

University of Pennsylvania News Bureau  
The Museum of the University of Pennsylvania  
33rd and Spruce Streets  
Philadelphia, Pa. 19104

Dr. Rainey  
Techniques

For information, call: Joseph P. McLaughlin  
EVergreen 6-7400 or KIngsley 6-1830

FOR RELEASE 12 NOON FRIDAY, NOVEMBER 12, 1965

Archaeologists and physical scientists of the Applied Science Center of the University Museum of the University of Pennsylvania and Oxford University have developed a method of accurately dating pottery by thermoluminescence, Dr. Froelich G. Rainey, director of the Museum, announced today. Dr. Rainey presented the data in a paper delivered before the Autumn General Meeting of the American Philosophical Society in Philosophical Hall, Philadelphia.

The discovery is a significant break-through because pottery, a product made by man for the past 6,000 or 7,000 years, is the most common artifact found at sites of ancient civilizations, but it cannot be dated by the Carbon-14 method which is restricted to dating the remains of organic matter. Also, pottery is contemporaneous with ancient cultures, whereas remains of organic matter could antedate or follow the culture under investigation.

"The thermoluminescence technique for dating pottery has been under investigation for more than ten years," Dr. Rainey said, "most recently at the Research Laboratory for Archaeology and the History of Art in Oxford and at the Applied Science Center for Archaeology in the University Museum.

"Today, I am pleased to announce here that only within the last few months, the method has been worked out so that accurate dating of pottery is now possible." Dr. Rainey explained the technique thus:

"Radiation from the minute traces of radioactive elements (primarily thorium and uranium) in pottery clay bombard other substances in the clay and raise electrons to metastable levels. When the clay is fired in the kiln each electron falls back to its stable position and emits a photon of light. Then when a fragment of ancient pottery is reheated in the laboratory, the amount of

(MORE)

thermoluminescence observed is representative of the accumulated radiation damage and hence of the time elapsed since the original firing of the pottery.

"As I understand it, the basic principle is straightforward but there were many uncertainties and difficulties facing the scientists who have explored the adaptation to a dating technique for pottery."

Dr. George F. Dales, also of the University Museum staff and assistant curator of the South Asia Section, read another paper at the same session on recent trends in South Asian archaeology. Dr. Samuel Noah Kramer, Curator of Tablet Collections of University Museum, presided over the Symposium.

The University Museum's work with thermoluminescence was one of several methods of dating ancient cultures and artifacts that have been developed, or are in the process of development, as a result of new knowledge in the field of nuclear fission, by Museum scientists and those in a number of institutions in the United States and abroad which were discussed by Dr. Rainey. His paper was titled "New Techniques in Archaeology." He gave much of the credit for the development of the method of accurately dating pottery to Elizabeth K. Ralph, assistant director of the Applied Science Center, and Mark Han, Research Associate at the Center.

Dr. Rainey also cited the application of the potassium-argon, rubidium-strontium, uranium and lead isotope methods of dating developed during the post-war years. These, he said, are of primary importance in calculating geological time, but they are also applicable in dating the earliest stages in human development in a probable range of from one and one-half million to 0.36 million years. Predictable improvements in the rubidium-strontium method will, he said, make it applicable in early Pleistocene ages when applied to obsidian and acid volcanic rock.

(MORE)

Still another new method of radioactive fission track dating was described by Dr. Rainey as now being applied to natural and man-made glasses.

Dr. Rainey continued his paper with a discussion of the successes achieved by the University Museum with underwater archaeology. He described the research by George Bass of the Museum staff on sunken hulks and other objects well below the sea's surface, most recently with the use of a two-man submarine constructed for the Museum by the Electric Boat Division of the General Dynamics Corporation.

"There is one aspect to this research into the new technology of archaeology which in the long run may be most significant," Dr. Rainey concluded. "For **once** in a very small way to be sure, some of us interested in the humanities are working directly with the physical scientists on specific research projects to solve technical problems of concern to us both. Here we are at least crossing over between the two worlds of science and the humanities in a very practical day-to-day experience."

Dr. Dales noted the revival of interest in the archaeology of South Asia since the partition of India and Pakistan in 1947. The trend, he said, has been to re-examine and re-evaluate prehistoric phases in terms of internal evidence as opposed to the earlier method of relating everything to the better known sequences of the Near East and Europe. Modern archaeological techniques, he said, also introduce the cooperation of the natural and physical sciences in interpretation of archaeological evidence.

"Considerable attention has been focused on the Indus (Harappan) civilization, the earliest civilization of South Asia, contemporary with ancient Egypt and Mesopotamia," Dr. Dales said. "Some of the most recent investigations were

(MORE)

conducted this past winter by the University Museum, with help from the American Philosophical Society, at Mohenjo-Daro in the lower Indus Valley, West Pakistan. These were the first major excavations in more than 30 years at this largest and best preserved Harappan city."

