

# SYRACUSE UNIVERSITY

DEPARTMENT OF RELIGION | 316 H. B. CROUSE HALL | SYRACUSE, NEW YORK 13210  
23 Nov 66

Dr. Froelich Rainey  
ASCA, University Museum  
University of Pennsylvania  
33rd & Spruce Streets  
Philadelphia, Pennsylvania 19104

*Techniques*

Dear Sir:

I have taken the liberty of mentioning your name in a letter of inquiry to Dr. William T. Pecora. Dr. Pecora, as you probably already know, is the director of the U.S. Geological Survey who has been named to head up Project EROS, Earth Resources Observation Satellites), a program of the Interior Department to study the natural resources of the earth. It occurred to me that this might be another means of archaeological surveying. I told him quite frankly that my first reaction to my own thought was, "crackpot". But considering your work with the multi-band camera and George Mendenhall's work in Jordan with aerial infrared photography, I thought the idea at least worth exploring.

It may be that something is already going on in this area. I would be interested in "who?" and "what?" if you are aware of such. If nothing is being done at the moment, and if Dr. Pecora is open to the possibilities, the ASCA would seem to be the logical (if not the only) agency to follow it up.

I would be interested in your response to the idea.

Sincerely yours,

*Henry O. Thompson*  
Henry O. Thompson

Assistant Professor of Old Testament

December 1, 1966

Dear Dr. Thompson:

Many thanks for suggesting our research on techniques to Dr. Pecora of the U.S. Geological Survey. At first to me also it sounded a bit wierd to link archaeology with satellites, but our own experiences with 25,000 ft. aerial photography and the fact that there are some strange earthworks which do show up only from high elevations might really make this whole thing reasonable. In any case at this stage I am willing to try anything. I wonder how we can get together with Dr. Pecora.

All the best,

Froelich Rainey  
Director

Dr. Henry O. Thompson  
Department of Religion  
316 H.B. Crouse Hall  
Syracuse University  
Syracuse, New York 13210



UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY  
WASHINGTON, D. C. 20242

OFFICE OF THE DIRECTOR

DEC 12 1966

Professor Henry O. Thompson  
Department of Religion  
Syracuse University  
Syracuse, New York 13210

Dear Professor Thompson:

Quite frankly, we had not given much thought to the applications of the EROS satellite to archaeological exploration. It is quite possible, however, it might prove to be a valuable tool. One of the cameras is designed to record in the near infrared wavelengths so that the data would correspond to that obtained by Dr. George Mendenhall and Dr. Froelich Rainey in their successful use of aerial methods for archaeological purposes. The scale and resolution of the EROS images, however, would be considerably less than those obtained from aircraft cameras. Hence, values would probably be restricted to search for large features (more than 200' on the side) and studies relating to gross distributions of ancient cultural centers. It is also possible that linear elements, such as the Inca Trail, may be more clearly seen from satellites than from aircraft, and that some features on the forest floors, such as the geometric patterns of the Incan ruins, might be more clearly resolved on space imagery than aircraft imagery. I am enclosing a copy of the press release (and backup material) that announces the EROS Program, and a list of performance specifications for the first EROS vehicle. These may help in your assessment of potential application.

We are not aware of anyone working with satellite data in archaeological studies. We would be interested to know if you should learn of others who are actively engaged in this work or who have interest in its potential application.

Thank you for your interest.

Sincerely yours,

W. T. Pecora  
Director

Enclosures

# SYRACUSE UNIVERSITY

DEPARTMENT OF RELIGION | 316 H. B. CROUSE HALL | SYRACUSE, NEW YORK 13210

14 Dec 66

Dr. Freelich Rainey  
ASCA, University Museum  
33rd & Spruce Streets  
Philadelphia, Pa. 19104

*Get w. a. l. i.  
Photo  
Rainey  
wall*

Dear Dr. Rainey:

Enclosed is a carbon of Dr. Pecora's response to my suggestion of using satellite observation for archaeological exploration.

As you can see, the possibilities are there. Very few buildings are over 200' long but as he suggests, we can deal with cities and larger elements. I wonder if cultivation might be one of these, say in relation to Dr. Nelson Glueck's work in Transjordan and the Negev, and recent work by Dr. E. F. Campbell of McCormick (and editor of *The Biblical Archaeologist*) in the vicinity of Shechem. Incidentally, I know from my work with Dr. Campbell that accurate maps in ground survey work are extremely valuable. Improved cartography is already a feature of the satellite programs.

It occurs to me that a series of photographs at different times of the year of the same spot, would furnish additional data as related to your work and Mendenhall's at specific times of the year. The earthworks you mentioned are another possibility. I would assume that some of the Incan ruins Dr. Pecora mentions might be investigated with lower altitude photography once they were located. I would add Africa, SE Asia and Middle America to his suggestion. EROS will involve water studies. Water resources on known sites are sometimes an enigma. Underground moisture and water tables might be a clue in locating ancient springs, etc., now buried. Whether this could lead to the reactivation of such sources, I do not know. The same could be said of timber and forest cover, only in reverse. Can we learn anything about ancient forest cover from the current surface? And to come back to the earlier suggestion, ancient irrigation systems, rivers and flood control might be clarified. Would underwater archaeology find help in EROS?

