

UNIVERSITY of PENNSYLVANIA

PHILADELPHIA 4

The College

DEPARTMENT OF PHYSICS

file
Archival
Techniques

4 August 1960

Dr. Froelich Rainey

Greensboro, Vermont

Dear Dr. Rainey,

Dr. Belshe from Cambridge visited us last Wednesday, and I was glad to have the opportunity to meet him. Dr. Stephens joined us for lunch and was also interested in his work. We learned about some of the details of the proton magnetometer and much about Dr. Belshe's measurements of the weak magnetic fields of the earth. If we decide to purchase a British-made proton magnetometer, there may be difficulty because of Varian Associates patents, but we are looking into this.

The summer here is not so peaceful as it might be, with various small crises from time to time. The most recent was a letter from Dr. Cruzent from Venezuela requesting immediate collaboration between our laboratories. Wanted to send the person who is going to do their chemical processing here "by return mail" and wanted me to spend the month of September in Venezuela. I've stalled off the arrival until September 15 and shall remain vague in other respects until I talk to Dr. Kidder next week.

From August 15-17, I plan to attend a Conference on Organic Scintillation Detectors in Albuquerque, New Mexico, mostly to catch up with recent improvements, with the hope that someday the technique will be practical for C^{14} dating. The leading scintillation people will be there, including Dr. Hayes, who has obtained much higher counting rates for growing things by extracting oils and terpenes which can be combined easily with efficient scintillators. This is useful for the

Dr. Froelich Rainey, 4 August 1960, Page 2

study of the C^{14} increase from bomb tests, but not for dead wood, et cetera.

After that I hope to go to New Hampshire for a few weeks, and will be back at work on September 12. Henry Michael leaves for Russia tomorrow and plans to see Rudenko and various other people in Leningrad and Moscow. I guess I told you that on his western trip he obtained a Bristlecone Pine section that goes back approximately 4100 years. In addition, he gathered several 3000-year Sequoia sections, so that we are now well supplied with datable wood for my NSF grant project. There is still the problem of the dendrochronological analysis of the Bristlecone Pines. The Laboratory of Tree-Ring Research in Tucson has such a shortage of personnel and Dr. Smiley, the overall director, is so difficult that I wish we could develop a small tree-ring dating laboratory here. Dr. Bannister, in Tucson, hopes to work out an Egyptian chronology, but is pretty well tied down by University of Arizona duties. It would also be interesting to find out if a Gordian tree-ring chronology could be worked out.

Speaking of expensive ideas, reminds me of our C^{14} budget. It was approved yesterday with no cuts. I suspect that your talks with Dr. Eiseley are responsible for that--many thanks.

With best regards,

Beth

Elizabeth K. Ralph

EKR:JR

P.S. My NSF grant arrived today too.

show up when everything was waiting for them -- were off in Civita. They had lots of excuses, but each man managed to tell me a different one. I have been tempted to write to Mr. Lerici about all of this, but I guess I'd better not.

Speaking of money, if your return is delayed, I may run short. Ollie seemed to want to be reimbursed for his trip which consumed one of my checks. Then, I managed to lose 60,000. As far as I know, it was stolen from my room at night, but I don't know how I slept so soundly.

We have investigated the hotel at Spezzano Albanese (American Hotel), and it is very nice and doesn't cost much more than this, but it is completely isolated -- only birds and trees. We have decided that we would be bored to death there, and also it is so far from the sea. The swimming is good now.

We have all been meeting every morning at Cassele at 7:00 A.M. which has helped to reduce our wine consumption in the evenings.

With best regards,
Betty

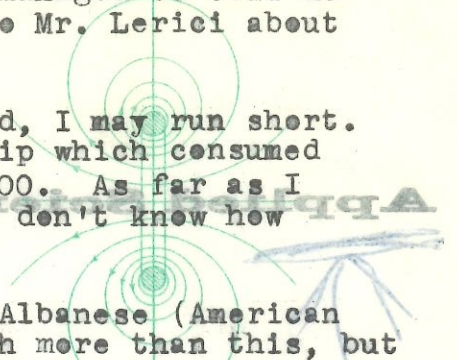
Dear Pro,
but there isn't much. In the Torre Merdilla area, the crop was cut on a strip, which spanned the center of the plateau. We did a complete grid with the magnetometer, but it revealed very little and test excavations of the more promising anomalies were discouraging. There were practically no sherds except for a few on the surface and mostly Roman, and no walls. We are still waiting for the grain to be cut on the rest of the plateau. We have had a lot of rain which is bad for us but worse for the farmers.

About 2 km east of Torre Merdilla, the magnetometer found a real anomaly for once -- a large terracotta pavement (at least, 5 x 16 meters) of a Roman villa, and also many Roman sherds. These were all at 20 cm and nothing underneath. Near this field (which is only about 5 meters above the river level in altitude), on a small hill (Collina della Croce) one of our donkey experts showed us where there is a Hellenistic temp. The sides consist of big blocks of cut stone, approximately 2 x 3 meters, but the top was removed years ago and nothing remains inside. We have searched this hill and some of the surrounding areas including the base of T.M. on the north and west sides, but haven't found other temps. In these regions, the drills have found sherds only near the surface and not many.

We are now working in the Capalana area. Some of the walls down the hillside do show up with the magnetometer whereas the natural rock doesn't so that there is some hope of tracing them if the test excavations indicate that they are interesting (Had a holiday for the Pope on Tuesday and were rained out today). We spent on the hill to the south but didn't find anything. I hope that we can find a temp. with as many things in it as the Is Sigmara has in her house.

Mr. Lerici must have telephoned to Mr. Mueller yesterday to say that we are spending too much money, so we are laying off two workers, taking one away from the Lerici crew and giving them Salvatore to do the records with the hope that Beniamino will work. I suspect that there will be a big blow-up tomorrow among the Lerici crew. The truth of the matter is that Umberto does the work of three people and the rest do practically nothing. He proved that yesterday when he went ahead of the drill and dug the holes single-handed -- result, they made 13 holes which is a record. What the other four did all day, we don't know. However, more ridiculous as far as extravagances go were the four men from Rome who spent more than a week here making the documentary film. The Lerici crew lost 3 days, the rest of us 2, and Mr. Mueller had to keep the pumps going and hold up the bulldozer which was clearing the Test Pits for four days just because they didn't

P.S. New plan blew up this evening. Lerici crew went to function without the extra operator.



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Applied Science Center for Archaeology

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

August 23, 1963

Dear Fro,

Here are a few notes about my Petty Co. visit in case Mr. Johnson or someone appears before I return.

C-14 speech went pretty well, but there wasn't a great deal of interest in the new suggestion I made-- namely, that perhaps we should take more notice of Prof. Thellier's measurements of remanent magnetism and the consequent effect upon the magnetic intensity of the earth in the past, and, that if we accept this, we can find an explanation for the discrepancy in C-14 dates older than 1000 B.C. At any rate, Prof. Thellier was in Berkeley and I couldn't catch up with him in the short time I was there, but invited him to visit us after September 10th. Don't know whether he will.

Perhaps one of our future projects should be this business of remanent magnetism. It's beginning to be more and more closely related to C-14 and outer space problems, as well as a means of dating pottery.

Am off to Louisbourg, and hope to be back early in September.

Both (rs)

EKR:rs

A. Scarfe

Visit to Petty Laboratories, Inc., San Antonio, Texas, August 20, 1963. Discussions with Mr. Mayne, Mr. Hasbrook, and Mr. ?

There are funds of about \$4000.00 remaining, enough to continue work through September.

Experiments to date have furnished some concrete data as a foundation for further development. Main points are

1) Transmission is optimum at 600 cps. At higher frequencies, the attenuation becomes too great; at lower frequencies, we won't see walls less than one meter thick. Moreover, the frequency band must be narrow in order to interpret results.

2) With a transducer crystal operating at 2000 volts, or with a 25-watt speaker, direct transmission is detected up to six feet.

The next two to three weeks are to be devoted to design considerations of a more powerful transducer. Present possibilities are

1) Use a BaTi crystal 1/2" thick and of larger diameter at 25,000 volts. The gain improvement should be about 40 db.

2) Increase the diameter to about 24" (about one wavelength). The gain improvement should be about 20 db.

3) Use a large steel plate approximately three feet in diameter, perhaps energized by a Boomer or similar device. The steel plate would have to be of such dimensions that it resonates at 600 cps; main problem there is the damping or elimination of other frequencies.