Dr. Dales reported that the new excavations were designed to obtain a complete sequence of architecture and artifacts from all levels with the hope of obtaining new insights into the origin, life and decline of the vast civilization. Environmental studies, especially concerned with the history of flooding, are part of the overall program, he said.

"Dramatic new information has already been obtained which suggests that massive floodings of an unusual nature were one of the major causes of the decline of Mohenjo-Daro and the Harappan civilization," Dr. Dales told his listeners.

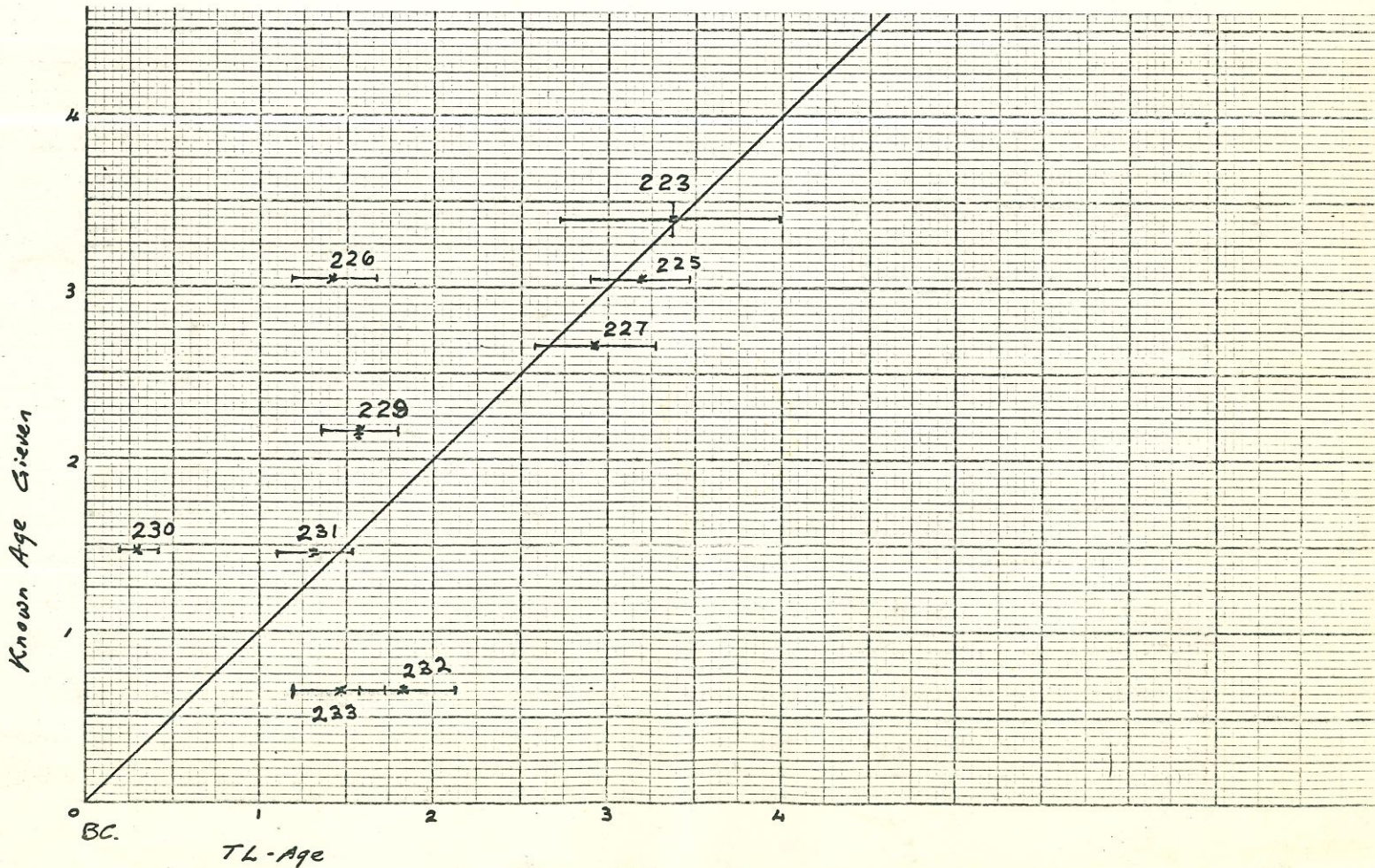
April 10, 1970

To: Dr. David O'Connor Egyptian Section

Re: Results of TL-dated Egyptian Known-age sherds.

