Agate Fossil Beds Prehistoric Archaeological Landscapes, 1994-1995

Report on 1994 and 1995 Archaeological Activities by the Department of Anthropology, University of Nebraska-Lincoln and the NPS Midwest Archeological Center at Agate Fossil Beds National Monument

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With Contributions by
Corey Cashmere
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Richard E. Hughes
William V. Volf

Appendix H, containing sensitive locational information, is selectively available as a separately bound volume from the NPS Midwest Archeological Center

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Nonsite archaeological survey in the southern portion of Agate Fossil Beds National Monument in 1994 documented the presence of archaeological remains throughout the area. No ceramics were located, but hundreds (N=852) of chipped stone fragments, including 32 tools, were found. In addition, 5 cairns beyond those reported by Marvin Kay in 1975 were documented. Using artifact density and the presence/absence of features, 32 sites beyond those identified by Kay were defined. In 1995, test excavations were carried out at 4 of these sites: 25SX152, 25SX251, 25SX253, and 25SX268. In all, 777 pieces of chipped stone (9 of them tools) and a small amount of bone and fire-cracked rock were recovered through these excavations. Site 25SX251 had no subsurface component, and that at 25SX152 appears shallow and heavily impacted by various soil processes. The cultural deposits at 25SX253 and 25SX268 are more deeply buried and appear to have better preservation of bone. The document reports on archaeological remains recovered through survey and excavation, and it presents analyses of chipped stone, the most numerous class of artifact recovered, that consider the change through time in prehistoric mobility and the role of the Niobrara River in prehistoric economies.

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ABSTRACT

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This document reports on archaeological remains recovered through survey and excavation. It presents analyses of chipped stone, the most numerous class of artifact recovered here, that consider the change through time in both prehistoric mobility as well as the role of the western Niobrara River in prehistoric economies.

The report concludes with a series of recommendations regarding the eligibility of sites documented here for nomination to the National Register of Historic Places and their management. Also addressed is the efficacy of the distributional approach for documenting the archaeological landscape at Agate Fossil Beds NM for management purposes.

Maps with sensitive locational information and the raw data generated as a result of this project are presented in Appendix H, a separately bound, selectively available volume.

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John Rapier and his staff at Agate Fossil Beds NM made our work most pleasant and enlightening, for which we thank them.

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We take responsibility for lingering errors.

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Appendix H
AGFO Sensitive Locational Information

(selectively available as a separate volume)

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CHAPTER I
INTRODUCTION

LuAnn Wandsnider and George H. MacDonell

This document reports on the methods and results of archaeological fieldwork carried out at Agate Fossil Beds National Monument (abbreviated herein as AGFO on maps and as Agate Fossil Beds NM) in 1994 and 1995 as part of a cooperative agreement (CA 6115-4-8026) between the University of Nebraska and the NPS Midwest Archeological Center.[1]

During 1994, an archaeological inventory using distributional survey techniques was undertaken with a crew of 14 from the Department of Anthropology, University of Nebraska-Lincoln. In the course of this survey, 34.8 hectares were inspected on the south side of the Niobrara River. Ten cairns (5 of them previously unreported), 852 prehistoric chipped stone artifacts, 52 historic artifacts, and 1 historic foundation were mapped and described. The chipped stone artifacts were also collected and are currently housed at the NPS Midwest Archeological Center in Lincoln, Nebraska. On the basis of the distribution of the artifacts and cairns, 32 new archaeological sites were defined, as were 116 isolated occurrences.

In 1995, four of the sites discovered during 1994 were tested by a crew of four. The goal here was to assess the potential for these sites (and those in similar settings) to have a subsurface component and to evaluate the relationship between the surface and subsurface components.

This report describes our efforts to document the archaeological landscape at Agate Fossil Beds NM. Chapter II discusses our attempts to model the landscape at Agate Fossil Beds NM in terms of its potential for archaeological surface manifestations that are visible and therefore discoverable. Chapter III presents the methods and techniques employed in discovering and documenting archaeological materials at Agate Fossil Beds NM. The next two chapters focus on the chipped stone assemblage recovered through these efforts. The first, Chapter IV (derived from MacDonell's 1996 University of Nebraska-Lincoln M.A. thesis), focuses on northern High Plains hunter-gatherers and what can be learned about them from the chipped stone assemblage at Agate Fossil Beds NM. The second, Chapter V, presents an analysis of chipped stone assemblage variation. The final chapter, Chapter VI, offers recommendations on National Register eligibility and other management concerns. Basic descriptive information is presented for the other classes of archaeological materials—historic remains and cairns—in the appendices.[2]

We begin this endeavor with a brief history of Agate Fossil Beds NM, following which we outline the environmental setting of Agate Fossil Beds NM and then summarize our current understanding of the culture history of this northern High Plains area.

AGATE FOSSIL BEDS NM

Agate Fossil Beds NM is located 69 km (40 mi) north of Scottsbluff and 25 km (15

mi) south of Harrison in Sioux County, Nebraska (see Figure I-1).

Agate Fossil Beds NM is renowned for the Cenozoic Age paleontological specimens recovered there. These deposits first came to light in the late 1870s when discovered by James H. Cook (Cook 1980) near his ranch, the Agate Springs Ranch. Over several decades, the scientific importance of the fossils was established by scholars from the Carnegie Museum and the University of Nebraska State Museum (Cockrell 1986).

In addition to the fossil quarries, James Cook is remembered for his close relationship with the Lakota Sioux and Cheyenne. Cook was frequently visited by the Sioux, including Red Cloud, and in return for his hospitality, received many gifts of Siouan craft work. These items are included in the Cook Collection, now housed at Agate Fossil Beds NM (Meade 1994).

In 1921, Cook initiated a plan to preserve the rapidly fading Old West and prevent the fossil deposits from being commercialized. His plan included erecting replicas of both Fort Laramie, in which Indian crafts and fossils might be displayed and lectures offered, and an Indian village (Cockrell 1986:15). It was this germ that eventually, after many decades of negotiations with the State of Nebraska and the federal government, resulted in the creation of Agate Fossil Beds NM in 1965 (Cockrell 1986).

With the establishment of the Monument, both cattle grazing and artifact collection, which had previously been allowed by the Cook family, were regulated. Today, cattle grazing and artifact collection are strictly prohibited. Agate Fossil Beds NM is currently administered through the Scotts Bluff National Monument.

ENVIRONMENTAL SETTING

We now turn to our current understanding of the present and past environment at Agate Fossil Beds NM. The Monument straddles a several-mile reach of the Niobrara River, which flows from west to east. While natural springs immediately west of the Monument contribute significantly to the flow of the river, the Niobrara is still only one to two meters wide throughout the Monument.

For this High Plains area, Eighmy (1994:224) recognizes two major physiographic features, the Tertiary age sediments that mantle the area, and the basins formed by major drainages such as the Platte and the Niobrara, which have cut through this mantle. Associated with each of these, respectively, are two related ecological communities occupying the uplands and, along the river, the bottomlands.

As reported by Stubbendieck and Wilson (1986:26), the uplands floral community of the high tablelands at Agate Fossil Beds NM is short-grass prairie with needle-and-thread, blue grama, western wheatgrass, slender wheatgrass, prairie sandreed, Indian ricegrass, ruck skeletonplant, fringed sagewort, and little bluestem. In disturbed areas, sand dropseed, downy brome, sunflowers, sweet clovers, and Rocky Mountain beeplant may be found. Other economically useful plants include chokecherry and wild currants. The bottomlands community includes tree species such as cottonwood and willow along with hackberry, wild plum, wild cherry, currant, gooseberry, and cattail. The cottonwoods observed along the Niobrara today are recent, and wood for housing, cooking, or heating may have been restricted to willows and buffalo chips. The fauna residing in these communities includes bison, elk, antelope

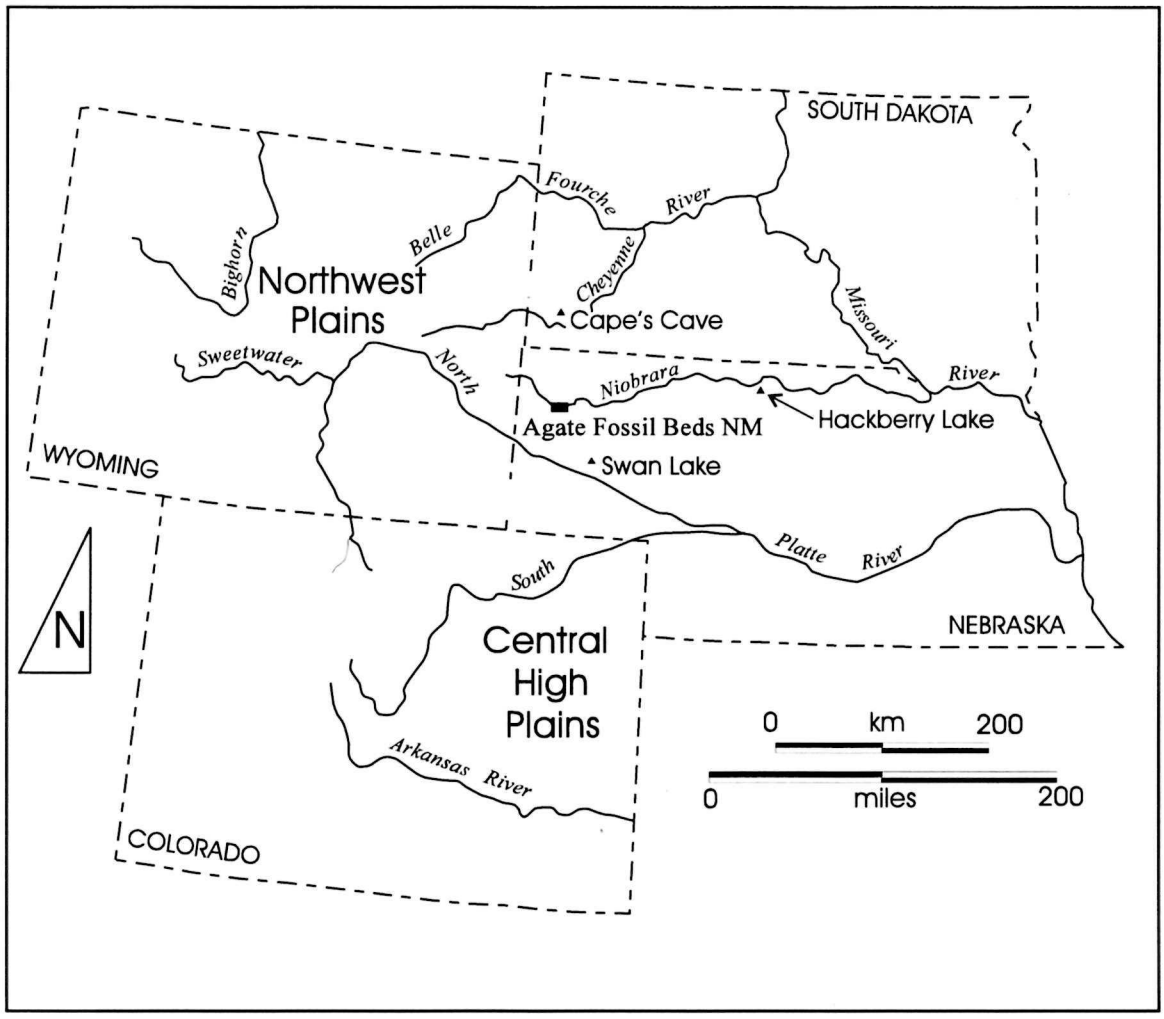


Figure I-1. Agate Fossil Beds NM location.