With 1) and 2), we might achieve direct transmission to twenty feet, and might detect a target (see reflection) at eight feet.

With the additional information obtained during the next two weeks, Petty will submit a proposal for design and construction of a workable transducer and the associated components, and cost estimates.

Probable future procedure will then involve

1) extensive field tests of the above unit, and determination of limits of penetration and reflection detection; and

2) design and construction of improvements, possibly including magnetic tape intensification of the reflected signal, etc., in order to reach the desired detection at thirty feet.

If we can get some more money, I think there is hope for something workable, at least for moderate depths.

August 23, 1963

Elizabeth K. Ralph

EKR:rs

Technique

March 30, 1965

Dear Beth:

I just have the letter from you and Ellen written at the Hotel Boston, and certainly want to congratulate you both on untangling the mess about the Sybaris publication. Tell Ellen I will needle Meyerhoff about a short version of his article. I will also dictate a summary of the investigations prior to 1960 and to speed things up I will send it to Vannoni for translation.

This concerns plans for the spring. I gather from Roger that Rodney feels you might have a crack at the Gyges mound at Sardis and that, of course, is fine with me provided it does not interfere with our commitments in Italy. I told Paola that we would certainly work with her at the Selle sometime in May, and I am very anxious to begin work again with the rubidium magnetometer at Sybaris in late May or in June, if that is ready, so I suppose I should plan on being in Italy by the middle of May at the latest to begin work with Zancani. I will keep you posted on the time when the rubidium magnetometer will be in Italy. If all goes well with the rubidium magnetometer I will join you at Sybaris in June.

The small job in ^{SOUTH} Carolina is now scheduled for August. Should I try to set somebody else up for that? There is still no work from the A. E. C., but they promised to call me about that grant this week. Also the Wenner-Gren ^{Board} has not yet met. Mark's work looks very promising and I hope we can apply to the N. S. F. for that at least, when you get back.

Please give my very best to everybody on the site.

As always,

Froelich Rainey

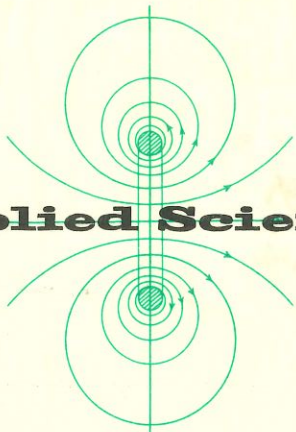
Miss Elizabeth Ralph
c/o Gordion Expedition
P. K. 14
(Polatli), Turkey

P. S. Congratulations on the Artena job. It is always good to see the instruments work!

FGR/vg

Techniques

Applied Science Center for Archaeology



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

July 8, 1965

Professor Froelich Rainey
Brown Univ. Archaeological Expedition
Ambler, Alaska

Dear Fro:

Vittoria and David included various messages from me yesterday. Since then, I have talked with Lee Langen. He was delayed in New York, so we met at my house last evening and had a five hour session. The main result of this is that there is some possibility of starting the instrument tests on August 5th instead of the 15th. This would enable us to have one day at Grasshopper before the field school terminates. Dr. Thompson had hoped that his students could see the new gadget. Then, we'd probably go to Thompson's sites near Tucson and to New Mexico.

This, however, brings us into direct conflict with the Camden, S. Carolina job. May I back out of this, or offer Henry Borstling alone if there is enough money left from our \$500 Penna. contract? In the latter case there would still be the complication of getting the proton magnetometer to Mr. Beer in Peru.

In regard to the alkali vapor (they have used caesium instead of rubidium) magnetometer costs, Varian would like to have the \$15,000 after the August field tests. Then, they are expecting \$10,000 in September or October for six months' rental for a period of two years. If the instrument proves satisfactory, perhaps we could revise this agreement and have the \$10,000 applied to its purchase. I hope that we can rustle this \$10,000 out of the NSF.

We seem to be getting funds for our fringe activities, but nothing for the core. There are the new metallurgical grant (\$23,800 for two years), the C-14 grant, and our little contract with the state of Pennsylvania.

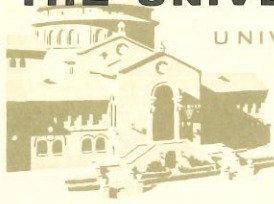
I just telephoned Dr. Aborn, and he said it was too soon for a reply - early next week, hopefully. He did say that I had answered the major issues and that the biggest problem remaining is the amount. He and Dr. Smith will go over it this week and may then suggest which item(s) should be deleted.

With best regards,

Beth

EKR:ek

THE UNIVERSITY MUSEUM



UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS

PHILADELPHIA, PA. 19104

CABLE ADDRESS "ANTIQUE"
TELEPHONE: EVERGREEN 6-7400
(AREA CODE 215)

October 19, 1965

Dear Beth:

Many thanks for yours of the 10th and I am deeply sorry to leave you with all those problems, because I think you should slow down and not speed up. Actually I was so tired when I got back, I slept all afternoon and all night and was just able to get around for the Board meeting and Members Night.

After my report to the members about Sybaris, the Inquirer again announced the discovery of Sybaris in the headline, for the fourth time ! But the text was all right and I do not think it will get back to Italy and cause trouble again.

I checked the drill records over that big rubidium anomaly, and all the sherds are recorded as archaic. No Hellenistic or Roman, whatever this means. I agree it is now terribly important to do a few drill holes but also to cover as much area as possible around the Parco del Cavallo to determine the extent and to detect as many big structures as possible.

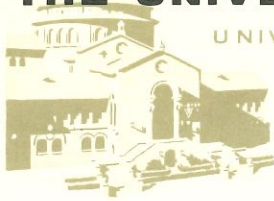
You ask about Tarquinia - I think I would not bother with that now, because that is just canning peas. The Gravina site is much more interesting. There has been no word from Marynatos about Helice, so that may be out. But I will let you know at once if I hear from him. Continue as long as you can and we will find the funds somehow. Glad to hear that Foti approves the drilling. I will talk with Orville about further excavations. I hope everything goes well, but be careful not to kill yourself running around too hard. Give everyone my best and here is hoping the thing finally does prove out.

The very best,

Froelich Rainey

Miss Elizabeth Ralph, Hotel Meranda, Torre Cerchiara, Cosenza, Italy

THE UNIVERSITY MUSEUM



UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS
PHILADELPHIA, PA. 19104

CABLE ADDRESS "ANTIQUE"
TELEPHONE: EVERGREEN 6-7400
(AREA CODE 215)

October 23, 1965

Dear Beth:

I just have yours of the 16th, and I am pleased to know the Gravina job went so well. You will be glad to know that Mrs. Bullitt turned in another \$2,000 to make up some of the deficit. My account shows we are still overdrawn, but we have discretionary money to keep you going until the rains come. There is no word from Marynatos and I will poke him up again. You had a copy of my letter to Lerici about Tarquinia so I hope that is off. If you do not do Greece, I should think a few days at Selle with Zancani will be fun. But do come back by boat and take it easy.

Jeannette and I are are trying to get out the new MASCA bulletin and she will write to you to get a paragraph on the cesium magnetometer from you.

I just heard about a perfect way to dig at Sybaris, which should solve the problem of the sands and I will go into this at some length with the American Cyanamide Company, and I will tell you about it when you get back. Orville insists on digging next spring and when you get back with the final records of this fall, I will make a report to Foti and propose a proving excavation next spring. Now that I am hopeful that we have the sand problem licked, I will also suggest to Foti that the Antiquities Service make the news announcement about the cesium magnetometer to put them in a good state of mind. But keep all this under your hat until you get back, so we can do it officially through Foti.

Very best wishes,

A handwritten signature in blue ink, appearing to be "F. R." with a stylized flourish.

Miss Elizabeth Ralph, Albergo Meranda, Torre Cerchiara, Cosenza, Italy

THE UNIVERSITY MUSEUM



UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS

PHILADELPHIA, PA. 19104

CABLE ADDRESS "ANTIQUE"
TELEPHONE: EVERGREEN 6-7400
(AREA CODE 215)

November 5, 1965

Dear Beth:

I have just phoned Varian and talked with Shelly Breiner since Lee Langan was away. Shelly feels that you really ought to bring back both of the sensors as well as both the recorders. Of course, you can leave the batteries there. I think they want to keep the sensors in use somewhere here during the winter. But we certainly can take it back to Sybaris in the spring. Shelly was naturally very pleased about the way things have worked out, but since I did not talk with Lee I have no idea about the financial aspect of this business. I think that if we want to use it ourselves, this winter, here in the U. S., that it can be arranged.