The following eleven sherds (P-T-223 - 233) were processed in ASCA Lab., resulting TL-age was calculated from our Known-Age Calibration Curve.

Sample No. P-T-	Known-age given in BC	TL-age in BC	Alpha activity C/hr.
✓ 223	3500-3300	3362 ± 630	17.2 ± 0.4
- 224	3500-3300	No N-TL	16.2 ± 0.3
✓ 225	3050	3180 ± 283	12.1 ± 0.3
check I Dyn burning check NK X 226	3050 ← 1500 →	1416 ± 240	11.0 ± 0.2
✓ 227	2660	2926 ± 350	6.94 ± 0.28
- 228	2494-2133	Off Scale	1.10 ± 0.16
check obs. date X 229	2181-2133 — 600 —	1570 ± 227	15.7 ± 0.3
check off for water → X 230	1504-1450 ← 200 →	300 ± 111	16.1 ± 0.4
✓ 231	1450-1425	1317 ± 217	6.40 ± 0.3
check by eye { - 232	689-609	1846 ± 278	7.95 ± 0.31
- 233	689-609	1452 ± 264	7.35 ± 0.24



Research Laboratory,  
THE BRITISH MUSEUM,  
LONDON, W.C.1B 3DG

AEAW/EB

8th September, 1970.

Dear Beth,

I should very much like to have an offprint of the article by yourself and Mark C. Han "Potential of Thermoluminescence in Supplementing Radiocarbon Dating", which appeared in World Archaeology Vol. 1 No.2 pp. 157-169 (1969). I would like to have this offprint for our radiocarbon file.

With all best wishes,

Yours sincerely,

*Elizabeth L. M. Taylor*

*E* A. E. WERNER  
KEEPER

Miss E. Ralph,  
University Museum,  
University of Pennsylvania,  
PHILADELPHIA, Pa.,  
U.S.A.

TO OPEN SLIT HERE

SENDER'S NAME AND ADDRESS

Dr. A. E. Werner,  
Research Laboratory,

The British Museum,

London, W.C.1.

AN AIR LETTER SHOULD  
NOT CONTAIN ANY ENCLOSURE;  
IF IT DOES IT WILL BE SURCHARGED  
OR SENT BY ORDINARY MAIL

3/17/71  
EKR

file

Dating of Pottery  
by  
Thermoluminescence

The phenomenon of thermoluminescence (TL) provides a means of dating pottery and other fired ceramics. As the name indicates, heat and light are involved. Not so obvious is the fact that natural radioactive isotopes are essential.

The mechanism for the production of TL is as follows:

(1) Particles such as alphas, betas, and gammas from radioactive disintegrations of uranium, thorium, and potassium inherent in the mineral constituents of clays bombard the quartz (or possibly other components susceptible to radiation damage), and in doing so, they cause electrons to be excited. These electrons move from ground states to so-called metastable levels.

(2) These few excited electrons remain in metastable levels until the clay is heated. The heating, or rather firing, of the clay supplies enough additional energy to enable the electrons to return to their original ground levels or states. As they do so, energy is released in the form of photons (ordinary particles of light).

For the dating of pottery by TL, three basic measurements are required. ~~and~~ For all of them, the pottery is first ground to a fine powder. These are as follows:

1) The Determination of the Inherent Radioactivity.

Most of the production of TL, or in more technical terms, the radiation damage, is caused by the disintegration of uranium and

thorium. In the decay series of these elements, alphas, betas, and gammas are emitted. Even though we do not know the relative effects of alphas versus betas, gammas, and x-rays (the latter three behave similarly in producing radiation damage), we know that the total rates of disintegration are proportional to the alpha rates. Therefore, we may obtain a relative determination of the total dose by measuring the alpha rates - the particles which are the easiest to detect at these low rates of disintegration - usually about 20 per hour.

As a refinement, the total inherent potassium content can be measured by chemical techniques such as flame photometry. Then the small contribution from the fraction of radioactive  $K^{40}$  (a beta emitter) can be calculated. Also, if soil samples which surrounded the ~~pottery level~~ <sup>Pottery</sup> in situ have been collected, these can be measured for inherent radioactivity, and a small correction for this contribution from external sources can be made. Similarly, if the depth of an in situ collection is known, a very small correction may be applied for the contribution from cosmic ray bombardment of the pottery.

2) Measurement of Natural TL.

This is the light emitted from natural causes, primarily from the bombardment by the inherent radioactivity. It is measured in the laboratory by rapid reheating of a small portion of powdered pottery. From this reheating, a "glow" curve is plotted on an X-Y recorder. This glow curve is a measure of the accumulated photons in the form of light detected by a sensitive photomultiplier tube

versus the rate of heating as detected by a thermocouple. For pottery of different ages, but with identical inherent radioactivities and susceptibilities to radiation damage, the higher the peak of the glow curve, the longer ago the pottery was last fired.

