 University of Pennsylvania
 33rd and Spruce Streets
 Philadelphia, Pennsylvania

YOUR ORDER NO.
 DATE OF ORDER
 DATE SHIPPED
 TERMS **Net**

NO.

QUANTITY ORDERED	QUANTITY SHIPPED	DESCRIPTION	UNIT PRICE	AMOUNT
		<p>Services performed in accordance with our contract for Sonic Archaeological Probe dated January 10, 1962:</p> <p>March 1962</p> <p>Project Engineer 16.332 hours @ \$7.50</p> <p>Materials and supplies</p> <p>May 1962</p> <p>Project Engineer 109.742 hours @ \$7.50</p> <p>Asst. Engineer 68.994 hours @ \$5.00</p> <p>Secretary 7.833 hours @ \$3.13</p> <p>Materials and supplies</p> <p>June 1962</p> <p>Project Engineer 154.754 hours @ \$7.50</p> <p>Asst. Engineer 160.847 hours @ \$5.00</p> <p>Materials and supplies</p>		<p><i>Xtra copy</i></p> <p>\$ 122.49</p> <p>40.90</p> <p><u>163.39</u></p> <p>823.07</p> <p>344.97</p> <p>24.52</p> <p>1.51</p> <p><u>1,194.07</u></p> <p>1,160.66</p> <p>804.19</p> <p>410.27</p> <p><u>2,375.12</u></p> <p><u>\$ 3,732.58</u></p>
		<p>Note: Schedule "A" of contract specifies weekly rates which are based on a 40-hour work week.</p>		



P. O. DRAWER 2061 • SAN ANTONIO 6, TEXAS

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INCORPORATED 1932

August 16, 1962

Handwritten signature

Dr. Froelich Rainey
The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia, Pennsylvania

YOUR ORDER NO.

DATE OF ORDER

DATE SHIPPED

TERMS

Net

Handwritten: Xtra Copies

NO. L-573

QUANTITY ORDERED	QUANTITY SHIPPED	DESCRIPTION	UNIT PRICE	AMOUNT
		Services performed for your account in accordance with our contract for Sonic Archaeological Probe dated January 10, 1962:		
		July 1962		
		Project Engineer, 128.837 hours @ \$7.50 per hour.		\$ 966.28
		Assistant Engineer, 123.502 hours @ \$5.00 per hour.		617.51
		Secretarial services, 4 hours @ \$3.13 per hour.		12.42
		Materials and supplies		<u>158.95</u>
				<u>\$1,755.16</u>

Arch. Tech

September 26, 1962

Mr. W. Harry Mayne
Petty Geophysical Engineering Company
P. O. Drawer 2061
San Antonio 6, Texas

Dear Mr. Mayne:

All of us are very curious to know how you are getting on with the research for the archaeological instrument. I had your last report upon my return from Europe at the end of August and was encouraged to learn that your program is under way and that you now have some ideas about how it can be done. MacLaughlin's sonic device did not function in Italy probably because we did not have a satisfactory ground couple nor sufficient power, although his recording device seems to be satisfactory. It is obvious that we need to know a lot more about behavior of electrical impulses in the surface soils and so we are relying very much upon the research you are doing there.

It happens that I shall be giving a lecture in Dallas on the 31st of October, and at that time I shall certainly expect to go down to San Antonio to see how you are making out. In Italy we did have great success with the Proton-magnetometer and I would like to explain to you in more detail in San Antonio something of what we learned with these instruments at Sybaris in three months of field research.

With very best wishes,

Froelich Rainey
Director

FR:ad



INCORPORATED 1932

P. O. DRAWER 2061 • SAN ANTONIO 6, TEXAS
512 CAPITOL 6-1393 • CABLE: PETTYCO

Ralph
How about this?
FJW

October 4, 1962

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

Dear Dr. Rainey:

I was happy to have your letter of September 26, and hear of your visit to this part of the country.

A progress report is now being finalized and should reach you before you leave. In connection with our development here it would be interesting to have further information concerning the MacLaughlin Sonic device. As you point out, the most formidable problems in this program are the development of convenient and efficient coupling means, and the generation of adequate power at the desired frequencies. The report which is in preparation will supply many of the numbers for these parameters, and define the procedures required.

I will be looking forward to your visit and the opportunity of discussing the performance of the various devices with you. Would it be possible to get the MacLaughlin device or further information concerning it prior to your arrival? With best regards, I am

Very truly yours,

W. Harry Mayne
W. Harry Mayne

WHM:bw

cc: Mr. F. L. Johnson
Mr. A. F. Hasbrook





INCORPORATED 1932

P. O. DRAWER 2061 • SAN ANTONIO 6, TEXAS
512 CAPITOL 6-1393 • CABLE: PETTYCO

17 October 1962

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

Dear Dr. Rainey:

Enclosed are three copies of Interim Technical Report No. 1, "Propagation Measurements in Typical Earth", describing the initial field investigation in the sonic probe development program. We will be looking forward to your visit and the opportunity of discussing this program with you.

Very truly yours,
PETTY LABORATORIES, INC.

W. Harry Mayne
Vice President
Technical Services

WHM/pp
Enclosures

cc: Mr. F.L. Johnson-
Sun Oil Company
Philadelphia, Pa.

cc: Mr. Fred M. Mayes-
Sun Oil Company
Dallas, Texas



November 9, 1962

Mr. Andrew O. Bergquist
Project Engineer
Petty Laboratories, Inc.
P. O. Drawer 2061
San Antonio 6, Texas

Dear Mr. Bergquist:

Dr. Rainey has asked me to write to you as a result of his recent discussions with you. Apparently, the next step was for us to send to you the prototype which Gray MacLaughlin built last March. Here, we have encountered a snag.