These are but a few possible suggestions for EROS and archaeology off the top of my head. I do not know how valid they are but would trust your judgment here.

I presume that the next step would be discussion between yourself and Dr. Pecora. I will be interested in any developments.

Sincerely yours,

*Henty O. Thompson*

# SYRACUSE UNIVERSITY

DEPARTMENT OF RELICION | 316 H. B. CROUSE HALL | SYRACUSE, NEW YORK 13210

14 Dec 66

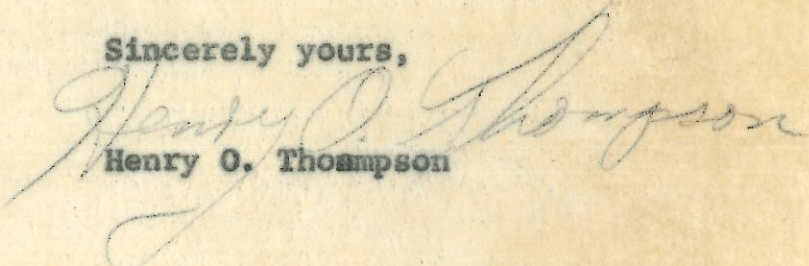
Dr. W. T. Pecora, Director  
Geological Survey  
Department of the Interior  
Washington, D.C. 20242

Dear Dr. Pecora:

Thank you very much for your interest in EROS and archaeology.  
Enclosed is a carbon of my letter to Dr. Rainey.

You will note that in the last paragraph, that I have suggested  
discussions between you. I do not know what procedure to follow  
at this point, except to hope that you can contact him for such  
discussion.

Sincerely yours,



Henry O. Thompson

December 23, 1966

*Techniques*

Dear Mr. Pecora:

I have a copy of your letter of December 12th to Professor Thompson, and a letter from him of December 14th regarding the possibilities for EROS and archaeology. With these two letters, the whole thing does not seem beyond the realm of possibility, and hence it seems to me we should get together and talk about this. Enclosed are two reprints of mine on new techniques in archaeology and a copy of our MASCA newsletter, which will give you some idea of what we are interested in, here. Sometime within the next two weeks I should have a chance to go over the high altitude aerial photographs made by the Cambridge Air Force Research Laboratory for us in South Italy. This should give me a better idea about the utilization of remote sensors and perhaps a better understanding of this whole thing, in order to discuss this possibility with you. With the possibility of distinguishing features as small as 200' in diameter, then surely, there must be applications for EROS in archaeology.

For example, I have just seen aerial photographs of Hadrian's wall in England which show with a remarkable clarity the maximum extension of Roman cultivation in Britain. Also, I have recently been in the Sahara in Libya, searching for extensive city ruins in the desert. I suspect it is possible to locate not only these ruins, but the underground water system upon which they depended. In any case, it is worth exploring.

I expect to be in Washington anyway on Friday, January 13th and I wonder if it would be possible for me to drop in on you that afternoon.

All the very best wishes for Christmas and the New Year,

Most sincerely,

Froelich Rainey  
Director

Mr. W. T. Pecora  
Director , Geological Survey  
Department of the Interior  
Washington, D. C. 20242

FGR/vg

enclosures

*W. T. Thompson*

# SYRACUSE UNIVERSITY

DEPARTMENT OF RELIGION | 316 H. B. CROUSE HALL | SYRACUSE, NEW YORK 13210

2 Jan 67

Dr. Froelich Rainey  
The University Museum  
33rd and Spruce Streets  
Philadelphia, Pa. 19104

*Wile*  
*Quelby*

Dear Sir:

Thank you for the copy of your letter to Dr. Pecora. I spoke of the possibilities of satellite research to Dr. Mendenhall in NYC last week. He hopes to go over his aerial (including infrared) photographic material with an expert in interpretation at the University of Michigan in the near future. I know the results of this detailed study will be of interest and I will keep in touch with him.

I trust your meeting with Dr. Pecora will be fruitful.

Sincerely yours,

*Henry O. Thompson*  
Henry O. Thompson



OFFICE OF THE DIRECTOR

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY  
WASHINGTON, D. C. 20242

January 3, 1967

*file*

*Techniques*

Dr. Froelich Rainey  
Director, The University Museum  
University of Pennsylvania  
Thirty-third and Spruce Streets  
Philadelphia, Pennsylvania 19104

Dear Dr. Rainey:

Please feel free to drop in at the office on January 13 if you are in town. I shall alert my colleagues of your visit.

My office is located in Room 5242, GSA Building, 18th and F Streets, N. W., and my telephone number is 343 3888.

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It seems to me that using techniques of remote sensors from aircraft might have some promise in the field of archaeology. It's with this idea in mind that I am asking some colleagues to meet with you.

Many thanks for the reprints which I found most helpful.

Sincerely,

*W. T. Pecora*

W. T. Pecora  
Director

~~Dr~~

Techniques  
January 28, 1967

Dear Dr. Thompson:

This is just to let you know that your idea about EROS has developed into quite a thing. I have had a most interesting meeting with Dr. Pecora and the committee working on the programming for EROS. We concluded there really is a possibility of archaeological survey from the satellite and also that we should experiment with remote sensing from aircraft in preparation for EROS. We have some interesting results from infrared photography and infrared scanning in southern Italy and we expect to make another experiment over a site in Arizona during February. But I will remain in touch with Dr. Pecora and the planning group in order to carry out further experiments with aircraft during the next year.