I have just sent you a copy of my letter to Foti and I guess it is self-explanatory. You will immediately see the advantage of having him make the news release. Also, it seems to me that we will do better working directly with Foti about the test excavations and I have not said anything about this to Lerici. Since you have a copy of the letter you should talk to him in these terms about working next year.

I have sent all the physical dope about the Sybaris plain to the American Cynamid Co. through Dr. Raymond here at the Hospital. And he thinks they will do the job of chemical grouting as a publicity measure. Also we think we will actually try it out here near Princeton, to see exactly how it works, before it gets into the field. Also, let me know how you are making out with funds. It seems to me you will need more if you will stay through November.

Very best wishes,

F.R.

Miss Elizabeth Ralph, Hotel Meranda, Torre Cerchiara, Cosenza, Italy

FGR/vg

*Lee just now called -
He wants batteries also for
improvement - but will write
you direct, will cement on more
money for Varian.*

7.

*work letter
Varian happy -
Morris letter*

*Excavate -
Jane*

*Aitken
Society -
Sibari
Adamastara -
aerial photos -
new camera -
expects
Cone*

May 28, 1967



NOMIKOS LINES PIRAEUS GREECE

D.E.S. DELOS

Dear Fro,

Thera is a beautiful island, but the most magnetic place that I have ever encountered. We had hoped to find where the pumice was thicker, which might have indicated a mound over a structure, but the pumice was overlain with several meters of volcanic gravel - so confusing that even a gradiometer arrangement could not cancel this. However, this didn't matter to Prof. Marinatos because for him, the magnetometer is a political instrument. He seems to have great influence in the new government so much so that he was asked to help with the organization of the Universities. I guess he thought that this was a little touchy, so he said - oh no - he was just starting an international program with magnetometer, etc. Therefore, he was very happy that Cs & I, plus Mavor & a seismograph arrived when we did.

Along with Mavor came Bill Wetmore, & I haven't yet figured out why. He knows nothing about archaeology nor any science, & he doesn't talk much so I didn't find out what he does at home. At any rate, they were both good leg-men for the magnetometer, & I didn't have to struggle with Greek. For 4 days, we liked

2 kilometers down a mule path (south of Akrotera) with all of our gear & back up it at the end of the day - all in soft pumice. When we found that everything was so magnetic, we alternated with the seismograph, & got some indications of the thickness of the pumice layer & of the depth of bedrock. We had the nice little Seismiktron that you used in Arizona, but the readings were a bit uncertain due to the poor coupling in the mixed gravel & pumice. My main contribution to the expedition was to show Mavor how to calculate the seismic results.

I haven't figured out ~~either~~ ^{also} just what Mavor is up to, but he is really quite stupid - not much "upstairs". He hadn't met Marinatos before, so apparently he used us for that purpose. He talks of providing funds for Marinatos' excavation, but I suspect this is phony too. With the slight language difficulty, Marinatos is treating him well, but, perhaps, he, too, is a bit puzzled. This is a bit of a long story, but while we were fooling around with the instruments, Marinatos talked to "old men of the land" looked around, & started to excavate. In the first trench, he found 1500 B.C. pottery & a small structure. Therefore, he plans to return to Athens on Monday to buy up the land & make all of the arrangements for a full-scale excavation, starting in the 2nd week of June. At breakfast this morning, he asked Mavor what he planned to do in the interior (as he had asked 2-3 times before), & Mavor replied that he would walk around the island & use the seismograph here & there - puzzled expression on Marinatos face. Then, he asked me what I planned, & I told him that since the island is so magnetic,



D.E.S. DELOS

I should leave as soon as possible. With a concealed sigh of relief (since Marinatos is paying all our expenses here), Marinatos had me booked on this cruise ship this evening, within 10 minutes. He thought that this would please me because it stops at two islands on the way to Piraeus. At any rate, we reach Athens Sunday evening, & that will give me time to find the Fiat (it went with us as far as Thera but because of rough weather couldn't land & was sent back to Athens somewhere) & catch the boat at Patras on Monday evening. To return to the long story, I hope that we can remain a bit aloof from Mavor & Co. because I suspect that Marinatos may tire of him.

Marinatos sends his best greetings to you, & says that when he talks to you again in June or July, he will have a non-magnetic site for the magnetometer. Perhaps, there will be another small political crisis. If you are coming this way, I think that you would enjoy seeing his excavations at Akrotera - last week of June would probably be best. Boat trip is very pleasant - one night and one day. For very special treatment, contact Mr. John Kutsogiannopoulos in Athens - he seems to control the boats. This evening his nephew, who lives in Thera, escorted me all the way down to the ship - 2 mules for the luggage, & 2 for us, put us on board & ordered the captain to give me a good cabin - Marinatos' expense again.

That reminds me of the monetary problem. I have

#1200 left in travellers' checks, but it would be better to keep them in case I have to return to Greece. Since I now have more time to work in Italy, I suspect that it will cost about \$2000. If you could send a check to me from the Italian account for \$2000, or better, two checks for \$1000 each, I'll use them as needed. If Adamastanau "coughs up", I may not need the 2nd. Fortunately, both Giacinto & Nunzio are free to work, so we'll cover as much ground as possible before we go to work with Adamastanau. With the new batteries I have this year - more portable, we can try out Mr. Bullitts' line system much more easily. They are so portable, that I carried them ^{more than} half of the time in Greece.

Next address is % Enrico, but I'll probably get back in time to overlap with Zancani & Stoop at the Hotel Meranda (Torre Cerchiara, Cosenza). That will give me a good excuse to go to the hotel. I had a good time in Cassano while I was there, but now there is more family than ever with Luisa's new one. She & Mimmo are now in your room while their apartment is under construction. Also, if the melons aren't too big, I ~~want~~ might map out Copiae-Thuris unless you send instructions otherwise. Don't worry, we'll start the lines up the Ragenello as well. Rented sensor arrived in Greece with Mavor, & works only as a reference oscillator. My reliable one #90 has gone out, but the best reliable of all - #65 is now working well. Therefore, can carry on with rented one as reference, plus #65 while I trouble-shoot #90. Another reason for being in the Meranda - the backyard is non-magnetic! Please excuse all of this scribble. Have now had several ONSO. If you have time to call Dr. Stephens, please tell him that trip to Greece was partly political or something or other because he knew perfectly well that the magnetometer wouldn't produce results here. I must compensate for this & make some significant finds in Italy. With best regards,
Beth

At Vittoria - Please tell AS&A 6C-14 to send mail to Italy



ALBERGO BOSTON
ROMA

Hotel Meranda
Torre Cerchiara
(Cosenza)

Festa della Repubblica
2 June 1967

Dear Fro,

Today is a big holiday in Italy & it is the start of my 25th reunion at Wellesley (in absentia), so we worked only half a day. Also, Foti came here this afternoon to talk to Zancani & see her excavation. It gave me a good opportunity to talk to him. Thanks to your trip to Reggio C. & the magnetometer, we are now in high favor. He is quite anxious, however, that we cover the Parco del Cavallo areas with the magnetometer — he means just the area surrounding the Italian excavation. The land is now owned by Rizzo (that difficult one), & he wants to have a good excuse to expropriate it. He told me to deal with Rizzo & pay for a few melons if necessary, in case we step on them. His thought is that if we find many anomalies there (and there is no doubt about it), he can get money from the Cassa del



ALBERGO BOSTON
ROMA

p. 2

Me

Mezzo Giorgio to buy up the land.

Foti was in better health than I had ever seen him before - he scampered around "lo scavo" of Zancani's & made a few jokes with me at her expense. Thank goodness, that I understood them.

At any rate, I think that Giacinto, Nuncio, & I had better spend about a week in Parco del Cavallo to cover it. In the meantime we have been following the southern leg of the Long Wall - it continues right on to the Crati. We tried to pick it up on the south side this morning, but missed - our lines were just a bit west of it because of a grain field in the way.

The one IR photo^{that I have} is a great help in locating our grids on the map - the sketch that I sent to you is wrong - the scale is 1:8000. If any more IR blow-ups come along, I can use them.

