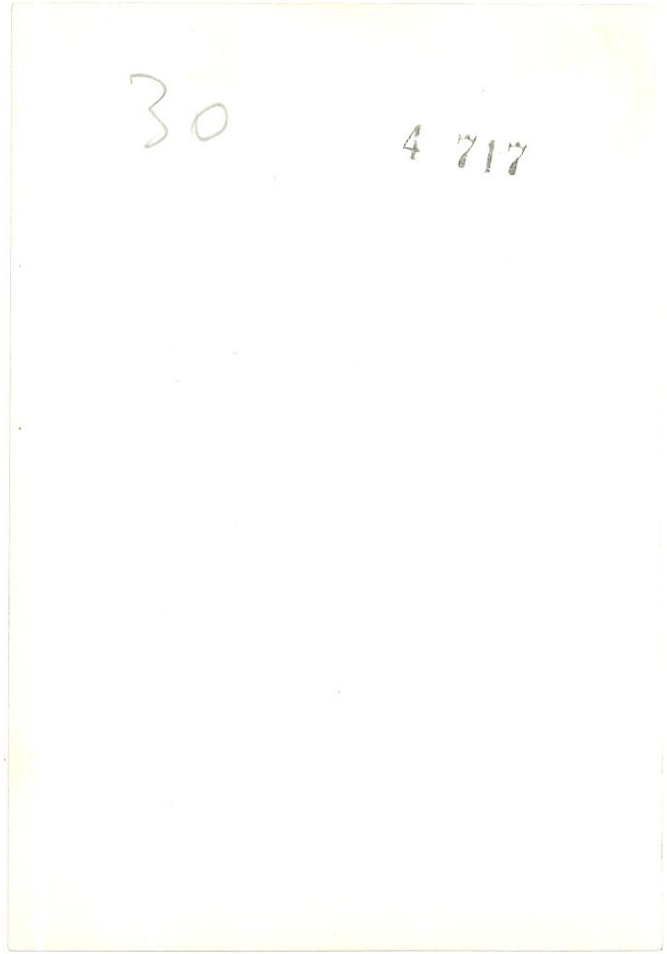
M. J. AITKEN
AERIAL PHOTOS (PRINTS)
ROMAN VILLA @ ISLIP NEAR
OXFORD ENGLAND
SUMMER 1972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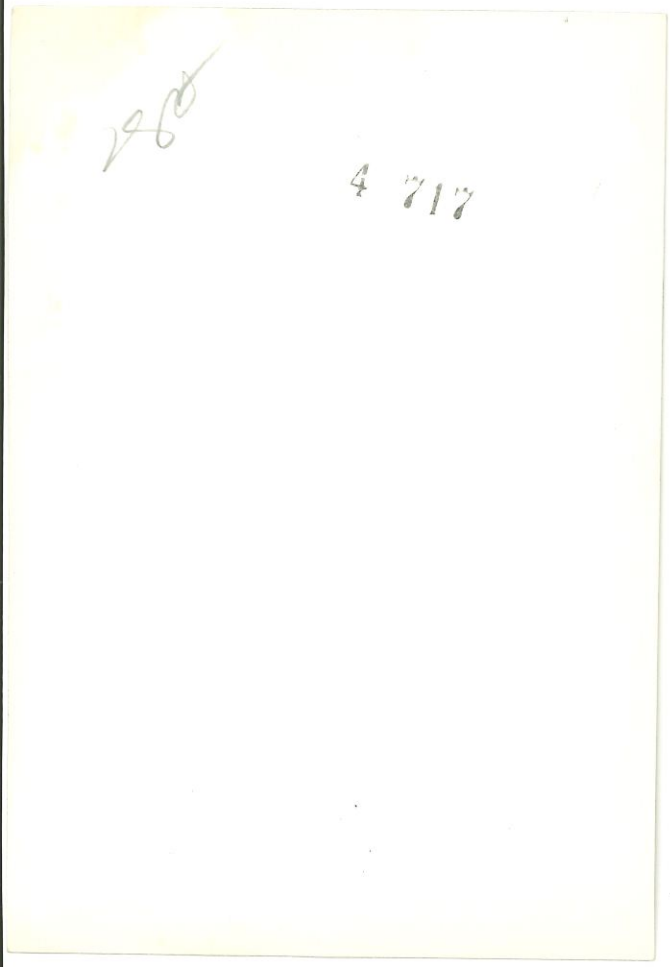
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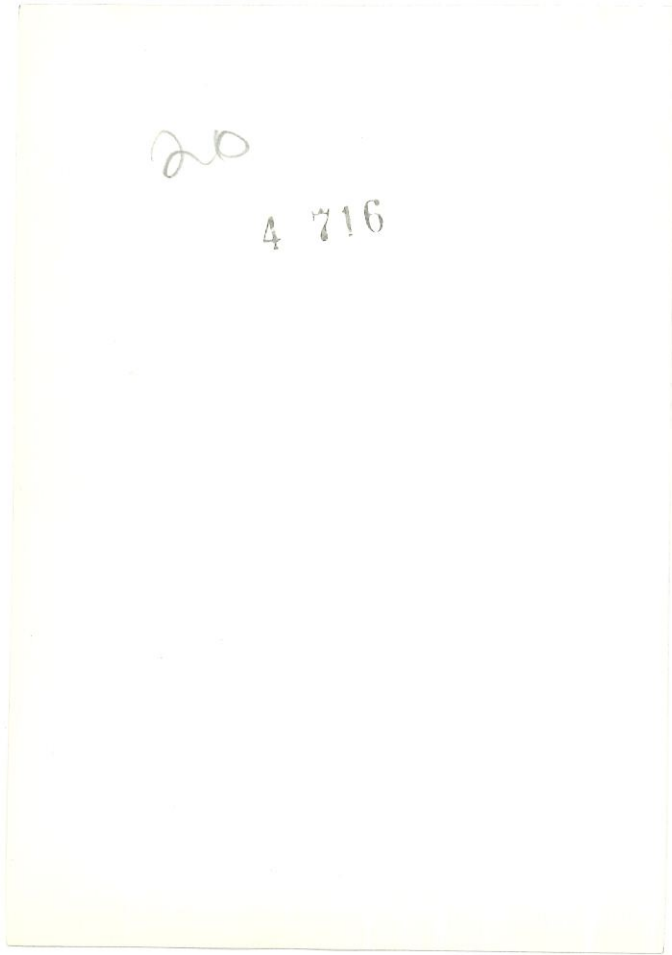
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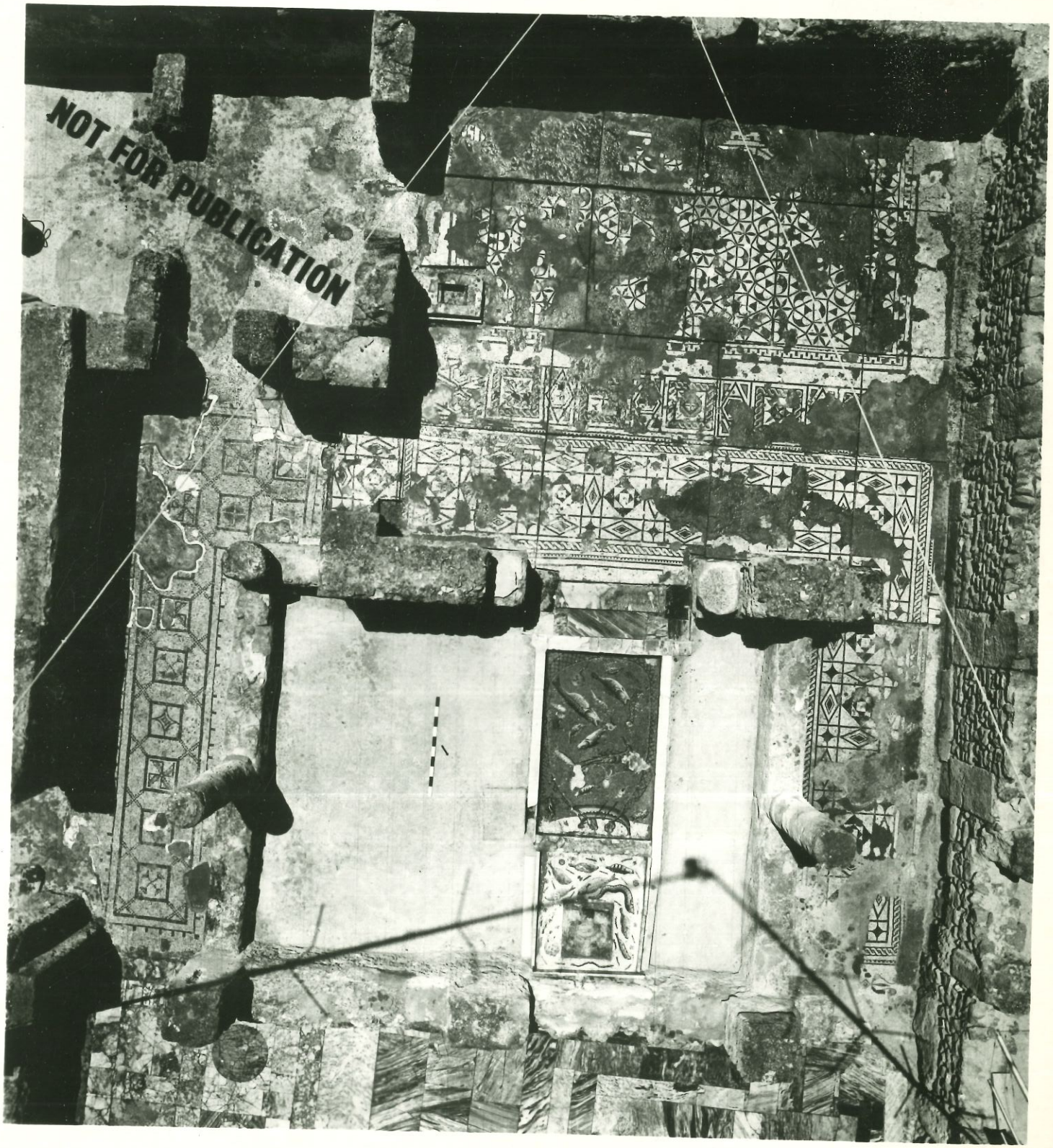

JULIAN HILL WHITTLESEY
21 UNION SQUARE, NEW YORK, N. Y. 10003

JULIAN HILL WHITTLESEY
31 UNION SQUARE, NEW YORK, N. Y. 10003

JULIAN HILL WHITTLESEY ARCHITECT FAIA

N E W S L E T T E R

Julian and Eunice Whittlesey

Salzburg
October 3, 1971

This letter skips lightly over a three and one half month archaeological season which recently closed with achievements beyond our expectations.

We left Paris June 16, in the new Peugeot 404 stationwagon for Munich, where the Piccard hot air balloon, "Cloud Nine", had arrived by air freight from Connecticut. We stopped en route at Augsburg to pick up one of our hydrogen balloons which had been enlarged by BALLONFABRIK. Thence on to Salzburg to collect our other balloon and various gear which winter there each season.