Many thanks for suggesting this whole business. We will keep you posted on developments.

Most sincerely yours,

Froelich Rainey  
Director

Dr. Henry O. Thompson  
Department of Religion  
Syracuse University  
Syracuse, New Ybrk 13210

FGR/vg

SYRACUSE UNIVERSITY

DEPARTMENT OF RELIGION | 316 H. B. CROUSE HALL | SYRACUSE, NEW YORK 13210

5 Jan 67

Dear Sir:

You have probably received similar correspondence but in case not, here is a carbon.

I assume that archaeological interests, as set out earlier correspondence, is not limited to geography. At any rate, you'll be discussing this with Dr Pecora, so I'm simply sending the carbon as a matter of information.

Yours

Henry O. Thompson



UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY  
WASHINGTON 25, D. C.

December 29, 1966

Dr. Henry O. Thompson  
Department of Religion  
Syracuse University  
Syracuse, New York 13210

Dear Dr. Thompson:

Dr. Pecora has asked me to express his thanks for sending him a copy of your recent letter to Dr. Rainey and Dr. Rainey's reply to this letter, as well as his interest in the possible applications of EROS to the field of archaeology. He has also asked me to indicate that any of us involved with the EROS Program will be very happy to meet with you or Dr. Rainey, at a convenient time and place, to discuss possible applications and to seek suggestions regarding the needs of archaeology and the possibility of their being met by the first or subsequent EROS vehicles, or perhaps as a part of the NASA manned spacecraft program.

We have organized our effort in the Survey into disciplines and we have a coordinator, who concerns himself with the applications of space data to each of the fields of geology, hydrology, cartography, and geography. More recently, we have expanded this group to include scientists concerned with land utilization and conservation and various aspects of oceanography. It is quite likely that the findings and considerations in each of the disciplines will have some bearing on the use of the EROS imagery for archaeological purposes; perhaps the most direct bearing would be in the geographic program.

Dr. Arch C. Gerlach, the Bureau Geographer, heads our geographic effort and I am sure he would be happy to answer any specific questions you may have concerning geographic activities and the current makeup of the program.

If I can provide you with any other information relating to the characteristics of EROS or the Earth Observation programs planned as a part of the NASA's manned space flight efforts, I will be very happy to do so. We sincerely appreciate your interest in the program and it certainly has brought new thoughts to mind regarding the potential applications of the data that are to be derived from space.

My very best wishes for a Happy New Year.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "W. A. Fischer".

William A. Fischer  
Research Coordinator  
EROS Program

RESERVATION COPY 03/21/2014

Operational requirements for global resource surveys  
by earth-orbital satellites

EROS Program

The EROS Program of the Department of the Interior requires sensors to be placed in orbit to obtain systematic synoptic and repetitive imaging of natural and cultural features whose description and understanding is vital to Interior Department missions in many disciplines. The Interior Department is convinced that the earliest possible acquisition of satellite data is of great importance and therefore outlines the following requirements for the first EROS satellite on a "performance specification" basis. All presently available qualified satellite platforms, sensors, and facilities, as well as all developmental and proposed satellite platforms, sensors, and facilities should be evaluated for their capabilities to fulfill Interior Department requirements. We hope to begin acquiring resource data from an operational system by the end of 1969.

The first satellite, planned as an optimum general purpose data collector, should be followed by a series of EROS satellites carrying more sophisticated sensors using other regions of the electromagnetic spectrum and also measuring force fields. A tentative priority for the later sensors is 1) high resolution infrared imager, 2) radar imager and scatterometer, 3) ultraviolet luminescence sensor, 4) microwave radiometer, and 5) gravity gradient and magnetic sensors. Specific requirements for these sensors are not stated at

this time, but will be developed as the engineering of the sensors and interpretive capability develops of users of data.

I. Basic Requirements

- A. Near global coverage
- B. Repetitive observation at same local time
- C. Photographic or imaging data
- D. Vertical viewing required in normal operation but oblique viewing desirable for supplementary coverage
- E. Slight overlap of images in direction of flight and sidelap at the equator
- F. Minimum operational life of one year
- G. Analog data return
- H. Capability for in-flight command programming
- I. Capability of carrying additional unspecified instruments with weight of 50-100 pounds.
- J. Data telemetering capability from ground-based instruments through satellite communications link to central data-reduction facilities
- K. Unclassified systems and data

II. System constraints imposed by basic requirements

- A. Sun-synchronous orbit with sun angle at  $30^{\circ}$  at  $50^{\circ}$  latitude, at vernal equinox at 2.6 hours (local sun time) before or after true noon

- B. Power supply sufficient for sensors and data transmission and relay
- C. Stabilization sufficient to maintain a minimum of  $1^\circ$  pointing accuracy at vertical
- D. On-board data storage as required by relation of orbit altitude, and tracking stations
- E. Data rate commensurate with resolution and number of elements in final design

### III. System requirements for optimum data acquisition

#### A. Imagery

1. Ground resolution of 100' - 200' per resolution element (on a side)
2. Field of view of about 100 statute miles on a side (square format)
3. Spectral resolution
  - a. about 100 m $\mu$  spectral increment peaked at 510 m $\mu$
  - b. 150 m $\mu$  spectral increment peaked at about 700 m $\mu$
4. Ground recording in two modes (direct analog image and magnetic tape) with the least image degradation

1. Capable of relaying digital data from earth-based sensors to central data-reduction and computing facilities

2. Required data transmission to be on a basis of at least daily readout of data stored at ground stations and collected at intervals of 1-5 hours. Data rate and volume would be low.

