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USE OF OPAL PHYTOLITHS IN PALEOENVIRONMENTAL RECONSTRUCTION

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ABSTRACT.—Soil and climatic conditions in the Wyoming-Nebraska-Colorado area of the High Plains are not conducive to pollen preservation. Opal phytoliths, which are present in many achaeological sites in sufficient quantities to provide information concerning both natural and introduced vegetation, are proving to be a viable alternative to pollen in paleoenvironmental reconstruction. The results of phytolith studies can amplify the archaeological data in regard to environmental, cultural, and geological processes.

Examination of soil samples from archaeological sites on the High Plains is on-going research by the Department of Anthropology and the Wyoming Recreation Commission, University of Wyoming. This paper deals with past and current research being conducted and the results of these studies.

INTRODUCTION

One of the goals in recent archaeological excavations has been to obtain data useful for reconstructing paleoenvironments. Palynology has been the best and most widely used method for this purpose. However, soil and climatic conditions in the Wyoming-Nebraska-Colorado area of the High Plains are often not conducive to pollen preservation. To find a viable alternative to pollen studies in paleoenvironmental reconstruction, the Department of Anthropology, University of Wyoming, has been conducting opal phytolith research. Opal phytoliths are present in many archaeological sites in sufficient quantities to provide information on vegetation, both natural and introduced. The results of phytolith studies can amplify the archaeological data in regard to environmental, cultural, and geological processes.

Phytolith studies can provide data about types of grasses growing on the site area and on nearby grazing areas, changes in vegetational types, and changes in moisture levels. It may be able to determine use of buffalo chips for fuel, primary butchering areas of game animals, sleeping areas with grass pads, and types of grasses ground on metates. Humid grass phytoliths may indicate a previous water source, and phytoliths in fill materials can provide information about vegetation from areas draining into the site.

Rovner (1971:343-344) states:

> For any fossil system to be useful to the archaeologist at least three criteria must be met. The material must withstand decomposition, exhibit sufficient morphological differences to be of taxonomic significance, and provide sufficient quantities to reflect the nature of the entire assemblage from which it is derived.

Although phytoliths may not meet all 3 criteria in all situations, they can provide valuable insight and their contribution to the archaeological record must be considered.

Opal phytoliths form as plants take up soluble silica. The soluble silica forms around and in plant cells producing distinctive shapes (Yeck and Gray 1972:639). However, the shape of the silicon bodies may not be the same as its cell, making phytoliths difficult to classify. Pollen is produced in a single repetitive form by each plant, phytoliths are produced in a wide range of sizes and shapes within any specific plant and parts of plants.

When the plants decay, the resistant silicon forms are deposited in the soil. Twiss et al. (1969:111-112) produced a morphological classification of grass phytoliths of 4 classes: Chloridoid (short grass), Panicoid (tall grass), Festucoid (humid grass), and Elongate which appear in all grasses (Fig. 1). Amounts of opal phytoliths available in samples differ from site to site depending on the variables present. A percentage count of phytolith types