### 3) Measurement of Susceptibility to Radiation Damage

The third measurement is the determination of the susceptibility of the pottery to radiation damage, that is, the effect that the bombardment of the quartz component by the alphas, etc. in this particular sample has in producing TL. This measurement is made on the same small samples that were used for the natural TL. These are subjected to a fixed dose of radiation (usually x-rays for convenience), and then the glow curve is remeasured. The peak height of this curve, usually greater than that of the natural, is used as a correction factor in the calculation of a TL date.

In summary, the essential features of TL dating are the measurements of the inherent radioactivity, the natural, and the artificial glow curves. These three, as well as a calibration curve based on the measurements of pottery of known ages, tell one the date of last firing of a piece of pottery of unknown age. Depending upon the homogeneity of the pottery - the more fine-grained the better - the uncertainty in TL "dates" is now of the order ~~of~~ of  $\pm 100$  years, but is sometimes greater.

For the measurement of the glow curves, only a few milligrams are required, but since the normal inherent radioactivity is so low, ~~it is~~ it is necessary to have 3 grams for the alpha counting. This last dictates the sample size requirement at our present stage of development.

Foundation Deposit Pottery and Faience  
in Various American Museums

and British

ISKANDER CHRON.

<u>Dynasty XVIII</u>		<u>Pottery</u>	<u>Faience</u>
Ahmose	1575 - 1550 B.C.	C	-- BERLIN
Amenhotep I	1550 - 1528	--	--
Tuthmosis I	1528 - 1510	--	--
Tuthmosis II	1510 - 1490	--	--
{ Hatshepsut	1490 - 1468	C, NY, B	C, NY
{ Tuthmosis III	1490 - 1436	P, BM, ASH, UC	-- UC, ASH
Amenhotep II	1436 - 1413	C, P, UC	-- BR
Tuthmosis IV	1413 - 1405	--	-- NY
Amenhotep III	1405 - 1367	--	--
Amenhotep IV	1367 - 1350	-- BM	-- BM
Semenkhkare	1350 - 1347	--	--
Tutankhamun	1347 - 1339	-- C (Embalming cache)	--
Ay	1339 - 1335	-- C	C
Haremhab	1335 - 1308?	--	--
<u>Dynasty XIX</u>			
Ramesses I	1308	--	--
Sety I	1309 - 1291	--	--
Ramesses II	1290 - 1224	C, P, UC	C, NY, P, UC, ASH
Merneptah	1224 - 1214	--	-- UC
Sety II	1214 - 1208	--	NY, B, UC
Amenmesse		--	--
Siptah	1208 and later 1208 - 1202	P	C, ASH, UC
Twosret	1202 - 1194(?)	--	C, NY, ASH
[Kingless period of about 10 years.]			
<u>Dynasty XX</u>			
Setnakht	1184 - 1182 B.C.	--	--
Ramesses III	1182 - 1151	C?, NY	C, NY, B
Ramesses IV	1151 - 1145	C, NY	C, NY, P
Ramesses V		--	--
Ramesses VI		--	--
Ramesses VII		--	--
Ramesses VIII		--	--
Ramesses IX		--	--
Ramesses X		--	--
Ramesses XI		--	--

ASH = Ashmolean Museum

P = Philadelphia

B = Boston, Museum of Fine Arts

NY = New York, Metropolitan Museum of Art

C = Chicago, Oriental Institute

BR = Brooklyn Museum

UC = University College, London

BM = British Museum

## Remarks:

Potentially available materials span time period 1575 - 1145 B.C., that is 430 years. Because of gaps (see attached list), it seems best to start with Hatshepsut (1490 B.C.) and continue through to Ramesses IV (1145 B.C.), a span of 345 years. For the latter period, samples are available from reigns of 14 kings, and materials from 5 of these reigns are available from more than one source.

A potentially meaningful comparison of pottery and faience is possible.

Faience (not pottery) may be plentifully available also for the XXIst dynasty.