and deer, as well as other small mammals and migratory waterfowl.

Temperatures in the region vary from, in January and February, -20°C, to close to 40°C in July and August (see data in Kay 1975), reflecting the seasonal nature of the environment. The climate of the area is described as semi-arid continental with average annual precipitation of 37.5 cm (Wendtland 1993). However, there is a considerable amount of variability in annual rainfall in this region. In years of high rainfall, productivity is moderate to good (i.e., not as productive as the eastern plains or the Black Hills but still capable of sustaining ungulate populations). In periods of drought, the productivity of the region is very poor. Precipitation is seasonal, with the heaviest rainfalls between April and June. Moderate amounts of precipitation occur during later summer, and much smaller amounts occur through the winter (Wendtland 1993:28).

Given the semi-arid nature of this area, the Niobrara is an especially important feature on the landscape to both humans and fauna. The springs at Agate Springs Ranch, just west of the Monument, are quite productive and greatly enhance the flow of the Niobrara. In Chapter IV, we discuss in greater detail the role of moisture in driving the temporal and spatial variation in plant and animal biomass in this area.

Unfortunately, no paleoenvironmental work on the Late Pleistocene or Holocene has been conducted along this stretch of the Niobrara, and so the prehistoric environment here is consequently little understood. Deposits from the nearby Hell Gap site (Irwin-Williams et al. 1973) have yielded some information on this score, but these deposits are currently being reassessed by C. Vance Haynes, Jr. (one of the original excavators) and the University of Wyoming. Sears (1961) reported on a pollen core from Hackberry Lake near Valentine, Nebraska (and the eastern reach of the Niobrara River). Pollen and sediments have been described by Wright and colleagues (1985) for a core from Swan Lake in the southwest portion of the Sand Hills (Nebraska). And, in the southern Black Hills, Fredlund and colleagues (1985) have reported on deposits from archaeological excavations at Cape's Cave. The utility of each of these samples is hampered by the fact that there are few radiocarbon dates, making it difficult to differentiate a general regional climatic signal from the noise of local conditions, as evident in Table I-1. For example, that Swan Lake became a lake around 3,700 BP (signifying local wet conditions) appears at odds with the increase in artemisia pollen (signifying dry conditions) also noted at this time. In any event, the climatic picture from around the west-central Great Plains may help little in understanding the climatic conditions along the western Niobrara. All of this points to the need previously identified by Kay (1975) and reiterated by Clark (1993:29) for paleoenvironmental work in this area.

CULTURAL-HISTORICAL OVERVIEW

Although Agate Fossil Beds NM lies within Nebraska, its environmental and cultural affinities are more closely tied with the Northwest Plains of eastern Wyoming, the Black Hills of South Dakota, and the High Plains of northeastern Colorado and western Nebraska (see Chapter IV for extended discussion). While specific archaeological research along the western Niobrara is not extensive, eastern Wyoming (Frison 1991), the western Black Hills (Kornfeld 1994) and the High Plains of NE Colorado/SW Nebraska (Eighmy 1994; Gunnerson 1987:130-132) have been

Table I-1. Summary of palynological evidence for the paleovegetation of the west central Great Plains.

<table>
<tr><th>Date (k years ago)</th><th>Hackberry Lake Sears (1961)</th><th>Swan Lake (Wright et al. 1985)</th><th>Cape's Cave (Fredlund et al. 1985)</th></tr>
<tr><td>1</td><td>grass pollen dominates</td><td rowspan="4">artemisia high; decline in aquatics (lake present; yet artemisia grassland is in the area)</td><td>herbs give away to trees 250-350 BP</td></tr>
<tr><td>2</td><td rowspan="3">artemisia and grass pollen dominate</td><td rowspan="6"></td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td rowspan="3">semi-aquatic pollen high, indicating marshy conditions prevail</td></tr>
<tr><td>6</td><td>high tree, low grass pollen</td></tr>
<tr><td>7</td><td rowspan="2"></td></tr>
<tr><td>8</td></tr>
</table>

well researched and recent syntheses of this work are available. A brief overview of the cultural sequence established for these areas provides a useful background to research at Agate Fossil Beds.

Cultural-Historical Framework

Frison (1991) describes the succession of cultural groups in eastern Wyoming as being one in which the level of complexity remained relatively constant from Paleoindian times until the Late Prehistoric. Cultural groups operated as band-level hunter-gatherers, which remained mobile in order to utilize various food resources. While other groups in different regions of North America became sedentary and turned to crop domestication and agriculture, groups on the Northwest Plains remained highly mobile and maintained a high dependence on wild plants and animals. Large animal kill sites are the most visible sites in the archaeological record and their impressive assemblages of faunal remains and tools have attracted a great deal of attention from both the public and research communities (e.g., the Vore Site [Reher and Frison 1980] and the

Hudson-Meng site [Agenbroad 1978; Todd 1995]).

These types of sites, however, provide information on only one aspect of the cultures in question. As recently emphasized by Kornfeld (1994), however, small sites and lithic scatters owed to small mammal foragers and plant collectors are more representative of the majority of cultural activities by Northwest Plains groups. These types of assemblages are not as visually impressive as massive bison bonebeds and they are much more difficult to interpret.

The cultural chronology of Northwest Plains has been developed from a small number (25) of stratified multi-component sites (Frison 1984, Frison 1991; Frison and Stanford 1982; Irwin-Williams et al. 1973; Mulloy 1954)(Figure I-2).The cultural distinctions identified for the Northwest Plains and also the High Plains are based on projectile point types, other indicators of prehistoric subsistence organization, and paleoenvironmental indicators.

Northwest Plains Culture History

Through the efforts of Frison (1991) and others (Irwin-Williams et al. 1973; Mulloy 1958), the Paleoindian period (12000 to 7500 BP) is the best studied time period on the Northwest Plains. Within the Paleoindian time period, a series of complexes have been defined, the earliest of which is designated as Clovis. Clovis sites are attributed to early Native American colonizers of North America and may contain large fluted projectile points (used to tip spears or darts). These remains are sometimes associated with extinct large mammals, such as mammoth, horse, camel, and an extinct variety of bison. Small mammals have also been recovered and the use of plant foods is inferred on the basis of grinding implements. (It should be noted that there is growing evidence for a pre-Clovis occupation of the New World, which is not discussed here.)

A sequential series of Paleoindian complexes—Goshen, Folsom, Agate Basin, Hell Gap, and Cody—defined primarily on the basis of distinctive projectile point forms, is recognized for this area. Like Clovis sites, sites in these complexes show little evidence of living structures, and hearths are rare. However, bison kill sites (with extinct species of bison) are a major source of information about the Paleoindian time period.

With the onset of the Altithermal, subsistence reorganization was seen throughout the Plains. During the Archaic (7500 to 1700 BP), atlatl-and-dart weapon systems came into use, as did ground stone and pit hearth food processing technology, pit houses and tipi rings, bison corrals, and, during the Late Archaic, ceramic technology (Frison 1991). The sequential appearance of all of these technologies reflects several trends in prehistoric subsistence. For one, past people were relying on an increasingly diverse larder that included increasingly high-cost plants and animals or portions thereof. Thus, ground stone and pit hearth processing suggest the use of plant foods that required a great deal of processing prior to consumption. As well, both the targeted use of specific locations (such as pit house and bison corral sites) and a continued reliance on high mobility, as evidenced in the use of tipis, is clear.