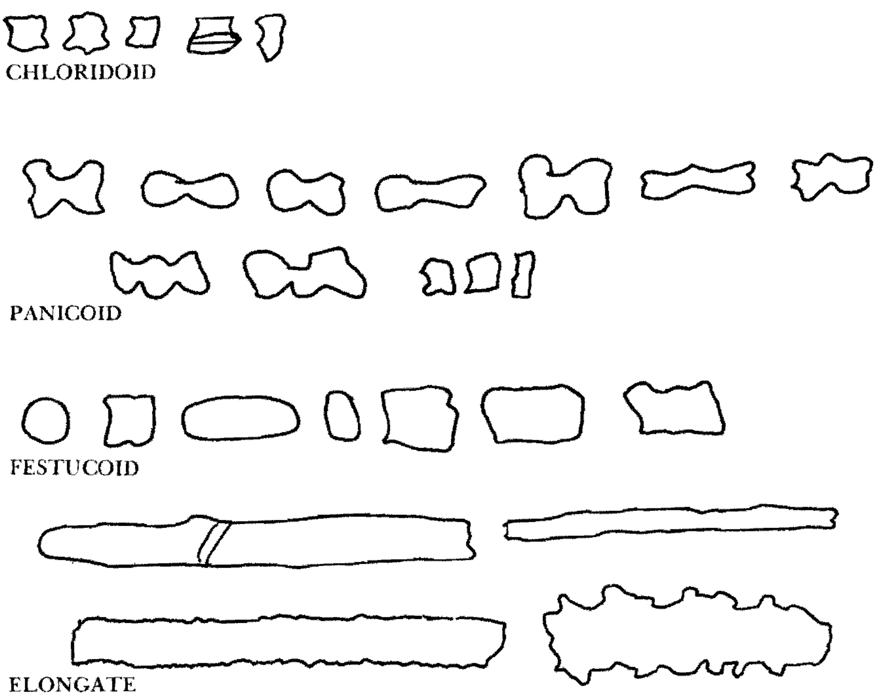

FIG. 1.—Morphological classification of grass phytoliths.

appearing in each slide ascertains with some degree of reliability the grasses predominent in the site area.

Opal phytolith studies can provide information concerning not only the climate of an area during the time a site was occupied, but can also show changes that have occurred in an area over a period of time. Changes in vegetation are shown by changes in class type of phytoliths. Phytolith size is also indicative of changes in moisture (Yeck and Gray 1972:639). Phytoliths are not indestructible; they can be fused by fires, eroded by soil action, and are susceptable to destruction by the soil chemistry.

DISCUSSION

In the past 4 years, samples from a variety of sites in this High Plains region have been examined for phytoliths. The sites range in age from Folsom to Late Prehistoric, spatially cover most of Wyoming and parts of northwestern Nebraska and northeastern Colorado, and represent various functions as campsites, kill sites, and rockshelters. Some sites have produced excellent phytolith evidence, others have been totally void. This paper presents a broad overview of phytolith studies that have been conducted (Fig. 2).

The Hanson site, located in the northern Big Horn Basin on the west side of the Big Horn Mountains near Shell, Wyoming, is a prehistoric campsite. The site has been dated 10,700+670 B.P. (RL-374) (Frison 1978:23) and is culturally affiliated with the Folsom complex. Phytolith evidence from Hanson was very poor. Samples from a soil column in Hanson I yielded nothing. However, a sample taken in the occupation level from the organic fill below a *Bison* humerus in Hanson II produced representative samples of tall grass and humid grass phytoliths.

Another site which produced extremely poor phytoliths was the Agate Basin site located in eastern Wyoming in the Cheyenne River drainage close to the southern Black Hills of South Dakota. Agate Basin dates 10,430+570 B.P. (RL-557) (Frison 1978:23) and is the type