A bit of Mozart and Bach and we were on our way over the Alps to Rome to collect Barbara Beggs Bini of the American Academy and Bruce Bevan of the University Museum. Both were scheduled to assist us and become trained in the Bipod and balloon systems. These will become the property of the University Museum in due course, to the end that these systems may have further development in field archaeology.

T U N I S

From Rome our party headed variously by plane and ship to Tunis. The Bipod, shipped from the American School at Athens, was taken on at the port of Naples and rode to Tunis atop the Peugeot. "Cloud Nine" - gondola and all - was taken off the Peugeot and deposited at the port, destined for later use in Greece. Hydrogen balloons stayed with us for work in Tunisia.

We were well chaperoned through Tunisian customs by friendly hands from the Smithsonian's Marine Sorting Center in Tunis and comfortably quartered in a seaside hotel in Khereddine, a suburb of Tunis. Bruce Bevan chose to stay with the fish at the Marine Sorting Center, where he was welcomed among their trainees.

Work started promptly on July 1st, with recording of mosaics in the complex of Roman villas at Utica some thirty beautiful miles from Tunis. The work took on some urgency, considering that Mrs. Alexander and her team were aiming to go to print

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in August with the corpus of Utica mosaics. This is in collaboration with the Tunisian Archaeological Service and the American Academy in Rome.

For thirty days we pursued this work, studying each villa for optimum location of the Bipod over its mosaics, to the end that they be recorded in context with the architecture. The Bipod, its two legs looking much like masts of a high strung racing sailboat, was manipulated about the site to swing the radio controlled Hasselblad EL 500 camera some 11 to 12 meters above the mosaic floors. Suspended true vertical, the camera took in better than 100 square meters, with each exposure made upon Eunice's signal from the radio transmitter. There is no system to equal the Bipod for comprehensive recording of mosaic floors. This is why we went to Tunis, having already proved the system some years before at Sardis in Turkey. Both color and black and white were taken as we proceeded. Bevan and Bini both became experts in the operation, as did Jerrold Gretzinger, architect for the expedition and resident in Tunis.

Films were developed and printed each day in the darkroom of the Marine Sorting Center under Eunice's expert hand. Results were so favorable as to require few exposures having to be retaken, as we worked our way to a total coverage upward of 50,000 square feet. We were glad to finish as the even more blazing heat of August approached. There is no shelter from the reflected heat and glare of the floors, especially as the work must be done in mid-day when disruptive shadows are at a minimum. Moderate wind was a blessing, high wind a nervous strain, dead calm an ordeal. We had them all.

I have chosen to include in this letter one example of the mosaic coverage. Relation of the mosaic floors to the house walls is evident. Scale of the print enlargement is approximately 1:50. The subject is "The House of the Cascades".

K E R K O U A N

The Utica work sequence was interrupted by a most rewarding and spectacular coverage of the great Punic settlement at Kerkouan near Cape Bon at the east extremity of the Gulf of Tunis. This was done with the hydrogen balloon flown twice in one morning at various heights up to a bit over seven hundred meters. One flight was for black and white, the other for color. Sixty exposures were taken in the soft early morning light on a truely calm day, rare so near to windy Cape Bon.

Once the high stereo sequence was taken at the top of the flight, the balloon was brought down to a succession of lower levels, taking details in ever closer spacing around the site to make

up a comprehensive large scale mosaiced photo map. The lowest coverage was down to 50 meters height. We made print enlargements two days later in Tunis at scales of 1:4000, 1:2000, 1:400, and 1:250, taken from the various flight levels.

This work was for Prof. Fantar of the Tunisian Archaeological Service. It represents the only available mapping of the Phoenician city excavated originally by the French. However, the French scholars left no drawings, maps or excavation notes following the bitter expulsion of the French from Tunisia in 1956. So our mapping is timely for Prof. Fantar"s publication of Kerkouan soon to be issued. The excavation is immaculate, especially as Kerkouan never suffered destruction. Its walls and floors and baths remain as they were occupied, only the mud and wood superstructures having disappeared.

I have also included in this letter a photo from the Kerkouan flights, taken from approximately 200 meters. It shows a major portion of the site and well illustrates the mapping potential from such coverage. The enlargement is 3.45 times the negative, taken with Zeiss Distagon f50 wide angle lens. The approximate scale of the print is 1:1000.

Refreshed by the success at Kerkouan, we returned to finish the Utica mosaics in the first days of August. Barbara Bini, who had been introduced to the balloon system last summer at Cosa in Italy, had returned to Rome. Bevan stayed on for the full treatment and dispalyed hidden talents at every turn. He and Bob Alexander could not have proved handier,for instance, in rigging up the temporary hangar for the hydrogen balloon as we awaited a calm morning. There were other talents displayed at Kerkouan as well. An international conference was then in progress in the comfortable conference center built there by the Tunisian Service. After two weeks of scholarly debate, the Tunisian scholars broke into song and dance, even upon the dining tables.

L I B Y A

After a flurry of printing and cataloguing at the Marine Sorting Center in Tunis, Eunice poured out her chemicals and we were off on a busman's holiday to visit Leptis Magna and Cyrene in Libya. We flew to Tripolis and Bengazi in turn, Bevan having taken the Peugeot on to Greece via Naples where "Cloud Nine" was taken aboard for our next show at Porto Cheli with Prof. Jameson. The Bipod remains at Utica for another season's work at other sites - hopefully to be operated by Jerry Gretzinger who so well embraced the disciplined techniques. Without these the Bipod can give one a very hairy time indeed.

Leptis Magna leaves one convinced of Roman power expressed in architecture and a bit appalled by some aspects of the culture which bred that overwhelming architecture. Thus we came to the Greek site of Cyrene with a sense of relief and home coming. The original basic site has much in common with Delphi, set dramatically on a terrace in exciting topography 2000 feet above the sea. Here at last was relief for us, as it must have been for the Greeks, from the arid coastal and inland desert climates we had left behind and below. Pine groves and refreshing breezes caress this great site, eminently Greek in its concept.

Travelling in Libya afforded a variety of frustrations. Still beset by xenophobia, Libya is fully equipped to discourage the foreign traveller. Its new found Alice in Wonderland economy is something else to marvel at. How long can a country live it up that way, fed artificially on oil? Our few days in Libya were well rewarded, and especially by the archaeological welcome of Donald White and his University of Michigan team excavating at Cyrene.

P O R T O C H E L I

August 10 brought us to Athens by plane from Bengazi. Four days later we were again installed at Porto Cheli in the Peloponnesus with the University Museum / Indiana University team to resume our role in the exploration of ancient Halieis. This was our fourth season at Halieis among good friends from past years. The expedition has come to attract a wide variety of disciplines, including geographers, geologists, anthropologists (social and physical), speleontologists, not to mention the conservators, epigraphers, linguists, architects, divers, balloonists, working wives and little off-spring. Between the prehistoric cave work, the underwater and the land work, we came, it is said, to nearly thirty strong at the height of the season. Jameson, like Hanfmann at Sardis, was everywhere at once, while co-director, Tom Jacobson if Indiana concentrated on the Franchi Cave excavation and study of extensive material from previous seasons in the relative quiet of the museum at nearby Nauplia.

But for the unfavorable wind and Bruce Bevan not having arrived with our precious "Cloud Nine", we were ready upon arrival to fly Jameson over the underwater remains in the harbor. These had first been surveyed by the hydrogen balloon in past seasons, and the diving excavators were still exploring those early findings. Anxiety mounted awaiting Bevan and the Peugeot. Embassies were phoned, etcetera, until finally he turned up late on the 17th minus balloons!

Bruce, coming in to Greece alone and for the first time, had been at some disadvantage before the Patras customs authorities. They wrapped both him and the balloons in red tape and sent him

on without them. It took some ten days to unravel the situation. A week of promises from Athens went by, during which Eunice and I travelled some 1000 miles visiting sites from Monemvasia in the south to Ioannina in the northwest. We kept in touch by phone each night with Porto Cheli, hoping for news of release of the balloons from Patras customs.

Jameson, meanwhile, took full advantage of the hidden talents of Bruce Bevan, be it on the water, the land, under the water, or in the work rooms of the conservators. Finally, we went to Athens to face the authorities personally, just as they were signing permits for our having, as well as our flying, the balloons. With these in hand, we raced to Patras and thence back to Porto Cheli with balloons aboard the Peugeot.

This frustrating interlude had its rewards. The authorities at high level in the Greek Archaeological Service and other departments, including the Air Force, were now fully aware of our balloon program - and interested. In past years we had flown rather informally, if not covertly, without permit, yet openly as the Archaeological Service was concerned. Now at last we were legitimate, with written approvals in hand and face to face acquaintance made at the top of the Greek Service.

Several trial hot air flights soon followed over the harbor. We had first to train a ground crew for the inflation and handling of a hot air balloon which carries people in a gondola - quite different from a hydrogen balloon carrying only cameras. The first practice flight was too windy, although made at dawn. The second, also too windy, was by moonlight, and I touched down by mistake in the water. The fire lit balloon is a thing of beauty at night. Admittedly, this had been the temptation, as well as the prospect of the full moon shining upon "Cloud Nine".

With a crew that had mastered the inflation, tethering, and other matters, we were ready for the calm mornings that soon followed. The crew was panting to go before sunrise each day and knocking at our door for pre-breakfast coffee as I loaded the cameras. I chose little Lucinda Buck to operate the burner in flight so that Mike Jameson or I could, while flying, give full attention to observation and the cameras. Lucinda is light and bright. Perched on the corner of the gondola atop a propane tank, she could just reach the throttle handily. Soon she got the feel of "Cloud Nine" - every balloon is different - and had confidence in flight.

Each flight was guided by tethermen and tetherwomen along the beach, in the water or in the attendant launch. An aerostat, as the Greeks properly call a balloon, carries a ton or two of hot air. It develops surprising momentum even in the lightest air current. A taut tether too tightly held in the slightest wind brings her down, howsoever ardently little Lucinda burned the six foot flaming torch. Thus we brought Jameson into the drink for a wet touchdown on one occasion.

Once the coverage had been taken and some propane remained for further flight, we favored the ground crew and Dr. Kleemann, visiting from Athens, with short ascents. Eunice with her temporary leg disability was lifted into the gondola for her first flight - after some persuasion by me - and loved it. As Piccard says, it is the best way to fly, though the poorest to travel.

Quite aside from all this fun, my dream of getting the archaeologist airborne at low elevation to cruise slowly over his underwater site had finally been realized, after months of preparation. Heretofore, Mike Jameson could assess his own work on the bottom only from very restricted fish-eye views. For the first time, he could assess it as a whole and in detail from a bird's-eye view.

Vertical and oblique photos were taken on three flights, operating color and black and white cameras in unison as Lucinda managed the ascents and landings expertly.

Besides ballooning at Porto Cheli, we doubled in regular photography and darkroom work, for David Walton had returned to Athens. The closing weeks of a dig generally call for much last minute recording work of the finds. Thus we were the last of the expedition to leave. Even Jameson had been swept out as Greek hunters arrived to take over our quarters on September 10th.

