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Photoarchaeology

Reconnaissance tests using color, as well as other films, indicate that exploration studies may be reduced from months to hours

ABSTRACT: *In the spring of 1965, the Itek Data Analysis Center conducted a photoarchaeological investigation for the National Park Service. The objectives of this investigation were to determine what type of film, black and white IR, pan-minus-blue, natural color, or color IR, was best suited for detection of archaeological sites along the Missouri River in South Dakota. Coverage was obtained at several scales, and compared with pan-minus-blue scale 1/20,000 USDA photography of the same area. We concluded that natural color and color IR, scale 1/10,000 provided the best interpretation medium, considering the saving in time which these mediums provided.*

INTRODUCTION

ABOUT 130 YEARS BEFORE Columbus landed in the New World, the inhabitants of the village site shown in Figure 1 constructed bastioned fortifications, surrounded by dry moats. This site is located in Lyman County, South Dakota, about 22 miles south of Pierre, the state capital. During this same period in history, my ancestors from southern Sweden constructed similar fortifications in Finland, Western Russia, and other areas then under Swedish control. I bring this point out because this similarity, and other evidence, tend to prove that early Norse explorers visited the New World between the year 1000 AD and at least as late as 1362 AD. This thesis is controversial; particularly to Italians as evidenced by their reaction to the Vinland Map. I reopen this controversy, however, because many bits of evidence, for which archaeologists have no satisfactory explanation, indicate the possibility of late Viking age Scandinavian penetration into the middle of North America. Mysteries of this kind are examples of the types of problems which may be solved through the proper use of aerial reconnaissance, termed here *photoarchaeology*, a scientific tool which is made more interesting and effective when color and false color photography are employed.

The full extent of the village site shown in Figure 1, for example, was not known within the Smithsonian Institution's River Basin Archaeological Salvage Program until it was discovered by photoarchaeology in the spring of 1965.

Photoarchaeology is similar in many respects to ground combat tactical photointerpretation. In both instances interpreters are usually searching for small camoflaged installations in rural terrain. The camouflage, in the case of archaeological sites, is generally harder to pierce. It is truly natural camouflage, emplaced over a span of many years,

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* Presented at the Annual Convention of the American Society of Photogrammetry in Washington, D. C., March 1967.