3. Ground sensors may include, but not be limited to:

- a. insolation meters
- b. stream gages and water-quality recorders
- c. tiltmeters
- d. thermal probes
- e. seismometers
- f. strain gages
- g. displacement meters

Pecora

Office of the Secretary

Similarly, engineering designs that minimize damage from earthquakes, floods, or other hazards increase the effective use of the land for construction and other engineering purposes. For other resources - minerals and mineral fuels, for example - increased effective consumption depends not only on increased efficiency of use, but also on the discovery and development of new supplies.

During the last 30 years, the United States alone used more minerals and fuels than did the entire world in all previous history, and we will double our present consumption of most minerals within 15-25 years. The supply problem is literally compounding with growth in population and rise in per capita consumption of raw materials and energy.

In spite of widely expressed fears that demand will shortly exceed potential supply for many resources, there is good reason to believe that the world's undeveloped resources are large enough to support a growing demand far into the future - provided, however, we aggressively and imaginatively press the search for knowledge of our resources and for ways to discover, extract, and use them more efficiently.

If we had to depend on known supplies, we could predict collapse of our industrial civilization in a couple of decades, and if we had to depend on supplies that could be found and developed, with present knowledge, disintegration would not be long postponed.

To match the acceleration in demand for resources, then, means must be found to accelerate acquisition of knowledge concerning them. The development of aerial photography and of airborne geophysical surveying techniques has already increased the rate at which new knowledge of the world's resources can be acquired.

Fortunately, it appears that further acceleration required can be obtained through the use of remote-sensing devices mounted in earth-orbiting satellites.

The synoptic, metric, and panoramic cameras now under investigation and development, together with laser technology, should make possible the construction of topographic maps of presently standard quality and accuracy at scales as large as 1:250,000 (1 inch equals approx. 4 miles) and perhaps even 1:62,500 (1 inch equals 1 mile). Metric photography suitable for 1:250,000 scale mapping acquired at orbital heights of more than 100 miles would be approximately 10 times smaller in scale than conventional photography. This is an indication of the accelerated data-acquisition potential of satellite photography.

Udall

Office of the Secretary

"Facts on the distribution of needed minerals, our water supplies and the extent of water pollution, agricultural crops and forests, and human habitations, can be obtained on a global basis, and used for regional and continental long-range planning," he said.

Secretary Udall named Dr. William T. Pecora, Director of the U. S. Geological Survey, to head the program.

"A team of knowledgeable scientists and resource data users will guide government and private agencies in making their data needs known, and to help plan a major effort in the exploration of the earth for human benefit," Udall said.

Pecora and his earth science colleagues described space-sensing of the earth as "the ability to 'see' more easily beneath the water and forest or soil cover, and the ability to view areas of the earth repetitively at various times and seasons. Another basic advantage is the fact that comparable observations can be made all over the earth."

"Although we are now gaining valuable information from existing satellites," Pecora said, "none are capable of providing global coverage of the type required for successful resource application."

"We visualize EROS as an evolutionary program," said Pecora, "beginning with television cameras flown in an orbit that will cover the entire surface of the earth repeatedly, under nearly-identical conditions of illumination."

"What we have learned from photographs taken recently from orbiting spacecraft," the Survey Director said, "indicates that the lands can be examined, evaluated, and mapped, and the type and vigor of plants can be determined. "In addition to the cameras that will provide the photographic record, the first vehicle will also have a small telecommunications unit so that we may relay data to and from ground stations that will aid in interpreting the television images. These relayed ground data will include seismic and other information that, hopefully, will enable us to predict some natural disasters."

Pecora explained that "future sensing systems will employ heat-measuring devices to monitor the earth's volcanoes and search for sources of geothermal power, radar that will 'see' beneath the clouds, and eventually cameras with sufficient resolving power to permit timely up-dating of our national topographic map series."

# SYRACUSE UNIVERSITY

DEPARTMENT OF RELIGION | 316 H. B. CROUSE HALL | SYRACUSE, NEW YORK 13210

April 3, 1967

Dr. Froelich Rainey  
The University Museum  
University of Pennsylvania  
33rd and Spruce Streets  
Philadelphia, Pa. 19104

Dear Dr. Rainey:

Thank you again for the time on Wednesday. I believe I forgot to thank you for the reprint which Miss Ralph gave me of your joint article in Science.

Miss Greene has probably found Dr. George Mendenhall's address by now, but if not, would you be kind enough to tell her that he is at the University of Michigan, in Ann Arbor? Thank you.