Before we start along the Rajanello, it would be much better to have some of



ALBERGO BOSTON
ROMA

p. 3

the results of the IR photography. The standard photography shows that the Raganello's bed may have been south, but Zancani says it was north - that leaves an enormous amount to cover. But, I think that the IR will pinpoint it more precisely.

I hope that a check for \$1000 or \$2000 is on its way.

Tanti saluti,
Beth

P.S. May I trouble you to tell Mr. Bullitt that the Muellers own 680 hectares - he wanted to know this.

2nd P.S. We talked to Rizzo this morning, & he has rented the land & we can't go in Parco de Cavello unless we pay £1,000,000 for the melons. I'll tell this to Foti & see what he wants to do about it. One possibility would be for me to return in Sept.

The IR photos for the Raganello area are now needed urgently. Hope to have some results from Adamastana next week, but maybe not.

April 5, 1968

Dr. Froelich G. Rainey
c/o Antiquities Service (David O'Connor)
Arabeh el Madfunah (Abydos)
SOHAG

Dear Fro:

Shelly Breiner has returned from Mike Coe's site in Mexico where he had good success in locating structures with the magnetometer. He suggests that 2-1/2 months sometime in the future will be required to do a complete survey. In the meantime, Mike is eager to continue his excavations through April or until the bad weather starts in early May, but according to Shelly, he lacks funds to do this. I reported this to Mr. Carpenter, but Mr. Carpenter said that the funds should come from the Coe Foundation and also that he didn't want to do anything until you return.

Unless I hear otherwise from you or Professor Marinatos, I will be at Elis in May, then inspect other sites in Greece in early June. Then, Bob Dyson wants me to come to Iran for the rest of June. There is some hope of locating graves in one of his areas so that he can dig deeper where there are not graves.

Since my little Fiat will be so crowded in Greece, there won't be room to take the instrument suitcases with me. Therefore, it would be easier to drive directly from Greece to Iran. Since this means crossing Turkey, I'd like to have someone with me, preferably one who speaks Turkish. This, of course, made me think of Ellen, and she is willing to go if her eye is better. Also, Bob thinks that he will have enough money to pay her travel costs. Before going to Iran, Ellen has some studying to do in Ankara. What do you think of this scheme? Perhaps, you could accompany me on this trip and that would be even better.

We have had a request too from Alan McPherron in Pittsburgh to do a magnetometer survey at Divostin, a Neolithic site in Yugoslavia, about

100 km. south of Belgrade. He plans to start working there in September, 1968, and to continue in the summer of 1969. How practical this will be for us, I don't know. From what I've been able to find out about the geology of the area, it is probably not magnetic. To test the site ahead of time, McPherron could meet me there in early July. This would mean another long drive. If the new smaller cesium magnetometer works well, there is the other possibility of leaving the bulky gear in Greece and flying to these places.

There is bad news from the NSF - our proposal was turned down. I talked to Lieban and he said that our case just wasn't strong enough in this very competitive year. He said that testing of a new model of a magnetometer wasn't important enough and that we don't yet have any specific results that would demonstrate that LR photography is useful, and I guess that's true.

I had planned to take off on April 25th in order to meet you in Rome on the 26th. If you are returning directly from Ireland, I'll plan to wait here until the 26th unless I hear from you that I'll miss you anyway.

With best regards,

Elizabeth K. Ralph

EKR/ek

April 9, 1968

Dr. Froelich Rainey
% Shepheard's Hotel
Cairo, Egypt

Dear Fro,

My plans now seem to be in a turmoil. In order to get to Iran from Greece, I found out that one needed a Jeep or Landrover. Therefore, I was planning to leave by ship with my Jeep on April 19th. However, without Giacinto (and Nunzio), I can't take both the Fiat and Jeep to Greece, and the Jeep alone isn't big enough to transport the gear and Greek assistants who never have any transportation of their own.

Also, Bernard Wailes has just heard from the Irish and they are eager to start at Dun Ailinne about June 15th, just when Dyson wants me in Iran. Bernard doesn't want to do this without an instrument survey. Therefore, I'll wait until Bob gets back, about April 19th to see what can be done about this. If it is necessary for me to go to Iran, I'll have to fly there, and the Irish project would have to be postponed until about July 10th.

If the new cesium magnetometer works well, and if the two students from Oxford join me in Greece in June, there is the possibility of our dividing up. However, I doubt if they will come if we don't have funds to pay for their transportation from England. Also, if any component of either instrument breaks down, this wouldn't work.

I am surprised that Prof. Marinatos changed his mind. He wrote to me in January as follows: "The question of your assistants is left up to you to be settled as you think it better." I'll be lucky if I don't strain my back just lifting suitcases for customs inspection in Greece, and the work there will go more slowly.

Please let me know what you want me to do about the Irish-Iran conflict. Also, do you want us to collaborate with McPherron in Yugoslavia and if so, how shall we fit that in?

With best regards,

Elizabeth K. Ralph

Copy sent to Hotel Eden
49 via Ludovisi
Roma, Italia also -

EKR/abn



LUNGOMARE N. SAURO, 7
TELEFONI: 210.238 - 210.307 - 214.891
Tel. 331023 - 331030 - 331728
LA DIREZIONE

Dear Fro,

Leave
Send to
Mr. Puller
247

May 30, 1969

Things went well at Ciró. We found 3 anomalies east of the "tempio" and a number of smaller ones west of it. We explored around it within a radius of about $\frac{1}{2}$ km with the audio gadget, and there don't seem to be any more except those which we found in grids just around it. We also explored some of the promontory & the beach and found a large anomaly on the promontory where the beach begins - it's probably due to a mass of iron, but it might be somewhat ancient since it seems to be deep - 2-3 meters. There was no hope of anyone excavating while I was there because Foti was tied up with a meeting of superintendents, and the head at the Museo in Crotona is even more stupid than Spinella. The geometra Pisani from there worked with Nunzio and me and will survey the anomalies. Also, I have sent Pamela Hemphill a report, copies of the grids, and a map. We've also marked the anomalies, but the stakes may disappear. The original grids, I left with Pisani at Museo, Foti doesn't seem to know about Hemphill's coming to excavate at Ciró. He doesn't object, but he would like to have a letter from you. Perhaps, this is because of the mail strike too. The strike is now over, but they haven't cleared up the backlog. The Muellers received my letter of May 9th yesterday. This explains why no one expected me when I arrived.

At Sibari, Foti is building an expedition house in Parco del Cavallo - right on top of the long wall, just west of the Bruscate. He is also starting to excavate a square about 50 x 50 meters surrounding the old (Italian) excavation in Parco del Cavallo. They are installing well-points - 50 x 50 meters - one single system, and they are excavating by hand. They haven't yet reached the water. They have one extra pump, but it is the old "cippolla" type. So far, he's not doing anything



LUNGOMARE N. SAURO, 7
TELEFONI: 210.298 - 210.307 - 214.891
Tel. 331623 - 331630 - 331728
LA DIREZIONE

north of the Stompi. The Muellers are 2
all fine except for Luisa who is going to
have her appendix removed. Enrico is
drinking very little, and feels much better.

I came to Bari because I noticed on
the map that there is a boat from here
to Debrounik, and it looked like a much
shorter route to Kragujevac. I telephoned Yugoslavia
last evening and found that the road that I had
planned to take doesn't exist. Therefore, I'll have
to drive north and then west, and he said that
it will take 2 long days - mountains, small bad
roads, etc., but very beautiful scenery. At any
rate, if I get through customs and the Fiat doesn't
break down, I'll arrive on June 1st which is when
I said I would come. The boat leaves at midnight
and lands at 7:00 A.M. Just wish I knew some
of the language.

Best regards,
Beth

P.S. Went shopping in Bari today for various
supplies. In Yugoslavia, they lack simple
things such as tags to label objects.

Dear Fro,

Fortunately, ~~our car~~ ^{the} Hotel "Bristol"
~~at~~ ^{at} ~~the~~ ^{today} car went well today, Tuzla, Yugoslavia

From the music floating through

hotel raphaël

5/31/69

HR

00186 - roma
largo febo 2
(piazza navona)
Telef. 6569051
telegr. raphotel

this hotel window, I would think that I was in Italy, but I am half-way to Kragujevac - 300 km from Dubrovnik, but it took 8 hours of driving, and when I found myself falling asleep, I fell into this hotel, and asked for "ein zimmer" - German here, but fortunately, in Sarajevo someone spoke French, so I found my way. The roads that are on the maps that I have don't always exist.