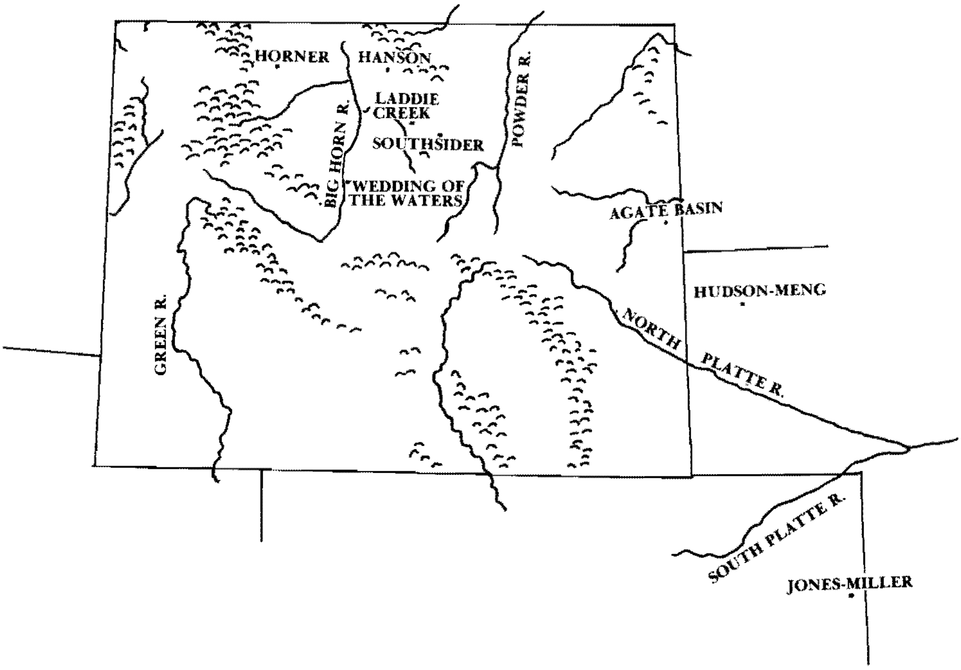

FIG. 2.—Location of sites discussed in this study.

site for the Agate Basin point. It is a bison kill and processing site. Samples from soil profiles and within the bone bed produced rod-shaped phytoliths but none that could be classified. One exception is a sample from Unit 4 in a soil profile. This sample is within the Agate Basin level in the site and contained short grass prairie phytoliths.

Hudson-Meng, a bison kill and processing site, is located a few km to the south and east of Agate Basin in northwestern Nebraska near Crawford on the northern slope of the Pine Ridge Escarpment in the Hat Creek drainage (Agenbroad 1978). The site dates 9820+160 B.P. (SMU-224) (Frison 1978:23) and is associated with the Alberta cultural complex. Soil samples were taken from Hudson-Meng during the 1975 field season. Samples from a trench at the west edge of the site (Fig. 3), in the bone bed, and from a hearth within the bone bed produced the following results. A high percentage of Festucoid class phytoliths were in all the productive trench samples indicating the constant presence of humid grass, possibly a microenvironment caused by a spring or stream. Trench samples 1, 3, and 4 imply a period of increased moisture when tall grass prairies would be present. Trench samples 6 (the Alberta bone bed level) and 7 show reversal of this trend with short grass phytoliths being more common. Samples 2 and 5 were essentially void of phytoliths which may indicate an extremely dry period. These interpretations are supported by the pollen analysis at the site (Agenbroad 1978:117).

Extrapolated figures from the bone bed, hearth area, and sample 6 are compared in Fig. 4. Sample 6 was taken outside the butchering area; the high percentage of Festucoid phytoliths indicates a nearby water source. The phytolith counts of Festucoid and Panicoid classes in the bone bed sample are consistent with sample 6. The contents of the bison viscera deposited during butchering account for the significant increase in Chloridoid class phytoliths. The evidence in the bone bed sample implies that the bison had been grazing on short grass prairie prior to the kill. Increased phytolith counts from the hearth area, high percentages of Chloridoid class phytoliths, and lack of charcoal at the site strongly suggest the use of buffalo chips for fuel.