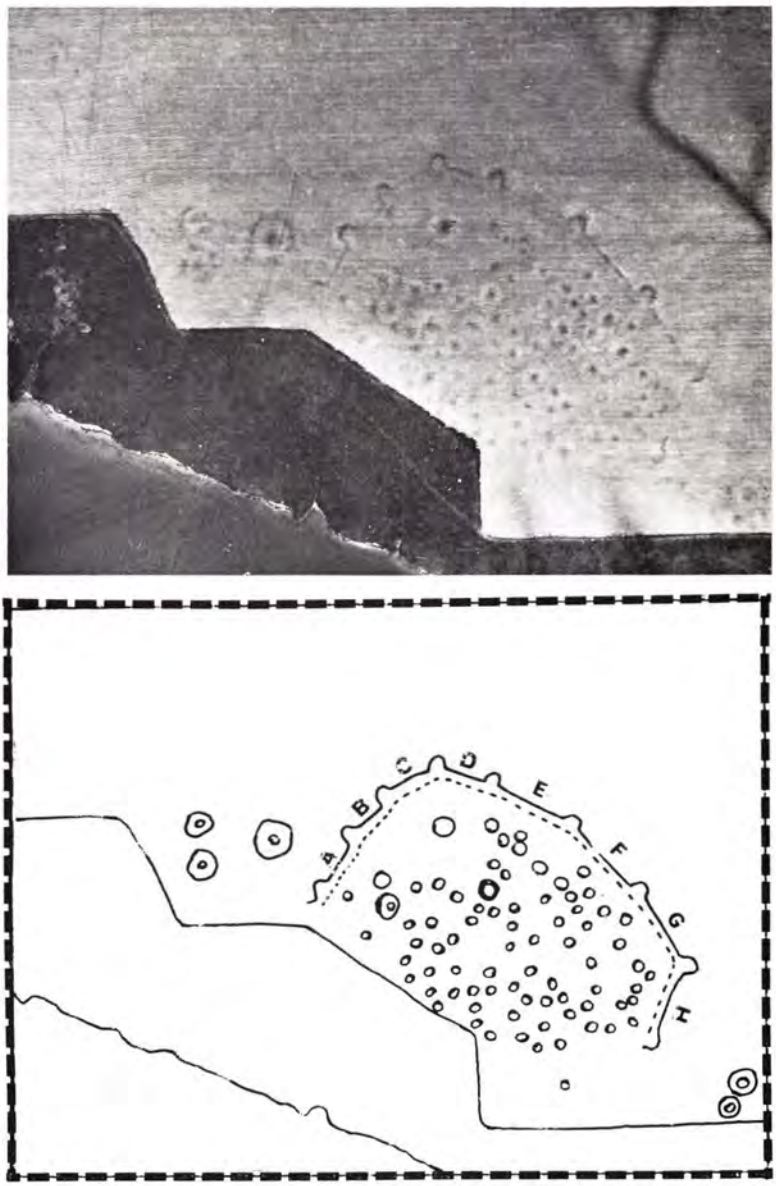

FIG. 1. This photo and accompanying sketch map illustrate the present-day appearance of a fortified village site, classified as Pre-Arikara. The solid outer line on the sketch map marks the location of the moat. The dashed inner line marks the location of the palisade. The smaller circles mark the locations of the older houses which were occupied at the time that the moat and palisade were actively defended. The larger double circles mark the locations of more recent Indian earth lodges. Residual traces of these features can be seen in the photo. The distances between the centers of the bastions are:

A—124 feet	C—129 feet	E—209 feet	G—195 feet
B—121 feet	D—135 feet	F—218 feet	H—202 feet

sometimes hundreds or even thousands. In the case of infantry tactical photointerpretation, detecting critical images under camouflage requires that the proper sensors be used, and that interpreters have knowledge, understanding, and experience. These same requirements exist in photoarchaeology.

THE PROJECT

In the spring of 1965, the Itek Data

Analysis Center, under contract to the U. S. National Park Service, undertook a field reconnaissance project in cooperation with the Smithsonian Institution to determine what type of aerial photography, black and white IR, normal pan-minus-blue, natural color, or color infra-red, yielded the best results for photoarchaeology. The critical factors of scale and time of day (because of the impact of sun angle on shadow length) were also evaluated.

Test Area

The test area selected is located south of Pierre, South Dakota, along the Missouri River, as shown in Figure 2. This area was selected because much of it is being flooded by dams, and concerted efforts were underway to salvage as many bits of American pre-history as possible before critical sites were covered by mud, silt, and water, and lost for all time. This area has been continuously inhabited for thousands of years. The earlier cultures are classed as Woodland, and are believed to have been largely nomadic. No evidence of permanent villages has been found dating to the Woodland cultures along the Missouri River The Indian and/or pre-Indian inhabitants seem to have developed an essentially settled agricultural form of culture about the year 1000 AD. Squash, corn, and beans were staple food items, supplemented by meat from buffalo and other native animals. Fish were also probably included in their diets.

The native inhabitants of this area built earth and log houses of three types during the span of years extending from about 1200 AD to the start of the 20th century. These houses have long since collapsed, leaving residual

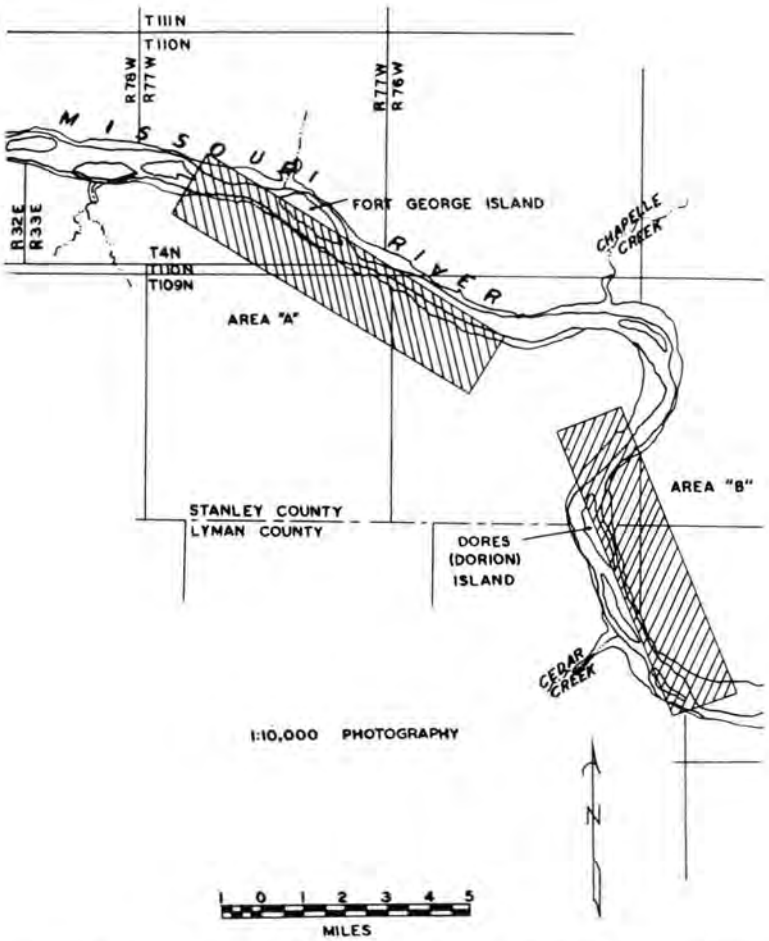

Fig. 2. The test area is located south of Pierre, South Dakota, along the Missouri River as shown in the photo cover diagram.

house pits. Some of these houses were accompanied by cache pits for the storage of food as shown in Figure 3.