The Late Prehistoric period (1700 to 300 BP) is marked by the appearance of the bow-and-arrow, stone mauls, steatite vessels, and other varieties of ceramic vessels. Again, these additions to the technological repertoire signal the use of

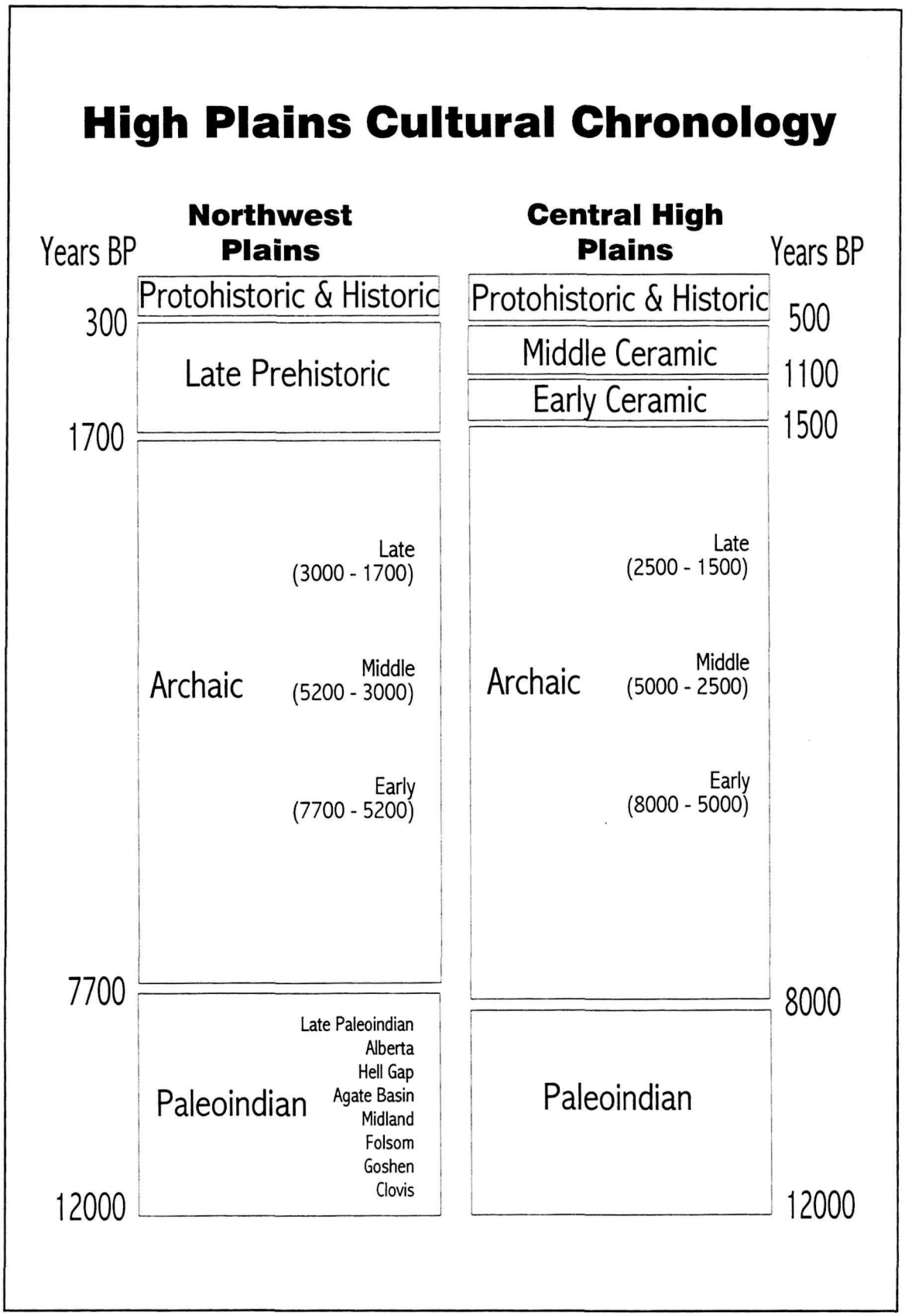


Figure I-2. Cultural chronologies for the Northwest Plains (after Frison 1991:24) and the Central High Plains (after Eighmy 1994 and Gunnerson 1987).

still other strategies for making a living on the Plains.

The effects of European colonization were seen on the Northwest Plains during the Protohistoric and Historic periods (300 BP to present). As the eastern and southwestern portions of the North American continent were colonized, indigenous groups were displaced to the west. Moreover, as groups gained and lost access to weapons, European trade, horses, bison and other resources, major social and political reorganization occurred. Into the historic period, the economies of the aboriginal inhabitants of the area became closely tied to that of the colonizing European and American populations.

High Plains Culture History

The cultural sequence from the High Plains is similar in broad sketch to that just described for the Northwest Plains, at least at the beginning of the sequence. Following the Late Archaic, however, other developments are recognized, as recently summarized by Gunnerson (1987), Eighmy (1994), and others. During the Early Ceramic (Gunnerson 1987) or Middle Woodland (Bozell and Winfrey 1994; Butler 1988) period, from about 1500 to 1050 years BP, the High Plains seems to have been populated by mobile hunter-gatherers operating out of a series of camps. Sites with structural remains appear to be in better watered areas in eastern Colorado along the foothills of the Rocky Mountains. Ceramics from this time period are thick, with cord-roughened exteriors and conical bases. As well, the prehistoric economy of this time incorporated to some extent non-maize agriculture. Isolated deep cylindrical pit hearths, likely used for baking seasonally available bulbs such as onion and sego lily, were also constructed and used at this time in the vicinity of the Black Hills (Wandsnider 1997).

Reviewing the Middle Ceramic (1050 to 500 BP; Late Woodland) evidence, Eighmy (1994) reports no indication of residential use of the area. He suggests instead that task groups from both the intermountain area of eastern Wyoming and from the core Upper Republican area (southwestern Nebraska) were foraging in the area. Roper (1990), however, suggests that a single Late Woodland (Upper Republican aspect) population with differing adaptive poses—horticultural to the east and hunting to the west—may be responsible. During this time period, relatively highly productive strains of maize were incorporated into the economies of both more westerly (Gunnerson 1987) and easterly (Adair 1988; Roper 1995) groups, and the distinctive globular jar variety of ceramics came into use.

During the Protohistoric period, as has also been seen elsewhere on the Plains, the High Plains witnessed a kaleidoscope of population shifts. By about AD 1500, Plains Apache groups were in NE Colorado. Gunnerson (1987:132) reports the archaeological evidence of living structures, which suggest a semi-sedentary residency, as well as limited agriculture and the use of ceramics. The Apaches were forced out of this area by the Comanches about AD 1730; Pawnee and Wichita people, however, continued to hunt here. Arapaho, Cheyenne, Kiowa, and Kiowa Apache groups were in the area after AD 1800, the latter two shifting to the south by the mid-1800s. At this time, Shoshoni, Blackfeet, Crow, and Sioux groups ranged into this area for hunting purposes. Meanwhile to the north, in the vicinity of Agate Fossil Beds NM, Siouan groups had penetrated into this area by 1800 and continued to hold sway until subjugated by American troops (Strong 1935:28-29).

Unfortunately, archaeological information on the recent historic period is not available for this area. McIntosh (1996), however, has recently produced a detailed account of the settling of the Nebraska Sand Hills (just east of Agate Fossil Beds NM) by Euro-Americans. His analysis highlights several aspects of the settlement process, including the origins of the American settlers, the impact of railroad transportation, the competition for water and the fencing of the Sand Hills, and the effects of the Kinkaid Act. The general succession of events reported by McIntosh is similar to those that transpired in the area of Agate Fossil Beds NM (see Meade 1994), and the archaeological expression of this history remains to be assessed.

Archaeology at Agate Fossil Beds NM

Past archaeological investigations within Agate Fossil Beds NM have been both informal and formal. James H. Cook, the founder of the Agate Springs Ranch, was an avid collector of Native American material culture (Cook 1980; Meade 1994). The majority of the ethnographic artifacts that comprise the Cook collection were given to James Cook by Native American friends, both Cheyenne and Sioux. Among the many Indian visitors that James Cook received at his ranch, the most famous was Red Cloud, chief of the Oglala Sioux (Cockrell 1986; Meade 1994; NPS 1980). Also in this collection are chipped stone artifacts collected from the surrounding area, which were displayed by the Cook family in their home for visitors to admire (Meade 1994).

Thus, some of the first informal archaeological investigations along this portion of the Niobrara were conducted by the Cook family. This fact means that the current surface archaeological record likely was negatively impacted during the historic period. Cattle grazing, both historic and recent, likely also affected this surface. Given these two factors, we might expect the surface archaeological record at Agate Fossil Beds NM to be diminished with respect to projectile points (a frequently collected object) and bifaces, which are abundant in the Cook Collection. Without prior knowledge of the artifact population, it is understandably difficult to assess this situation. We simply note that compared with the Oglala National Grasslands to the north of Agate Fossil Beds NM, where systematic archaeological research using similar distributional methods has been conducted (Wandsnider et al. 1994), the artifact inventory from Agate contains relatively high ratios of tools to debitage and dramatically more complete chipped stone. These observations suggest that the archaeological surface here is being "renewed" by rodents at an unknown rate.

Over several decades, several formal archaeological surveys and excavations were executed by Kay (1975), Olinger (1980), and Clark (1993, 1994) at Agate Fossil Beds NM. Kay (1975) surveyed the entire Monument at an unspecified intensity and recorded 12 sites, including a potential occupation site, a tipi ring site, several cairn sites, and several chipped stone scatters. He also noted the many locations in the Monument that were appropriate for paleoenvironmental work, including those with exposed soils. In general, he noted the important contribution that these sites could make to our understanding of the Late Prehistoric time period on the High Plains.

Olinger (1980) reported on test excavations at site 25SX163, from which Kay had recovered ceramics. Olinger (1980) noted that the chipped stone material at the Monument appeared to come from lithic sources to the north and west and that secondary, as opposed to primary, reduction seemed to be

occurring here. At 25SX163, a post-A.D. 1000 occupation was inferred on the basis of the ceramics and projectile point forms. A lack of obvious structures and overall low artifact density indicated a temporary, rather then extended, residential presence.

Development within the Monument required archaeological investigations in 1991 and 1992. Caven Clark of the NPS Midwest Archeological Center documented 36 archaeological sites in the Monument and excavated 74 one-meter-square test units in 1991. Two sites identified in 1991 were excavated by Clark in 1992 and over 6,000 pieces of chipped stone were collected over the two-year period (Clark 1993, 1994). No easily dateable materials or stratigraphically distinguishable materials, however, were recovered.

Clark (1993, 1994) also made several important observations about the archaeology in the Monument. First, he noted that the people using the Agate Fossil Beds NM area in the past obtained most of their lithic sources from the west, specifically, the Spanish Diggings area of eastern Wyoming. Second, he observed that the archaeological landscape here generally appears almost continuous throughout the Monument. In addition, he, and Kay (1975) before him, emphasized the important role of rodent and ant activity in bringing cultural remains to the surface. These several observations were taken into consideration in designing our archaeological field work here.