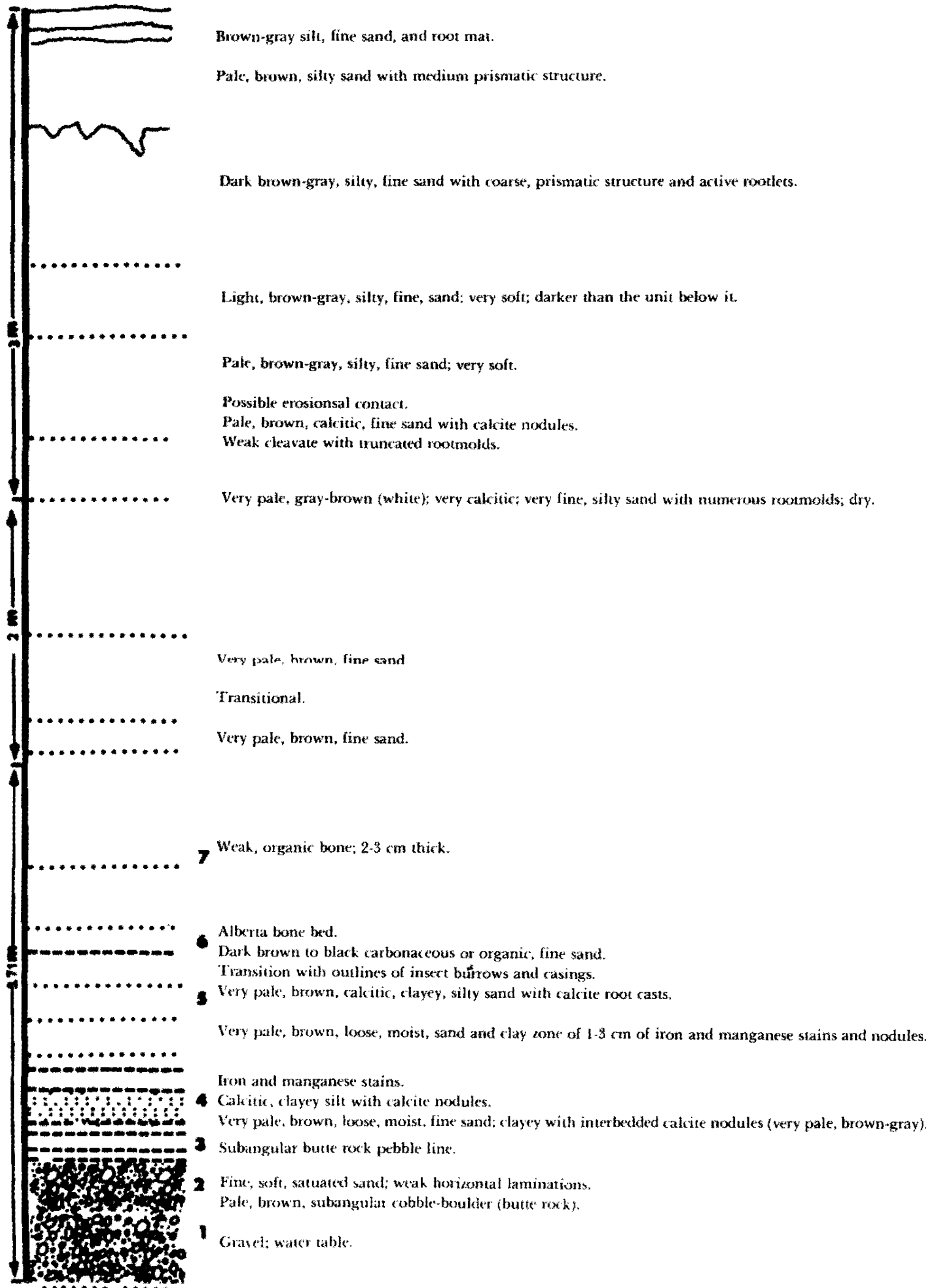

FIG. 3.—Hudson-Meng soil profile from the north wall of the west trench.