Village fortifications progressed through three stages. Fortifications which were constructed about the time of the Kensington Rune Stone, of Norse origin and dated 1362 AD were bastioned, as was shown in Figure 1. The bastions were, in my opinion as a bow hunter, too far apart to have allowed mutually supporting enfilade fires using bows of the type used by Plains Indians during the historical period. Scandinavian long bows or crossbows were another matter. Indian villages of this period are termed *Hull Focus* and sometimes as *Middle Mandan* sites. Later, when the possibility of European contact was less likely, dry moats were constructed, but bastions were omitted.

The native inhabitants of this area are termed *Pre-Arikara*. The Arikara was the principal tribe that lived in the area at the time the French explorer Verendrye arrived in 1732. The Mandans also lived in the area. Verendrye reported that the Mandans were taller, and that about 7 per cent of them were blond and blue-eyed, which may offer another clue to the origin of Viking-like fortified villages.

Test Procedure

A coordinated aerial photographic flight program was conducted, aided by extensive field work. Flight lines over areas of interest on both sides of the Missouri River were set, and comparative aerial photographic coverage was obtained. The area on the west side of the Missouri was quite well known. Two *digs* were being conducted in the area along the west bank in the spring of 1965. The area along the east bank of the Missouri was scheduled for detailed exploration in the spring of 1966.

Photographic Operations

Vertical photography was obtained along both flight lines from three altitudes: 1,500, 2,500, and 5,000 feet. Four types of film were used: (1) Kodak Infrared Aerographic type 5424; (2) Kodak Plus-X Aerographic, type 5401; (3) Aerial Anscochrome D-200; and (4) Kodak Ektachrome Infrared Aero, type 8443. A Wratten 25 (red) filter was used to obtain modified infrared. A Wratten K-2 filter was used with the type 5401 film to obtain pan-minus-blue. Zeiss filters equivalent to the Wratten 2B and Wratten 15 were used to obtain the natural and false-color photography, respectively. One flight using the pan-minus-blue combination was made early in the morning when the shadows were long, thereby accentuating positive vegetation marks.

A Zeiss RMKA Camera (six-inch focal-length lens) was used. A portable resolution target was emplaced near the camp where the Itek personnel and the Smithsonian teams lived. Field work included soil sampling for soil color and acidity determination. Low-altitude low-oblique photos were obtained using a Nikon F 35 mm. Camera with a Micro-Nikkor lens, and with a Nikon S-2 with a Nikkor-SC 50 mm. F/1.4 lens, from a Cessna 172 airplane. Oblique photos were obtained using Kodak SO-243 High-Definition Aerial film with a Wratten 16 filter, Kodachrome II using a Wratten 2A filter, and with Kodak Ektachrome Infrared Aero, type 8443, using both a Wratten 15 and a Wratten 32+2A filter combination.

Extensive ground photography was obtained to support the aerial photointerpretation phases.

Photointerpretation

Interpretive analyses were made, comparing the project photography with existing USDA scale 1/20,000 pan-minus-blue coverage which had been flown three years earlier in the fall of 1962.

All photography was interpreted at the Itek Data Analysis Center facility in Alexandria, Virginia. Comparative analysis were made using an Itek AM-4 Variable-Width Rear-Projection viewer, Zeiss mirror stereoscopes, Union Instrument folding stereoscopes, and related equipment. The film types were evaluated against each other to determine relative image content and ease of interpretation. The ease of detecting and identifying images of archaeological significance at different scales was evaluated by comparing the number of sites detected, and the density of detail which could be identified.

Findings

In the course of our analyses, we found every site which had been found by professional archaeologists on the ground over a fifteen year period. We found a few additional sites which had not been found in field study. One of these was the fortified village shown in Figure 1. In addition, an Indian grave was discovered—the first burial site to be discovered in the area. These findings should not be misinterpreted to mean that photoarchaeology can replace field work; it cannot. The two must go hand-in-hand.