Summary

In sum, previous investigations, both informal and formal, have shown that the prehistoric archaeological record in the Agate Fossil Beds NM consists primarily of chipped stone debris that is scattered across the landscape, with much of it from sources exotic to the Monument. Historic remains have received little attention. Archaeological work in Agate Fossil Beds NM offers the opportunity to press these chipped stone assemblages for more information about the past. For example, if there is a residential presence on the High Plains during later time periods, the Niobrara River and other drainages are prime candidates for its location.

GOALS AND PROJECT DESIGN

As specified in the cooperative agreement between the University of Nebraska-Lincoln and the NPS Midwest Archeological Center (Cooperative Agreement Number: CA6115-4-8026), two goals were identified. The first goal, and the primary reason why this inventory was funded by the National Park Service, was to survey the Monument using field techniques available in 1994. Documenting the Monument in this fashion would provide inventory information useful for making management decisions within the Monument. It would also provide information helpful in achieving the second goal, that of identifying areas within the Monument where archaeological materials suitable for further research on various topics might be carried out. To make a determination of the eligibility of cultural properties at Agate Fossil Beds NM for the National Register of Historic Places, attainment of this latter goal is imperative.

The project was carried out in two phases. Intensive archaeological survey yielded a broadly drawn picture of the archaeological landscape as it existed during the late summer of 1994. Subsequently, the subsurface component of selected portions of that landscape was documented through test excavation in 1995. Together, these two sampling strategies yielded complementary

information on the nature of the archaeological landscape at Agate Fossil Beds NM.

NOTES

[1]Personnel from the University of Nebraska-Lincoln operated as agents of the government under an authorized cooperative agreement. Field collections were made as per exceptions from normal ARPA permitting procedures under 43CFR7.5(b)(5)(a). No Native American tribes were notified of these archaeological activities because, while the historic visits of the Sioux and Cheyenne people to Agate Springs Ranch are well known, no specific Native American sites of religious or cultural significance have been identified at Agate Fossil Beds NM. Indeed, the activities reported upon here were designed to elucidate this unknown.

[2]Maps with sensitive locational information are available in a separately bound volume, Appendix H. Also available through a special request to the NPS Midwest Archeological Center is a diskette containing data generated as a result of this project.

CHAPTER II
GIS MODELING OF ARCHAEOLOGICAL SURFACE VISIBILITY AT AGATE FOSSIL BEDS NM

Corey Cashmere and LuAnn Wandsnider

In this chapter, we identify those portions of the Monument where pedestrian survey methods may perform best in discovering archaeological remains. This model-building actually followed the 1994 pedestrian survey at Agate Fossil Beds. In presenting it here, we hope to explore the utility of geographic information, compiled by other researchers involved in land management and calibrated for archaeological needs, for use in planning archaeological survey. Specifically, we attempt to use it to model the archaeological surface visibility across the landscape at Agate Fossil Beds NM.

This attempt is similar to some recent applications (e.g., contributors to Allen et al. 1990; Kvamme 1989) of geographic information systems (GIS) in archaeology in our reliance on widely available environmental GIS data. It departs markedly from many of these recent applications, however, in that we are attempting to *model the potential for surface archaeological remains to exist and be found* rather than to predict the locations of archaeological remains. Thus, this modeling attempt is more similar to the work of Bettis and Benn (1989), Ebert and Gutierrez (1981) and O'Brien and colleagues(1982) in our recognition that, because of the age and activity of particular surfaces, potential and actual archaeological visibility is not uniform across a landscape. Thus, the objective is to identify those portions of the Monument where pedestrian survey methods will be successful and other areas where other documentation procedures will have to be employed.

The modeling carried out here relies heavily on geographic information system (GIS) manipulations. GIS refers to a system of hardware, software, data, and human expertise that work together to manipulate spatial data. This analysis made use of both raster and vector layers and tools. A raster is a matrix of cells to which various values have been assigned. An example of a raster image is a digital photograph in which individual pixels have different grey or color values. In addition, vector layers were employed. A vector represents a point, line, or polygon in terms of the x,y coordinates of nodes that define those entities. An example of a vector layer is the digitized elevation contour layer containing individually digitized contour lines with assigned elevation values.

FACTORS INFLUENCING THE POTENTIAL ARCHAEOLOGICAL SURFACE

Schiffer (1987) has documented a host of factors that are responsible for the formation of archaeological deposits in general and that influence the documentation of the deposits. In the grassland setting of the High Plains, recent eolian sedimentation acts to bury

artifacts, while rodent activity may selectively bring artifacts to the surface. In this area, too, the visibility of a surface archaeological record is greatly affected by the density and height of grasses. In the following, we outline our attempt to model the potential archaeological surface in Agate Fossil Beds NM in terms of these three main factors.

Rodent Activity has been described previously in terms of homogenization or mix-ing of archaeological deposits (Erlandson 1984) and in terms of horizonation, the artificial differentiation of clasts (Bocek 1986). Here we are primarily concerned with the effect that rodent activity has on exposing an archaeological record that might otherwise be buried. In the course of removing backdirt from their feeding tunnels, gophers may bring objects to the surface that are about 5 cm in length. If they encounter larger objects, gophers will tunnel beneath them, leading to the eventual subsidence of the artifacts (Bocek 1986:591).

Gophers feed on grass roots from 10 to 200 cm beneath the surface, with a tunnel depth of 15-30 cm most common (Bocek 1986:590). During archaeological work at Agate Fossil Beds NM, we noticed recent surface disturbance by pocket gophers (genus either *Thomomys* or *Geomys)*, and in the excavations, found modern rodent disturbance to a depth of 70 cm. Thus, archaeological deposits within 70 cm of the surface appear to be most susceptible to being disturbed through rodent activity. Of course, this surface may be aggrading or eroding, so it is conceivable that rodents may move material upward even several meters. In this study, we have rodent burrow density information from selected locations through the southern portion of the Monument. We analyze this by vegetation class and soil type, and project rodent activity accordingly.

Schiffer (1987) and O'Brien and colleagues (1982:133-140) note (and field archaeologists are intimately familiar with) the effect of vegetation on the *visibility* of archaeological remains. The amount and type of vegetation at Agate Fossil Beds NM varies considerately across the landscape. On the Niobrara flood plain, the reed grasses grow tall and thick, obscuring the ground surface. In contrast, on the buttes, the vegetation becomes more sparse and the ground surface correspondingly more visible. With the knowledge gained from past field excavations and the interpretation of aerial photographs, we ranked the surface visibility at Agate Fossil Beds NM.

Recent eolian sedimentation, which we describe in terms of *Potential Sediment Depth*, has obvious implications for using survey methods to locate surface archaeological deposits. If sediments are shallow, artifacts may be brought to the surface by many different process. If recent sediments are deep, however, then buried artifacts could remain hidden indefinitely. In this study we model the potential sediment depth based on the type of soil and the aspect of the surface. Based on recent excavations at Agate Fossil Beds, it is clear that deeper sediments are found to the east-southeast of wind obstructions, like terraces and high tables. This observation is consistent with the differential deposition of sediments by the prevailing winds from the west-northwest.

In the following, we attempt to look at the additive and interactive effects of these three factors. Our strategy is to develop independent layers that describe the Agate Fossil Beds NM surface in terms of potential sediment depth, rodent activity, and surface visibility owed to vegetation. These independent layers, then, are

compiled using standard GIS techniques. For these manipulations, we relied upon a geographic information software package known as TNTmips

PRIMARY DATA LAYERS

The base data layers employed here include a digitized elevation contour layer, a soil classification, and a vegetation classification (Figure II-1). Aerial photographs (on loan from the NPS Scotts Bluff NM administrative office and covering only the area in the immediate vicinity of the road to the Agate Fossil Beds NM Visitor Center) were used to assess vegetation density, and field observations were made on rodent activity and the height of various grasses.

Elevation Contour Layer

Elevation contours were hand-digitized from the USGS 7.5 minute quadrangles, Agate, Nebraska (1979) and Whistle Creek NW, Nebraska (1983) (Figure II-2).

Soil Layer

The soil layer comes from the National Resources Conservation Service soil classification for this area. Their classification is based upon the interpretation of topographic features from aerial photographs along with selective field checking. As part of his thesis, Wendtland (1993) digitized these soil polygons without geospatial information. Upon acquiring the vectors, we georeferenced them to our base layer, the elevation layer. Soil classes reported for Agate Fossil Beds NM are listed in Table II-1. Figure II-3 maps this soil classification. Note that not all of the soils in the Monument have been classified, hence the odd shape to the map in Figure II-3 (see also Figure II-2).

Table II-1. Soil classification (from Wendtland 1993).

Bd	Banker loamy sand channeled
BvE	Busher-Tassel loamy very fine sands (6-20 percent slopes)
Ln	Las Animas-Lisco very fine sandy loams (0-2 percent slopes)
Lp	Lisco very fine sandy loam, wet (0-1 percent slopes)
OwB	Otero loamy very fine sand (0-3 percent slope)
OwD	Otero loamy very fine sand (3-9 percent slope)
OwE	Otero loamy very fine sand (9-20 percent slope)
RkG	Rock Outcrop-Tassel complex (9-60 percent slope)
TbF	Tassel-Busher-Rock Outcrop complex (6-30 percent slope)
TbG	Tassel-Busher-Rock Outcrop complex (25-60 percent slope)

Vegetation Layer

The vegetation layer is based on work by Wendtland (1993). As part of his thesis on the effects of fire on the mixed grass prairie, Wendtland (1993) developed a vegetation classification for Agate Fossil Beds NM. This classification was digitized for him without geospatial information. We georeferenced the vegetation class vectors to our base elevation contour layer. Eight vegetation classes (Table II-2; Figure II-4) were identified and described by Wendtland and are included in our analysis. (Again, note that Wentland's study did not encompass the entire Monument.)