# Preliminary outline of budget:

	<u>1st year:</u>	<u>2nd year:</u>
Salaries:		
Mark Han	2000	2500
Student assistant, part-time	3600	3600
Equipment:		
Two alpha counters (to count up to 50 samples)	4000	—
Supplies:	1500	2000
Travel (foreign and domestic)	1000	500
Overhead:		
11.1% employee benefits	622	677
30.0% of employee salaries*	1680	1830
Totals	<u>14,302</u>	<u>11,107</u>
Grand Total		<u><u>25,409</u></u>

\* Results in free tuition for student assistant

4/14/71

# Thermoluminescence Dating of Egyptian Faience

by

MASCA

Preliminary experiments with three objects indicate that ancient Egyptian faience does exhibit the phenomenon of thermoluminescence (TL), that is, the artifacts give off light when heated. X-ray irradiation of these same objects shows also that faience is susceptible to radiation damage in a manner similar to pottery. However, faience, since it consists mostly of quartz, does not contain traces of uranium and thorium. This fact was confirmed in tests with our alpha counters - there were no alpha disintegrations. Therefore, the natural TL of faience must be due to three causes - namely,

1.  $K^{40}$  inherent in the faience
2. Irradiation from natural radioactivities within and surrounding the tombs or other burial sites
3. Cosmic ray exposure.

The first can be determined by analyzing (by flame photometry) the total potassium content of each object, and calculating the dose from the known ratio of  $K^{40}$  to total K. The second and third can be determined by placing dosimeters (small vials of  $CaSO_4$  doped with dysprosium or other suitable phosphors) in the tombs from which the faience artifacts have been excavated. After six months to a year have elapsed, the dosimeters can be brought back to the laboratory and the TL that they have accumulated

will give a relative measure of the external radiation dose (items 2 and 3) that the objects have received.

This project appeals to us in that it involves some new techniques, and as far as we know, has never been done before. For the purpose of the foundation, it may be the ideal technique for dating or comparing the relative dates of the 21st, 20th, and 19th dynasties. The main reason is that abundant samples of faience representative of these periods are available and expendable. We anticipate that the technique will be successful for relative dating and might, possibly, furnish absolute dating as well if enough corollary experiments are performed.

BUDGET - TL Dating of Egyptian Faience

1<sup>st</sup> Year

	Proposed Funds
Salaries	
Research Assistant - (Graduate student, full-time in summer & half-time during academic year)	\$3600
Employee Benefits (14.1%)	508
Overhead (34% of salaries)	1224
Equipment	
Recording Spectrophotometer with Flame Attachment	7000
Office Equipment & Supplies	500
Expendable Equipment & Supplies	
Dosimeters	200
Nitrogen	150
Recorder chart paper	100
Aluminum foil, graphite, grinding supplies, etc.	<u>300</u>
sub-total	<u>750</u>
Travel	
Henry N. Michael, travel to Egypt to collect dosimeters & to USA museums	2500
Mark C. Han, transportation & expenses	<u>1000</u>
Total First Year	\$17,082

BUDGET - TL Dating of Egyptian Faience  
2<sup>nd</sup> Year

	Proposed Funds
Salaries	
Research Assistant (Graduate student, full-time in summer & half-time during academic year)	\$3600
Employee Benefits (14.1%)	508
Overhead (34% of salaries)	1224
Expendable Equipment & Supplies	
Nitrogen	170
Recorder chart paper	110
Aluminum foil, graphite, grinding supplies, etc.	330
Supplies for potassium analyses	250
sub-total	860
Travel	
Henry N. Michael, USA museums & meetings	500
Mark C. Han, transportation & expenses	1200
Total Second Year	7892
Total Two Years	\$24,974

JOHN FRYE

Route 1 Box 153 Kilmarnock, Virginia 22482

November 13, 1971

Miss Elizabeth K. Ralph  
University of Pennsylvania Museum  
Philadelphia

Dear Miss Ralph:

Many thanks for sending me the offprint of your and Mr. Han's article on thermoluminescent dating. It will be most useful.

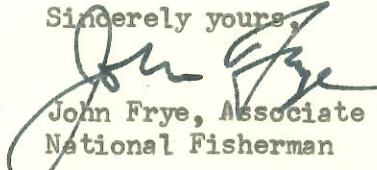
I note this at the bottom of page 167:

"The ages of most samples may now be determined with a precision of plus or minus 200 years."

My understanding was that the shard submitted by Fred Dickson as a possible artifact from the Santa Maria was dated to 1475, plus or minus one hundred years. If you did the work on it, can you clarify the situation for me, please?

I will pass the offprint around among some people digging among 17th and 18th century ruins around here. They ought to find it helpful too.

Sincerely yours,

  
John Frye, Associate Editor,  
National Fisherman

November 16, 1971

Mr. John Frye  
Rt. 1, Box 153  
Kilmarnock, Va. 22482

Dear Mr. Frye:

On p. 167, we made a general statement about the uncertainty in TL dating -- namely,  $\pm 200$  years.

The uncertainty for a particular sample can vary widely from this depending upon the consistency of replicate runs. For homogeneous pottery such as that from the Santa Maria, the uncertainty may be much less.

