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Dan Printup

Arkansas Archeological Survey

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EXPERIMENTS IN AERIAL PHOTOGRAPHY

Dan Printup

Arkansas Archeological Survey, Fayetteville, Arkansas

In recent years ancient roads, walled areas, architectural features, long forgotten works of man, have been discovered, often accidentally, as a result of aerial reconnaissance. Improved equipment, aircraft, cameras, and materials have made it possible to photograph these areas and produce valuable prints for laboratory analysis. Dr. W. B. McCoy, Department of Civil Engineering, University of Saskatchewan, in a paper presented at the Sixth Annual Saskatchewan Archaeological Society Meeting, offered several suggestions for the use of aerial photography in archeology (1968). He particularly mentioned the work at Louisbourg, an 18th century French fortress on Cape Breton Island. The site is being restored by the Canadian Government as a National Park, and aerial photographs were used in delineating and exploring the fortress area (McCoy 1968).

The value of aerial photography to archeological research has been recognized for some time, but the cost of equipment and trained personnel has limited its use by those with small resources of money and equipment. Some excellent work has been done by a few, but the obstacles have discouraged too many of us. In the early summer of 1968 an opportunity arose for some experiments of this nature in connection with archeological work being done in northwest Arkansas in the Ozark Reservoir, under a cooperative agreement between the University of Arkansas Museum and the National Park Service, Southeast Region (Hoffman 1968).

In the latter part of May and early June, 1968, two aerial flights were arranged by the University of Arkansas Museum for the purpose of photographing certain archeological sites in the Ozark Reservoir. It was hoped that the resulting photographs would reveal additional information that would supplement that already obtained during surface investigations of these sites (Hoffman 1965). I agreed to handle the photographic chores, although my previous experience in aerial photography had been limited to making a few color slides of sites on which I had worked. These slides were used to show the general lay of the land and appearance of the areas, and not for analysis of details of the sites.

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AIRCRAFT

The aircraft used on both flights in 1968 was a high wing, single engine Aero Commander. The door on the right (the photographer's side) was removed to give an unobstructed view and to avoid reflections. This necessitated sitting far enough back from the opening to prevent prop-wash hitting the camera. It goes without saying that the cameras were secured by straps. A seat belt gave the photographer a small feeling of security.

CAMERAS AND FILM

The cameras used were a Retina III, with a 50mm. f:1.9 Schneider lens, and a Contaflex I, with a 45mm. f:2.8 Zeiss Tessar lens. The films used were Kodachrome II, Plus-X Pan, and Kodak Infrared. A skylight filter was used with the Plus-X film, and a No. 25(A) with the IR 135 (infrared).

Subjects of the same visual appearance may be quite different in the amount of infrared radiation that they emit. Infrared film used without a filter will produce only "ordinary" results. To get the desired infrared effect, it is necessary to use a filter over the lens (or the light source) in order to eliminate the blue light to which the film is also sensitive. In the case of the red filter used with the infrared film the exposure time is increased considerably. Visual and infrared rays do not focus in the same plane. Unless the camera has a setting for infrared it is usually necessary to compensate for this difference. From the distance at which we were working in the Ozark Reservoir, with relatively short focus lenses, this was no problem. The camera was set on infinity, and the results were good.

EXPOSURES

Since the sites to be photographed were in cultivated bottomland along the Mulberry River, with no elevations that might be delineated by shadows, both flights were made toward the middle of the day. At the time of the first flight the weather was clear, and soil conditions were good, although there was some water standing in the fields. Too much water results in a loss of visible detail on ground surfaces, and completely arid conditions are even worse. Differences in soil colors (often significant in archeological work) are most visible when the ground has been wet and has partially dried. This is particularly true when one is checking old stream channels from the air. The old stream beds are quite visible when they are still

moist and the higher areas bordering them have dried out. They are best seen, of course, on relatively level cultivated land.

On the first flight Kodachrome II was used in the Retina. Exposures were at 1/250 second at f:5.6; one stop smaller would have given better exposures. The built-in exposure meter could not be relied upon, as the slight bumping of the plane caused too much fluctuation of the indicator needle.

Plus-X film was used in the Contaflex on the flight. Good exposures were obtained at 1/500 second at f:8, with the skylight filter.