In thinking further on the proposed experimental work that might be done this year for EROS, it occurred to me that the Air Force has planes all over the world, so it probably is not at all necessary to limit our thinking to this hemisphere, although the convenience might still be of consideration. Two further thoughts: Viet Nam material would presumably be classified but are there currently materials at hand of neighboring areas such as Siam and the ruins there? Secondly, the way in which water pollution shows up makes me wonder about salt. Could we get comparative studies of fresh water, ocean water, and high density salt bodies such as Great Salt Lake, the Dead Sea and perhaps the Caspian? Or, in discussing the possibilities of underwater remains, perhaps these distinctions could be kept in mind. I would assume, for example, that they are already planning to check the bottom of the Great Lakes for iron ore, etc. Perhaps a check for shipwrecks could be made at the same time, with this water distinction in mind.

*FOR*  
*Greene*  
*Arca*  
*Please*  
*return*  
*to my*  
*files*  
*FR*

-2-

We spoke briefly of aerial survey uses for EROS. I presume photogrammetric studies are already planned. As planned, would they be directly useable (e.g., contour maps for places like Turkey) or would archaeological needs require some modification which they could plan in advance?

Yours,

  
Henry O. Thompson

HOT/ag

PS: The enclosed "satellite report" has been sent to Science News for possible publication. As you can see, our visit was a major source of inspiration for it. Thank you.

QUALITY AND PROMISES

The News has made a contribution to archaeology in a way that it probably has not expected to make. The author read with interest the article on Project EROS (Earth Resources Observation Satellites) in Vol. 2 (p. 28), 9 Oct '66). If satellite collected data could be used to study mineral and water resources, why not archaeology? At first it seemed a bit weird to think of going 800 miles up into the air to find archaeological remains hidden under ground. Several things, however, made the idea appear feasible. Aerial mapping and photography (aerial, balloon, and airplane) has made extensive contributions to archaeological discoveries over the past several decades. In 1946 Dr. George E. Nash (University of Michigan), then Director of the American School of Oriental Research in Jerusalem, experimented with aerial photography with infrared film in the desert (Journal, "Science and Archaeology," The Biblical Archaeologist, Vol. XXIX, p. 121, Dec '66). The September 66 issue (Vol. 2, No. 2) of the MAJCA Newsletter (AFFiliated Science Center for Archaeology of the Pennsylvania University Museum) reported on the work of its Director, Dr. Froelich Rainey, with the Air Force's new multi-lens camera in his search for ancient Sybaris in southern Italy.

The News article plus these recent developments led the author to approach Dr. Rainey and Dr. William Peters, who the article identified as in charge of Project EROS. After a series of letters, the two men met and discussed the possibilities of satellite photography in late June, with the natural resources information of EROS. The author was told of a "view" that has some extremely exciting potential. The News article also mentioned the Archaeological Survey of Texas showing the difference between a series of standard aerial photographs and the same area with a single satellite photograph. The efficiency of this is obvious, but its significance for archaeology may not immediately appear. The discovery of archaeological remains depends heavily on light and shadow effects, in both standard and the newer sensor types of photography. Before the time of airplane "take one run" and then turn back for a second run parallel to the first, the light has changed and the shadows with it. A satellite photograph records the entire area under the same light direction and intensity.

One of the major facets of aerial photography and archaeology is vegetation. Where soil is deep, plants grow greener and more luxuriantly, than in shallow soil, such as that over a burial vault or other archaeological feature. However, the distinction varies with the season and the stage of growth. The archaeological value of observation in different seasons is already being demonstrated by the Rheinisches Landesmuseum in Bonn (p. 29, MAJCA Newsletter, Vol. 1, No. 1, February '65). EROS would be able to provide almost constant coverage of almost any spot on the globe throughout the year. The mere thought of such potential staggers the imagination. It will take a computer just to process such an immense amount of data.

Currently under consideration are plans and suggestions for preliminary experiments with known sites (as scientific controls), jungle and other heavy growth, and under-water features. A letter from Dr. Rainey's wife suggested the possibility of detecting archaeological features under heavy growth and under cultivated land, but areas which are "under water" do not appear in neighboring cultivated fields. In the past, that might have been very growth areas of Central America, Africa, South America, and even the Middle East as the "jungle" of the Jordan River in the Near East. An interesting light beam in the growing "tropical" countries in these areas are due to their "tropical" climate, development of archaeological sites for tourism. Then they would probably enjoy this satellite exploration of their countries.

Aerial photography has not been used for underwater archaeology as far as the author has been able to determine. This is a very rapidly developing division of archaeology and perhaps it should already be considered a discipline in its own right (Under the News, Vol. 2, p. 126-127, 13 Feb '66, and Vol. 2, p. 287, 5 Nov '66). EROS is already planning to look through the waves to study such underwater phenomena as reef formation. Ship-

\* with archaeological potential include such widely scattered areas

2)

reefs tend to be in the vicinity of reefs and their location could be a very natural adjunct to the other study. Similarly, the search for minerals, such as iron ore underneath the Great Lakes, could be very naturally expanded to look for ships that have gone down in America's inland "seas." The search for Sodom and Gomorrah on the bottom of the Dead Sea fascinates many people, and similarly the remains of places like Port Royal, or simply the study of ancient harbors, causeways, etc., could be a considerable benefit which archaeology might derive from EROS.