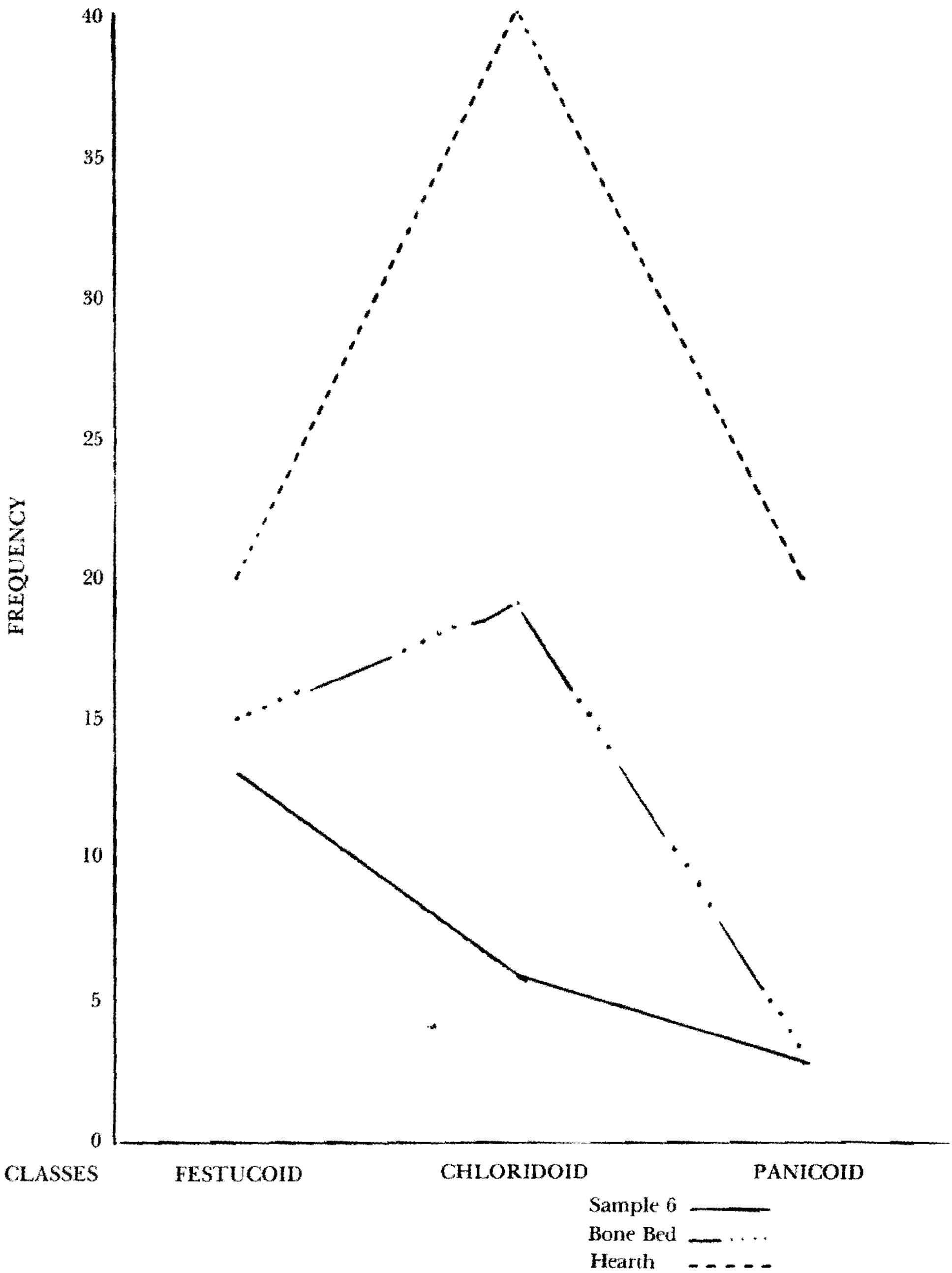

FIG. 4.—Comparisons of phytolith count from trench sample 6 and extrapolated figures from the bone bed and hearth areas.

Jones-Miller, a Hell Gap site, was also tested for phytoliths. Jones-Miller is a bison butchering site in northeastern Colorado near Wray located at the head of a draw draining into a tributary of the Arikaree River (Stanford 1974:29). Soil samples were taken from Jones-Miller in 1974. The occupation level at Jones-Miller produced multiple rod-shaped phytoliths as well as tall and short grass prairie phytoliths. The ratio of short grass to tall is 2:1. No samples were taken out of the bone bed so no explanation can be made for having 2 types of phytoliths in the occupation level. Samples taken from above the occupation level showed a marked reduction of any identifiable phytolith.