At any rate, I am writing now in case the mail still doesn't go from Italy. The survey at Ciró went well and I have sent reports to Hemphill, both Phila. and the British School in Rome. We found anomalies east and west of "il tempio" and one large one - probably iron - at the inland side of the beach of the promontory. Geom. Pisani at Museo del Crotona knows where they are. If you have my other letter, this will be repetitious, but Foti would like to have a letter from you in regard to Hemphill's coming to excavate. He doesn't object, but would like a letter from "headquarters." I hope that she will start before July 1st so that I can stop there for a day to make sure that they know where the anomalies are. Pisani is a bit stupid, but if I'm not there, Nunzio can find them.

Forgot to mention in the previous letter that there is a delightful campground 1 km. from the site at Ciró. Simple bungalows, but the whole out-of-doors for work tables, etc. in a pleasant Eucalyptus & pine grove. Also, the owners are from Firenze, and ~~supply~~ run a family-type restaurant - have never eaten better food - especially, the fresh fish, cooked perfectly. Also, il vino di Ciró è buono! Cost less than \$5.00 per day to live there - incl. breakfast & dinner & half of our lunch food.

Best regards,
Beth

Wed., Jan. 20, 1971

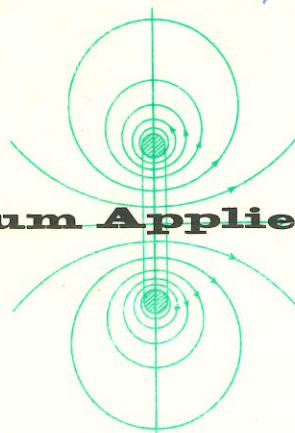
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Mexico
Tel. 14

Museum Applied Science Center for Archaeology

Froelich Rainey, Director

Elizabeth K. Ralph, Associate Director

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33rd & SPRUCE STREETS • PHILADELPHIA, PENNSYLVANIA 19104
594-7400 (Area Code 215) Cable Address "Antique"



Dear Fro,

We completed three large magnetometer grids - one over the tomb mound & surroundings, one west over "normal" ground, & one further west over the next ridge (where you and Sam walked at first). We get all kinds of small magnetic disturbances over the tomb & pit area but only one anomaly that corresponds with a known tomb - the other two deep shafts made no magnetic fuss. However, in the third grid, over the next ridge, we have a tremendously ^{strong} magnetic anomaly about 6 m in diameter. It looks exactly like those from large Olmec heads or altars, or possibly an iron meteorite.

Harry Mayne (from Petty Co.) arrived Friday night with the new Bison seismograph, and has stayed for 5 days instead of only 2. Therefore, we have given the new instrument a real workout. We tested our strong magnetic anomaly from every direction, & are sure now that it consists of high velocity (& magnetic) rock & that it is 2 meters below the surface & may extend down to 7 m. It is probably not of archaeological interest, but we are urging Betty to excavate it since it is only 2 m deep. There seems to be some little hold-up in her digging permit, & I guess I'll just have to give her a deadline if she doesn't do

→ P.S. Bill Winnie returned tonight with permit arranged, so digging will start tomorrow.



Museum Applied Science Center for Archaeology

Froelich Rainey, Director

Elizabeth K. Ralph, Associate Director

THE UNIVERSITY MUSEUM • UNIVERSITY OF PENNSYLVANIA

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something about it soon.

We ran some seismic lines below the tomb area to see how the ground behaved, & others over & between the known shafts. It is a bit discouraging. The mixed top layer of soil, rocks, etc. has a very low velocity - almost equal to that of air. The tepetate below it extends down 50 or so meters, & has only a slightly higher velocity for sound waves. Therefore, in testing at short intervals right over a shaft, we had a difference of only 1 millisecond which isn't really significant in this confused earth. We plan to move to another site tomorrow or the next day with the hope that the earth will be less mixed-up.

The hotel is not bad at all, & we discovered that they have a corn-cobs hot water heater which they now fire up when we come home from work. In the restaurant, occasionally they have good rice & "bistecca", but I am becoming very fond of "tacos" which they always have.

Bruce should probably return at the end of next week, since he will already have missed two weeks of classes, but I can stay longer if there seems to be more to do.

With best regards,

Beth

P.S. Bruce's photos are excellent, and are, at least, a big help in locating ourselves on the ground.

Application of the Physical Sciences to Archeology

Recent developments in locating sites by high-sensitivity magnetometers, in the study of provenience by elemental analysis and petrographic methods, in dating and authentication, and in recreating ancient techniques of making artifacts were reported at a symposium on the application of the physical sciences to archeology (1).

F. Morrison (Department of Engineering Geoscience, University of California, Berkeley) reviewed the latest applications of the recently developed cesium and other alkali vapor magnetometers in locating archeological features (such as ancient brick walls, kilns, and stone monuments) and in locating and mapping buried cities.

The action of the magnetometers is based on their ability to sensitively detect anomalies in the static magnetic field of the earth. With a sensitivity of 1 gamma (10^{-5} oersted), the magnetometer can detect an anomaly caused by 1 kg of iron at a distance of 10 m. But remanent magnetism (such as that associated with fired clay, building block material, and basalt in surrounding clay) requires a sensitivity of 0.1 to 0.01 gamma. Alkali vapor magnetometers now available are sensitive to as little as 0.001 gamma. To make use of such sensitivity, the background must be homogeneous. Time variations of the order of 0.1 to 10 gammas are also superimposed on the magnetic field of the earth, but these can be canceled out by using two detectors differentially.

When the magnetometer is operating, the cesium in the cell is heated and light is fed into the vapor. The excitation of the electrons of the cesium atoms causes the cell to become opaque. The radio frequency that is applied to return the electrons to the ground state depends critically on the magnetic field at the cell; the output from an alkali magnetometer is a frequency proportional to the magnetic field in which the sensor is placed. The proportionality constant for cesium and rubidium magnetometers is typically 3 to 5 cycles per second per gamma. With a counting interval of 20 seconds, conventional counters can yield sensitivities as high as 0.01 gamma.

In the magnetic survey of the buried town of Sybaris, roof tiles and walls were accurately located at 4-m depth to within a few tenths of a meter. Out of the eight holes that were drilled, six were on the anomaly, within a meter from where its position had been predicted.

The largest structure at the Olmec ceremonial center of La Venta is an earth pyramid, which is the oldest pyramid in the Western Hemisphere. This pyramid was assumed to have a rectangular base until 1967, when it was found, instead, to be a fluted cone with ten alternating valleys and ridges running up its sloping surfaces. This finding revived interest in the function of the 33-m mound and in the possibility that it might contain buried structures. Samples of the soil were tested and found to be effectively non-magnetic. The known Olmec monuments, including the famous giant heads, are made of a basalt that is of a particularly magnetic type; it was therefore felt that any stone monuments or basalt structures buried or built within the pyramid would be detected by a magnetometer of the type described.

In 1969, a team sponsored by the National Geographic Society surveyed the La Venta pyramid. Surprisingly, 3- to 5-gamma anomalies were found along radial lines; they were identified as soil layers of unexpectedly high magnetic susceptibility. However, 20-gamma anomalies were also found, and a computerized interpretation of the complex data indicates a strong probability that a thin (approximately $\frac{1}{2}$ m) horizontal slab forms a base for two walls; the slab would come within 1 m of the surface, and the walls to within 1 to $1\frac{1}{2}$ m of the surface. Although the anomaly may derive simply from suitably arranged rubble, it is probable that basalt is producing the anomaly. Future excavation will show how well the survey has outlined the structures in the pyramid.

I. Perlman (Department of Chemistry and Lawrence Radiation Laboratory, University of California, Berkeley) spoke about neutron activation of pottery. The significant progress in this technique results from a combination of factors: a powerful reactor; the novel lithium-drifted (silicon and

germanium) detectors, which combine high resolving power with high sensitivity; high-quality computation facilities; and the accumulation of considerable experience and of a background of data. It is now possible to determine over 40 different elements in the pottery samples, although such a complete analysis is usually not made. Many of these elements can be determined to 1 percent, even if present only in concentrations of one part per million. In other elements, precision is only a few percent, and some can be estimated with even less precision. Because of the nature of the activation process, neutron activation analysis actually tends to be most sensitive for the elements normally present in low concentration.