To the above, we should add the value of discovering such gross geological features as shifting river beds and the formation of shorelines and deltas. It is well known that ancient settlements developed in relation to rivers and harbors. Dr. Rainey is currently investigating such information in his search for Sybaris. The location of irrigation features, such as ditches and dams, will not only be a clue to ancient settlements, but also have current practical benefit for modern agriculture. The location of water resources in desert regions might have a similar modern value, while giving archaeologists clues to archaeological sites as well as information on the water sources for known sites. The last statement is a reminder that while EROS is perhaps of greatest value for discovery of new sites, it may contribute to our knowledge of known sites as well.

Aerial-visual survey work is expensive, and much necessary work is presently waiting to be done, such as in Iraq, is delayed for lack of money and personnel. EROS will certainly facilitate the location of sites by the ability to cover vast areas at once. This will be helpful to the need for ground surveys, but will surely make them more efficient. Aerial-visual surveys will be the almost instant production of accurate aerial photos, and topographic maps. Their value to archaeology has already been noted by Science News (Vol. 77, pp. 17, 18, 19, and Vol. 81, pp. 30-33, 14 Jan 67).

One of the interesting side notes on all of the above is the growing involvement of the federal government in archaeology. To the counterpart funds in places like Israel, the AID program in places like Jordan, the emergency salvage efforts in this country, the NSF grants and the ever increasing of the NFAH, might well be added Project EROS.

If preliminary work proves fruitful, as there is every indication it will, the next bold and fascinating step in the burgeoning list of modern technological developments in archaeology, will be seeing what's down under from 200 miles up there, Archaeological research by satellite -- thanks to Science News!

H. O. Thompson

January 23, 1968

Dear Mr. Solheim:

I have yours of January 14 and hasten to give you what information I have on EROS. This is supposed to be launched next year and the resources survey to be made is under the direction of the Interior Department of Geology. I have had some discussions with the Director of the USGS, the NASA people, and with the Air Force about the archaeological possibilities, and we all think there are possibilities. However, I am supposed to test out some of the remote sensing devices with the Air Force in preparation for EROS and at the present moment I am waiting for reports from the Air Force about our most recent experiment over archaeological sites in Arizona. The results are being studied by NASA people and I still do not have them.

Of course I shall be glad to let you know what results we get and keep you in touch with the EROS project. There are some fears that Vietnam will delay the EROS construction, but I am hopeful that our government has enough sense to go ahead with this project at least.

All the best.

Sincerely,

Froelich Rainey  
Director

Dr. Wilhelm G. Solheim, II  
Aldeia Turistica das Areias de S. Joao  
P. O. Box 7, Albufeira  
Algarve, Portugal

FGR/sjc

Arch. Techniques

September 14, 1967

Dear Dr. Thompson:

Many thanks for the clipping on archaeology in orbit. Nothing much more has happened regarding Eros, but I am in the middle of two more experiments with infrared sensing, and as soon as I get the hoped for results, I will be in touch with Mr. Pecora. I will also keep you posted.

All very best wishes,

Froelich Rainey  
Director

Dr. Henry O. Thompson  
Department of Religion  
Syracuse University  
Syracuse, New York 13210

FGR/vg

SYRACUSE UNIVERSITY

DEPARTMENT OF RELIGION | 316 H. B. CROUSE HALL | SYRACUSE, NEW YORK 13210

7 Aug 67

Dr. Froelich Rainey  
The University Museum  
33rd and Spruce Streets  
Philadelphia, Pa. 19104

Dear Dr. Rainey:

Enclosed is a reprint from the June issue of Archaeology.

I would appreciate being kept posted on any developments in this project. If you should happen to have a spare photograph or two or three illustrating the type of thing we hope to accomplish through the satellite program.

Since I last wrote, I have changed jobs. I'll be here teaching second Summer Session until 7 Sept. This Fall I will be teaching at New York Theological Seminary, 235 E. 49th Street, NYC, 10017. We will be living in Madison, NJ. Hopefully, I'll be able to get down to the Museum and see more of your collections.

Sincerely yours,

  
Henry O. Thompson

plained reason the nether grinding stones (*metates*) outnumber the handstones, a reversal of the usual situation in the Southwest. Most flake tools show little or no refinement, although graters, finely flaked bifacial knives and well executed bladelets are common. Projectile points are too few and too varied to permit clear-cut cultural and chronological inferences, though this scarcity may connote less reliance on a hunting economy.

Substantial amounts of charcoal came from most of the structures excavated, and a sample from the pit house has been submitted for a radiocarbon determination. Judging from the architecture and artifacts, it seems unlikely that the site dates earlier than the fourth or fifth century of our era.

Although the pit house at the Sun House Hills site shows a relationship to the Mogollon culture, too little is known of the attributes and sequence of events of the pre-ceramic period in the Laguna district for it to be considered as clearly Mogollon, Cochise (the pre-pottery ancestor of the Mogollon culture) or Anasazi. Although the Laguna district was subsequently occupied by Anasazi people, it is not particularly surprising to find a typically Mogollon dwelling in that area. Reconnaissance by Dr. A. E. Dittert, Jr. has demonstrated that contact between these two cultures was established in this region at a very early date and was maintained in varying degrees as long as the Mogollon culture could be recognized as a separate cultural entity.

