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Mapping an Ancient Trade Route with Balloon Photography

Mapping from balloon photography was more rapid than from ground stadia survey and less costly than from conventional aerial photography.

Abstract: *The Phokis-Doris Expedition from Loyola University of Chicago is in the process of investigating an ancient trade and communication route which extends 60 kilometers through the mountains of central Greece. With the exception of small-scale (1:50,000) regional maps and a few intermediate-scale (1:5,000) maps, the expedition has had to produce its own maps. After experiencing the limitations of conventional methods of field mapping and being forced by budget and logistics to forego the advantages of conventional aerial photography, the expedition in cooperation with the Whittlesey Foundation decided to obtain non-metric aerial photography using an unmanned tethered hydrogen-filled balloon. This procedure has been used by the Whittlesey Foundation for several years with a variety of archaeological projects, but the Phokis-Doris project presented unique problems in terms of total coverage required and the mountainous terrain encountered. Flying heights varied from 50 meters to 800 meters, and both black-and-white and color coverage were obtained, much of it in stereo. The resulting photographs are being used both as photo-maps for those areas which ground investigations have shown to be archaeologically important and also to continue these investigations back in the United States.*

The Phokis-Doris Expedition, centered at Loyola University of Chicago and in cooperation with faculty members from the University of Minnesota and the State University of New York, is currently investigating an ancient trade and communication route whose terminals are located near the present Greek cities of Amfissa and Lamia (see Figure 1). The natural corridor containing the route is approximately 60 kilometers long and follows a series of valleys and passes through the mountains of central Greece. A modern highway parallels much of the ancient route, and recorded history indicates that the corridor was used at least as far back as Classical Times (c. 5th Century B.C.). One objective of the Phokis-Doris Expedition is to investigate the use of this route in prehistory and to substantiate the hypothesis that its use dates back to Mycenaean Times (c. 1600-1200 B.C.).

Most archaeological field work in Greece is confined to relatively small and well-defined sites, usually no more than a few thousand square meters in extent. A notable aspect of the Phokis-Doris Expedition is the large area that is under investigation. At the present time, after two field seasons totaling 12 weeks, approximately two -thirds of the 60 kilometer corridor has been covered to some degree by surface exploration, and a total of 26 sites have been designated along

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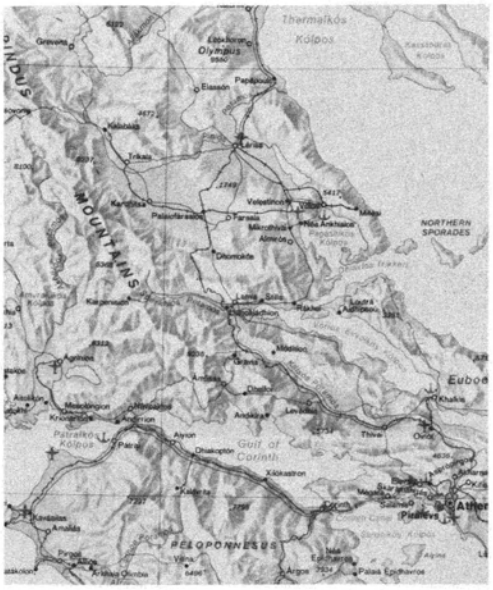

FIG. 1. Map of central Greece including the approximate terminals of the ancient trade route, Amfissa and Lamia.

the route. These sites range in size from a few hundred square meters to several thousand square meters.

MAP REQUIREMENTS

Based on anticipated archaeological requirements and on limited existing maps, the expedition initially decided on three map classifications: (1) Site maps at 1:500 or 1:1,000; (2) Area maps at 1:5,000 or 1:12,500; and (3) A region map at 1:50,000. The operational plan called for a site map for each designated site, area maps which would include all the sites, and a region map covering the entire corridor.

The site maps were to be topographic maps produced by stadia methods, but at the end of the first field season it became apparent the plan would have to be modified. There were several reasons for this: first, the corridor was yielding more sites than originally anticipated; second, the time required to map the larger sites by stadia methods took longer than estimated; third, many of the sites presented logistic problems (one site on a mountain top could only be reached by packing in the equipment with a mule); and fourth, the resources of the expedition did not permit any increase in survey personnel (normally two persons, supplemented on occasion by a third person).

Problems were also encountered in obtaining the area maps. Much of Greece is covered by a 1:5,000 topographic series, and the expedition had planned to obtain these from government or commercial sources. For various reasons it was possible to obtain area maps covering only a third of the sites.