Sincerely yours,

Elizabeth K. Ralph

EKR/ek

February 17, 1972

Dr. Luis N. Alberti  
599 W. 190th St.  
New York, New York 10040

Dear Dr. Alberti:

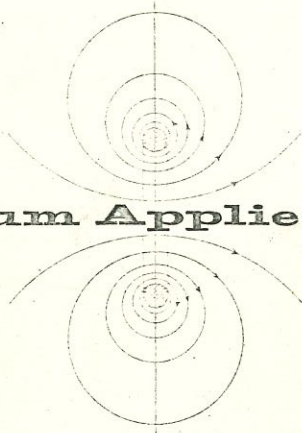
In response to your letter of February 10th, I have enclosed a reprint of one of our articles on the subject of dating pottery by thermoluminescence.

The technique seems to work reasonably well, but we accept samples for dating only if they are of importance to the curators of our Museum.

Sincerely yours,

Elizabeth K. Ralph

EKR:ek



**Museum Applied Science Center for Archaeology**

Froelich Rainey, Director

Elizabeth K. Ralph, Associate Director

THE UNIVERSITY MUSEUM • UNIVERSITY OF PENNSYLVANIA  
33rd & SPRUCE STREETS • PHILADELPHIA, PENNSYLVANIA 19104  
386-7400 (Area Code 215) Cable Address "Antique"

Apr. 4, 1972

To: Dr. H. N. Michael

From: Mark C. Han and D. Hancock, MASCA

Ref.: Six sherds from Medinet-Habu, Egypt, dated by thermoluminescence.

(P-T-293-A,B,C,D,): Four sherds from interior of mud-wall  
surrounding temple complex.

Wall rebuilt during XXI st. Dynasty.

(Two sherds (A & B) are from thick-walled vessels,  
two sherds (C & D) are from thin-walled vessels.)

(P-T-294-A,B,): Two sherds are from interior of wall, i.e.,  
embedded in wall.

(A) is from a thick-walled vessel, the other (B)  
from a vessel of medium wall-thickness.

The TL dates are based on MASCA Known-age samples.

<u>Sample No.:</u>	<u>Wall type:</u>	<u>Alpha activity:</u>	<u>TL Date:</u>
P-T-293-A	Thick	8.33 ± 0.19 C/hr.	3,000 B.C. ± 250
-B	"	7.53 ± 0.21	2,100 B.C. ± 300
-C	Thin	7.10 ± 0.18	A.D. 700 ± 150
-D	"	7.49 ± 0.25	1,300 B.C. ± 300
P-T-294-A	Thick	7.63 ± 0.17	2,700 B.C. ± 200
-B	Medium	8.46 ± 0.16	1,200 B.C. ± 230

20 September 1972

Dr. Anna Marguerita McCann  
Department of Art History  
University of California  
Berkeley, California 94720

Dear Anna,

Your samples for C<sup>14</sup> dating have arrived safely.

In regard to the instrument survey that I did at Cosa, there seems to be no record in our files.

As I remember I used the cesium magnetometer (described in the enclosed reprint) in the level area between the canal and the embankment. I found that the earth was highly magnetic and that the readings were so variable that a magnetometer survey in that area was useless for the detection of archaeological features.

We used the Geohm (resistivity instrument) just below and up (and down) the embankment, but the anomalies detected at the juncture were probably caused by the change from wet to dry ground.

Sorry that I cannot remember more.

With best regards,

Elizabeth K. Ralph

EKR:lsy

Enc.

September 23, 1972

Dr. Robert McGhee  
Department of Sociology and Anthropology  
Memorial University of Newfoundland  
St. John's, Newfoundland, Canada

Dear Dr. McGhee:

Thank you for your letter of September 19th. Your find of a bronze bowl in the Canadian Arctic sounds very exciting, but unfortunately, we cannot date metals by thermoluminescence - only pottery and similar semi-conductors.

As far as we know there is no way to date metals unless their lead contents are very high, and this technique is far from precise.

Sincerely yours,

Elizabeth K. Ralph

EKR/11

December 20, 1972

Mrs. John Bunker  
The Denver Art Museum  
100 West 14th Avenue, Parkway  
Denver, Colorado 80204

Dear Mrs. Bunker:

Ellen Kohler has asked me to reply to part of your letter of October 23rd.

We have finished our thermoluminescent (TL) tests of the figure of the Hacilar type, but unfortunately, the tests were inconclusive. For TL dating, we measure three components - the natural TL, the inherent radioactivity, and the susceptibility of the pottery to an artificial fixed dose of radiation. This figure (our No. P-T-306) had very low natural TL, no inherent alpha activity, and unusually low susceptibility to the artificial dose.

These atypical results make us suspect too that the figure is not genuine, but we must state that we were unable to date it.

We shall return the figure under separate cover.