There are two main problems - the first is due to the instrument itself. When I tried it out on the Plain of Sybaris last spring, I found that the main reason for my not being able to detect reflections was due to the low power output of the transducer and/or the poor ground coupling. But, in addition, the detecting circuit itself was unstable. Since I had so little laboratory equipment down there, I couldn't determine whether this instability was due to something that had gone wrong or its design. Now, MacLaughlin tells us it is the latter and that we will have to make some changes to make it operable. The main bug is the range of the sweep circuit - it is now too high. This, however, does make it useless for slow repetition rates.

We are trying to persuade MacLaughlin to make these changes as rapidly as possible so that we can send it to you without too much delay.

The measurements which you reported in your Interim Technical Report No. 1 are very encouraging. I think that they are fine and a good step forward toward getting some specific data. You may have guessed by now that MacLaughlin

Mr. Bergquist

Page 2
November 9, 1962

is an independent soul and has rather definite ideas of his own. He has made some suggestions which he has outlined on the enclosed three pages. These are his ideas, and I imagine that you have already considered several of the pitfalls which he has mentioned, but I am sending them along without further comment.

MacLaughlin is now building a gadget for Dr. Romberg at Texas Instruments. This is a transistorized 4 channel unit with galvanometers, and its function is to record the surface travelling wave and the reflected wave as received at 4 positions on one photo, and thereby determine whether or not true reflections have taken place. Since Dr. Romberg is interested in our problem and Texas Instruments may eventually obtain some data that will be helpful to all of us, I am wondering if you would object if we forward a copy of your report to Dr. Romberg.

Sincerely yours,

Elizabeth K. Ralph

EKR:pc
Enc.

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P. O. DRAWER 2061 • SAN ANTONIO 6, TEXAS
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INCORPORATED 1932

27 December 1962

*May be
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Miss Elizabeth K. Ralph
Applied Science Center for Archaeology
The University Museum
33rd and Spruce Streets
Philadelphia 4, Pennsylvania

Dear Miss Ralph:

We appreciate very much your information concerning equipment developed by Mr. McLaughlin as well as the comments concerning our attenuation measurements. Please accept our apologies for the considerable delay in replying to your letter.

As you know we have been hoping to utilize the McLaughlin display oscilloscope in our attenuation tests and, perhaps, in the overall system design. We hope that he is proceeding with the changes and modifications which he thinks necessary.

It is apparent from Mr. McLaughlin's comments that he has devoted much time and effort to the problems encountered in sonic "probing". With regards to our measurements, however, we have attempted to determine the rate at which the signal decreases with distance for various frequencies; it is not necessary, of course, to know the signal level at or near the source in such measurements. As indicated in our report, determination of the signal level at several different distances suffices to define the slope of the decay curve. This curve represents the actual decrease of the signal within the earth due to both attenuation and geometrical spreading.

As to uniformity of response for different plants, this represents quite a problem. From several years of experience in such work we have found that relatively uniform plants can be made up to perhaps 500-700 cps, in competent media, by carefully following the same planting precautions for all detectors. At higher frequencies it becomes increasingly difficult to make reliable plants under typical earth conditions; in fact, above several kilocycles very careful procedures are required for coupling to such a uniform material as a flat steel plate. While it is desirable that the plant response be measured, the required arrangement for measurements in deep holes tends itself to adversely affect the high frequency characteristics of the plant. Thus it becomes desirable in practice to make the plants as uniform as possible, by carefully following the same procedures, and to judge the plant somewhat by its overall performance.



Miss Elizabeth K. Ralph
Philadelphia 4, Pennsylvania

Page 2-

We are well aware of the difficulties in coupling sonic energy from the transducer to the earth. Much effort has been spent on this problem. For our measurements it has been necessary only that sufficient signal be present to insure a usable signal-to-noise ratio. Additional signal would increase the maximum permissible distance but would not, of course, change the attenuation or decay characteristics.


It is good to know that Dr. Romberg at Texas Instruments is concerned with some measurements which may be applicable to the overall program. We will be pleased to discuss our measurements with him, on a mutual basis, at any time. Our reports, however, contain or relate to background material and proprietary information which make circulation to a third party undesirable.

As Dr. Rainey no doubt has mentioned, our present efforts are directed toward pulse instrumentation and measurements as well as possible signal enhancement techniques. Just now our field activities are restricted considerably by weather conditions, but preparation of the equipment is in progress.

Thank you again for your most informative letter and Best Wishes for the Holiday Season.

Very truly yours,

PETTY LABORATORIES, INC.


A.O. Bergquist
Project Engineer

AOB/pp



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INCORPORATED 1932

January 8, 1963

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

Dear Miss Ralph:

Attached is a block diagram of the pulser unit used in our arrangement to drive the sonic transducer. From your block diagram of the McLaughlin oscilloscope, it seems that synchronization can be provided readily and that the two units should work together satisfactorily.

Just now we are nearing completion of the new arrangement of pulse equipment for our field tests. We will advise you shortly as to when everything will be in readiness for tests with the special oscilloscope.

Very truly yours,

A. O. Bergquist
A. O. Bergquist
Project Engineer



PRESERVATION COPY 10/6/2014



LINCOLN STREET (RTE 341) HINGHAM, MASSACHUSETTS

(BY REPLY REFER TO)
500-2801 EM-31

January 26, 1963

Radio Laboratories, Inc.
P. O. Drawer 1061
San Antonio 6, Texas

Attention: Mr. Andrew C. Bergquist, Project Engineer

Dear Sir:

Our model TR-11 electromagnetic transducer may meet the requirements outlined in your letter of January 10. This transducer is described on the bottom of Page 6 of the enclosed memorandum DR-11.

The TR-11 transducer operates as an oscillator driver and will require a baffle structure for its operation. One simple type of baffle has been to use two of these units operating in phase at the opposite ends of a short piece of pipe, with an air cell mounted within the pipe near the center of the two transducers. Such an arrangement will become an omnidirectional source. The arrangement described will permit a radiation of approximately 100 watts of acoustic power in the vicinity of 400 cycles. The power radiation is relatively low because the effective diameter of the vibrating piston is only 1/10 wavelength. If a group of several of these transducers are mounted back to back, the acoustic power output will go up approximately as the square of the number of units used. The TR-11 transducers can be made available for 6 months delivery at a cost of \$3,200 each.