The Horner site is located on a terrace near the confluence of Sage Creek and the Shoshone River near Cody, Wyoming. Type site for the Cody Complex, Horner dates 8950+220 B.P. (RL-574) (Frison 1978:23) and is a bison kill and processing site. Samples taken during the 1977 field season produced short grass phytoliths from the bone bed. Samples above the bone level had an abundance of rod-shaped phytoliths which are non-diagnostic, and no others that could be identified. Samples from a profile from the top of the bone bed to the surface contained no phytoliths that could be classified. In 1978, a soil sample produced only rod-shaped phytoliths. These results appear to compare favorably with those obtained from Hudson-Meng.

The paucity of phytoliths from 2 stratified rockshelters, Wedding of the Waters Cave in the Wind River Canyon near Thermopolis and Southsider Shelter in the Big Horns near Medicine Lodge Creek is to be expected. Grass would not occur naturally in the shelters and remains would have to have been introduced by men and animals. The chances of locating bedding grasses or grass carried in as food are slight. Unidentifiable abraded phytoliths on a grinding stone found in a storage pit from Southsider indicate the cultural use of grasses at this site during the Early Plains Archaic.

The Laddie Creek site is located on the west flank of the Big Horn Mountains near the Medicine Lodge Creek site. This stratified site exhibits evidence of human occupation dating from the Cody Complex through Prehistoric or Protohistoric Crow with at least 7 levels of Altithermal occupation (Karlstrom 1977:11). The modern level containing Crow pottery, the Late Archaic level, and the Paleo level produced a predominance of Panicoid or tall grass prairie grasses. The altithermal levels produced a limited number of rod-shaped phytoliths, but no phytoliths that could be classified.

CONCLUSION

The study of opal phytoliths is not new. The technique has been used by botanists and range management people to trace forest migrations. However, its use with archaeological sites as an alternative and/or compliment to palynology has been a recent development. Phytoliths are an alternative to pollen as they appear to be preserved in some sites with little or no pollen preservation. Phytolith samples were obtained from Jones-Miller, a site with no pollen preservation, and Hudson-Meng, where pollen remains were limited. Phytolith studies can compliment palynology because grasses appear to be the greatest producers of phytoliths. Production of phytoliths is relatively weak in trees. Pollen production is the opposite and pollen is either wind or insect distributed. Phytoliths, if not found where the plant grew, died, or decayed are transported primarily by animal consumption, man's gathering of plants, or by soil erosion by wind or water.

Why phytoliths are preserved in one site and not in another is a problem facing the researcher. Rovner (1971) states that heavily alkaline soils most severely affect opal phytolith preservation. The pH for samples from Hudson-Meng, Jones-Miller, Agate Basin, and Horner appear to negate this statement. The highest pH readings (8.2 to 9) were from Hudson-Meng, the site producing best phytolith results. In his soil analysis of the Laddie Creek site, Karlstrom (1977) found pH values ranging from 6.9 at the surface (the Crow complex) to 8.2 at 261.6 cm below the surface (the Cody complex). The Late Archaic and Altithermal levels have values ranging from 7.4 to 7.7. Only the Altithermal level failed to produce phytoliths. Joel Norgren (personal communication) has suggested that stability of phytoliths in this area may be due to a water source. Moisture in this area is primarily from spring showers which suddenly cause the prairies to green. This instant water source may produce highly unstable phytoliths as opposed to those formed in grasses growing near a constant water supply.

The publications concerning archaeological work with phytoliths are scarce. Numerous problems are encountered in phytolith studies and methodology varies from researcher to researcher. Publications of modern comparative specimens are poor and in many cases lacking in necessary detail. Laboratory equipment and chemicals are expensive and facilities are not always available.

Phytoliths cannot be considered the definitive answer in paleoenvironmental reconstruction; instead, they must become a part of the whole — one discipline among many whose contributions aid in reconstructing paleoenvironments. Phytoliths have been shown to be a valuable tool to the archaeologist in paleoenvironmental reconstruction despite problems encountered in interpreting the data. They have proven to be a viable alternative to pollen in numerous sites in the High Plains and will continue to be investigated at the University of Wyoming.

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