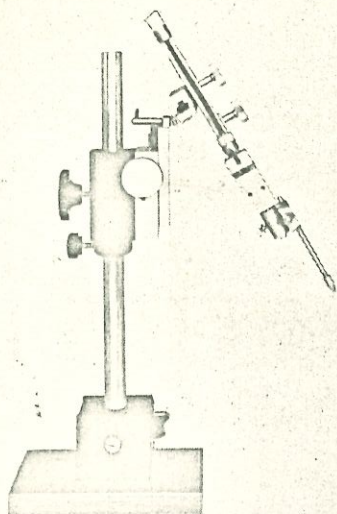
The fundamental composition of the clays is very similar, but the minor and trace elements provide a characteristic fingerprint; thus, if enough elements are determined, it should be possible to characterize clays of a particular area uniquely.

The analysis of pottery is valuable because clay is one of the most ancient materials and is universally associated with man. People settling in a new area seem to have brought their pottery with them, but they soon started to use the clay that was available locally, while continuing to make ceramic ware in the style of their country of provenience. Therefore, analysis together with comparison of style provides good evidence of migration and transplanting of groups of people.

Neutron activation analysis yields a wealth of data, which, by their very quantity, present difficulties and bring out intrinsic complexities. The first steps in handling this information are to collect local pottery from one spot, establish a standard for the local production, and group the data. The dispersion of the individual groups is then established by statistical analysis. Any particular sample can be fitted into a particular group with a probability dependent on the dispersion of this group. An interesting example of the acuity of the procedure was found in the analysis of the clay plugs used for sealing certain predynastic Egyptian jars. The clay plugs were found to agree very well in their composition with that of "Nile mud" pottery found in the vicinity, and the body of the jars was quite similar to clay that was also found locally but which represented a material apparently used for different purposes.

Fro, FEB. 1971

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this report. Science
should know better.
What do you suggest
that we do? Both



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An important question is how many (and which) elements are sufficient to characterize a shard adequately. Sometimes, but not usually, one or two elements are sufficient. The clay found in a place in southern Israel, for instance, is characterized by a high hafnium content (12 parts per million), whereas most other clays contain only 2 to 3 parts per million. In an analysis of a group of Cypriot pottery, one piece was found to contain this high concentration of hafnium, and the rest of the composition was subsequently found to match the clay from Israel.

Thus far, 1400 pieces of Cypriot pottery have been analyzed to obtain a background on this type of ceramic ware. To provide a reliable analysis for an unknown Cypriot sample, an estimated 10,000 pieces will be needed. Similarly, an adequate study of the Mediterranean pottery would require about 100,000 pieces. The present rate of analysis is about 2000 pieces per year. The rate of analysis may be increased, but the difficulty of handling and, particularly, of recalling the information needed for interpretation of results increases with the rate of acquisition of data.

To achieve high accuracy, it is necessary to irradiate a calibrated sample, as well as the unknown, for comparison. About 2 years was required to develop a reliable, homogeneous sample of suitable quantity, one which had a representative composition and filled all requirements for such a standard. Analysis can be made on a very small sample, but usually a 100-mg sample is taken by use of a sapphire drill. Even this quantity is small enough so that it can usually be removed in an inconspicuous place, thus causing no visible damage to valuable pieces.

S. Fleming (Research Laboratory for Archaeology and the History of Art, Oxford University, England) described the thermoluminescence method of dating ceramics. This method, which measures the faint luminescence that is produced when ceramic objects are heated to a point where normal incandescence would interfere with the measurement (500°C), is intrinsically absolute. The luminescence is caused by the release of electrons trapped in crystal lattice defects in the clay. The electrons are trapped as a result of radiation occurring in the ceramic object. Alpha and beta radiation of relatively low penetrating power comes from radioactive material always present in

clays; the gamma radiation, which has a substantially higher penetrating power, arises largely from the soil in which the object is buried. Average contributions of alpha and beta radiation are 0.22 and 0.19 rad per year, respectively, while the contribution from external sources (gamma and cosmic radiation) is on the average approximately 0.08 rad per year. Thus, about 16 percent of the total radiation to which the ware is subjected is caused by the environment. Because of the low penetration of the alpha radiation, it affects only the surface of the larger grains in the clay, and measurements are now made with samples from which the coarse grains have been eliminated by careful crushing and sieving and which, therefore, consist of grains with a diameter of about 1 to 2 μm . Alternatively, tests are made by using only coarse grains (about 100 μm in diameter) on the assumption that, of the intrinsic radiation, only the beta radiation has been effective. The calibration is performed by irradiating the material with a known dose and measuring the additional light produced on heating. The larger the ratio of light output on irradiation to that produced by the original sample, the less time has elapsed since the last firing of the ware, given an approximately equal background radiation contributed by the soil in which the object was buried.

In assessing the probability of authenticity, it is necessary to establish a minimum and a maximum age for the specimen. The criteria for authentication are (i) the minimum possible age may not overlap the documented era of forgery, and (ii) the maximum age must not exclude the archeological date of manufacture. The minimum age is given by the radiation experienced by ware that was buried at depths greater than 1 m in nonradioactive soil and that was therefore only affected by cosmic radiation. It amounts to 0.014 rad per year. The maximum external radiation is much more difficult to estimate; a figure of 0.17 rad per year is used. Usually great accuracy is not so important for questions of authentication, however, because the older specimens are normally the most interesting and the distinction between old and new is not difficult to make.

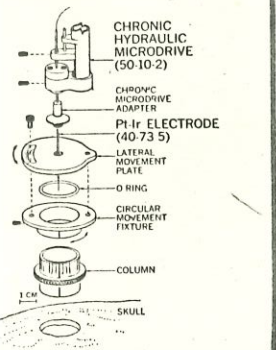
The size requirement for samples is about 25 mg, although measurements have been made on as little as 5 mg. A tungsten carbide drill is used for taking samples.

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F. J. Turner (Department of Geology and Geophysics, University of California, Berkeley) discussed the petrographic character of classic marbles. His emphasis was on the potential value of petrographic studies in determining the provenience of marbles and, particularly, on some notable pitfalls in this connection.

Since there are only two, and in some cases three or four, additional minor components in most marbles, examination of thin sections under polarized light gives information on the mineralogical identity of the component grains and on their mutual geometric relations, which define the rock texture.

Marbles are formed by metamorphic recrystallization of limestones; statuary marbles usually contain 90 to 99 percent calcite, whereas some marbles have dolomite as their principal component. Different recrystallization temperatures, pressures, and periods cause different reactions with clay and silica impurities and result in minor minerals with characteristics that are readily identifiable with the polarizing microscope. Conventional chemical analysis, x-ray diffraction, and superficial microscopy are not diagnostic since they determine only the features that these materials have in common, not those that distinguish them.

Two problems that concern the archeologist are the possible geographic source of a particular piece of stone and the matching of fragments of marble objects. Texture, fabric, and mineralogy are the characteristics that are most useful for distinguishing marbles according to their origin. Differentiation according to grain size is not a good criterion since grain size is highly variable in individual localities and, sometimes, even in single thin sections. Twinning of crystals, however, is a function of recrystallization conditions, and it varies substantially from quarry to quarry. The shape and outline of the grains also provide a textural characteristic useful for differentiating marbles.

Probably the best characteristic for matching fragments of statuary or inscribed slabs is the "fabric"—that is, the alignment of elongated grains, or crystallographic parallelism even of nonelongated grains. Fabric represents a pervasive pattern of orientation of the principal symmetry axis of the individual calcite grains. Special and laborious techniques of microscopy and

x-ray analysis must be used for such studies.

Mineralogical criteria do not give such positive information; therefore, differentiation by mineralogy depends heavily on the experience and background information possessed by the petrographer. However, where characterizing minerals are present, the experienced petrographer can usually identify them easily with a polarizing microscope.

Probably the most important contribution of petrography to identification of marbles is to rule out certain hypotheses. Occasionally a marble from a particular locality may have an unusual, and therefore diagnostic, mineral constituent, such as the red manganiferous silicate Piedmontite in a pink variety of marble from Mount Pentelicon. Since petrographic information is obtained with relatively low investment of time and special equipment, petrographic techniques should be considered important and useful adjuncts to other technological methods in the support of archeology.