A permanent magnet version of the TR-11 type transducer has been developed but it is not yet in production.

Very truly yours,

MASSA DIVISION
Gom Electronics, Inc.

Frank Massa, President

Enclosure:
EM-11

February 6, 1963

Mr. W. Harry Mayne
Petty Laboratories Inc.
P.O. Drawer 2061
San Antonio 6, Texas

Dear Mr. Mayne:

Many, many thanks to you, Mr. Hasbrook, and to Mr. Bergquist for your kind hospitality during my visit in San Antonio.

I have enclosed a copy of my brief report which I wrote for Dr. Rainey, who has, in turn, forwarded it to the foundation people.

Dr. Rainey plans to stop in San Antonio on his way back from Tikal on February 25th if this is a convenient date for you. He wants me to be there too so that I guess I'll be back again.

Professor Edgerton seems reluctant to ship a Model 230 Boomer -- possibly because of its weight (500 lbs.) but probably because he doesn't have one available. He sent one recently to Texas Instruments, and suggested that we try to borrow that one. All that I've been able to find out is that it is being used in Louisiana. Dr. Frederick Romberg at T.I. doesn't know anything about it, but told me they bought one several years ago and have disassembled it.

Professor Edgerton, however, is interested in our problem and is doing a few experiments this week with a magnetostrictive transducer -- an 8 in. diameter metal ring wrapped with wire -- that is normally operated at 9000 cps. He suggested that we could put this in a bucket with a rubber bottom, fill it with water, and "let it ping". He will let me know on Friday whether

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Mr. Mayne

February 6, 1963
Page 2

or not he thinks it will help us.

In our surplus stock we have a Jensen Model M-18 speaker Type C1610, 30 watts, 290-360 volts D.C., 8 ohms. This has a paper horn, and I imagine that the D.C. field coil (4000 ohms) would be a problem. If it would be of any use, let me know and I'll ship it immediately. It can be taken apart or wrecked in any way you like.

I have enclosed a copy of a page of Jensen speakers, and am wondering if the DD-100 Driver Unit would be appropriate. If so, I can order it locally and it would be shipped within 10 days.

With best regards,

Elizabeth K. Ralph

EKR:pc

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February 8, 1963

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✓ Mr. W. Harry Mayne ✓
Petty Laboratories Inc. ✓
P.O. Drawer 2061
San Antonio 6, Texas

Dear Mayne:

On Monday Professor Edgerton is shipping by air freight collect to Mr. Bergquist a rig which he thinks might work. It consists of a magnetostrictive transducer designed for 9000 cps which gives out short powerful pulses plus an "elementary" driver unit which will contain a trigger tube for operation with your 5, 10, and 20 repetition pulser.

He thinks that we shouldn't worry about the high frequency because he has gotten penetration to 50 ft. in mud with his 12,000 cycle pinger. He says that this rig which he is sending is hundreds of times more powerful than a 25 watt speaker. If it is not sufficiently powerful, he wants us to let him know right away and he will try to retrieve one of his Boomers. (The Boomer is resonant at around 600 cps.)

His main concern at the moment is that "we" will give this unit a real try. I assured him that Mr. Bergquist is an expert at making things work.

Dr. Rainey has left for Tikal without leaving any specific instructions, but I imagine that he plans to be in San Antonio for, at least, part of a day on February 25th. If there is any reason for me to arrive earlier or stay later, please let me know.

With best regards,

Elizabeth K. Ralph

CC. Mr. Andrew Bergquist

February 12 1963

Mr. Andrew Bergquist
Petty Laboratories, Inc.
317 Sixth Street
San Antonio, Texas

Dear Mr. Bergquist:

I have enclosed a report of the Lerici seismic work by Engineer Carabelli in Milan. It doesn't tell us much, but their results indicate that they have been finding similar frequency limitations.

Have enclosed also some literature about Alden recorders -- very expensive!

I have just ordered the following:

Tektronix Portable Oscilloscope Type 321 with standard P-31 phosphor and rechargeable batteries.

Additional Cathode Ray Tube with Type P-7 long-persistence phosphor.

I expect delivery of these before March 8th and will take them to Sybaris with me. I hope that you have not ordered one in the meantime.

With best regards,

Elizabeth K. Ralph

EKR:pc
Enc.

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DEPARTMENT OF ELECTRICAL ENGINEERING

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE 39, MASSACHUSETTS

February 13, 1963

Mr. Andrew Bergquist
Petty Lab.
317 Sixth Street
San Antonio, Texas

Dear Mr. Bergquist:

As requested on the phone by Miss Ralph of the University of Pennsylvania, I am sending you by Air Express collect the following.

- 1 Experimental pulse driver for a transducer
- 1 Ping transducer with cable
Nickel 9 KC

Please try this unit at 20, 10, and 5 pings per second and advise. It is my belief that the fundamental frequency of the pulse is about 9000 cycles/second.

I am enclosing catalog information on the "pinger (12 Kc)" and the "boomer (60-600 cycles)" since these devices might have some application later if this toy is not strong enough.

At the conclusion of your tests please return the material to me addressed as follows:

Harold E. Edgerton
M. I. T. Room 4-405
Cambridge, Massachusetts

I will appreciate a note when you send the material so I can spot it when it comes into M.I.T. I wish you success with your tests.

Sincerely yours,


Harold E. Edgerton

HEE:el
Enclosures



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18 February 1963

Miss Elizabeth K. Ralph
The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia 4, Pennsylvania

Dear Miss Ralph:

Please excuse the delay in replying to your letter of 12 February but I have been waiting to comment on the Edgerton Pinger.