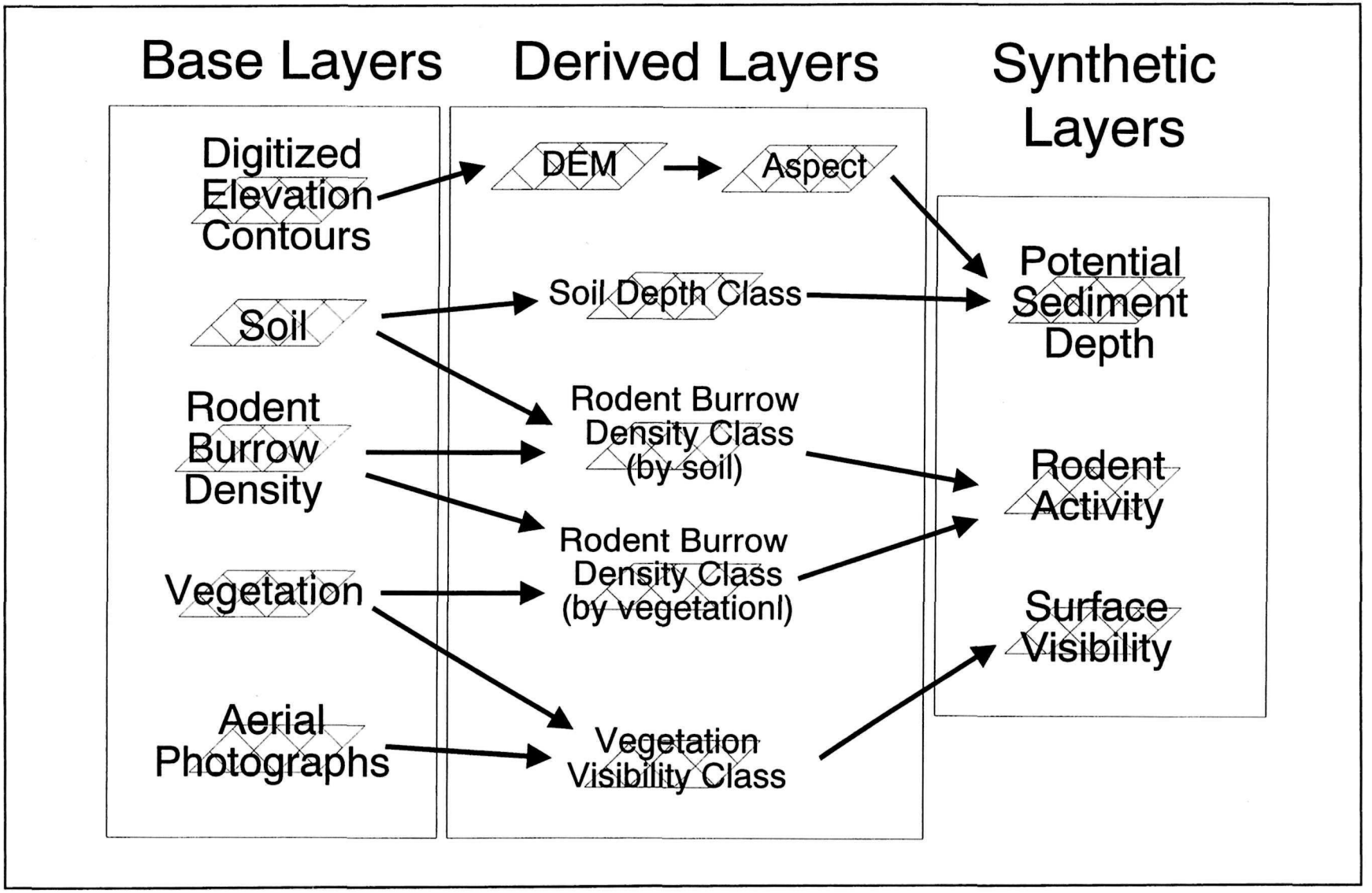


Figure II-1. Modeling schematic.

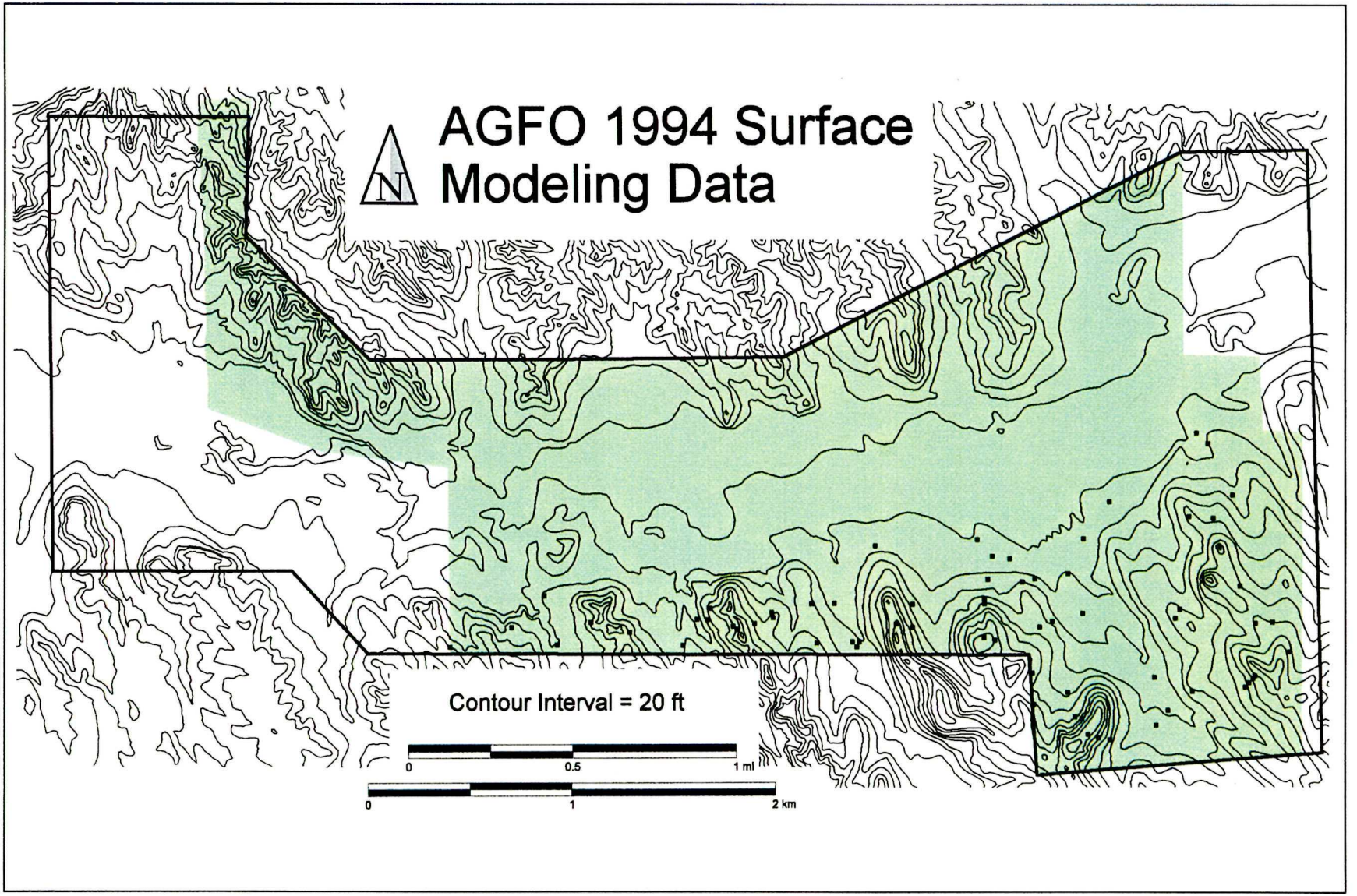


Figure II-2. Elevation contours, limit (in green) of Wendtland data layers, and locations (squares) of rodent activity sample units.

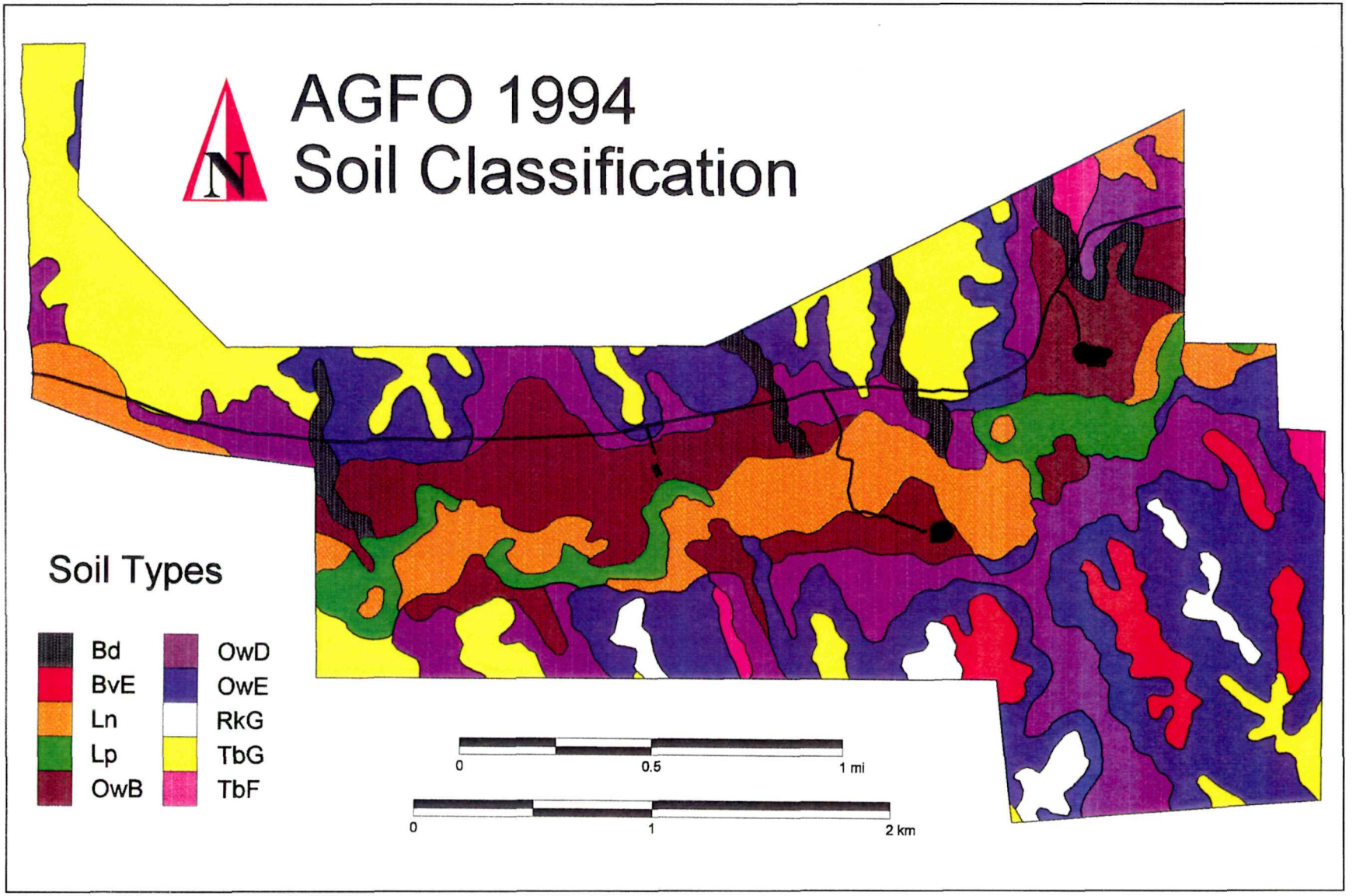


Figure II-3. Soil classification.