Sincerely yours,

Elizabeth K. Ralph

ER/sa

cc: Dr. Ellen Kohler, University Museum  
Mr. David Crowover, University Museum

January 6, 1973

Dr. Elizabeth Gardner  
Department of Anthropology  
University of California  
Los Angeles, Calif. 90024

Dear Dr. Gardner:

In AJA Vol. 74 (April 1970), I read a summary of your report entitled, "Ceramic Firing Temperature: A Simplified Method & Its Applications to Archaeological Problems."

In the summary, it is not clear to me exactly how one determines temperatures by this technique. May I trouble you to send me a fuller description?

Sincerely yours,

Elizabeth K. Ralph

ER/sa

Newsletters,  
Vol. 9 nos. 1 & 2  
sent Jan. 9 →

HENRY M. NOEL  
1056 SILVERMINE ROAD  
NEW CANAAN, CONN. 06840

December 23, 1973.

MASCA, Att: Dr. Elizabeth K. Ralph  
Department of Anthropology, University of Pennsylvania  
University Museum, 33rd and Spruce Streets  
Philadelphia, Pa.

Dear Dr. Ralph;

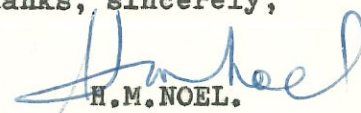
Professor Ralph Solecki of Columbia University has suggested that I write to you with reference to a thermoluminescence problem. I have read your 1968 paper on the subject, in the library of the New York Chemist's Club, and have consulted my friend, Bill Young of the Research Department of the Boston Museum who has recently installed the TL apparatus.

I have been interested in T'ang pottery since 1948-49 when I spent a year on General MacArthur's staff in Tokyo. The Japanese were great collectors of Chinese art and I patronized dozens of antique shops specializing in T'ang and Sung. These shops had to a large extent been rebuilt after the fire raids by our Air Force. Vast areas of Tokyo were completely burned out and one fire raid, for example, took an estimated 100,000 lives. In the intense heat generated, in the range of 1000-1500°C, I postulate that there must have been a diminution in the radioactivity of any pottery pieces involved in such a conflagration. This might even account for the number of presumably authentic T'ang articles which have been showing by TL test an indicated age of only between 100 and 200 years.

I became personally concerned when a T'ang horse which I bought in Tokyo in 1949 and recently sold through Sotheby Parke Bernet for \$20,000 was tested by Young at 119 years and by Fleming of Oxford at "less than 390" years .

I wonder if you will be good enough to give me your opinion (with which Messrs. Young and Fleming would no doubt concur) as to the possibility that the TL tests on pieces from Tokyo might have been influenced by exposure to fire. I am not a dealer but simply a member of the Oriental Ceramic Society of London who has inspected most of the T'ang horses on display in the shops and museums of London, Paris, Athens, Toronto, Boston, Philadelphia, New York, and Tokyo. I would greatly appreciate your advice as to the limitations of the TL test of age, as now practiced on specimens of ancient pottery, and if there are any competitive laboratory methods. Also, if your Museum does outside work, what the charges are.

With anticipated thanks, sincerely,

  
H.M. NOEL.

January 9, 1974

Mr. Henry M. Noel  
1056 Silvermine Road  
New Canaan, Connecticut 06840

Dear Mr. Noel:

Thank you for your information about the fires in Tokyo with estimates of the temperatures. Intense heat, even in the range of 600 to 700<sup>o</sup> C would wipe out the TL that ancient pottery had acquired. The heat might not have affected the inherent radioactivity, but it would have driven off all the photons (the sources of the TL signal), and therefore make the pottery appear to be modern, or 100 to 200 years old. The precision of the TL method, at best, is of the order of  $\pm$  100 years.

<sup>14</sup>C dating continues to be the main competitor and most reliable method of dating but, of course, this does not help with pottery which normally does not contain organic carbon. Other methods and some just now being developed are less reliable than TL. I have put your name on our MASCA Newsletter list, starting with vol. 9, nos. 1 and 2. In this Newsletter we try to describe new dating techniques as well as other endeavors.

Since one of our main objectives is to improve the technique of TL dating and to date series of excavated samples, we prefer not to accept outside work. To discourage it further, we request a donation of \$250 to the University Museum for each test.

We appreciate your alerting us to the hazard of the Tokyo fires because we have received a number of requests to date T'ang pottery. If you have any information about which collections were most likely to have been caught in the fires, we should be very much interested.

Sincerely yours,

Elizabeth K. Ralph

EKR/c

HENRY M. NOEL

1056 SILVERMINE ROAD, NEW CANAAN, CONNECTICUT 06840

January 16, 1974.