Two assignments of particular interest were, however, still before us, one for the Greek Archaeological Service over the harbors of Palaia Epidauros, and the other for the German Archaeological Institute over Tiryns. Both called for the hydrogen balloon carrying the radio controlled EL 500 Hasselblad. Accordingly, we moved our base to Nauplia, where Dr. George Schaefer made their fine darkroom and other facilities available to us.

P A L A I A E P I D A U R O S

Hydrogen was soon secured in Athens, and we proceeded, loaded down with four high pressure tanks, to the little port town of Palaia Epidauros. We were accompanied by Charalampos Kritzas, archaeological epimelit (supervisor) for the Argolid. His enthusiasm and expert help in the field were a great pleasure, as well as that of the filaz (guardian) of antiquities whom we found ever on duty around the acropolis.

September 15 and 16 afforded splendid early morning calm weather. Up before dawn, we were on site ready for flight as the light came up. Miles of walking along beaches, balloon and camera ever overhead some 150 meters, with Eunice releasing by radio as we paced the position for each exposure - all this produced

a fine sequence of mosaiced photos for each harbor. Some were taken at heights up to 500 meters for comprehensive views, and one was taken from mid channel of the harbor entrance, where I swam with balloon tether in hand.

Films were developed each day in a darkened basement in the little town. Thus we deflated the balloon with assurance of having fine results. Printing followed on September 17 in the Nauplia darkroom. Photo sequences were at 1:3000 scale, up to details at 1:500, showing ample evidence of underwater remains of archaeological interest. The object of the survey was to assist the Greek Service in protecting these remains when harbor improvements now pending are undertaken by the government.

The entire work was finally presented at Prof. Marinatos' office in Athens on a large panel on which contact prints were mounted in their true positions on a map of the harbors. A handsome bound album carried the enlargements and details for close study. We felt much rewarded from our side, because this survey may well lead to our assisting the Greek Service in further work of this kind elsewhere in Greek waters. Over 300 known underwater sites have been entered by Mr. Yalouris on a map, giving priority to those most urgent to cover. The volcanic island of Limnos offers a complex of buildings preserved even to roofs. Subsidence of this island has left these ruins some eight meters below the water surface.

The Greek Service is presently organizing a division devoted to underwater work. Our offer to assist in harbor survey work was left with Prof. Marinatos who had not yet returned from Thera.

Preparation of the exhibit in Athens was much facilitated by the use of Dr. Kleemann's drafting room and her critical eye in composition. Presentation to the Service was likewise assisted by her personal acquaintance with various officials and her fluent Greek, ever appreciated by the Greeks.

T I R Y N S

Having returned to Nauplia after the Epidauros flights, we prepared for another over the great Mycenaean acropolis at Tiryns where the new German excavations are in progress. Sunday, September 19, brought a fine calm, holding from dawn well into the morning. We had two flights, one for black and white, the other for color. Objectives were three-fold: to show the location of a series of inscriptions under study by Prof. Jameson and the Greek Service, to record the current excavations on the lower acropolis for the German Institute, and finally, to provide sponsors of the German work with spectacular air views of the whole of Tiryns.

All coverage was programmed in advance with Dr. George Schaefer. All objectives were attained, starting low over the excavations in the soft dawn light. Such early shots produce images as clear as an India ink wash drawing, devoid of confusing shadows. These are most valuable to the archaeologist, though less impressive to the layman. As light came up, we proceeded to a succession of higher levels, eventually taking in the entire acropolis and its immediate surroundings, where much excavation remains to be done.

The later sequences were in strong sunlight with dramatic shadows cast by the acropolis. Twenty-four exposures were taken at chosen points, several in stereo - all within two hours time, including the color flight. Films were developed by lunch time, and the balloon, meanwhile moored at Tiryns, was deflated with assurance of results in hand. The advantage of the tethered balloon over airplane or helicopter, as a camera platform for such work, was again well demonstrated.

Preliminary printing followed next day in Nauplia, whereupon Eunice dumped her chemicals as a signal that the season was about over. Further - and I may say superb - printing followed at the Institute in Athens, thanks to the great skill of their staff photographers. The sponsors in Germany will soon have a photo mural and stereo views and color slides of Tiryns as I think it has not been seen before.

So concluded our season, and we motored slowly back to Salzburg, visiting out of the way points in northern Greece and Yugoslavia.

WARD H. AUSTIN, JR.
CONSULTING GEOLOGIST AND PHOTOGEOLOGIST
DOMESTIC AND FOREIGN
MINING PETROLEUM

45 BALLIOL #1616
TORONTO 7, ONTARIO
CANADA

PHONE 483-6503
AREA CODE 416

CABLE "GEOWAR"
ADDRESS TORONTO

26 August 1967

Miss Beth Ralph:

The 7000Å - 8780Å photos appear to offer the most detail but have sent the other photos for additional work and will see that they are either at the museum or in the mail Monday. Only a few of the modern features are marked to avoid confusion. It seems possible that the stream flowed around the city (curved line lower right) prior to actually flowing across the city. Will give you a formal proposal and estimated amount of work that can be accomplished for the suggested $1000.00. Note that the work on this photo took 3 hours.

Best regards

Ward H. Austin Jr.

P.S. If you see Doug O'Brain or Frank Morrison please say hello. They will remember me from my Univ. Calif. work.

WARD H. AUSTIN, JR.

CONSULTING GEOLOGIST AND PHOTOGEOLOGIST
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CABLE "GEOWAR"
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August 28th, 1967

Miss Elizabeth K. Ralph
University Museum
University of Pennsylvania
Philadelphia, Pennsylvania

Dear Miss Ralph:

An examination of the enlarged (1" = 645') infrared photography in the Parco de Cavallo Area (Ponte Crati), Crati River Plain, Italy, clearly outlines the details of an ancient city. The maximum information was obtained from the band #7 photo 7000A - 8780A but, other interesting details were found on the band #6 photo 6250A - 7000A and the band #8 photo 7550A - 8780A.

The entire area of interest should be examined for other sites. Fees for this work are as follows:

1) Individual photos will be annotated at the rate of $10/hour

2) 50 Photos --- $1000

3) 100 Photos -- $1500

4) 200 Photos -- $1900

5) 300 Photos -- $2250

6) 400 Photos -- $2500

This service will include annotated, clear acetate overlays only. Drafting and report writing will be charged at the rate of $10 per hour. Supplies, telephone calls, transportation and living expenses will be charged, at cost, where approved in writing, in advance.

The term "photo", as used here, means an approximate 8"x10" aerial photograph. Photos of the same area but with

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different spectral ranges will count as different photos. Strips run from enlargements will be counted as one photo per 80 square inches.

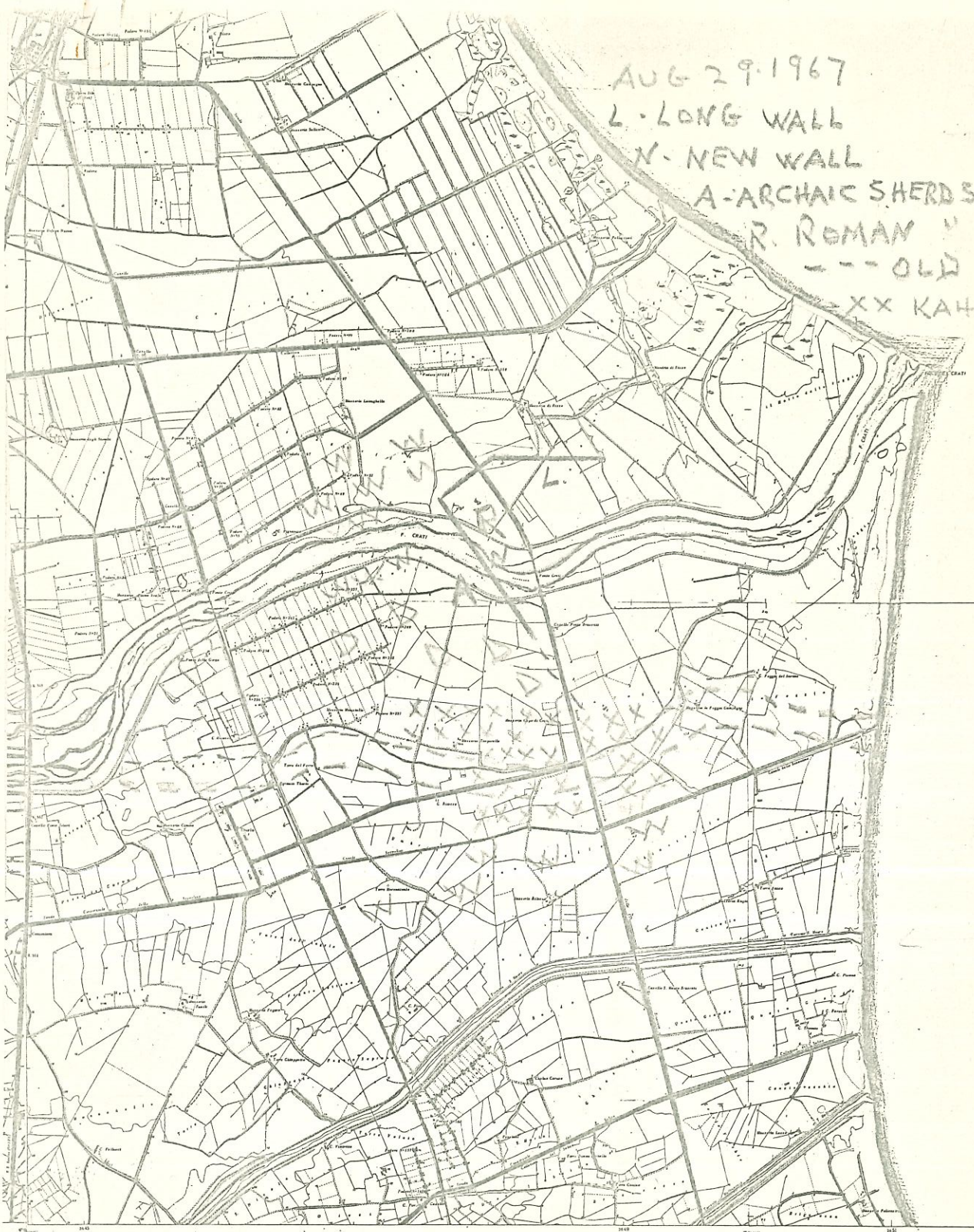
In the future, experiments should be conducted on enlargements of 1" = 200' on all areas of 1" = 645' which show ancient building outlines. Photos enlarged to the 1" = 200' will be worked in stereo by cutting into strips.