When it became evident that it would be impossible to map the sites with the available personnel and the time restraints of the field season, alternative methods had to be considered. The first possibility considered was to use some form of photogrammetric mapping. From a technical standpoint this would have been an excellent solution. The photography and ground control could have been obtained in Greece during the summer, and the plotting could have been done back in the United States. This solution had to be rejected for two reasons: first and foremost, the cost of the mapping very likely would have exceeded the entire budget for the expedition, and second, the time required to produce the maps back in the United States would have been too long. Project reports are required during the early Fall, and it is questionable if the photogrammetrically prepared maps would have been available when needed. If done commercially (which was never seriously considered) they would have had to fit the contractor's schedule, or if done by project personnel they would have had to be completed as time permitted, which could have taken several years. Also, it is questionable whether it would have been possible to obtain aerial photography in Greece because of flying restrictions or aircraft availability.

The basic archaeological need for the maps was then reexamined. It was agreed that the fundamental requirement at this time was to depict a site in relation to its physical surroundings. It is evident that the location of most human activity is the result of a requisite to satisfy certain needs: food, water, protection, etc. Therefore, in establishing the archaeological significance of a site it is necessary to determine the probability that some of these needs were met by the site's geographical location. One way, if not the only way, of accomplishing this is through some form of maps. As pointed out, this was to be accomplished by the use of three classifications of maps: site, area, and region. The site map would depict the location in considerable detail, the area map would show the site in relation to nearby sites and in relation to the topographical features influencing its location, and the region map would present all the sites with respect to the archaeological hypothesis under investigation.

Project personnel then asked themselves if topographic maps were a necessity, or if some other map form might satisfy the needs of the expedition. It was agreed that if general terrain elevations were available from the region map, then topographic maps were not a necessity at the current stage of the project and some form of aerial photography would satisfy the requirements. Topographic maps would be required later when the sites were excavated, but detailed topographic information in the form of contours was not a necessity for presenting the site in its geographical context. In fact, the added advantage of the detail contained in a photograph would more than offset the loss of topographic information.

The difficulties in obtaining aerial photography were still present, and it was apparent that some form of non-conventional photography would have to be used.[1] It was at this juncture that the Whittlesey Foundation was brought into the picture. Since 1964 this organization has been developing special techniques for archaeological photography[2–4], among which is the use of unmanned tethered hydrogen-filled balloons with radio-controlled cameras for aerial photography. Several archaeological projects have benefited from photographic techniques developed by the Foundation, and it seemed likely they would be able to help the Phokis-Doris Expedition. The project presented two challenges on the use of balloon photography: the total area to be covered, and the rugged topography of the corridor. The balloon would have to be flown close to its maximum altitude of 800 meters, and whereas this had been done before, it had not been done to the extent required by Phokis-Doris in the mountainous terrain of the corridor.

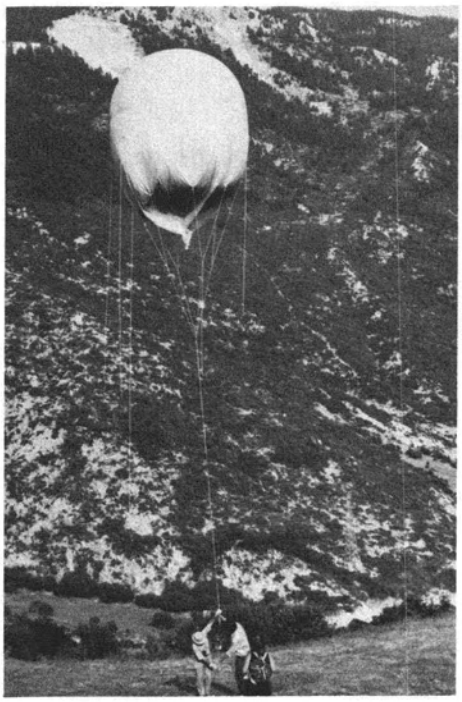

FIG. 2. Crew attaching camera to the inflated balloon prior to launch.