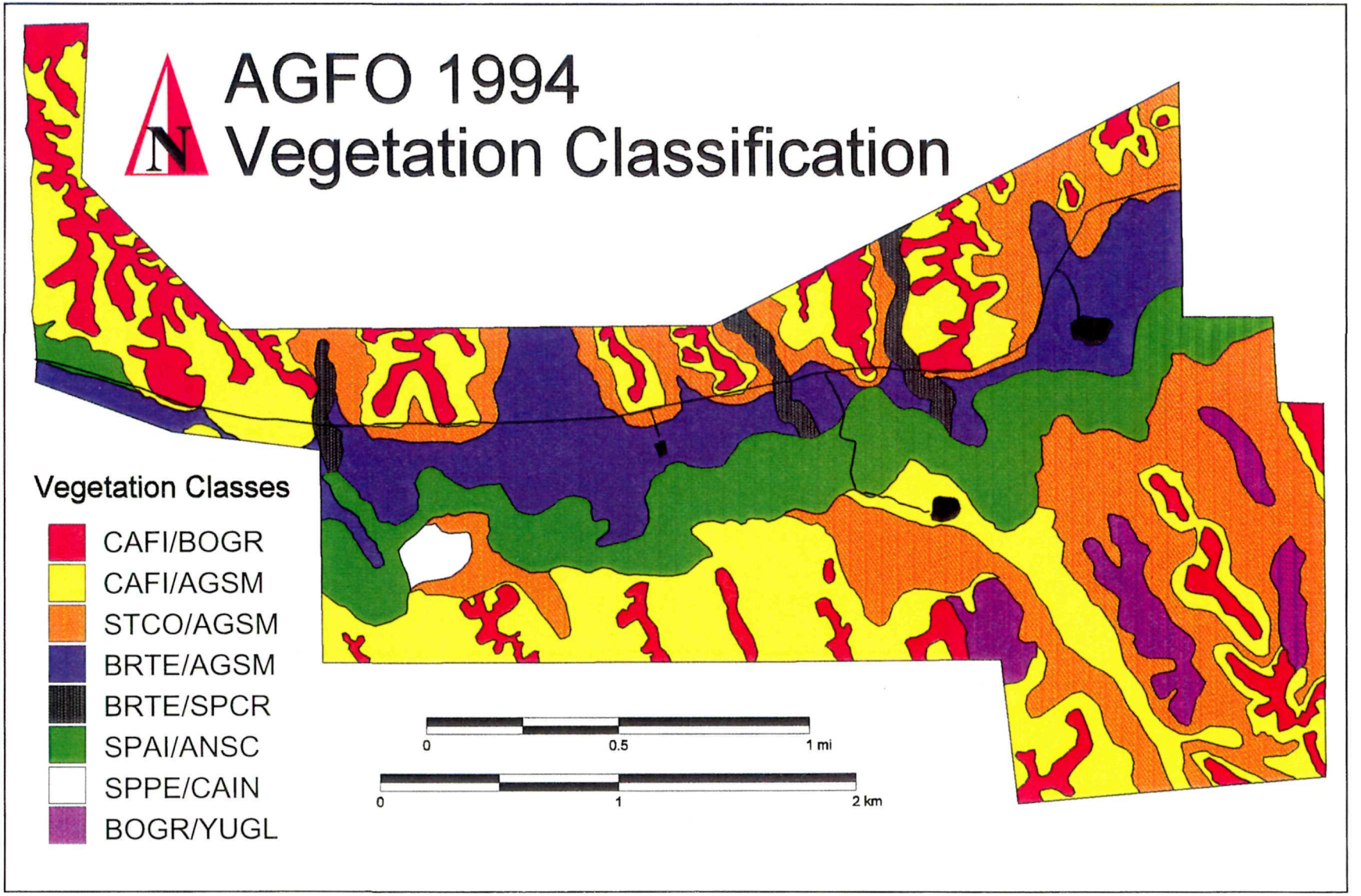


Figure II-4. Vegetation classification.

Table II-2. Vegetation classification (from Wendtland 1993).

CAFI/BOGR Threadleaf sedge (*Carex filifolia*) and blue grama (*Bouteloua gracilis*) upland vegetation type.

CAFI/AGSM Threadleaf sedge (*Carex filifolia*) and western wheatgrass (*Agropyron smithii*) upland vegetation type.

STCO/AGSM Needle-and-thread (*Stipa comata*) and western wheatgrass (*Agropyron smithii*) upland vegetation type.

BRTE/AGSM Cheatgrass brome (*Bromus Tectorum*) and western wheatgrass (*Agropyron smithii*) upland vegetation type.

BRTE/SPCR Cheatgrass brome (*Bromus Tectorum*) and sand dropseed (*Sporobolus airoides*) ephemeral drainage vegetation type.

SPAI/ANSC Alkali sacaton (*Sporobolus airoides*) and little blue stream (*Andropogon scoparius*) riparian vegetation type.

SPPE/CAIN Prairie cordgrass (*Spartina pectinata*) and northern reedgrass (*Calamagrostis inexpansa*) wetland (marsh) vegetation type.

BOGR/YUGL Blue grama (*Bouteloua gracilis*) and yucca (*Yucca glauca*) vegetation type.

DERIVED LAYERS

Given these primary data layers, we next derived several analytic layers used in this analysis.

Rodent Activity Layer

A Rodent Activity layer (Figure II-5a) was developed from both the vegetation and soil layers for which field data on active rodent burrow densities had been collected. These field data were collected in August 1994 by inspecting 70 mapped botanical transects, with lengths between 25 and 100 m, situated within the southern half of the Monument. The number of recently excavated gopher backdirt piles was determined for each transect.[1] Rodent burrow density was then calculated for each transect and assigned to its center point. By intersecting the point specific data with the vegetation and soil layers, these points were then assigned to the vegetation or soil class within which each fell. For every soil type and vegetation class, we then calculated a median rodent burrow density. This value, in turn, was applied to each respective soil and vegetation polygon.

Both soil and vegetation layers were converted to rasters with rodent densities as the assigned values for each of the raster cells. These values were ranked as 1 (low activity), 2 (medium activity), and 3 (high activity). Both layers were then combined, resulting in one layer that expresses rodent activity based on the recent rodent burrow densities noted for soil and vegetation.

Surface Visibility Layer

To create the *Surface Visibility* layer, aerial photos were evaluated for soil exposure and vegetation densities. Low and high visibility areas were identified

and then applied to all the vegetation classes of the vegetation class layer. A raster layer was then created from these classes that express the amount of surface visibility. The following are the 5 categories based upon the air photo interpretation. The lower the number, the lower the surface visibility (Table II-3; Figure II-5b).

Table II-3. Surface Visibility ranking based on vegetation class.

Visibility	Vegetation Class
2	SPAI/CAIN
	SPPE/CAIN
3	BOGR/YUGL
4	BRTE/SPCR
	CAFI/AGSM
	STCO/AGSM
5	BRTE/AGSM
6	CAFI/BOGR

Potential Sediment Depth Layer

The Potential Sediment Depth layer was derived from two separate layers, a *Simulated Eolian Deposit Depth* layer and a *Sediment Depth by Soil Type* layer.

Simulated Eolian Deposit Depth

For earlier excavations at Agate Fossil Beds NM, Clark's (1993, 1994) records show that sediment depths were generally greater on the leeward slopes (and also on slopes below high points in general). We thus created a layer to model this differential accumulation of sediment using derived aspect data. A multi-step process was required to create the Simulated Eolian Deposit layer. From the elevation contour layer, a Digitized Elevation Model (DEM) was created. A DEM is a raster for which every cell is assigned an elevation value. Given the DEM, we used the Aspect GIS tool to create a layer that simulates the depth of sediments deposited leeward of obstructions by a wind from the WNW, based on discussions by the Monument personnel regarding the prevailing wind direction (Table II-4).

Sediment Depth by Soil Type

This layer was derived from soil survey information on recent alluvium depths and test excavation data. Each soil class was ranked in terms of the depth of recent alluvium, and these ranks were then assigned to each soil class in the soil classification layer. The final step was to create a raster that classed each cell as shallow, medium, or deep sediment.

The two derived layers, simulated eolian deposits and sediment depth by soil type, were combined using a linear combination process.[2] The result was a single raster layer that depicts potential sediment depth (Figure II-5c).

Table II-4. Simulated Eolian Deposits based on a WNW wind.