Radiocarbon investigations of the La Brea Tar Pits were discussed by R. Berger (Institute of Geophysics and Planetary Physics, University of California, Los Angeles). Many Pleistocene animal fossils and the only human skeleton found in the La Brea Tar Pits in Hancock Park, Los Angeles, have been subjected to radiocarbon dating experiments. Because these bones were impregnated with an "infinitely" old asphalt, a special technique that makes use of the collagen of the bones was used to obtain a valid analysis. In the collagen method, the bone is washed thoroughly in petroleum ether, ground to powder, and dried in air. The calcium carbonate is removed by acidification, since the carbonate ion in groundwater can be exchanged with it and produce spurious results. The bone is then hydrolyzed in strong hydrochloric acid and refluxed overnight to obtain the amino acids in concentrated solution. The solution is passed through a chromatographic column packed with Dowex resin, which retains the amino acids. The column is washed to remove impurities, and the amino acids are then displaced with ammonia. The amino acids are burned to carbon dioxide, which is purified to eliminate impurities that might interfere with the counting. The carbon dioxide derived from the amino acids is then placed in the counter and measured. Gas chro-

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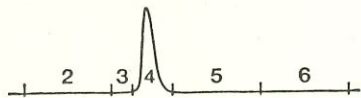
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ISCO absorbance recorders deposit each peak into a separate test tube.

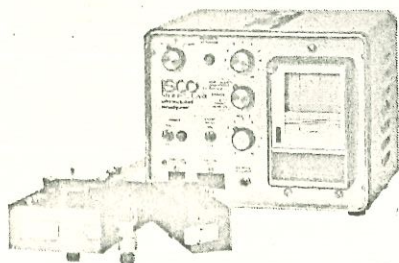


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matography is used to detect any hydrocarbons that might have slipped through. For greater precision, where sufficient sample is available, certain amino acids that occur only in bone, such as hydroxyproline, can be isolated chromatographically and used for analysis.

The collagen analysis was checked out on a quasi-mummified skeleton found in association with a bark mat in Nevada. The mat, the bone, the skin, and the hair were dated by conventional radiocarbon methods and were compared with the collagen procedure; the results were the same. The validity of dating of the La Brea fossils was further established by obtaining a radiocarbon date on wood fragments found in the tar pits; a comparison of fossil and wood gave very similar results.

The collagen method described gave an age of 9000 ± 100 years for the La Brea skeleton.

Further research along these lines has the following objectives: (i) find and date bones of little-known animal species; (ii) find how individual animal species change in their evolution over a span of 40,000 years; and (iii) look for other human bones or carbonaceous artifacts for additional dating studies.

G. H. Curtis (Department of Geology, University of California, Berkeley) reported that specimens of volcanic rock collected in 1969 at the principal hominid sites in Java (namely, Sangiran, Trinil, Ngandong, Ngawi, Jodjokerto, and Boetak) are now being dated at Berkeley. Owing to contaminants, mainly carbonate and zeolite which contribute large quantities of air, it has been difficult to obtain meaningful dates from most samples up to this time, but a fair date of 1.9 ± 0.4 million years for a tuff underlying the site of a mandibular fragment of *Meganthropus* can be reported. The *Meganthropus* fragments was found by P. Marks in 1952 in Djertis beds of continental origin near Modjokerto. Although the pumice tuff lies several meters below the hominid site, the site itself lies at least 400 m below late Pleistocene beds, all of which have been folded into an anticline and truncated by erosion, and it is believed that the pumice and hominid remains are penecontemporaneous.

The date of 1.9 million years makes this hominid, thought by many anthropologists to be an *Australopithecine*, contemporaneous with African hominids of similar evolutionary development. It seems reasonable to suspect that hominids were in Southeast Asia long be-

fore *Meganthropus* was entombed at this spot in Java.

In a discussion of lithomechanics and archeology, E. G. Thomsen (Department of Mechanical Engineering, University of California, Berkeley) showed that engineering analysis could be applied to archeological problems, and specifically to the reconstruction of methods for making tools and artifacts. The processes analyzed were the fracture of glassy materials in toolmaking, the use of stone flywheels in drilling, and the production of obsidian ear spoons. In glassy materials, fracture surfaces show a consistency in character—demonstrated, for instance, by the prismatic obsidian cores found in many sites. Flint, obsidian, and other non-crystalline materials have no preferred orientation, however. Engineering analysis is able to show that, with knowledge of the fracture patterns of brittle materials (empirical in the case of early cultures), even primitive toolmakers could achieve the astonishing consistency of fracture patterns that has been observed.

Centrally perforated stone disks found in the southwestern United States may have been used as flywheels for drills. If so, the string drill, the twist drill, or the pump drill could have been known in early California.

Obsidian ear spoons or plugs are among the most remarkable Central American pre-Columbian artifacts, because of their beauty, fragility, their paper-thin uniform walls, and their high axial symmetry. A relatively simple scheme was suggested for their manufacture: a rough, previously prepared and drilled core could be lapped by means of a self-centering mechanism, the principle of which may have been borrowed from weaving techniques that were well established in early antiquity.

Thomsen closed with a plea that appears applicable to the sense of the symposium: for continued and increasing exchange of the special knowledge developed in all disciplines.

FRED H. STROSS

*Department of Anthropology,
University of California,
Berkeley 94720*

Note

1. This symposium, held 23 June 1970, was part of the 51st annual meeting of the Pacific Division of the American Association for the Advancement of Science, which met on the campus of the University of California, Berkeley. It was cosponsored and supported by the California Section of the American Chemical Society and the San Francisco Society of the Archaeological Institute of America.

THE UNIVERSITY MUSEUM



UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS
PHILADELPHIA, PA. 19104

CABLE ADDRESS "ANTIQUE"
TELEPHONE: EVERGREEN 6-7400
(AREA CODE 215)

May 4, 1971

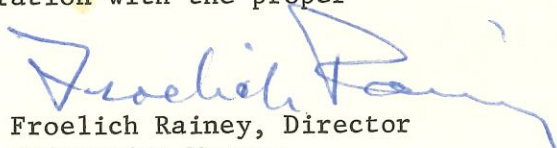
To Whom It May Concern:

Elizabeth K. Ralph, Associate Director of the Applied Science Center for Archaeology in the University Museum, University of Pennsylvania, Philadelphia, Pa., U.S.A. is duly authorized and delegated to take the equipment in her possession from Italy to France and from France to Italy or to any other European country. This authorization includes Great Britain and Greece.

The items of equipment in her possession are as follows:

- 1) Precision Portable Cesium Magnetometer, manufactured by Varian Associates, Palo Alto, California. Components include:
2 Readouts Nos. 49-116-90 and 49-116-93
2 Sensors Nos. 49-544-90 and 49-544-23
3 30-volt battery packs
1 Battery charger
Miscellaneous cables, carrying straps, tapes, and spare parts
- 2) Model V-4971 Portable Search Magnetometer, manufactured by Varian Associates, Palo Alto, California. Components include:
1 Audio Readout
1 Sensor, No. 49-544-195
1 30-volt battery pack
1 Battery charger
Miscellaneous cables, straps, and spare parts
- 3) 1 Tektronix Portable Oscilloscope Type 321, manufactured by Tektronix Inc., Oregon
- 4) 2 Triplet Model 310 Voltmeters
- 5) 1 Auto transformer, 220-110- volts, etc.
- 6) Miscellaneous hand tools for electronics repair
- 7) Notebooks, tape measures, simple drafting tools, etc.
- 8) Equipment enclosed in 4 Halliburton suitcases

This equipment will all be used by Elizabeth K. Ralph and Bruce Bevan for the purpose of archaeological research in collaboration with the proper authorities in each country.


Froelich Rainey, Director
University Museum

FR/emf



MEMO

TO : Beth Ralph
FROM : Froelich Rainey
DATE : May 30, 1975

This is in connection with the instrument survey on Paros. The Greek boy, Schilardi, was in this morning and is leaving for Greece about July 20th. I am very keen on making that instrument survey and I wondered if we couldn't set something up for August, September or October where we use some of our foreign travel money from MASCA and I use my Discretionary Fund. He says we'd need no more than about \$1,500 to send you or Bruce out there and excavate a couple of soundings when the instruments pick up anomalies. He will be in touch with you after he arrives in Greece to see when he can set things up in Paros for this late summer or fall. If you think we can manage this, why don't you cable me in Artimino and maybe I could join you on Paros if it is in late August. In any case, we ought to decide when we hear from him whether we can do this and when. As you know, Orville is not enthusiastic about the Artimino site. If we could pick up something good on Paros, we probably could switch his attention there. Do let me know.