BALLOON PHOTOGRAPHY

The Whittlesey Foundation provided the balloon and camera and all related equipment required for the photography plus a team of two persons to work with expedition personnel (see figure 2). The balloon was approximately 21 cubic meters in volume and developed a net lift of 9 kilograms after a fresh inflation. The camera and radio assembly weighed about 5 kilograms, leaving 4 kilograms to accommodate the weight of the tether line (which increased in direct proportion to the flying height) and the effect of drag produced by any wind. The camera was a Hasselblad 500 EL with a 50 mm*f*/4 Distagon lens. Wind was the critical factor in the operation, and flights were limited to wind velocities of 4 knots or less. Winds can develop rather quickly in mountain valleys and passes, and on several occasions unexpected increases in wind velocity dropped the balloon and camera out of sight behind the surrounding hills. With 800 meters of tether line out, recovery of the balloon required as long as 30 minutes, and the operational team was forced to respond with emergency recovery procedures. Fortunately these were sufficient to alleviate the situation, and neither balloon nor camera was damaged during the flights. Winds were most likely to be calm in the early morning, and the operational procedure called for the balloon to be ready for ascent shortly after sunrise. Wind conditions were evaluated by a wind gauge on the ground and by the flight of a small trial balloon. Normally a decision to fly or not to fly was made within two hours of sunrise, and almost without exception the flights were completed by noon.

Both color and black-and-white photography were desirable for the site areas, and this required two flights over each area. Normally, a roll of black-and-white film was exposed, the balloon was recovered, and a second flight was made with color film. It was impossible to precisely position the

camera, particularly with the higher flights and although the two flights covered the same general area, they did not duplicate one another exposure for exposure.

Results

Photography covering sites in the northern one third of the corridor was obtained during the second field season (see Figures 3, 4, and 5). This was taken over a nine-day period during which there were four days when it was not practical to fly the balloon because of wind conditions. During the other five days a total of 16 separate flights (eight color and eight black-and-white) were made, resulting in 180 photographs. Flying heights ranged from 50 meters to 800 meters, and the approximate coverage on the 180 photographs was 46 square kilometers (11,360 acres). Because of duplication of color and black-and-white and because of stereo overlap, the actual ground coverage was about 20 to 30 percent of the total photographic coverage.

Utilization

Initial use of the photography has been as photo-maps for those sites which have been shown by ground investigation to be archaeologically significant. There have been several advantages. The first has been the short time required to prepare the photo-maps for publication after return of the expedition to the United States. Preliminary reports of expedition results were due in this country and in Greece within two months, and it would have been impossible to produce any other type of map given the financial limitations of the project. Second, the detail and greater coverage provided by the photography have proved of more benefit to the archaeologists at this state of the investigation than the conventional larger-scale topographic maps. These photographs in combination with the small-scale 1:50,000 region map have allowed the investigators to present their findings in a way that permits maximum comprehension by those who must rely on the published reports for understanding and evaluating the project hypothesis.

Beyond the immediate requirements for

FIG. 4. Ancient site of Koukou photographed from 750 meters. Approximate scale 1:7,500.

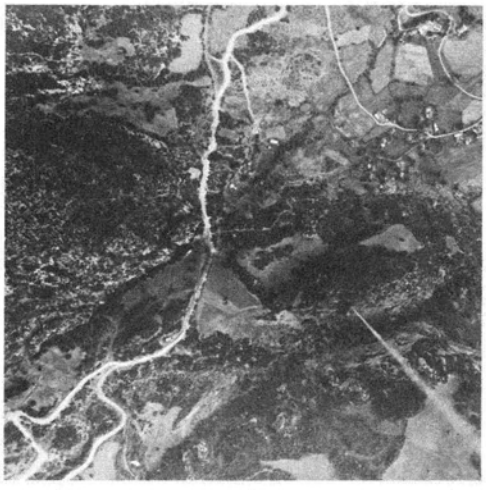

FIG. 3. Ancient site of Dhema photographed from 800 meters. Approximate scale 1:8,000.

FIG. 5. Ancient site of Kouvela photographed from 200 meters. Approximate scale 1:2,000.

the published reports, there is a need continually to examine and reassess the work of the previous field season as plans are made for the coming season. Several of the photographs have revealed features and patterns that were not readily apparent on the ground and which have been marked for further investigation. For those sites requiring more investigation and possible excavation the photographs will serve as working plans to be taken into the field for orientation, annotation, and investigation.

Conclusions

Balloon photography has permitted the Phokis-Doris Expedition to "map" all the sites thus far identified. In addition it has added the dimension of aerial photography to the expedition's work without adding the costs normally associated with such a technology.

The balloon system is constantly being analyzed and improved by the Whittlesey Foundation. More efficient balloons are being built, and a dual camera configuration (permitting simultaneous color and black-and-white photography) has been developed. These technical improvements along with the experience gained in photographing relatively large areas of rugged terrain have improved overall capability of balloon photography for archaelogical investigation.

Acknowledgment

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