The weather was partly cloudy at the time of the second flight, but the site areas were clear for the first part of the flight. On this flight Plus-X film was used in the Retina, with a skylight filter, and IR 135 (infrared) in the Contaflex with the No. 25 filter.

In the publication *Kodak Black and White Films in Rolls* (Eastman Kodak Company 1967), the manufacturers explain that, since photoelectric cells measure only visible light and this may vary considerably from infrared radiation from the same area, it is impossible to give exact data for exposing infrared film. On the basis of a suggested trial exposure our infrared pictures were taken at 1/250 second at f:2.8, using the No. 25 filter. (The advantage of using a fine lens such as the Zeiss Tessar is that it will give excellent definition at full aperture.) Our results were very good.

All shots were necessarily oblique because they were made through the plane door, with the camera held inside the plane. Altitudes were between 200 and 500 feet.

RESULTS

The results of our aerial photography were rewarding (Hoffman 1968: 10), the infrared film brought out some elements that were not picked up by the Plus-X film. This was particularly true at the Spinach Patch Site (3FR1) where the infrared pictures suggested there may have been a second mound in addition to the one already recognized on the surface and from Plus-X photographs made during the first flight (Hoffman 1968: 3). What looked like a featureless sandy area when we flew over the Natural Levee Site (3FR33) showed some soil discolorations in the Plus-X pictures. These discolorations were much more noticeable in the infrared photographs. The aerial photographs suggested that the River Bank Site (3FR23) extended into an area that had not been recognized

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during surface investigations. This has since been confirmed by surface examination.

At the Spinach Patch Site the soil was drier at the time of the second flight (when infrared film was used), and this usually results in a loss of detail. Even so, the infrared photographs showed more detail than did the Plus-X pictures made under more moist conditions. It is possible, of course, by manipulations during printing to produce pictures from the same negative that look quite different from each other. In processing the film from these flights and printing the pictures every effort was made to get "normal" prints with no exaggeration of any aspect.

SUGGESTIONS

Although we were pleased with the results of our first aerial reconnaissance, there are several points that deserve consideration before additional flights are made:

(1) If possible, flights for aerial photographic purposes should be made on clear days. Although haze penetration is one of the qualities of infrared film, ground shadows cast by clouds were quite dark in prints. This would seem to indicate that the cloud cover had obstructed the infrared as well as the visual rays.

(2) Unless the photographer and pilot are familiar with the area being photographed, it would be helpful to have ground markers delineating the area of interest. Strips of white cloth of known length would give scale as well as location.

(3) While a 50mm. lens with an angle of approximately 46 degrees does well enough in showing a large site, it necessitates flying too low in order to get a large image of a small area. Most of our pictures were made at around 400 feet altitude; an effort to get a larger image at the Spinach Patch Site from about 200 feet was unsuccessful.

Using a 45mm. lens from about 400 feet altitude we got good over-all pictures of the Spinach Patch Site and adjacent areas. Had we then switched to a 135mm. lens we could have made detailed pictures of specific areas. These would have been more useful in analyzing the site.

(4) Excellent sketch maps can be made from aerial photographs, but detailed measurements are probably beyond the range of our equipment.

(4) Another factor is safety. With lenses of suitable focal length there is no need to fly dangerously low.

The cameras that we have described are not ideal for aerial work. We have determined, however, that it is possible to do useful aerial reconnaissance without special equipment. The 135mm. lens might seem to be special, but anyone doing serious photographic work should have lenses of different focal lengths. The skylight filter is standard with many photographers who keep it on cameras in which ordinary film is used. It protects the lens and does not alter exposure requirements. The No. 25 filter is not an expensive item.

Obtaining the use of a plane is a bit more of a problem. All similar flights that I have made prior to the Ozark Reservoir have been in a plane owned by a friend who was interested in what we were doing. I know of several others who are sufficiently interested in the archeological work being done in their areas to contribute the use of their personal aircraft. Local flying schools would seem a good place to start trying to locate such persons.

Having discovered the possibility of doing relatively inexpensive aerial reconnaissance, we are hoping to use this archeological tool to good advantage during the coming season. We were pleased with the results obtained last summer, but additional experience will undoubtedly result in photographs of even greater archeological value.

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