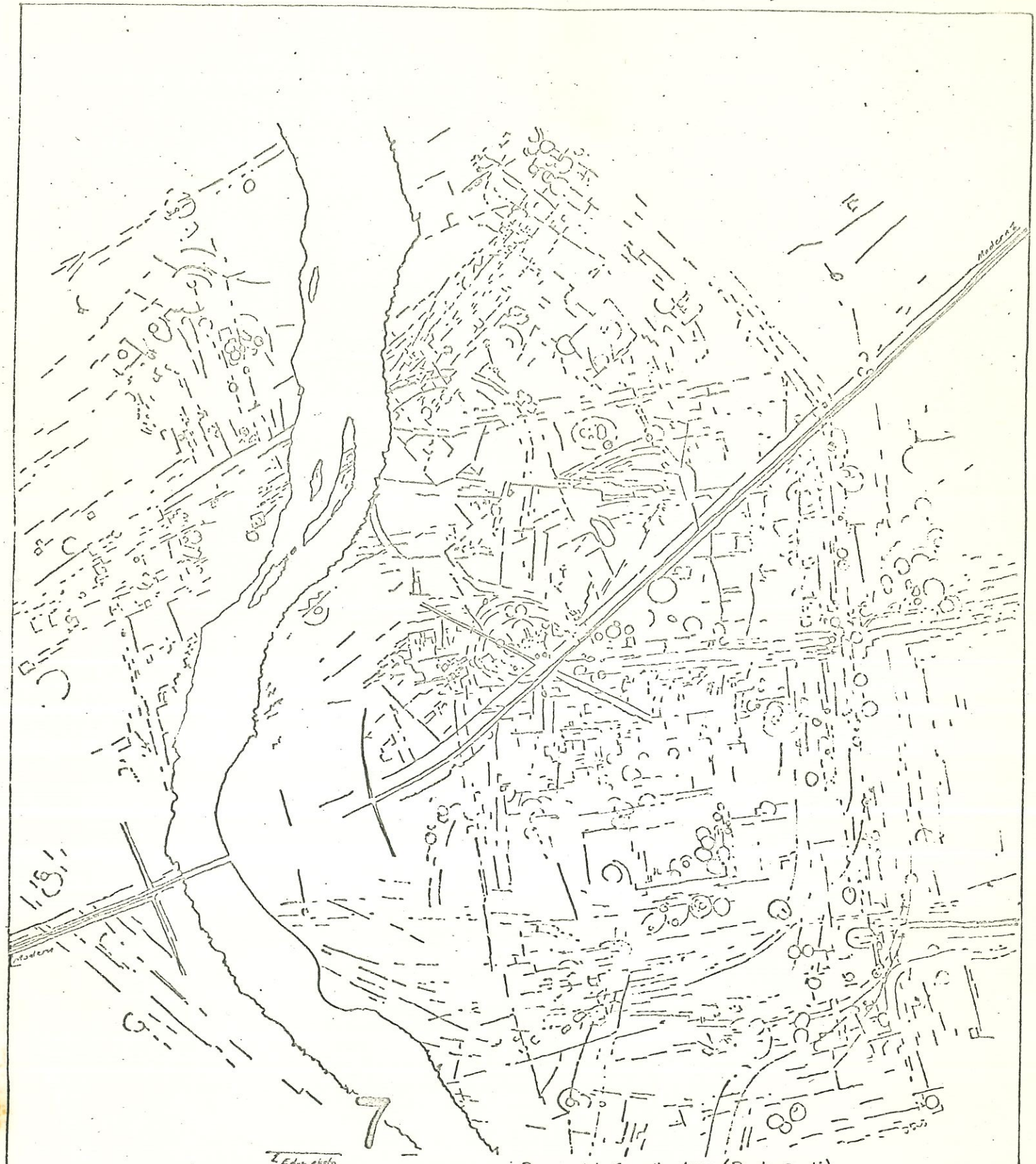
It is understood that clients paying annual retainers have a priority on my time, so that this work will have to be done as my schedule permits.

Yours very truly,

Ward H. Austin, Jr.

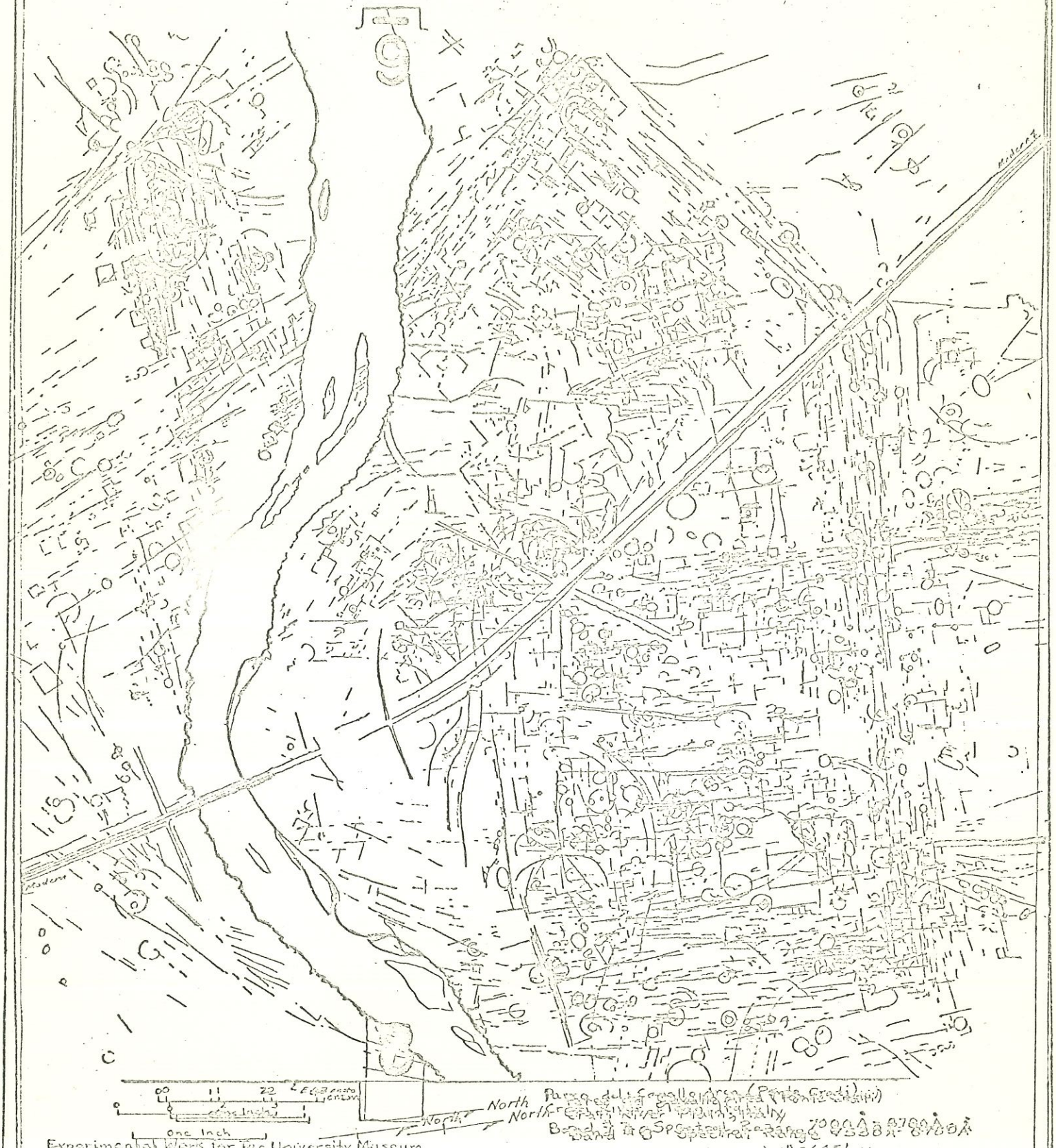
WHA:jm


AUG 29 1967
L - LONG WALL
N - NEW WALL
A - ARCHAIC SHERDS
R. ROMAN
OLD CRATI BED
XX KAHRSTEDT AREA
N
F. CRATI

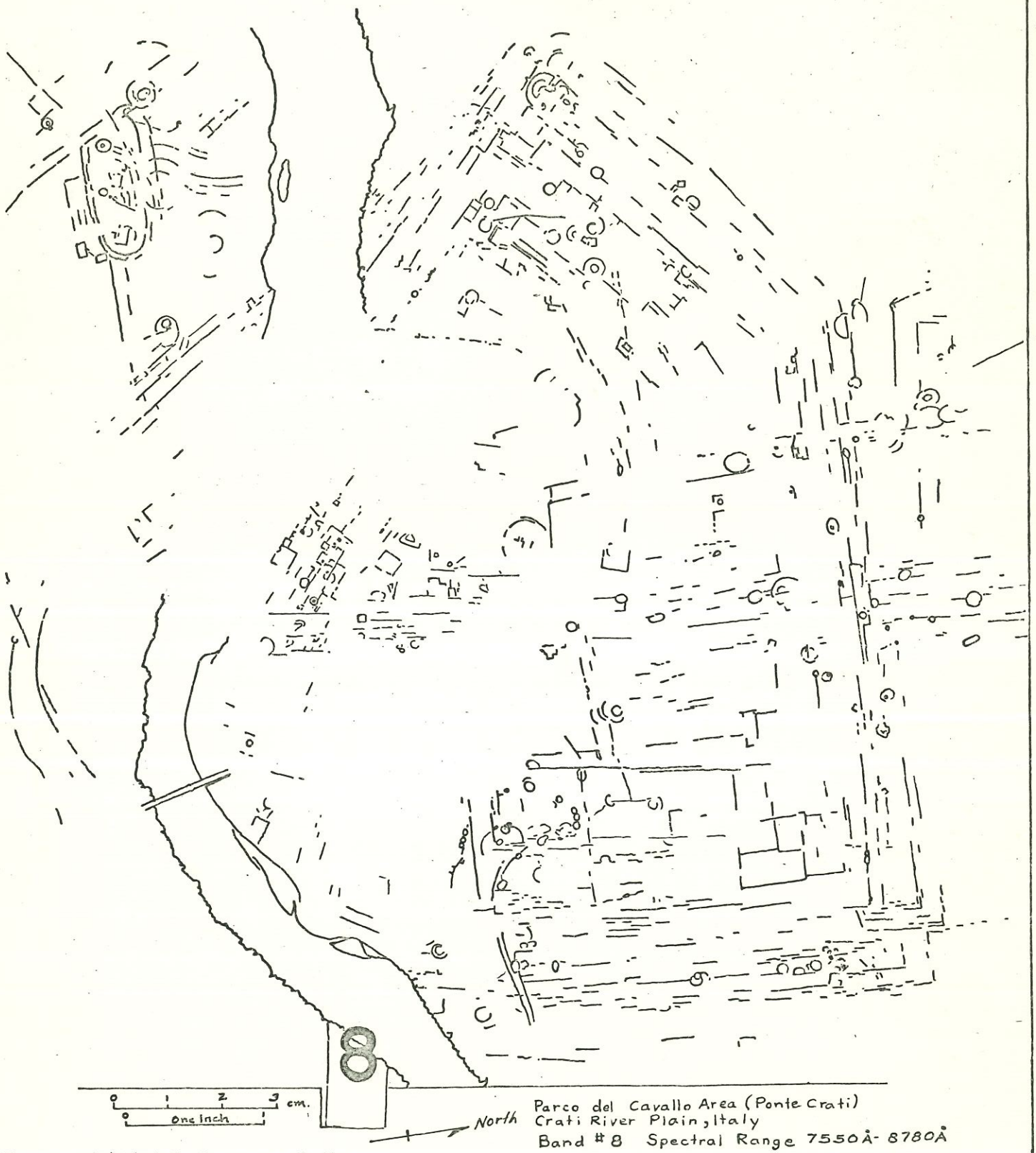


Parco del Cavallo Arca (Ponte Crati)
Crati River Plain, Italy
Band #7 Spectral Range 7000 Å - 8780 Å
Scale Enlargement (Approx.) 1" = 645'
Prelim. Photo Study W. H. Austin Jr.
25 August 1967 (Time 3 hrs)