Accumulation	Aspect
Shallow	75° to 90° and 136° to 150°
Intermediate	91° to 105° and 121° to 135°
Deep	106° to 120°

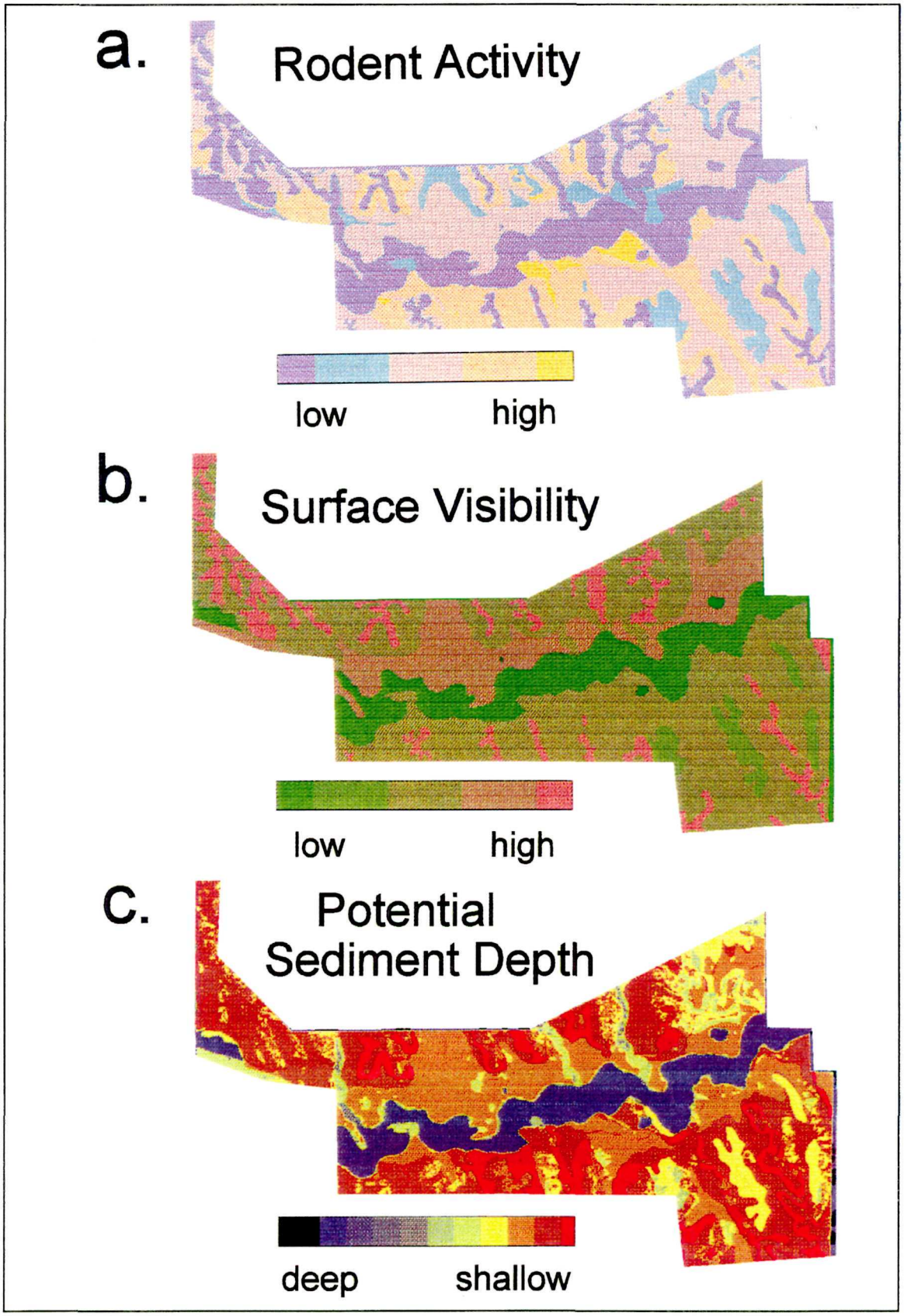


Figure II-5. Derived layers: (a) Rodent Activity, (b) Surface Visibility, and (c) Potential Sediment Depth.

POTENTIAL ARCHAEOLOGICAL SURFACE VISIBILITY

An estimate of the visibility of archaeological deposits across the landscape at Agate Fossil Beds NM is depicted in Figure II-6. This final layer represents a linear combination of the three derived layers, Rodent Activity, Surface Visibility, and Potential Sediment Depth. This layer should be interpreted to mean that, in areas with high visibility (red, yellow), the potential to discover archaeological remains using standard pedestrian survey techniques is very high. In areas with low visibility (lavender, purple), the prospect of discovering archaeological remains on the basis of survey is low; other means (trenching, remote sensing) would be required to locate archaeological remains, should they exist in these areas. The areas with intermediate visibility (green) may or may not be best inventoried using pedestrian survey.

This model remains to be evaluated for its predictive ability and utility. In general, the expectations provided by this model appear to agree with past field experiences. Sites located by Kay (1975), who surveyed under optimal, grazed conditions, are mostly located in moderate-to-high visibility areas; Clark (1993, 1994) located many sites in the high visibility areas of the northern portion of the Monument. When trenching was done for water lines and the visitor center construction on the lowest Niobrara terrace, subsurface archaeological remains were noted that had not been found during the preceding survey. The survey results presented below are in accord with these findings.

SUMMARY

In sum, our goal was to explore the feasibility of using readily available GIS-compatible information produced by other environmental scientists usually involved in land management. We hope to put these data layers to use in serving cultural resource management goals, that is, to help plan where pedestrian survey dollars might best be expended and to identify other areas where close monitoring of subsurface disturbances will be essential.

This model-building exercise, we think, demonstrates the potential of GIS technology to help cultural resource management, especially in the planning phase. There are several areas, however, where these efforts could be improved. For example, we relied on soil and vegetation layers that had been created for illustrative rather than analytic purposes. We supplied the georeferencing for these layers and undoubtedly introduced some errors in the derived and final synthetic layers, especially in the location of small soil or vegetation polygons. Also, we relied on simple linear combinations of rasters to develop the derived and final rasters. It may be that some of the derived layers should be prorated or emphasized more than other layers. The final product would probably be similar to that given here, but may differ in detail.

NOTES

[1]During the 1994 field season, we collected botanical information to be used in looking at the relationship between vegetation and both rodent activity and sediment depth. We later learned that with his thesis work, Kyle Wendtland had already compiled vegetation information for Agate Fossil Beds NM, which we relied upon here. Information from the 1994 botanical transects, however, are on file at the NPS Midwest Archeological Center in Lincoln, NE.

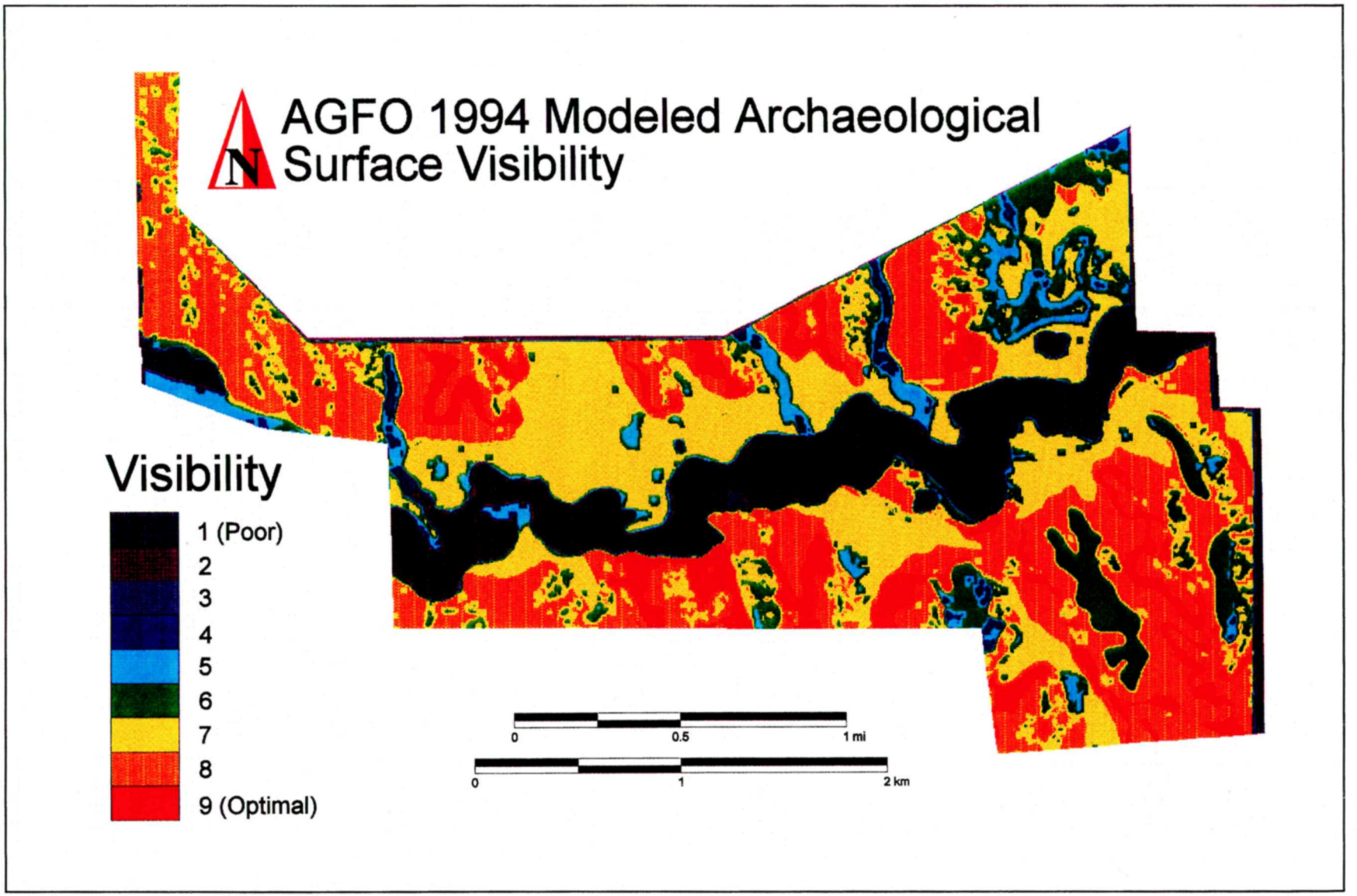


Figure II-6. Modeled Archaeological Visibility.