The unit and letter arrived this morning from Dr. Edgerton.

The Alden and Lerici information was quite interesting and appreciate receiving it.

I am enclosing a copy of the Trll device from MASSA Division of Cohu Electronics.

Right now our part of the world has turned into mud but we should be able to do some field work with the "pinger" shortly. We will try to have some evaluation of the Edgerton Pinger made before you and Dr. Rainey arrive on the 25th of February.

With best regards,

Andy Bergquist
Andy Bergquist

AOB/pp





INCORPORATED 1932

3 July 1963

Miss Elizabeth K. Ralph
Hotel Miramare
Trebisacce, Italy

Dear Beth:

Enclosed is a copy of the May activities report and as the report indicates, we do not have anything ready for trial in Italy.

We were in the process of trying to obtain reflections from larger buried objects when your letter arrived with information that the work was needless.

The power supply has been developed with about 2000 volts peak power pulses from a variable duration 600 cps source. This is about maximum power for the cable moulded into the transducer. We will be testing it south of town.

I suppose all of you will be coming back to the states soon, but I do hope that you have had a very successful season's work.

With best regards,

Andy

Andy



August 7, 1963.

F. L. Johnson

Richardson Lab

Mr. Jno. G. Pew
Philadelphia Office

Dear Mr. Pew:

The following is a summary of the situation as it now exists with regard to the sonic archeological probe. I have delayed replying to your note of June until I could confer with the people at Petty and determine more accurately the situation which now prevails.

On July 9, 1963, I visited the Petty Laboratories and the project was thoroughly reviewed at that time by all of those in the Petty organization who were concerned. This meeting was a very good one and a complete meeting of the minds was obtained and the program objectives fully agreed on. It is my understanding that a report of this meeting has been forwarded to you and Dr. Rainey.

Boiled down, the situation is this: the Petty organization has conducted numerous laboratory and field measurements concerning the generation and coupling of acoustic energy into the surface soils. These investigations have revealed that the transmission of acoustic energy in the soil is accompanied by a rather severe attenuation (energy loss) during its transit from the surface to the object and reflection back to the surface. These losses increase quite rapidly with the frequency of the energy which further complicates the matter. In order to resolve (see) an object as small as 3 feet in diameter it will be necessary to use frequencies of 600 cycles per second or higher. Since the losses are high even at 600 cycles it is necessary to obtain rather large amounts of driving energy and to couple this energy to the soil without experiencing too great a loss. It was agreed that although a promising start has been made to this problem the success or failure of the entire program would depend on obtaining higher driving power and more efficient coupling and that the funds remaining (I understand there is approximately \$8000 yet unapplied) should be applied to studying this aspect of the problem. Several possible unconventional acoustic drivers (transducers) were suggested for investigation. At my suggestion it was decided that Dr. Paul Klipsch, a well known authority on acoustics be hired as a consultant in the power generation and coupling problem. His fee will be about \$1000. I have just received word from Petty that Klipsch has started work on the problem and will present his recommendations shortly.

Page 2.

It is my feeling that the work carried out to date by Petty has been very much worthwhile and their charges reasonable. In fact I am sure they have put in extra-curricular time not charged to the project. The results to date have shown this to be not an easy problem to solve but it was our unanimous feeling that it is by no means impossible of solution. It is my hope that in focusing attention on the heart of the problem we will be able to finish this feasibility study with a soundly backed engineering appraisal of the equipment required, its physical form, and the results which may be expected. As stated in the memorandum our discussions in San Antonio ended on an optimistic note.

Sincerely,

F. L. Johnson

F. L. Johnson

FLJ:be

cc: Dr. Froelich Rainey ✓
Mr. P. E. Chaney
Mr. F. M. Mayes



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13 August 1963

*Copy to
Jury to
B&R
15/8/63*

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

Dear Dr. Rainey:

Attached herewith three copies of report on Sonic Archaeological Probe and Experimental Tests With the Edgerton, Germeshausen & Grier "1000 WS Boomer System".

Sincerely yours,

PETTY LABORATORIES, INC.

John F. Tolk
John F. Tolk
Laboratory Director

JFT/pp
Enclosure



SONIC ARCHAEOLOGICAL PROBE

Summary of Activities

June-July 1963

Tests were conducted with a ceramic transducer, using a previously tested underwater speaker as a reference for comparison. A 2000 volt rms power source of 600 cps discrete frequency was constructed to drive the transducer which had a resonant frequency of 6000 cps.

The transducer was tested with a vertical spread of detectors planted at depths of 3, 5 and 7 feet. Detector holes were drilled on an 18 inch radius around the transducer hole of 1 foot depth. The transducer was pulsed with 2 to 4 cycles of a cycle per second waveform.

In the first test the ceramic transducer was cemented to the bottom of the hole with thick mud. Records of the signal output of the transducer were taken with the detectors at distances of 2.5, 4.3 and 6 feet. The maximum distance for useful signal amplitude was 4.3 feet.

In the second test the ceramic transducer was suspended at different levels in an oil-filled hole. A maximum signal through the earth was recorded when the transducer was against the bottom of the hole. The maximum distance for useful signal amplitude was 4.3 feet, with approximately 3 db signal increase in comparison with the tests using mud coupling. Next the underwater speaker was placed on the bottom of the oil-filled driver hole and a signal to a distance of 6 feet was recorded. The gain in signal output, using the speaker versus the ceramic transducer, was approximately 20 db at a distance of 4.3 feet.

The sonic signal amplitude of the speaker was encouraging; therefore, a hole was dug directly above the 7 foot concrete target, with a detector planted directly on top of the target and other detectors planted on an 18 inch radius around the drive hole. Backfill material in the hole above the target is

unconsolidated, as velocity measurements for the signal at 7 feet were less than the normal velocity of this soil. Possibility of reflections exists on the records, but reflection quality must be improved for definite identification of buried objects.