(Experimental Work for University Museum, University of Pennsylvania)

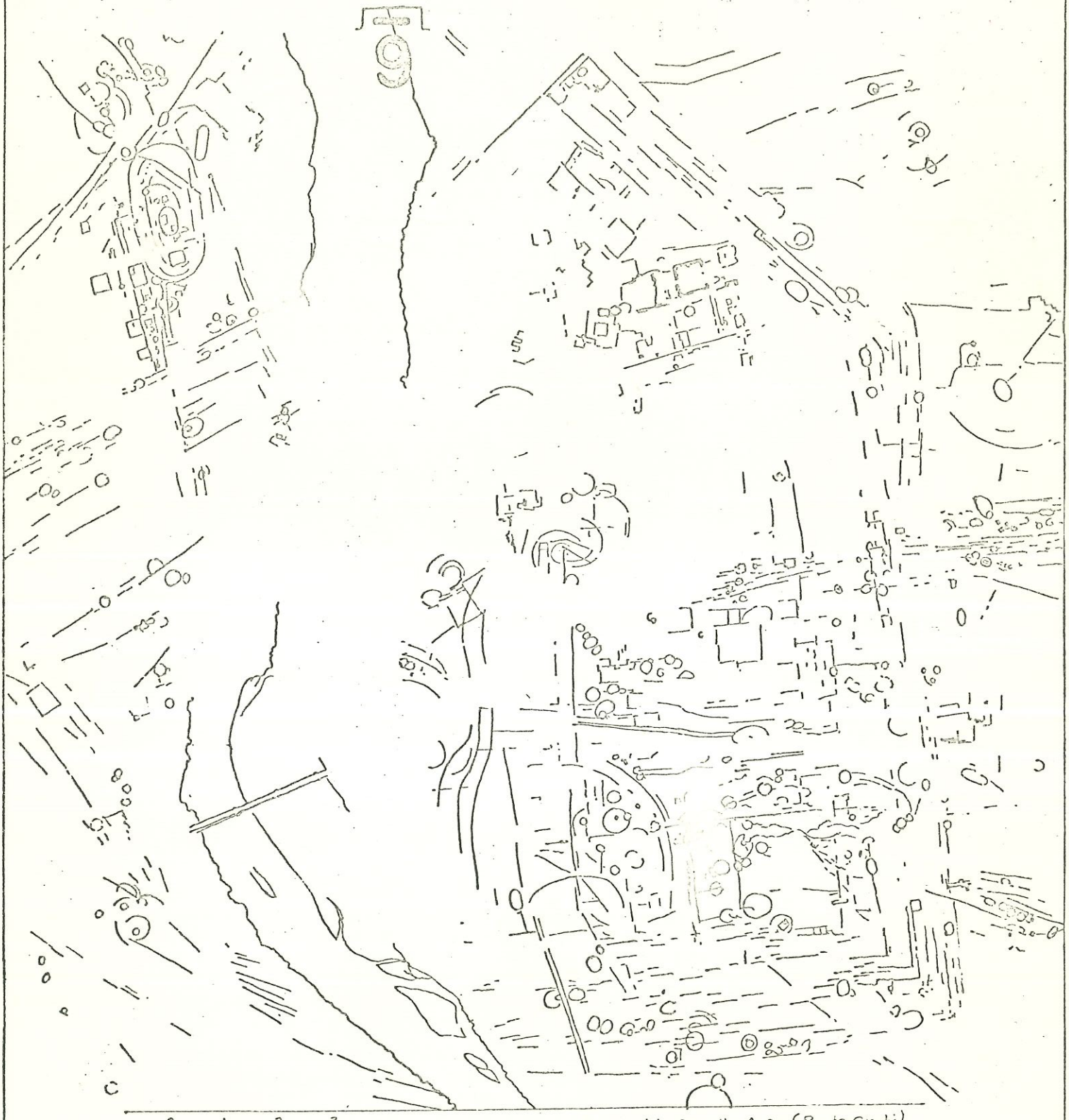


(Experimental Work for University Museum, University of Pennsylvania)



Parco del Cavallo Area (Ponte Crati)
Crati River Plain, Italy
Band #8 Spectral Range 7550Å - 8780Å
Scale Enlargement (Approx.) 1" = 645'
Prelim. Photo Study W.H. Austin Jr.
27 August 1967 (Time 2 hrs)

Experimental Work for The University Museum
University of Pennsylvania



Experimental Work for The University Museum
University of Pennsylvania

Parco dal Cavallo Area (Ponte Crati)
Crati River Plain, Italy
Band # 6 Spectral Range 6250Å - 7000Å

Scale Enlargement (Approx.) 1" = 645'

Prelim. Photo Study W. H. Austin, Jr.
27 August 1967 (Time 2hrs.)

January 18, 1968

Mr. Peter C. Badgley, Chief
Advanced Missions
National Aeronautics and Space Administration
Washington, D.C. 20546

Dear Mr. Badgley:

Your letter of June 9, 1965 to Dr. Rainey (Ref: SM(PCB:nm)) has just come to my attention. Thank you for it and for the attached articles. It has occurred to me that you and your colleagues will have made considerable progress in the use of remote sensing techniques during the past 2½ years, and we shall appreciate it very much if you will send us copies of your recent articles.

We are particularly anxious to know if radar sensing has advanced to the point where it might be useful in detecting ancient cities hidden under jungle cover. The site of Tikal in Guatemala where the University Museum has excavated for ten years would provide an ideal test site. I mention this with the hope that it might be possible to carry out a trial program with yours or some other organization.

I have enclosed a reprint from Science and copies of our recent Newsletters.

Sincerely yours,

Elizabeth K. Ralph

EKR/abn

H R B - S I N G E R , I N C .

SCIENCE PARK, P.O. BOX 60 • STATE COLLEGE, PA. 16801 • PHONE 814 • 238-4311

9 February 1968

Museum Applied Science Center for Archaeology
33rd and Spruce Streets
Philadelphia, Pennsylvania
19104

Attn: Elizabeth K. Ralph
Associate Director

Gentlemen:

In reference to your letter of 25 January 1968 addressed to Mr. J. Carroll Dean, I have prepared the following comments on the questions posed in the second paragraph.

The papers on infrared scanning were originally addressed to Dr. Rainey and were sent to him as complimentary reference material in view of his past interest in IR scanning systems and techniques. HRB-Singer, Inc. has for several years, through the Environmental Sciences Branch of it's Radiometrics Laboratory, provided airborne infrared survey services in the United States, Canada, and more recently to overseas areas.

Ballpark costs will vary as to the geographic location of the archaeological sites in question. A mobilization charge will usually run between five and ten thousand dollars depending on target area in the U.S.. Fixed in-field costs will be about eleven hundred dollars per day plus approximately $200/hour of flying time. A fixed reduction rate of approximately $1800 covers film printing and annotation.

Should you be interested in discussing a specific area or site we could provide you with a definite proposal and costing. If I may be of further assistance please contact me at the above address.

Cordially yours,

Ronald W. Stingelin

Ronald W. Stingelin
Senior Research Geologist
Environmental Sciences Branch

RWS/elt

18

April 22, 1968

Mr. Jon C. Leachtenauer, Manager Senior Research
Photics Research Corporation
Box 337
Montgomeryville, Pa. 18936

Dear Mr. Leachtenauer:

Thank you for your lecture and demonstration last evening. As I mentioned then, I am sending you a sample IR photograph taken over the plain of Sybaris, southern Italy, and two articles in which some of our work there is described.

In collaboration with the Cambridge Research Laboratory of the U.S. Air Force at Hanscomb Field, someppictures were taken in June 1966 with the multiband ITEX camera. Nine images in the 2000Å to 9000Å range were taken from an altitudes of 12,500 feet over an area of about 80 square kilometers. This covered both the plain of Sybaris and the surrounding hills.

I have enclosed a sample of band 8 (7550-8780Å) from the region which corresponds partly with Figure 5 (Rainey and Ralph, page 5). In the photo, the location of the long wall has been drawn in and the black line may obscure the aerial viewing of the wall. However, there are known to be Roman structures in the area within the wall, especially in the region around the two small excavations (holes filled with water). Some of the Roman structures are at depths of 2-3 meters. In other areas there are archaeological features and remnants of structures at greater depths.

Dr, Rainey and I are wondering if it is possible to detect anything with certainty in the infrared photographs. There is, perhaps, more hope for the surrounding hill regions where the archaeological deposits are well above the water table.

We shall appreciate it very much if you find time to look at the enclosed photograph. If you want to express an opinion about it, and discuss the possibility of collaboration in the future, please contact Dr. Rainey after April 29th when he will have returned from Europe.

Sincerely yours,

Elizabeth K. Ralph

cc. Dr. Rainey
EKR/EKR/abn

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CAMBRIDGE RESEARCH LABORATORIES (OAR)
LAURENCE G. HANSCOM FIELD, BEDFORD, MASSACHUSETTS 01730

REPLY TO
ATTN OF: CRJT

7 January 1969

SUBJECT: Remote Sensor Data of Archaeological Sites

ASCA

TO: Prof. George R. Rapp, Jr.
Institute of Technology - School of Earth Sciences
Department of Geology and Geophysics
University of Minnesota
Minneapolis, Minnesota 55455

Dear Prof. Rapp

Thank you for your letter of 19 November 1968. The Terrestrial Sciences Laboratory has flown three archaeological sites (one in Italy, two in Arizona) during the course of flying nearby sites for our airborne geological research program. The three sites were flown in association with Prof. Froelich Rainey, Director, University Museum (33rd and Spruce Sts., Philadelphia, Penna. 19104) and copies of all data of the Italy site have been turned over to him. Multiband aerial photography (nine different film/filter combinations acquired simultaneously on 70 mm. Plus-X and IR film with AFCRL's nine-lens camera) was obtained of the Crati River Plain in Italy in June 1966, as part of the University of Pennsylvania Museum's search for the ancient Greek city of Sybaris.

I have also had frequent contact with Julian H. Whittlesey (31 Union Sq., New York, New York 10003) who has been interested in various film/filter combinations for detection of buried limestone artifacts and for maximum water penetration in coastal areas, particularly where submerged archaeological sites are known or suspected to exist. Mr. Whittlesey has been using both tethered balloons and a type of parafoil as camera platforms. He has devoted a number of years to tethered balloon photography and is probably the leading U.S. expert in this technique.