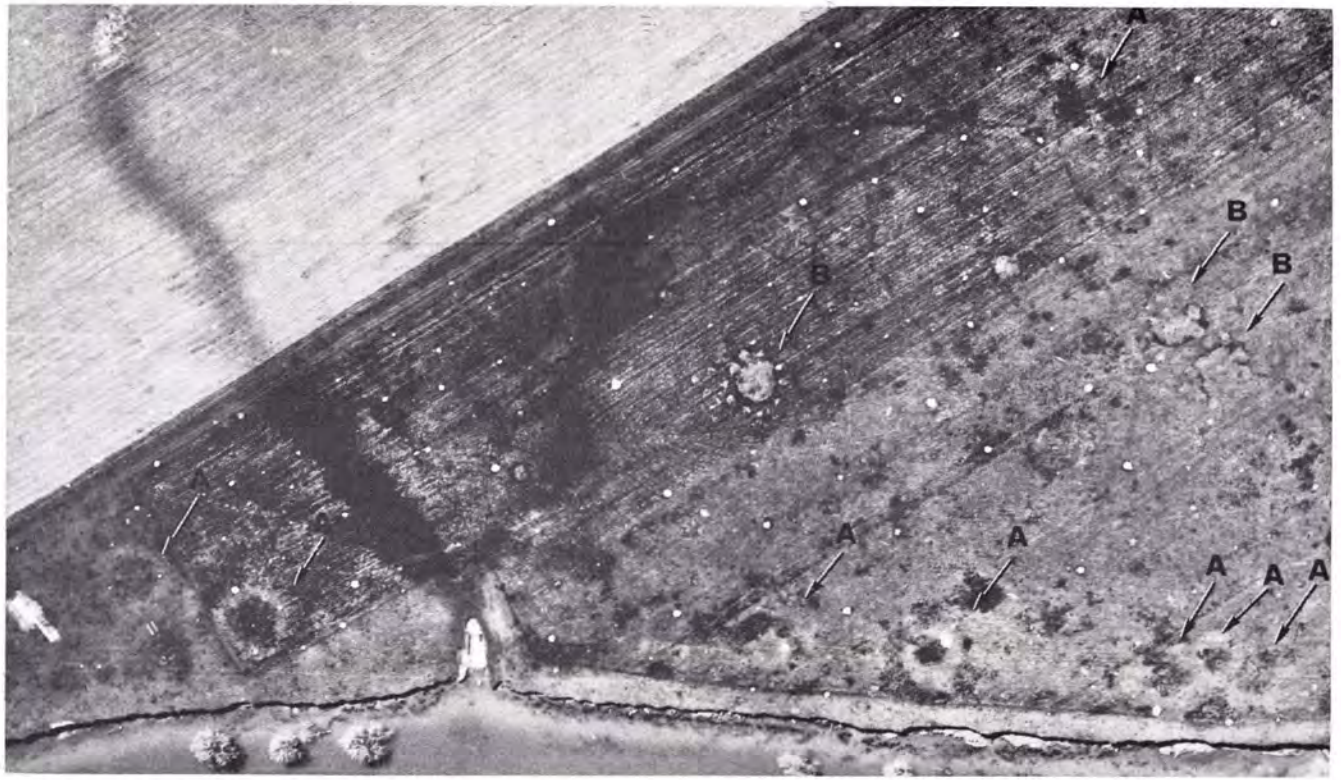

FIG. 3. This photo illustrates the appearance of typical earth lodge traces A without cache pits and B with cache pits. The site with cache pits near the center of the photo has been excavated. The small white patches in the field are ant hills. They average about six feet in diameter.

FIG. 4. This photo shows the circular images which mark the former locations of haystacks. These images resemble the dark images which are created by the denser vegetation in the centers of house pits. While they look almost alike in pan-minus-blue photography, they are strikingly different in infrared—particularly color infrared—photography. The rectangular excavation, incidently, marks the remains of Ft. George, a "whiskey trading" fort which was established in 1840.

Many of the sites could be located on the 1/20,000 USDA photography, and almost all of them on the 1/10,000-scale pan-minus blue photography that was obtained for the project. The modified infrared was much less useful than had been expected.

The major advantage found in the use of the color infrared photography was the improvement in interpretation accuracy. Some circular patterns which looked like house pits in the pan-minus-blue photography were found on re-examination to the earth scars which remained following removal of haystacks. Six of these circular patterns are shown in Figure 4. The similarity of these patterns to the dark center pattern of house pits can be seen by comparison with Figure 3.

The principal advantage of the color and color-infrared photography was that it simplified and speeded-up the interpretation.

CONCLUSIONS

Photoarchaeology can be a valuable tool for archaeological reconnaissance. Field exploration which may otherwise take months to conduct can be performed in just a few hours by stereo study of vertical aerial photography; we believe that this is a general conclusion. Regarding the specific types and scales of aerial photography, our conclusions are limited to exploration along the Missouri River. In that area we conclude that pan-minus-blue at 1/10,000 scale is adequate for preliminary reconnaissance, considering time and cost factors, and the convenience of being able to take paper prints and a folding stereoscope into the field. For more detailed reconnaissance, particularily in inaccessible areas which cannot be field checked conveniently, color infrared photography at 1/10,000 scale is preferred.