Three detectors were planted around the 7 foot deep target and detectors connected in parallel in an attempt to phase out noise or unwanted signals. No improvement of reflected signal was indicated.

On 9 July 1963, a meeting was held in San Antonio with Mr. F.L. Johnson of Sun Oil Company to discuss the present status and future progress of the sonic probe program. It was decided that a transducer of considerably higher power of discrete frequency is necessary for any future tests.

Mr. Paul Klipsch has been engaged as a consultant to the program to suggest methods of producing high sonic powers. Also, inquiries are being made of various sources to determine the possibility of high power drivers adaptable to piston operation in a fluid coupling medium.

Experimental Tests With the Edgerton,
Germeshausen & Grier "1000 WS Boomer System"

Initial tests were made in a brown sandy-clay soil having an average velocity of 1900 feet per second. Signals were recorded using acceleration type detectors carefully planted in the earth.

Two vertical spreads of detectors were used, with plants in separate holes of 3, 5, 7 and 15 feet depth and arranged on an 18 inch radius about a transducer hole. The other spread had detectors planted in holes of 16, 26 and 31 feet depth. The 500 WS transducer was suspended in the center hole of the spreads, while the 1000 WS transducer was located as close as possible to the detector spreads. The 1000 WS transducer hole was lined with a thin plastic material to prevent loss of the water coupling medium to earth.

The 1000 WS and 500 WS transducers proved to be excellent sources of high sonic power and the sonic signal was detected to a distance of 30 feet through earth. Frequencies below 600 cps largely predominate so apparently the pulse from the transducer is either altered or suffers severe high frequency attenuation through the earth.

In another test detector plants were spaced horizontally at intervals across a concrete target which is 3 feet in diameter and 24 feet deep. The 1000 WS transducer was moved from one hole to another along a line of holes spaced at intervals of 0, 5, 10 and 15 feet, with the "0" hole directly above the target. Detectors were then spaced at one and two foot intervals along this line across the optimum distance for signal reflection from the target.

No definite reflections were recorded with either method. The absence of 600 cps or high frequency energy probably results in no measureable reflection from a target of fractional wavelength.

In order to determine the feasibility of recording seismic signals from larger

buried objects, another test site, characterized by chalk and limestone series immediately beneath a thin layer of soil, was chosen. Hard sections are present below 18 feet and hard limestone at forty eight feet. Also, the chalk is a good high frequency medium in comparison with the sandy-clay soil of the initial location. Four transducer holes were dug 6 feet apart along a horizontal line, with holes of two foot depth for detectors drilled on either side of the transducer holes. Records were made using amplifiers with high pass 400 cps, high pass 200 cps and broadband filters. Results indicate possible seismic signal reflections from the 24 foot and deeper limestone beds.

No further work was performed on this site. Information was received, from Miss Ralph, that the largest buried objects of interest have walls no more than one meter thick, with no pavement in association. So, continued experiments to improve results from continuous beds is outside the scope of this project.

Based on results to date, it is thought that a high power discrete frequency source of sonic power is necessary for possible detection of small objects buried in alluvium to depths of 30 feet.

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18 September 1963

Dr. Froelich Rainey
Director
University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia 4, Pennsylvania

Re: Sonic Archaeological Probe

Dear Dr. Rainey:

Enclosed are three copies of the Report of Activities for August 1963.

Very truly yours,

PETTY LABORATORIES, INC.

John F. Tolk

John F. Tolk
Laboratory Director

JFT/pp
Enclosures

cc: Mr. F.L. Johnson
Mr. Fred M. Mayes



Petty
LABORATORIES INC.

INCORPORATED 1932

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2 October 1963

Dr. Harold E. Edgerton
Edgerton, Germeshausen & Grier, Inc.
160 Brookline Avenue
Boston 15, Massachusetts

Re: Sonic Archaeological Probe

Dear Dr. Edgerton:

Enclosed herewith three copies of the report titled, "Experimental Tests With the 1000 WS and 500 WS Boomer System".

Very truly yours,

PETTY LABORATORIES, INC.

John F. Tolk

John F. Tolk
Laboratory Director

JFT/pp
Enclosures

cc: Dr. F. Rainey
Mr. F.L. Johnson
Mr. F.M. Mayes

E L E C T R O N I C S D I V I S I O N



3 October 1963

Miss Elizabeth K. Ralph
University of Pennsylvania
Department of Physics
Philadelphia 4, Pennsylvania

Dear Beth:

All of the equipment that you had sent has arrived in good order. The 30 kv power supply works very well with the stack of eight ceramic transducers loaded under compression between two thirty inch plates, with one plate in contact with the ground. As of now, the energy level of this transducer is below that of the underwater speaker.

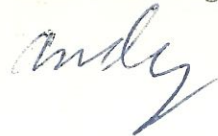
The 18 inch Jensen speaker arrived today and we have shaken the walls before dismantling it. The voice coil gap appears to be sufficiently large to be adaptable for piston operation.

A brief technical report on Dr. Edgerton's "Boomer" system was sent to him and the Museum.

Sorry I missed you in San Antonio, but plans were made and couldn't be changed very easily. As for the fishing, it wasn't much, but the cool weather and beautiful scenery were. Also had lots of fun camping and digging around a lot of old abandoned mines and mining towns.

Thanks for sending the equipment. We will be putting it to good use.

With best regards,



AOB/pp



SUN OIL COMPANY

COPY

October 29, 1963

F. L. Johnson

Richardson Lab

Ralph

Mr. Jno. G. Pew
Philadelphia Office

Dear Mr. Pew:

The following is a report on the status of the archeological sonic probe project which has been under development at the Petty Geophysical Engineering Company in San Antonio, Texas.

The writer visited the Petty group in San Antonio on October 10 to review the situation as it now exists with respect to the archeological probe. This meeting was attended by Mr. Harry Mayne, Research Director, and several members of his staff who have been concerned with the project.