I'm afraid the Crati River Plain aerial photography was of little use to Prof. Rainey (he had much success with his magnetometer and drilling surveys), but a later aerial infrared photographic survey may have yielded better results. I am unfamiliar with the outcome of the IR survey. It is probable that the Sybaris site may have been too deeply buried by alluvium to be detected by airborne techniques. In addition, canalization of the plain to drain the swampy areas and intensive irrigation-agriculture probably destroyed any subtle surface evidence of any buried features.

The results of Mr. Whittlesey's research with various film/filter combinations are also unknown to me. I expect to hear from him shortly, however, on his water-penetration photographic work in Greece last year. I have

been doing research on water-penetration aerial photography off the coast of Puerto Rico since 1966 and am anxious to compare my results with Mr. Whittlesey's.

I am enclosing some copies of letters to Prof. Rainey and Mr. Whittlesey in reference to the benefits to be gained from various film/filter combinations in aerial photography. A copy of an abstract on some of my initial work in water penetration is also enclosed.

I would be most happy to arrange a visit by you to AFCRL if you desire further information. Thank you for your interest in my work. I look forward to your reply.

Very truly yours

RICHARD S. WILLIAMS, JR.
Geologist, Geotechnics Branch
Terrestrial Sciences Laboratory

Atch
Letters
Abstract

Cy to: W. A. Fischer
F. Rainey
J. H. Whittlesey

Beth Ralph

ROYAL COMMISSION ON HISTORICAL MONUMENTS (ENGLAND)
NATIONAL MONUMENTS RECORD
Air Photographs Unit
Wellington House
Buckingham Gate LONDON SW1
England

18 June 1970

Professor Rainey
The University Museum
University of Pennsylvania
33rd & Spruce Streets
Philadelphia PA 19104
USA

Dear Professor Rainey

We have received the first batch of multi-spectral photography from Fairey Surveys and have completed an initial appraisal. For three of the four sites, we have details of the crops in the various fields. I anticipate we shall complete the next phase of analysis in about three to four weeks, when I propose to send the first batch of material to Dr Williams. A recap might be useful at this stage to remind ourselves exactly what we are going to send you:

1. Multi-spectral negative material for four sites.
2. A map of archaeological detail known at the above sites derived from (A) previous photography (B) ground survey.
3. A map showing crop disposition in these areas.
4. Old air photography recording archaeological details.

And at final stage:

5. A graph showing incidence of flying to sun, temperature, and precipitation.
6. A summary of our methods and results.

If there is any additional information you may require please let me know. Incidentally, Fairey appear to have had trouble with the cameras: the first flight took place 4/6/70, thus reducing the time base for our comparisons.

I am sending a copy of the above to Dr Williams for his information, but I wonder if you could advise me on the following points.

I should like to make a brief statement on this exercise at a symposium to be held in London in December 'Photography in Archaeological Research' under aegis Royal Photographic Society of Gt Britain, with such tentative conclusions as may be then available. Would you have any objections to this, and, secondly, how would you wish the part played by your Museum & Board described; for I think some publication - advance notice - should appear in, say, Antiquity.

Yours sincerely

John Hampton

J N HAMPTON

xox
ASCA
8.26
Beth Ralph

21st August, 1970

Dear Dr. Rainey,

Thank you so much for your letter of 29th July. First, I must apologise for the time we have taken in sending you the film and associated material. Hopefully we should send Dr. Williams the first batch at the end of next week, i.e. about 28th August, for it has taken us much longer to deal with the film than I anticipated in my letter of 18th June.

As to your suggestion of a meeting I think this would be most useful. I have in fact made an application for an official journey: perhaps the most useful time that suggests itself is when we complete our stage of the exercise and pass it on to Dr. Williams for analysis. I do not know what he has in mind, but possibly it might be useful to consider the archaeological aspects prior to the scientific examination of the film. Anyway, I should be guided by yourself as to the best time of meeting and look forward to hearing your views on this.

As to the experiment itself. As you have gathered, we ran into difficulties. The first sortie was 'edited' by Fairey Surveys - and produced some poor results. The second was good: the third suffered from the lack of I.R. film: the fourth again was short of I.R. and plus X film: We scoured the country for film and eventually traced two tins of 50' type 8443 in store somewhere in the back waters. Unfortunately this meant that low-level flights had to be in part without I.R., because Fairey could not reload in the air, (50' being too short for the whole sortie). Weather conditions were excellent for the production of crop marks during May, June and early July. Late July produced unstable weather with heavy rain etc. This background will be shown by our charts, but there is little doubt that the photography prior to this weather change showed some very interesting features. I had intended to bring in a new P.I. for the analysis of what I anticipated would be the most important photographs of the whole series, those taken at the end of July. The weather collapse cancelled out this importance. I am therefore having the photographs from sorties two and three re-analysed by the fresh P.I., this will tend to delay the despatch until the middle of September: I hope you can bear with me over this additional delay.

Yours sincerely,

John Hampton

J. N. Hampton

Dr. F. Rainey,
Director of The University Museum,
University of Pennsylvania,
Thirty-third and Spruce Streets,
Philadelphia, P.A., 19104
U.S.A.

THE UNIVERSITY MUSEUM

UNIVERSITY OF PENNSYLVANIA

THIRTY-THIRD AND SPRUCE STREETS
PHILADELPHIA, PA. 19104

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

MEMORANDUM

TO: ELIZABETH RALPH AND BRUCE BEVAN

FROM: FROELICH RAINEY

DATE: October 14, 1970

SUBJECT: Aerial Photography

The aerial photography fellow in the Southwest just called from Washington to say that the survey area chosen by NASA is the greater Chesapeake Bay area. Arch Gerlach, United States Geological Survey, Department of the Interior, telephone: 202-343-5403 knows all about this arrangement and should be our contact man in the EROS project to see what we can do in this survey area.

597-7040

Lyons thinks that if John Cotter is interested in historic sites and John Witthoft is interested in Indian sites in this area, we might specify aerial photography areas to NASA through Fischer who is the United States Geological Survey man on the EROS program.

7&12

Beth, This Is A Copy Of The Note That I'm Sending Dr. Rainey.

UNIVERSITY INTRAMURAL CORRESPONDENCE

MUSEUM

THE CHACO CANYON EXPERIMENT

To Dr. Rainey 7 December 1971

It appears that the ideas suggested for imagery in the Chaco Canyon area present no significantly new techniques over those pioneered in the Sybaris and English experiments.

Thermal Infrared Imagery

The best possibility mentioned is that of thermal infrared imagery. The TV-like picture produced by this system gives an indication of the temperature and emissivity of ground objects.

There have been improvements in the resolution and flexibility of these infrared scanners since their use at Sybaris in 1966 and in Arizona in 1966 by Schaber and Gumerman for detecting prehistoric agricultural plots. Since we have no money to purchase or rent one of these elaborate systems, possibly Richie will know of a government agency which would loan us one.

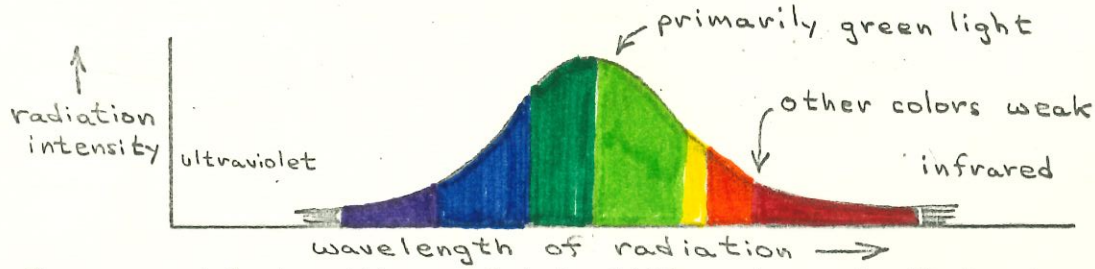
Since nothing is known about the apparent transportation net's infrared appearance, there is no way of predicting if the infrared scanner will show ~~them~~ it as an image contrast. Since ~~it~~ IR has worked in other cases, this trial is worth the gamble.

Spectral Signatures

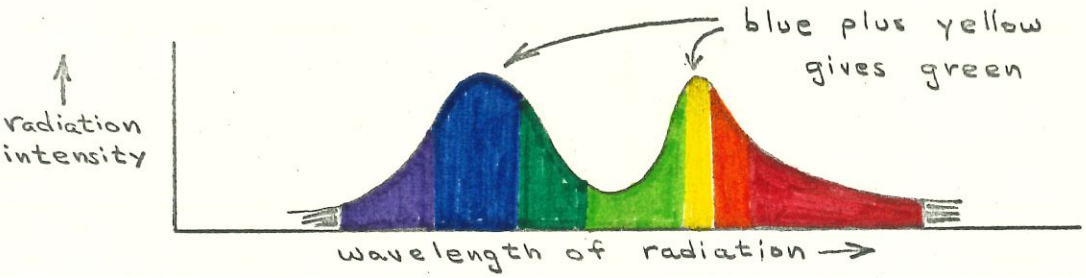
In our development of new techniques, a bolder, more difficult, but probably more fruitful next step would be the measurement of the spectral signatures of the anomalies to be detected so that the best optical system could be used.

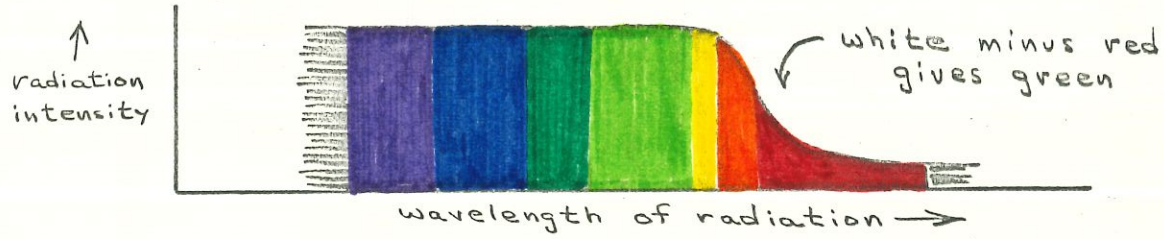
I will try to summarize the implications of this. With visible light, the spectral signature of an object determines its color. For example, a green object could have a spectral

signature like this:



However, objects with completely different spectral signatures could look exactly the same to the human eye, on color film, or on panchromatic black and white film. For example, objects with these two spectral signatures would be the same green as the above object (or the same grey tone in black and white):





While these different objects would look the same with classical photographic techniques, multispectral photography as used at both Sybaris and England could differentiate them. Multispectral sensing uses different light filters in front of a group of black and white cameras to chop up the spectrum into small segments and allow these different spectral signatures to be separated. In other words, proper film-filter combinations prevent the spectral averaging which makes different objects look

the same tone or color.