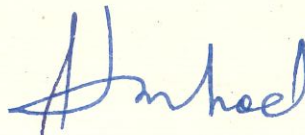
MASCA, Att: Dr. Elizabeth K. Ralph  
University Museum, 33rd and Spruce Sts.  
Philadelphia, Pa.

Dear Dr. Ralph,

Thank you for your letter of the 9th. I am taking the liberty of passing a copy of it to Bill Young of the Boston Museum, who recently acquired the TL apparatus. I sold four of the T'ang horses which I bought in Tokyo in 1948-9, in the Parke Bernet sale of October 12, 1955, lots #85, 87, 90, and 309. All of these were probably exposed to very high temperatures in the incendiary raids of 1944-5. I also sold a splendid glazed horse, said to have belonged to Prince Takamatsu, lot 92, which was probably not so overheated. The fine specimen which I sold at the Sotheby Parke Bernet sale of February 22nd, 1973, lot 80, was purchased in 1949 from a Tokyo shop in the zone of severe fire damage. I feel justified in questioning the indications of its recent TL tests.

The MASCA Newsletters have been received and I appreciate your kindness in putting me on your mailing list.

With best wishes, sincerely,



August 6, 1974

Dr. Prentiss S. de Jesus  
American Research Institute in Turkey  
71-7 Kennedy Caddesi  
Kavaklidere - Ankara  
TURKEY

Dear Prentiss,

We are very much interested in trying to date metal slags by thermoluminescence (TL). We do not guarantee success, but the few slags which we have tested do seem to have TL and to give dates that are not more than 400 years different from the dates anticipated. Also, in one comparison with a C<sup>14</sup> date, the difference was less than 100 years.

For each test, we like to have 10 to 15 grams of the sample. I hope that you will be able to send this much. Some of known age as well as a few companion C<sup>14</sup> samples would help to put us on firmer ground.

I have enclosed a sheet on which the items of information that we like to have are specified.

Sincerely yours,

Elizabeth K. Ralph

ENC:1

September 6th, 1974

I agree with Gieg that Tim should consult some experts in this field including Prof. Hargraves at Princeton.

I think it is a mistake, however, to do a project which requires equipment which we do not have. If he wants to build a spinner magnetometer, Dr. Philip Flanders in LRSM would be glad to talk to him. He would need \$2000 to \$3000 for a lock-in amplifier and other components.

From my experience in having measurements made at Princeton, if he used equipment at another institution, he would be last on the waiting list and if not allowed to make the measurements himself, he might not be sure of the results.

Elizabeth K. Ralph

September 4, 1975

Dr. R. E. Taylor  
Radiocarbon Laboratory  
Department of Anthropology  
University of California  
Riverside, California 92502

Dear Dr. Taylor:

Please excuse my delay in answering your letter of July 23. A trip to Europe and then two broken ribs upset my schedule.

About the NSF, we used to get grants from the Social Science Division (Anthropology), but they began to taper off about four years ago. Therefore, we went to the Special Projects Division (Dr. Murray Aborn), and have received two sizeable 2-year grants. However, we have been warned that there will be much less in the future. However, our work is not purely anthropological. The grants have supported thermoluminescent dating, archaeological prospecting instruments, aerial and balloon-kite photography, our information center, MASCA Newsletter, etc.

Probably this Special Projects Division is close to your idea of an interdisciplinary category.

For special C<sup>14</sup> projects such as the bristlecone pine dating, we go to the Earth Sciences Division, but recently they have been cutting our budget requests severely.

I hope that this information will be of some help, and that it is not too late.

With best regards,

Elizabeth K. Ralph

EKR/cat

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SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF ANTHROPOLOGY  
RADIOCARBON LABORATORY

RIVERSIDE, CALIFORNIA 92521

July 1, 1981

Dear AIA Member:

In early June of this year, representatives of several archaeological societies including the Archaeological Institute of America, met with a number of directors of radiocarbon laboratories in the United States to discuss current problems facing both the radiocarbon labs in sustaining their research and service functions and archaeologists concerned about obtaining high quality  $^{14}\text{C}$  determinations within reasonable time and budgetary frameworks.

Part of the work of the conference organizers is the collection of data from archaeologists concerning their views and anticipated requirements for  $^{14}\text{C}$  data over the next five years. A few minutes of your time to complete the enclosed questionnaire will be of great assistance in the process of accurately assessing both needs and priorities in the radiocarbon dating field for archaeology over the next decade.

You do not have to identify yourself if you do not choose. However, if you would like to obtain a copy of the data collected as part of this survey, as well as the report that is being developed, please include your name and mailing address and this material will be sent to you as soon as it becomes available.

Thank you very much for your help.

Yours truly,

R. E. Taylor

RET/js