The Sun House Hills site was only one of nine excavated in late 1966 as part of the Museum of New Mexico's highway archaeological salvage program. In the past thirteen years over one thousand sites within or near highway rights-of-way have been recorded. Through complete or partial excavation, 137 of these sites have been rescued from unrecorded oblivion.

The Museum's archaeological salvage projects got their start in 1950, and they have maintained a steady pace during the past seventeen years, occasionally through the agency of the School of American Research. All told, over five thousand sites have been catalogued, 315 subsequently excavated. Construc-

tion of new highways, pipelines, powerlines, schools, urban developments and the like continue to require New Mexico archaeologists to be vigilant lest the state's prehistoric and historic resources be obliterated. Such problems are not unique to New Mexico—they are world-wide.

### Mycenaean Congress

The First International Congress of Mycenaeanology will be held in Rome, September 27-October 3, 1967. The date, first announced as September 21-27, has been postponed in order to avoid conflicting with the Congress of Greek and Latin Epigraphy to be held in Cambridge, England.

Reports and papers are to be arranged in three sections: archaeology, philology and history. Reports have been promised for the archaeological section by N. Platon, Sp. Marinatos and D. Levi; for the philological group by E. L. Bennett, J. Chadwick, M. Lejeune, C. Galavotti, O. Masson, Vl. Georgiev and L. R. Palmer; for the historical section by V. d'A. Desborough, M. S. Ruy Pérez and G. Pugliese-Carratelli.

The Executive Committee of the Congress states that scientific and educational institutions in every country may be represented by one or more qualified scholars as official delegates. The official address of the Congress is c/o Centro di Studi Micenei, University of Rome, Rome, Italy.

### Archaeology in Orbit

[The author of the following account of a fascinating new possibility for scientific aid to archaeology is Professor Henry O. Thompson of Syracuse University, whose article, "Science and Archaeology" in the *Biblical Archaeologist* (29 [1966] 114-125) provides valuable information and bibliography on other scientific techniques.]

In September 1966 the United States Department of the Interior released a report on a project called Earth Resources Observation Satellite, abbreviated EROS. Whatever the initials may imply, the Department's intention is to gather information on natural resources via satellite. The satellite, the launching

date of which was set for 1969 but may be moved up to 1968, will be equipped with television cameras, radar equipment and cameras with various types of sensor films such as infrared. As I read of the plans to study mineral resources, forest reserves, water pollution, etc., it occurred to me that if a satellite could be used to collect this type of information, why not archaeological data also? It may seem a bit odd to go two hundred miles up in the sky to find out what is underneath the ground. However, several things made the idea appear feasible. Aerial viewing and photography have made extensive contributions to archaeological discovery over the past several decades. In 1966 Dr. George Mendenhall, then director of the American School of Oriental Research in Jerusalem, carried out some aerial photography with infrared film in Jordan. Dr. Froelich Rainey, director of the Museum of the University of Pennsylvania, has recently used the Air Force's new multi-band camera in his search for ancient Sybaris in southern Italy.

This combination of developments led me to approach the Project EROS Director, Dr. William T. Pecora, as well as Dr. Rainey about using EROS for archaeological exploration. After some correspondence the two men were able to meet and discuss the matter. They concluded that the idea is not only feasible but has an extremely exciting potential. Five hundred standard airplane aerial photographs (which must then be carefully fitted together to form a mosaic) are required in order to cover the territory included in a single satellite picture. The efficiency of the latter is obvious. The discovery of archaeological remains from the air depends heavily on light and shadow effects. This is true for both the standard and the new sensor types of photography. Between the time a plane flies over a strip of the earth and then returns to photograph the parallel area next to it, light and shadows over the area have changed. A satellite picture records the entire scene with the same light.

The variation in vegetation as seen from the air is another factor of importance for the archaeologist. Where the soil is deeper, growth is more luxuriant and where the soil

is shallower, as over a wall or other archaeological feature, the vegetation is less so. This, of course, varies with the seasons. The significance of this is currently being demonstrated by aerial survey work being done in Germany. The advantage of EROS will be its ability to cover any spot on the globe at any time—weekly or daily if need be. With this kind of potential, it would take a computer just to process the data obtained.

Currently under consideration are plans and suggestions for preliminary work with known sites, jungles and underwater remains. The jungle areas of Central America, Africa and Southeast Asia are rich in archaeological possibilities. Several of the countries in these regions are taking new interest in their history as well as in the development of archaeological sites for tourism. This suggests that they might welcome this type of "exploration" of their lands.

So far as I have been able to determine, aerial photography has not been much used for underwater archaeology. It seems a natural next step in this rapidly developing discipline. EROS is already planning on peering beneath the waves to study the formation of coral reefs. Ships have foundered on reefs, and the study of wrecks is a major aspect of underwater archaeology. EROS could easily include the study of wrecks along with the study of reefs. Similarly, the search for minerals, such as iron ore under the Great Lakes, could well be expanded to look for ships that have sunk in our great inland "seas." The search for Sodom and Gomor-

rah of biblical fame under the waters of the Dead Sea, the study of remains like Port Royal and of harbor installations could be a considerable boon to the archaeological world.