It is the choice of a good spectrum segment with a film and filter that is difficult. In the past this has been done by trial and error, using many different combinations in the hope that one will furnish the desired anomaly contrast. However, if the spectral signature of a known anomaly and its surroundings is measured, the optimum film-filter combination can be used such that the best possible anomaly-visibility would be achieved.

Field Spectrometers

The instrument for measuring these spectral signatures is called a spectrometer. A portable version, called a field spectrometer, could be operated on the ground over a known anomaly (available at Chaco Canyon), and also over adjacent "background".

Once these signatures have been measured, an imaging system can be used to detect the spectral anomalies wherever they are the same as the known case; that is, the vegetation, soil, and time of the growth season will have to be similar.

Here again we have the problem of obtaining equipment and the expense of operating it. I believe that a field spectrometer may be more difficult to locate and borrow than a thermal infrared scanner. This does remain, though, an experiment which is new and valuable.

Spectral Anomaly Camera

I will mention here some other work which I am doing which is unrelated to the New Mexico experiment. First, I am investigating the design of a new camera for locating archaeological features. This camera would outline spectral anomalies now matter what the spectral signature differences might be. Therefore, this camera would not need measurements of spectral signatures for each new situation; it would be quite general purpose.

Satellite Photography

The second project is a proposal to NASA for the second earth resources satellite, ERTS-B. This photographic satellite will pass over a point on the earth's surface once every 18 days, just as ERTS-A, the first satellite, will. Its photographic resolution will be much too crude to see archaeological anomalies of the crop mark type which we had with the experiment in England, which pointed out that photography must be done at just the right time during the season. In this English test I noticed that large geologic patterns, apparently ancient buried river meanders, and the archaeological patterns near them both produced crop marks at about the same time. These geologic anomalies will probably be visible in satellite photographs, therefore the satellite will tell us what time to take low level photographs from an airplane in order to see small features.

Since NASA seems to prefer proposals for photography in the USA, the upper Mississippi-Missouri valley in the great plains is the logical choice of location. Here we have the right combination of a meandering river, known presence of crop marks indicating Indian sites, low population density, little forest cover, and the urgency of salvage archaeology.

Electrical Engineering Department

Third, I am collaborating in the field of remote sensing with the electrical engineering department here at the university. Dr. Haralambos (Harry) Kritikos and a graduate student of his, Art Jordan, are both very interested in working with us whenever possible, as is Bernie Steinberg who is associated with the Valley Forge center. They have some spectrum measuring equipment in their lab, but need some additions for an operational system.

Bruce

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"

6 December 1972

Dear John, (HAMPTON)

Here is some information on the possibility of using the Earth Resources Technology Satellite, ERTS-B, for determining the time of year for photographing archaeological crop marks.

If this idea appeals to you, I would be delighted if you could join us in a joint project. I've outlined some of the facets which must be developed in a proposal to NASA.

Sections 4,5, and 6 are ones which I should do the most work on, although I may need your help with cloud cover statistics for Dorchester. You can best discuss sections 2 and 3. For the rest, we'll both have to work together.

While proposals for satellite experiments are due by the end of January, they can still be submitted later. Since the proposal instruction volume is too large to photocopy, you should ask for one from:

Mr. Thomas M. Ragland
Assistant Project Manager
ERTS/Nimbus Project
Code 430
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

Please give this idea close scrutiny; I hope we can make it go.

Bruce

Bruce Bevan

copy to: Dr. Rainey

SATELLITE PHOTOGRAPHY AND CROP MARK VISIBILITY

1 -- PURPOSE OF PROJECT

Aerial photos used to discover and map shallow-buried archaeological structures
Soil moisture anomalies of buried walls and ditches modify growth of overlying crop
Visibility is dependent on period during growing season as determined by local weather and soil conditions
Large, nearby geologic features, ancient buried river channels, cause crop marks correlated in time with archaeological marks
Geological marks will be visible in ERTS photos
Important to record sites before destruction by gravel mining
First is trial at known site, expand to unknown if successful

2 -- GEOGRAPHY OF SITE

Region is at bend of the Thames river near Dorchester
Latitude, longitude and British coordinates of site
Regional map showing river Thames course and other archaeology
Soil structure

3 -- ARCHAEOLOGY OF SITE

Archaeological periods and the buried structures associated with them
Crop mark basis for detecting buried features
Time of growth year dependence, soil moisture determined by weather
Example photos: 81/194 (4 Jun 70), 54/206 (19 Jun 70), same region of Northfield Farm, Dorchester

4 -- RIVER CHANNEL FIELD MARKS

Meander patterns in mature river valleys, Apollo 9 photo of lower Mississippi River
Buried Thames channels: correct size, shape, orientation, and location
Size: width, 30-300m; length, ½-1 km
Detectability by ERTS-B; directly or as texture change due to large scale field mottling

5 -- PROBABILITY OF SUCCESS

Determined primarily by cloud cover probability
Required ? : 70% probability of less than 20% cloud cover at 9:30 AM overflight time

6 -- IMAGERY REQUIRED

Spectral regions: yellow, green, near-IR
Format: 9 inch positive black & white transparencies
Time of year: May through August
Region of interest: Dorchester and surroundings
Receipt of imagery within one week of overflight required

7 -- FINANCIAL AID

8 -- FIELD WORK

Airplane photos for confirmation
Correlation with weather

9 -- BACKGROUND ON INVESTIGATORS AND INSTITUTIONS

Equipment available and required

June 7, 1974

Dr. G. W. Heath, Director
SAR-Assist, Inc.,
One Island Lane,
Greenwich, Conn. 06830

Dear Dr. Heath:

St several sites we are combining standard aerial or balloon photography with ground-based cesium magnetometer surveys, and I have enclosed a report and an article in which our efforts at Kingscote are described. Unfortunately I do not have copies of the aerial photographs at this site.

Since the satellite photographs are too remote to show the archaeological features, we think that their best use is in determining when the crops are optimum for low-level photography. Therefore, quick distribution of the satellite photos is important.

Sincerely,

E. K. Ralph

A Landsat-2 Experiment

DETECTION OF CROP MARK CONTRAST FOR ARCHAEOLOGICAL SURVEYS

First Quarter Progress Report

8 April 1975

Prepared for the

National Aeronoutics and Space Administration

Contract No. NAS5-20792

ERTS Investigation No. 23220

Fro, we don't need to do anything about that April 7 letter from NASA; It just told who is down there to give us help if we need it.

Bruce

DETECTION OF CROP MARK CONTRAST FOR ARCHAEOLOGICAL SURVEYS

No photographs have been received yet.

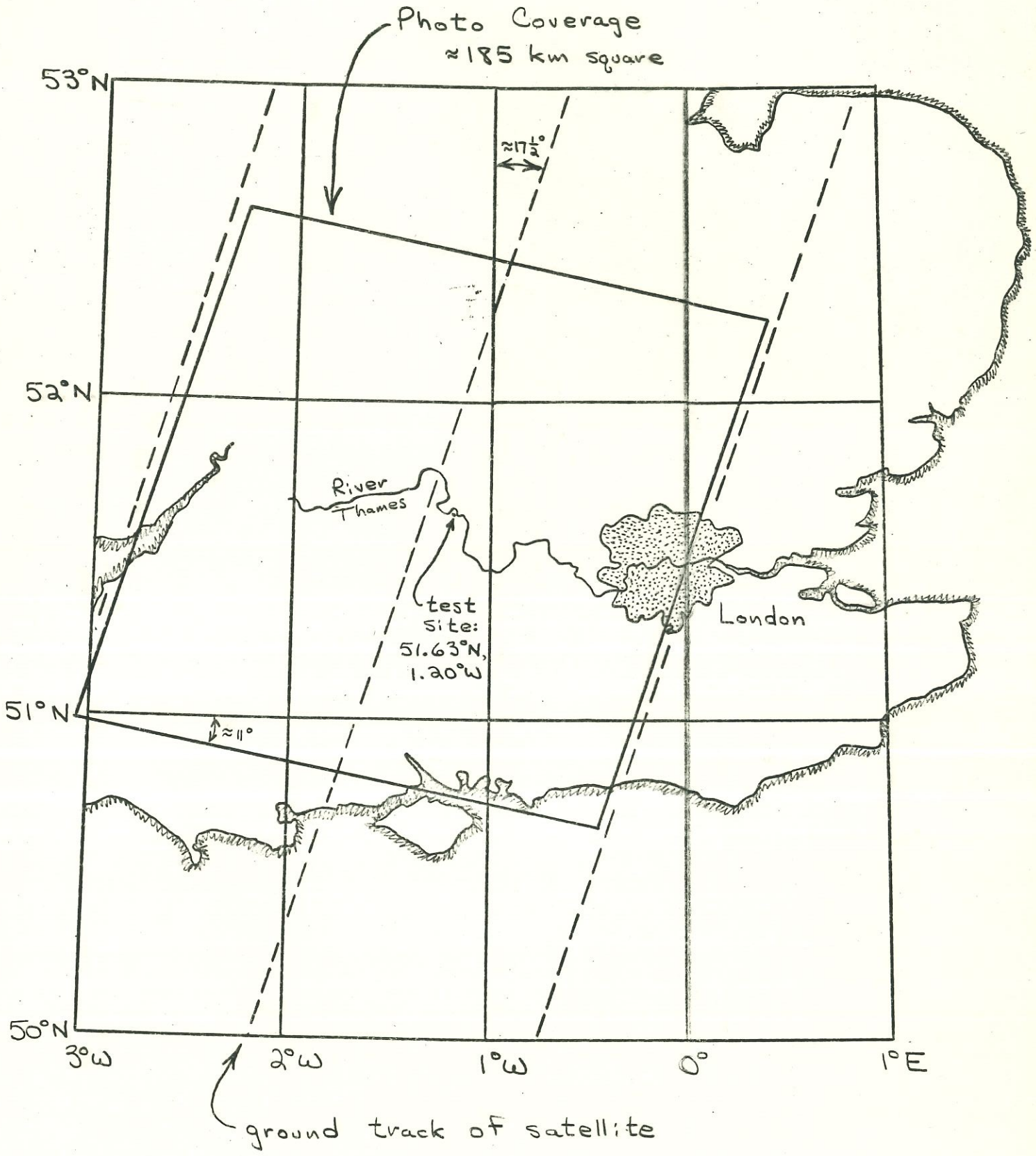
In order to prepare for the possibility of photography (from aircraft) in the region of the test site, an estimate of the overflight times has been made. This has been done by extrapolating the ground track lines for ERTS-1 (ERTS-1 Coverage of the United States, General Electric Co., January 1974) and allowing for the nine-day orbit shift (Landsat Newsletter No. 1, 29 January 1975). Photographs should be taken of the test site for the following nine dates, if the cloud cover is predicted to be less than 40%:

3 April
21 April
9 May
27 May
14 June
2 July
20 July
7 August

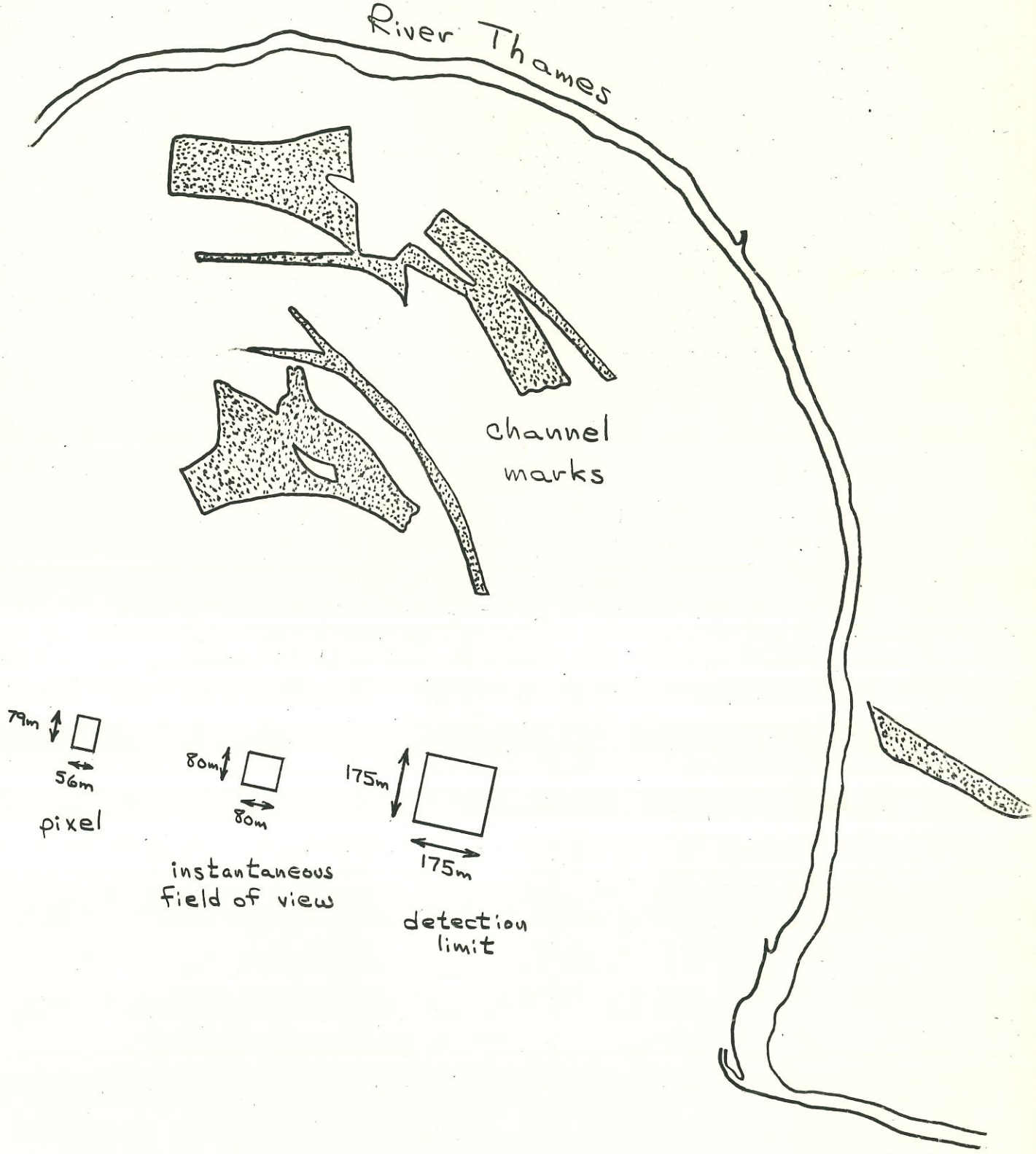
The extrapolated ground track of the satellite is given in the figure on the next page, along with an estimate of the MSS image orientation. At this latitude the ground track separation is 98.9 km in an EW direction; the sidelap of the photos will be about 45% and the satellite pass to the east of the central one may also be able to photograph the site.

The last figure shows the shape and size of the channel marks to be detected as compared to the size and orientation of the MSS pixel and instantaneous field of view (Data Users Handbook) and a guess at the detection limit for these channel marks (R. Welch, "ERTS-1 Image Quality", 8th Rem. Sens. of Envir. Conf., p. 1411). The contrast of these marks will probably be less than 2:1 at satellite altitude.

Bruce Bevan
Museum Applied Science Center for Archaeology
University Museum
University of Pennsylvania
Philadelphia, Pennsylvania



Southeast England



Test Site at Dorchester

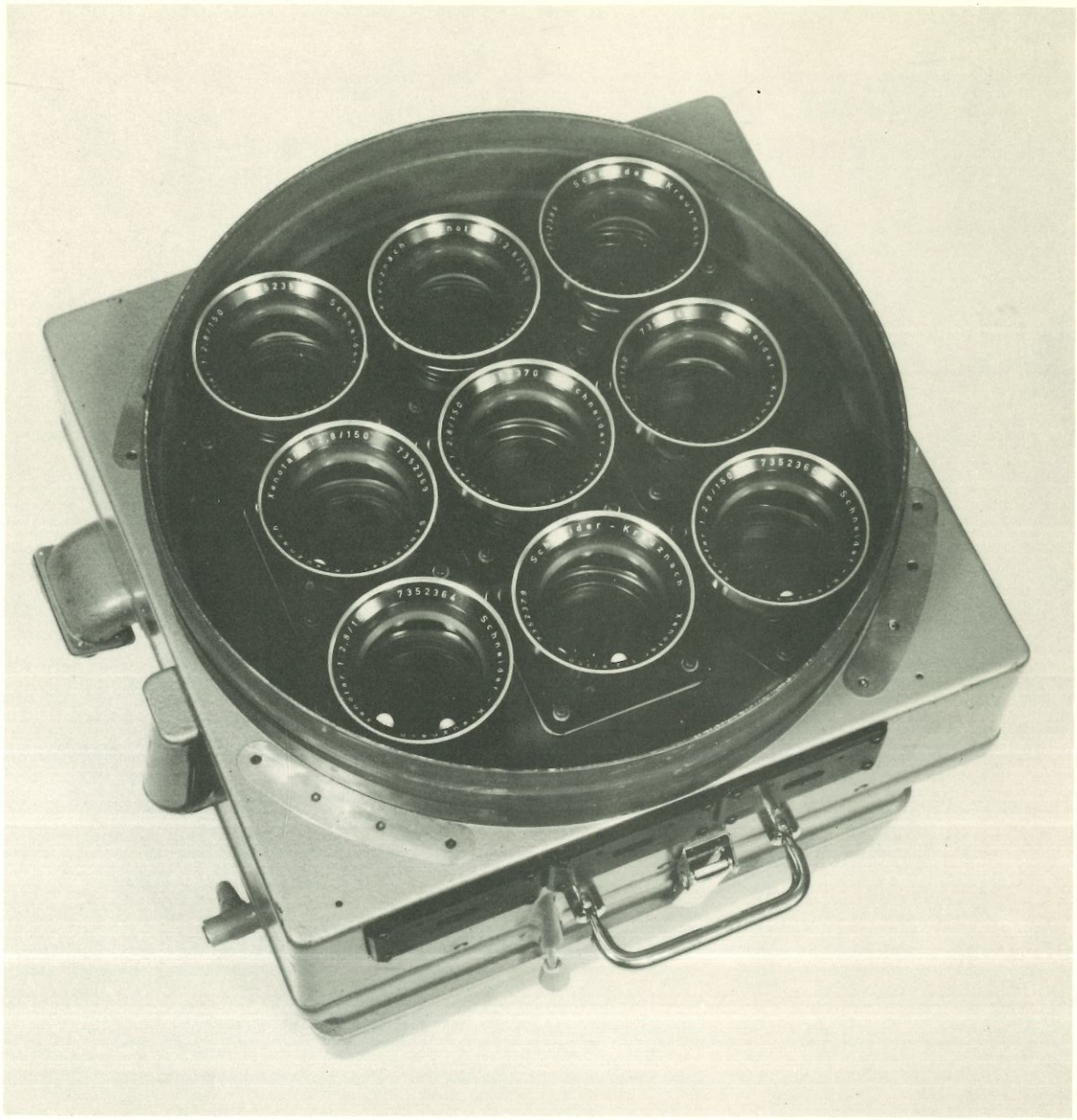
VIDYA DIVISION
1450 PAGE MILL ROAD · PALO ALTO, CALIFORNIA 94304 · DAVENPORT 1-2455 · TWX: 415 492-9270 · TELEX: 033815

Itek CORPORATION

MULTIBAND CAMERA SPECIFICATIONS

LENSES	Nine 6-inch, f/2.8 Schneider Xenotar, or 6-inch Leitz High Resolution. Other lenses may be fitted.
FILTERS	Normal complement covers 400 to 700 millimicrons in steps of 50 millimicrons approx. (6 bands); 700 to 900 millimicrons in steps of 100 millimicrons approx. (2 bands); one lens equipped with neutral density filter. Other combinations may be fitted.
FILM SUPPLY SYSTEM	Three 70 mm unsprocketed film supply and take-up channels, three filter bands per channel. Three 270 foot reels in modified A9B magazine provide approximately 325 exposure "sets" (9 bands) per load.
FORMAT	2.25 inch square frame (each band). Adjustable fiducial markers. Optical projection frame counter numbers each set of three frames in each channel.
SHUTTER	Stainless steel, focal plane with separate fixed opening for each band. Capping shutter on return stroke. Speeds of 1/30, 1/60, 1/120 and 1/240 second.
REWIND CYCLE TIME	1.25 seconds at 1/240 second shutter speed 1.75 seconds at 1/30 second shutter speed
CONTROL	Remote, for camera operation and shutter speed change. Operates from or through standard intervalometers.
IMAGE MOTION COMPENSATION	A9B magazine has IMC input drive fitting. Standard IMC drive units can be fitted.
WEIGHTS (approx.)	Camera 50 lbs. Loaded magazine 35 lbs. Control Box 5 lbs.
DIMENSIONS (outside)	Camera 16.38" x 14.87" x 14.25" (lens cone O.D. 13.625") Control Box 6" x 5" x 4"
POWER REQUIREMENTS	Film Wind 4 amps maximum, 28V DC Magazine Heater 4 amps, 28V DC Counter Lights and Control Box 3 amps, 28V DC Shutter 2 amps, 115V AC, 400 cps IMC Drive (typical) 8 amps, 28V DC 5 amps, 115V AC, 400 cps

9-29-64
Subject to change without notice



5768

MULTIBAND CAMERA. Developed by Itek as part of a spectral reconnaissance system whose goal is to detect and record surface evidence of underground nuclear explosions, the multiband camera contains nine lenses, eight of which record images through eight portions of the spectrum, while the ninth lens records the full spectrum image. The resulting photography displays any minor changes in vegetation or density caused by an underground nuclear explosion. Since dying vegetation can be identified in certain portions of the spectrum before the decay is visible to the human eye, the camera can also be used for the early detection of crop diseases.