On October 16, a meeting was held in your office to review the status of this situation. Very briefly, the work at Petty was summarized as follows: Petty has been working on this project for two years and during that time progress has been made when the pressure of their other current commercial activities would permit. Progress has been slow but has been thorough and in my opinion value has been received in the form of the information turned up during this investigation. I believe it is also only fair to say that members of the Petty staff, through personal interest, have donated considerable time to the project. A series of measurements were conducted in the laboratory and in the field which, for the first time, have given quantitative information on the problems which must be faced in applying this method to archeological problems. Foremost among these are the problems of generating sufficient acoustic energy and successfully coupling this into the loose surface soil. The tests disclosed that sound propagates into these loose soils at a velocity of approximately 1800 feet per second. With this transmission velocity, and in order to "see" an object 3 feet in diameter it is necessary to generate acoustic energy at a frequency of at least 600 cycles per second. The test work has shown, however, that the attenuation (energy loss) increases very rapidly as the frequency is increased. Many different types of energy sources were studied including the "boomer" loaned to the project by Dr. H. E. Edgerton of MIT. Many variations were tried in coupling these sources to the soil to achieve maximum efficiency. The end result, however, was demonstrated to be that we are (up to the present time) unable to achieve a frequency higher than 300 cycles per second regardless of the source or coupling medium. It is still believed that further development of sound sources will produce higher frequencies

SPACE
ASCA
Author

but it was thought desirable to take stock of the project at the present time to determine what course should be pursued.

The 300 cycle present limit means in effect, that field equipment can now be designed to yield a penetration of at least 25 feet and resolve objectives of the size of 6 feet in diameter or larger. Since this question is entirely one of utility in archeological prospecting, the problem was put directly to Dr. Rainey as to its value in his present and proposed exploratory programs. It was his feeling, as expressed in the meeting, that although some usefulness has been sacrificed, a large area of application still remains and it was suggested that Petty be asked to submit a bid on a complete field apparatus to be constructed for use in Italy next Spring.

Mr. Eckert raised the question of improvement capability and the writer indicated that this had been discussed during the conference at Petty. Any apparatus built would be of such a nature that it could accept (without alteration) frequencies up to 800 cycles per second. In addition, the instrument would have a magnetic recording capability which would allow compounding (addition) of several measurements at the same site, for example, 10 "records" could be added for 10 repetitive measurements made during a period of a few minutes. In other words, the proposed instrument would be fully capable of incorporating any or all improvements which may be realized by further development.

The proposed field equipment would be Jeep mounted and the automobile would carry a portable earth auger and hydraulic press. The auger would drill holes 6 inches in diameter and 8 inches in depth and three detectors would be mounted on a line on each side of this hole over a linear distance of approximately 30 feet. The central hole would be lined with a thin plastic film and filled with water. A blasting cap would be exploded in it as the energy source. The detectors would each be located in shallow 4 inch holes made by the hydraulic press. Approximately 10 minutes would be required at each set-up point whereupon the truck would be moved in line and the operation repeated for profile surveying.

After discussion it was agreed to ask Petty for a bid on the construction of such equipment. It was indicated at the meeting in San Antonio that the cost of such equipment would be \$35,000 plus \$15,000 for technical supervision. The latter figure would include Petty furnishing an operator to go to Italy for a three or four months period (not including travel and living expenses). Dr. Rainey agreed to write the Petty group and ask them to bid on this package for construction and delivery in the early Spring.

Very truly yours,

F. L. Johnson
F. L. Johnson

FLJ:be

cc: Mr. S. B. Eckert
Dr. Froelich Rainey ✓

Petty

INCORPORATED 1932

P. O. BOX 2061 • WASHINGTON, D. C. 20001
512 CAPITOL 6 1393 • CABLE: PETTYCO

November 9, 1963

Dr. Froleich Rainey, Director
The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia 4, Pennsylvania

Dear Dr. Rainey:

Mr. Mayne is, at present, out of the country, but we have prepared the enclosed bid proposal based on the minimum expenses with the hope that we can jointly continue to develop the probe.

This project has been and is a very interesting challenge. We have enjoyed our association with you and your group and look forward to continued association in developing a successful field sonic archaeological probe.

Very truly yours,

PETTY LABORATORIES, INC.

John F. Tolk
Director

JFT/ume

Enclosure

ELECTRONICS DIVISION



6, 9, 12" → 30"

Petty

P.O. DRAWER 2061 • SAN ANTONIO 6 TEXAS
512 CAPITOL 6 1393 • LABEL PETTYCO

INCORPORATED 1932

November 9, 1963

Timing Money
\$35K end Jan.

5 1/2"
Power earth
auger w. McCullough
engine
DR-450
Soil Test, Inc.
4711 W. North Ave.
Chicago 39. Ill.

RECOMMENDED EQUIPMENT
FIELD SONIC ARCHAEOLOGICAL PROBE

Quantity Item Tentative Minimum Budget Estimated Cost

1	Truck-2 wheel drive 3/4 ton with light weight cab		\$ 3,400.00
1	Drill-Auger type, vehicle mounted 2 large sections		750.00 100.00
8	Audio amplifiers-variable filters in 250 to 1000 cps range, 80 db calibrated attenuators, no AOC		5,200.00
1	Photo-paper recorder-minimum chart speed 50 inches per second		4,050.00
1	Magnetic recorder system-custom designed with 6 channel multitrack 100 multiplicity capabilities		15,890.00
23	Acceleration detectors-part of present project		
1	Switching control unit for detectors		431.25
1	Shooting box for dynamite caps		200.00
1	Tektronix type 321 DG Oscilloscope		785.00
1	Hewlett Packard transistorized AC Meter		275.00
1	Nathaway Model N-1 Audio signal generator		310.00
1	Simpson Model 260 Meter H-P 200 CD		58.60
10	Assorted hand digging tools		50.00
Asstd.	Wire and cables	+ hand digging	200.00
Asstd.	Small hand tools, soldering irons, etc. tools		50.00
	Mechanical Parts Total		331,218.60
	Labor for engineering, assembling, testing, etc. of above	less magnetic recorder = 10,000	15,870.00
	Salary for technician for three months in Italy		3,000.00
	Labor Total		18,870.00
	Basic Total		13,631
1	Edgerton, Germeshausen and Gerier 1000 watt-second "Boomer"		3,500.00
1	3 kw Zeus 115 VAC Portable Power Plant		431.25
1	Truck-2 wheel drive 3/4 ton		2,700.00
			6,631.25