It is well known that ancient settlements tended to develop on rivers and near good harbors. At the same time, we know that rivers occasionally shift their beds and harbors silt up. A study of such geological features, the formation of shorelines and deltas, may be a guide to the discovery of settlements. The location of irrigation dams and ditches will not only be a clue to ancient settlement but may be of value to modern agriculturalists as well. So, too, the location of water resources in desert regions, or in relation to already known sites, may benefit the people there today.

EROS would not be able to eliminate ground survey work but it could make it a good deal quicker and hence cheaper. Closely related to survey work are aerial, stereo and contour maps. EROS could produce accurate maps almost instantaneously. The value of this to archaeology is readily apparent. EROS and related satellite photography will not eliminate lower altitude aerial photography but will supplement it. A satellite may locate features that aircraft can then look at more closely.

One of the less publicized aspects of government activity is the federal government's role in archaeology. It is increasing every year in many ways. To the growing list of its activities we might well have to add Project EROS.

In recent decades archaeology has been making more and more use of modern technological developments, particularly electronics. If preliminary work proves fruitful, the next bold and fascinating addition to the list of such developments will be archaeology from outer space, archaeology in orbit.

#### Michael Ventris Award

The Michael Ventris Memorial Award for 1966 for Mycenaean Studies has been made to Mr. P. Hynding (University of Copenhagen). This award is given in alternate years for archaeological studies. A supplementary award from the Memorial Fund has been made to Dr. Paola Pelagatti (of the Soprintendenza alle Antichità, Syracuse).

#### Award to E. R. Caley

Earle R. Caley, professor of chemistry at Ohio State University, has for many years been interested in applying chemical techniques of analysis to ancient metal objects. He is best known for his work in analyzing the composition of Greek and Roman coins and has published extensively in the field of archaeological chemistry. Professor Caley has recently been presented with the 1966 Dexter Award in recognition of his work. This award, established in 1956 by the Dexter Chemical Corporation and administered by the American Chemical Society, Division of History of Chemistry, is given each year "to generate further interest in the history of chemistry." It includes a prize of one thousand dollars and a plaque.

*Highlights of the*

**OCTOBER**

*issue of*

**ARCHAEOLOGY**

EARLY MAN IN SOUTHERN TANZANIA

*by Frank C. Hibben*

A TEMPLE AT SEIBAL, GUATEMALA

*by Gordon A. Willey and A. Ledyard Smith*

BRITISH DIGS AND AMERICAN STUDENTS

*by Graham Webster*

*Arch.  
Techniques*

January 23, 1968

Dear Mr. Solheim:

I have yours of January 14 and hasten to give you what information I have on EROS. This is supposed to be launched next year and the resources survey to be made is under the direction of the Interior Department of Geology. I have had some discussions with the Director of the USGS, the NASA people, and with the Air Force about the archaeological possibilities, and we all think there are possibilities. However, I am supposed to test out some of the remote sensing devices with the Air Force in preparation for EROS and at the present moment I am waiting for reports from the Air Force about our most recent experiment over archaeological sites in Arizona. The results are being studied by NASA people and I still do not have them.

Of course I shall be glad to let you know what results we get and keep you in touch with the EROS project. There are some fears that Vietnam will delay the EROS construction, but I am hopeful that our government has enough sense to go ahead with this project at least.

All the best.

Sincerely,

Froelich Rainey  
Director

Dr. Wilhelm G. Solheim, II  
Aldeia Turistica das Areias de S. Joao  
P. O. Box 7, Albufeira  
Algarve, Portugal

FGR/sjc

# FEPA

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14th January 1968

Dr. Froeligh Rainey, Director  
The University Museum  
University of Pennsylvania  
Philadelphia, Pennsylvania, U.S.A.

Dear Dr. Rainey:

A few days ago I read the note in ARCHAEOLOGY about Project EROS and that you were involved in this as far as the possibilities for archaeological exploration are concerned. I would very much like to hear what is developing in this matter, both for publication in Asian Perspectives and for my own research in Southeast Asia.

For myself, I am interested in photographic coverage of northeastern Thailand. There are remnants of an old terrace field system in several areas in the northeast where I have excavated. I expect to continue working in this area for some time to come and one of the problems in which I am interested is the development of this terrace system and the change from dry, probably slash and burn agriculture, to wet agriculture. It should be possible to pick out the general form of these fields from EROS photographs.

I will be here in Albufeira, Portugal, until the 16th of February. If you are unable to write me in time to catch me here I would appreciate it if you could write me at my Hawaiian address and the letter will be forwarded. I will be back in Honolulu in late August. If there is sufficient information on this project for an article I would be happy to have such an article for Asian Perspectives.

Sincerely yours,

*Wilhelm G. Solheim II*

Wilhelm G. Solheim II

November 22, 1969

Dear Mr. Hampton:

Mr. Fischer, Coordinator for the EROS program, thought you might like one of the enclosed articles.

All the best,

Froelich Rainey  
Director

Mr. J. N. Hampton  
Air Photographs Officer  
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Fielden House  
10 Gt. College Street  
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FR/j