[1978]

Oldhay
Altarnun
Launceston
Cornwall
July 9 - 1978

~~Henry?~~

Dear Beth,

Maria and I are off to Greece for the Thera Conference on Aug. 17th and I am wondering if Henry or Sol or both are going also and what conclusions they have reached about the dating. Also I don't know whether either of them are now in Phlois. Could you let me know about their conclusions so I don't look too stupid when I get there! For me it is just for fun and for old times sake since I certainly won't be going any paper - but I gather from some article in the Sunday Times that there are some very different views on the explosion now being expressed and am curious about what develops at this meeting.

As you know we were in Morocco in May as guests of the King and expect to go ahead on both projects

this fall with Bruce and Heryl - but
After I got the Smithsonian to sponsor
the work with Orville's Waverly Martin
Meyerson decided I should do the work
under the auspices of his office for the
U. S. P. so now I guess both are
sponsors. Also the conservation job,
a tremendous project, is to be done
commercially at Morocco's expense
and I am trying to get that up with
a contracting company. Surely it is
nothing MASA could handle in any
case even if I were allowed to do
anything with the University Museum!
I arranged with Bruce to do the
survey as an independent contractor
using his radar and hopefully a
magnetometer that he is to buy - but
I suppose he has told you all about
this - just now waiting for word from
Morocco about the time schedule.

sorry we missed you in
Pheta. We trotted over to the hospital
with a big bunch of flowers only to be
told you had left. Then we were off
again two days later for England.
I was very briefly in the Museum feeling

very uncomfortable even going in to
the place. What a business!

How are you doing? I have
not been doing so well myself - just
a few days after we got back here
I bought a horse and he bucked me
off and then stove in my ribs with
his knee so I have been suffering
about ever since with three broken
ribs and a pinched nerve which
gives me very sore arm. But I
got about again and am able to do
a bit of carpentry again - but no
riding for three months - Hell to
set old, I think, all too brittle and
slow to heal.

Also what happened to
Morka? I had the feeling the whole
place was going to hell but maybe
that's only your paper - Glad I
bought a lawyer for the job, in any
case, and must admit I was wrong.

Maria sends her love -

All the best

Fro

I'm going to see doctor for my back
and I'm worried about it. really it
isn't - probably my own fault
that - probably back or joints next to
and pain about top of the back and
and below it and stretch of the
the whole part in with with the
inching and and I get back and
probably with the same way
inches even back in a few days
to the B. now work with
to to do and in some things
and to do - in the things to do
to do - stretch and
and stretch out and stretch
back of work

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and stretch out and stretch
back of work

Tom Lyons
382-2571
United 2:37

19 July 1978

Dear Fro,

Thank you for your letter of July 9th. That is good news that you and Marina are going to the Thera Conference. Henry, Gail, and Martin Biddle are going too. Under separate cover, as "printed matter", I am sending you copies of Henry's and Biddle's and Ralph's articles. We are in the process of dating more samples from Thera, and they are running about the same - more than 50% are too early when corrected. Gail's paper is on Minoan dates in general, and is in typical archaeological jargon - a lot of talk and no tables or figures.

Bruce just wrote to you, so you should have his letter long before this, especially if we have a mail strike.

Thank you for coming to see me in hospital. I won't say that I am sorry that I wasn't there, but I do regret that I missed seeing you and Marina. I am still not walking well, but I am O.K. otherwise. I was sorry to hear about your broken ribs.

MASCA is still alive, and Fleming is not coming until late August. Frankly, I can't stand him, so I'll stay mostly in the ¹⁴C lab. In October there will also be a replacement physicist for Mark, and he seems to be O.K.. The new NSF grant was turned down, but Biddle has found a fund to support MASCA for at least a year and possibly two.

Our project at Valley Forge is going well. We have covered more than half of the specified 50 acres with the magnetometer and Bruce is now using his soil-penetrating radar. Someone held up our permission to excavate, but we are now going ahead. So far, we have found a long (8') lightning rod, patches of magnetic soil, and just recently, a house foundation. (The hearth made a nice magnetic anomaly). The crew of workers is excellent and they all seem to enjoy their jobs.

My best to you and Marina,

Dominant le Vieux-Port...

Face à la colline de

Notre-Dame de la Garde...

Marseille, le

Tuesday 16 Feb

197

Hôtel***A

"LA RÉSIDENCE DU VIEUX-PORT"

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13-MARSEILLE (2^e)

Téléphone } 20-02-90
20-44-63

R. C. Marseille 125.014 B

Dear Beth,

I will send you Rome
(when I know it will get mailed!)
by air this letter and soil
samples from Algeria - Also large
letter to Arville all about the place, which I
asked him to send as to you so I wasn't have to
repeat it all - I think he likes these reports
from the field and God knows he pays for them!
(air photos - pictures - dope on land &
site, etc) you will see this looks good
archae. if not ~~polit~~ politically - bloody
French - as bad as Italians were -

Flying out to Rome today - no
plane from Bastia to Nice yesterday so returned
from Corsica via Marseille - Also to have
another letter will you tell Pritchard that
I had the Ministry address for Malraux only -
my letter did not reach him - his phone at
his Minister's Chateau unlisted and Tutbill
office Paris expects to find number and I can
phone him from Rome - Hense Jim, or
David, has not heard from the re. Malraux.
But understand he is very depressed - very old - and

Oldhay Farm
Altamun
Lanvester

Cornwall -
Sept. 15

Dear Beth,

Since you had no word
from me you will know that
I could not arrange that
darned Gov. to Gov. agreement they
~~insisted~~ insist upon in time to get
the magnetometer and operator over
here this summer. It is all a long
story which I will explain when
I see you in October but in effect
it will all come right sometime
during the fall and we will proceed
with the new brick job and the
mag. survey later in the year.

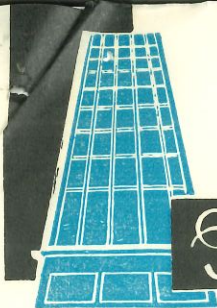
We have the house and
the land at Oldhay (so now we
go back to the old name of Oldhay farm)

but are waiting for the furniture
shipment - in England - but to be
trucked down from Hereford - and
staying at a quaint Georgian
Hotel in Hereford - just under
the Castle hill. All the business
of Maria's leg and the business
in Robot has delayed plans a
bit but I should be back in
Phila. early in October for
about a month in Wash. + Phila.

Hope everything is well
with you and "the shop". We
are very pleased with the whole
Cornwall set-up -

All the best,

Fro



Hotel Alexiou ALEX

BUILT IN 1960

18, VENIZELOU STR. - ATHENS - GREECE

c/o Prof. Sp. Marinatos
47, Polyta St.
Athens 903

CABLES: ALEXHOTEL - ATHENS
TELEPHONE: 624.201

Dear Fro,

So far everything is going as planned. I had dinner with Adamasteanu in Rome, but he is a clever one. He is not going to show me the results of his IR photography until I go to work with him about June 19th. He wants me to bring Giacinto & Nunzio, & he says that he will pay for them, so that is fine.

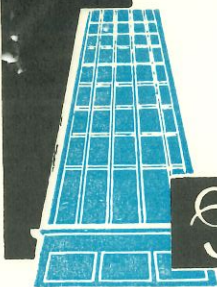
We had 2 days in the field before I left for Greece. The fields north of the long wall were filled with very tall grain so we did 2 big grids in Parco del Cavallo where criss-cross patterns showed in the IR photos (see sketch). There were anomalies everywhere, but I have indicated only the pronounced ones. Think, possibly, that if we covered this whole area around the "scavo", we could map out some part of Copiae-Thurii. But, then, it is Roman, & probably the melons will be too high when I return.

Greek customs was very difficult - they opened everything, and I don't think that I would have gotten thru with the magnetometer if Prof. Caskey hadn't been on board - he saved the day with his good Greek & influence.

Marinatos says that the new government is much better for the universities, archaeology, etc., but he is terribly busy meeting with various ministers, so we're leaving for the island tomorrow instead of today. Also, Mavon is supposed to land today.

Saluti, Beth

Scale of photo 1:12,500



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