Grand Total

856,719.85

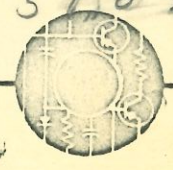
Total + Boomer = 30,131

1 Magnetic recorder system - 15,890 = 21,760
+ labor \$5,870

Total + Boomer + Magnetic Recorder = 51,891

ELECTRONICS DIVISION

ional saving with 4 Fisher Amps. = 2,000 + time





P. O. DRAWER 2061 • SAN ANTONIO 6, TEXAS
512 CAPITOL 6-1393 • CABLE: PETTYCO

INCORPORATED 1932

November 14, 1963

Raeply

Dr. Froelich Rainey, Director
The University Museum
University of Pennsylvania
33rd and Spruce Streets
Philadelphia 4, Pennsylvania

RE: Sonic Archaeological Probe

Dear Dr. Rainey:

Enclosed herewith are three (3) copies of the final report titled, "Final Field Experiments And General Review" of the development of the Sonic Archaeological Probe.

Very truly yours,

PETTY LABORATORIES, INC.

John F. Tolk

John F. Tolk
Laboratory Director

JFT/nme

Enclosures (3)

cc: Mr. F. L. Johnson
Mr. F. M. Mayes





P. O. DRAWER 2061 • SAN ANTONIO 6, TEXAS
512 CAPITOL 6-1393 • CABLE: PETTYCO

INCORPORATED 1932

512 - 226-5131

23 December 1963

Tower Life Bldg
7th Fl. 7th
~ Jan. 7th
7:30

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

Dear Miss Ralph:

Attached is a copy of the bid proposal which was submitted to Dr. Rainey. We are glad to know that you are preparing a list of the test equipment etc. which is already available.

Andy Bergquist left us several weeks ago to accept a position at the Bio-Electronics Laboratory of the School of Aerospace Medicine, Brooks AFB. His initial work there is concerned with test equipment standardization.

We will appreciate your addressing future correspondence on the Archaeological project to the attention of the undersign.

Sincerely yours,

PETTY LABORATORIES, INC.

John Tolk

John Tolk
Laboratory Director

JFT/pp
Enclosure

Dec. 17th

Mr. Hasbrook
Mr. Harry Mayne
Saint Antony



January 2, 1964

FIELD SONIC ARCHAEOLOGICAL PROBE
TENTATIVE MINIMUM BUDGET

Quantity	Item	Estimated Cost
1	Truck- 2 wheel drive 3/4 ton with light weight cab	\$ 3,400
2	Augur lengths larger than 3 1/4 dia. for use with University Museum Soiltest drill	100
8	Audio amplifiers-variable filters in 250 to 1000 cps range, 80 db calibrated attenuators, no AOC	5,200
1	Photo-paper recorder-minimum chart speed 50 in./sec.	4,050
1	3 kw Zeus 115 VAC Portable Power Plant	431
23	Acceleration detectors -- part of present project	
1	Switching control unit for detectors	
1	Shooting box for dynamite caps	200
Asstd.	Wire and cables	200
Asstd.	Small hand tools, soldering iron, and digging tools	50
	Mechanical Parts Total	<u>\$13,631</u>
	Labor for engineering, assembling, testing, etc. of above (less magnetic recorder -- EKR guess, only)	10,000
	Salary for technician for three months in Italy	3,000
	Labor Total	<u>\$13,000</u>
	Basic Parts and Labor Total	\$26,631
1	Edgerton, Carmeshausen and Gerier 100 watt-second "Boomer"	3,500
	TOTAL PLUS BOOMER	<u>\$30,131</u>
1	Magnetic recorder system-custom designed with 6 channel multitrack 100 multiplicity capabilities Labor for above	15,890
	Total Magnetic Recorder	<u>5,870</u> <u>\$21,760</u>
	TOTAL PLUS BOOMER PLUS MAGNETIC RECORDER	\$51,891

Sent to J. Tolk, Petty Labs,
cc. Dr. Rainey

3/67
After this,
the project was dropped
EKR 3/67

January 3, 1964

Mr. John Tolk
Petty Laboratories, Inc.
P. O. Drawer 2061
San Antonio 6, Texas

Dear Mr. Tolk:

Thank you for your letter of December 23rd with a copy of the bid proposal.

In regard to the items of equipment we have (in Italy) a Soiltest, Inc. (4711 W. North Ave., Chicago 39, Illinois) Power Earth Augur Drill Type DR-450 with McCulloch engine. We have 10 lengths (each 4 ft. long) of conveyer flight augurs with diameters of $3\frac{1}{4}$ in. For use with this, it is possible to purchase flight augurs up to $5\frac{1}{2}$ in. in diameter (depth limit probably 8 ft.) or augurs and bits up to 12 in. diameter with depth limit of 30 in.

This augur drill is not quite so rapid to use as one which is vehicle mounted, but, I think, would be sufficient for this purpose. If it is not necessary to drill deeper than 8 ft. (with $3\frac{1}{4}$ dia. augurs), the augurs may be extracted by hand - the motor is reversible. To drill deeper or with larger augurs, it is usually necessary to use a tripod and chain hoist to extract the augurs. We have this equipment in Italy, but, of course, the moving of the tripod from place to place is time-consuming.

In addition to this drill, we have a Volkswagen Microbus in Italy and, if necessary, can borrow large trucks and tractors from a friendly land owner. Therefore, we don't think that the second truck is essential.

In our ASCA labs here we have the following:

1 Tektronix Type 321 Oscilloscope
Various vacuum tube voltmeters -
RCA, Ballantine, etc. (not transistorized,
but o.k. with 115 v AC generator)
1 Hewlett Packard Model 200 CD Audio Signal Generator
1 Simpson Model 260 Meter
Assorted Hand Digging Tools

Mr. John Tolk

January 3, 1964

Small hand tools, Italian
Soldering iron, etc. (in Italy)
plus 2 small transformers for
conversion from USA 115 v to Italian 220 v
(for operation of battery chargers, etc.)

With these items deleted, I have made a tentative list of the minimum requirements for the Field Sonic Archaeological Probe on the enclosed sheet.

My feeling is that the Boomer is essential as the only transmitting source available now with strong power output at 600 cps. This thought is with the hope that, with the narrow band amplifiers, the lower frequency components will be blocked and it will be possible to detect the higher ones. Please correct me if I am wrong in this line of thought.

I have listed the magnetic recorder system separately at the bottom for two reasons - namely, timing and cost. Since this equipment will be experimental, it is important to test it in the field as soon as possible, preferably in the course of this year's expedition to Sybaris in April. My guess is (and please correct me again) that the magnetic recorder system will take the most time to construct. Of course, if you have one already constructed, which could be loaned for this project, that is a different matter. In regard to cost, this is the most expensive single item. Dr. Rainey is quite sure that he will be able to obtain \$35,000 for this project by the end of January, but doesn't know whether it will be possible to obtain more. Of course, the big question remains - whether with the Boomer or with dynamite, it will be possible to get a big enough signal into the ground for a reflection to be detected without the magnetic enhancement.

Could I trouble you for your comments and suggestions in regard to this tentative minimum budget and the essentiality of the magnetic recorder system? I am sorry about the rush, but Dr. Rainey leaves for Egypt on January 14th and will have to take care of the matter of funds for this project before he leaves. If you prefer to telephone him or me collect, we should be glad to have you do so.

Sincerely yours,

Elizabeth K. Ralph

EKR/deh

Encl.

March 25, 1964

Mr. A. F. Hasbrook
Petty Laboratories Inc.
P. O. Drawer 2061
San Antonio 6, Texas

Dear Art:

Thank you very much for returning the sonic equipment. In the packages I was unable to find the transducer itself. It is a brass cylindrical thing, about 3" x 3" and fairly heavy.

We have no immediate use for the little bench pulser, acoustic source, and detector. Therefore, if you should like to have them back, please let me know.

I am sorry that our collaboration has been stalled, and hope that something will be worked out some day.

With best regards to you and Mr. Mayne, I am

Sincerely yours,

Eliza beth K. Ralph

EKR:pc

Petty
MEMORANDUM

Date 5 March 1964

To MISS E.K. RALPH

From A.F. HASBROOK

SUBJECT: EQUIPMENT

We are returning by railway express prepaid this date the following:

- 1 ea Sonic transducer
- 1 ea Pulse generator
- 1 ea Sonic detector
- 1 ea Black & Decker Power pack charger
- 2 ea Black & Decker rechargable batt's
- 1 ea Transducer driver seismic probe cabling



P. O. DRAWER 2061 • SAN ANTONIO, TEXAS 78297

512-226-5131 • CABLE: PETTYCO. • TELEX: 076-7417

"Progress Through Excellence Since 1925"

March 19, 1973

Dr. Elizabeth K. Ralph
The University Museum
University of Pennsylvania
33rd & Spruce Streets
Philadelphia, Pennsylvania 19104

Dear Elizabeth:

I am sure that Shelley Breiner has thought to send you a copy of this, but just in case he didn't I thought it might be of interest.

Hope you have been staying busy.

Best regards.

Very truly yours,

A handwritten signature in blue ink that reads "Harry".

W. Harry Mayne

WHM:bjp

Enclosure

July 10, 1973

Dr. Elizabeth K. Ralph
Associate Director
University of Pennsylvania Museum
33rd & Spruce Streets
Philadelphia, Pennsylvania 19104


Dear Beth:

I thought the enclosed article might be of interest to you. The acoustic method might work for some of your projects, although the depth of penetration is too limited for general use. It might work on things like the shaft tombs in Jalisco.

Since we last made contact, Petty has been merged into a new company, Geosource International, Inc., and I will be moving to Houston in a month or so. The enclosed brochure gives some particulars. The Earth Resources Operation of Rockwell International will also ultimately become a part of the new company, so I am quite excited about the potential expansion of our combined capabilities.

I hope you have been staying busy on interesting projects, and that we can work together again soon.

Best regards,


W. Harry Mayne

WHM:bjp

Enclosures

*Home 512-
Houston 713-774-7561 Mandrel Co.
512-226-5131*

July 24, 1973

Mr. W. Harry Mayne
Petty-Ray Geophysical Group
Tower Life Building, P.O. Box 2061
San Antonio, Texas
78297

Dear Harry,

Many thanks for your letter and enclosures. Cook and Wormser seem to have made some progress with both the acoustic and resistivity methods. However, I hope that I can confine most of my field work to sites that are suitable for magnetometers that are so much faster to use.

That is good news that your company is expanding, but I was sorry to hear that you will be leaving San Antonio - it is such an attractive city. Maybe, Houston is too, but I haven't been there.

A new colleague, Gary Carriveau, may travel to Mexico in August, and I had suggested that he stop to see you en route. However, if you are moving, this may not be such a good idea.

I plan to attend and give a talk at the GSA meetings in Dallas in November. Hope that you will be coming to the meetings.

Sincerely yours,

Elizabeth K. Ralph