[2] Linear Combination Process Example

A linear combination process was used to create the Rodent Activity Layer as well as the Potential Sediment Depth Layers and the final Potential Archaeological Surface Layer. It is simply the addition of scaled cell values for corresponding cells within a raster. In all cases, we scaled the combined layers using a value of 1.0; i.e., we did not prorate the contribution of any one layer above or below that of another. For example,

1	2	3	2		2	2	1	3		3	4	4	5
2	3	1	2	+	3	1	1	2	=	5	4	2	4
2	2	3	1		1	1	3	3		3	3	6	4

CHAPTER III
FIELD METHODS AND RESULTS

LuAnn Wandsnider, George H. MacDonell, and Jennifer L. Galindo

INTRODUCTION

Archaeological work was conducted by the University of Nebraska-Lincoln at Agate Fossil Beds NM during two field seasons. During the first, in 1994, intensive archaeological survey of the southern portion of the Monument was undertaken using distributional field methods. During the second field season, in 1995, test excavations were conducted at four locations determined to be of interest by virtue of high artifact density, unique assemblage characteristics, or good preservation potential. The data collection methods used during each season, as well as the results obtained, are detailed here.[1]

DATA COLLECTION

1994 Survey

Following Clark's (1993) observations about the continuous nature of the surface archaeological record at Agate Fossil Beds NM, as well as the importance of rodent activity in re-arranging and making visible archaeological remains, field methods were designed accordingly. Nonsite (Foley 1981), siteless (Dunnell and Dancey 1983), and distributional (Ebert et al. 1987; Ebert 1992) survey methods have been used in the past to discover and document continuous archaeological surfaces. There is no standard nonsite survey procedure; we developed a suite of methods to meet the current situation, as described below.

Field Protocol

Pedestrian survey was conducted during August 1994. A crew of 11 archaeological technicians and three crew chiefs were involved (see Appendix A). Vergil Noble (NPS Midwest Archeological Center) and LuAnn Wandsnider (University of Nebraska-Lincoln) were the supervising archaeologists. Depending on the tasks to be completed each day, the crew was divided into several teams, which worked to establish survey control, survey the units at a 10-m interval, map and collect artifacts, and document botanical transects.

Work was confined to the southern portion of the Monument and did not include the scenic easements (Figure III-1). To ensure complete and even survey coverage, distributional field (Ebert 1992) methods were employed. Thirty survey units were established using a theodolite and tape. The "ideal" unit was 400 m on a side; most units, however, bordered the Niobrara flood plain or the Monument boundary and were therefore smaller in size and, in the case of the former, irregular in shape. Of the 30 units, all but two (19 and 28; with University and Carnegie Hills) were surveyed for features and artifacts at an interval of 10 m by crews with five members. Because University and Carnegie Hills were not systematically surveyed during this inventory but clearly feature the remains of historic and recent bone mining activities, these areas deserve attention in future surveys of the Monument.

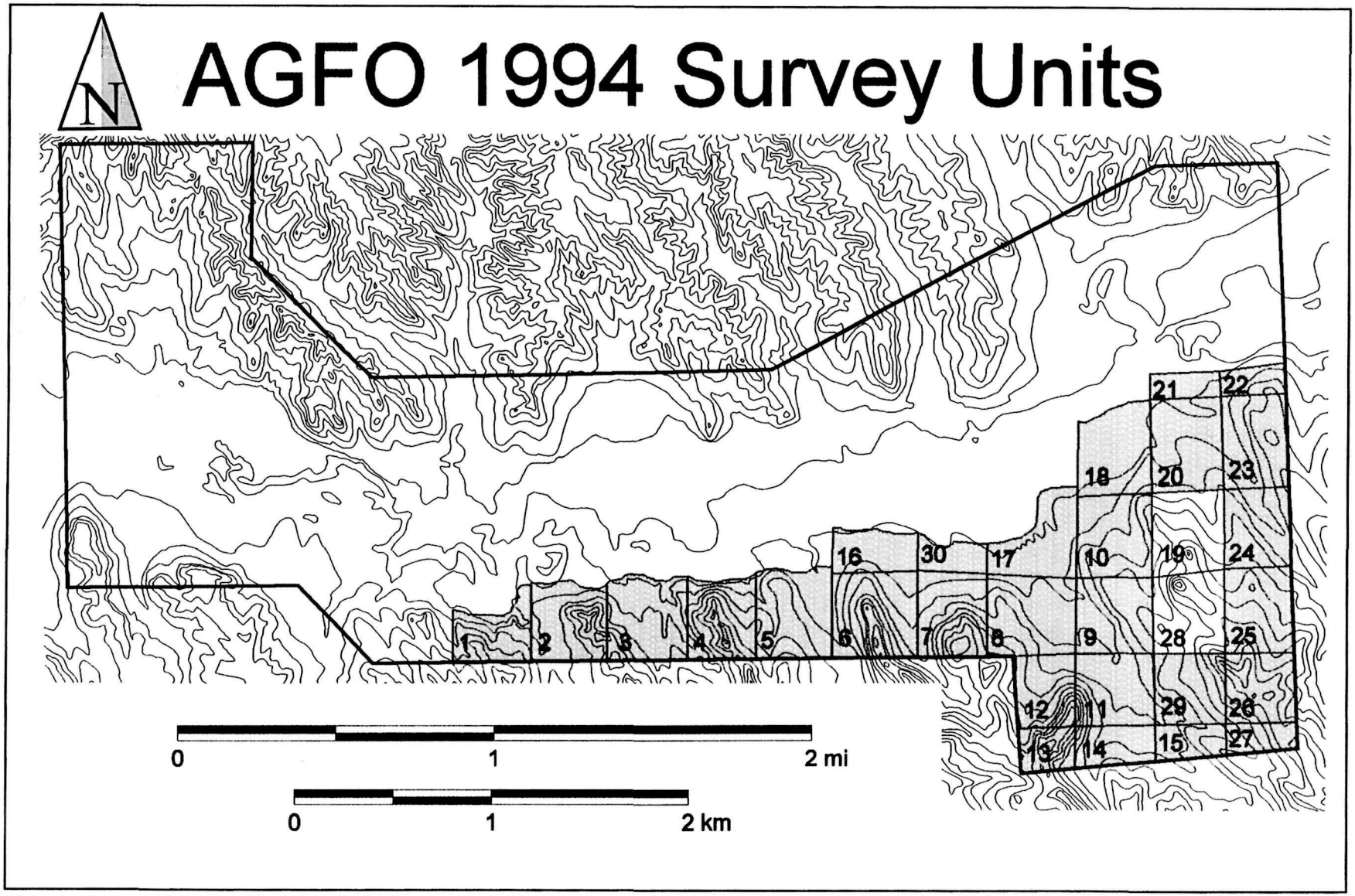


Figure III-1. Units surveyed (shaded).

Upon discovery, all artifacts and features, including foundations and cairns, were mapped using a Leitz-Sokkisha Set 4 total station with an electronic distance measuring (EDM) theodolite with a 5-second precision. Mapping took place within a local coordinate system with an arbitrary datum of N5000, E5000 at the SW corner of Unit 1. Mapping stations were established throughout the southern portion of the Monument, and from these stations most artifacts were mapped. Those that could not easily be mapped using the EDM theodolite were mapped using a Magellan ProMark V Global Positioning System (GPS) in conjunction with a Magellan Base Station.

For eight of the mapping stations, high-quality (PDOP < 8), three-dimensional differential GPS readings were taken, so that for these eight points, both grid system and UTM coordinates in UTM Zone 13 were obtained (Table III-1). The UTM coordinates were then regressed onto the grid coordinates for the eight stations using SAS (SAS 1985) Proc Regression. The resulting regression equation (Table III-2) was used to estimate the UTM coordinates for each artifact and feature. These UTM estimates have an associated error factor of ± 4.5 m along the east-west dimension and ± 3.0 m along the north-south dimension. The error is likely attributable to the internal precision of our mapping equipment, which, while very accurate over level terrain, was unable to totally compensate for the great changes in elevation within the Monument. Thus, overall, the coordinate system undoubtedly shifted as the mapping continued from west to east. Locally, however, the spatial structure of artifact clusters (discussed below) is likely accurately portrayed in this data base.

Artifacts, principally chipped stone flakes and debitage, were assigned a unique field catalogue number consisting of the

Table III-1. Agate Fossil Beds NM UTM and grid coordinate readings for eight mapping stations. All measurements in meters.

Reading	UTM		Grid Coordinate	
	Easting	Northing	Easting	Northing
STN100	600947.67	4696397.08	5000.00	5000.00
STN101	601103.50	4696447.79	5153.81	5051.37
STN102	601053.24	4696496.20	5105.12	5096.27
STN103	601905.09	4696800.28	5961.86	5388.73
STN106	602642.85	4696763.88	6699.30	5346.93
STN108	603454.14	4697008.60	7504.59	5587.06
STN111	604498.31	4697575.19	8565.15	6131.07
NPS_N6	601146.15	4696397.19	5195.96	5000.54

Table III-2. Regression linear model results.

UTMEAST = 596070 + (1.005)(GRIDEAST) + (-0.029)(GRIDNORTH)
UTMNORTH = 4691238 + (0.005)(GRIDEAST) + (1.027)(GRIDNORTH)

unit number (from 1 to 30) and a sequential item number. In the case of very high concentrations of artifacts, for example on ant hills, only the single item number was assigned to those artifacts. In addition, artifacts were cursorily described in the field using a protocol developed for documenting the archaeological landscape on the Oglala National Grassland (Appendix B) and were collected. Features were described and photo-documented. The mapping and collection crews located other artifacts as well, which were mapped, collected, and designated so as to be able to distinguish them from the systematically located artifacts. In all, 852 chipped stone artifacts were mapped, collected, and described in 15 of the 27 surveyed units (Map III-1). Ten cairns and one complex with foundation and well (the Kelley homestead) were discovered and described. And lastly, 56 historic artifacts, summarized in Appendix F, were mapped and field described.

Important Note: The UTM coordinates given in this report are with reference to the 1983 North American Datum and the GRS 1980 ellipsoid. The USGS maps available for the Monument rely on the 1927 North American Datum and the Clarke 1866 ellipsoid. Thus, to relocate site and artifact locations using a Global Position System, the appropriate datum and ellipsoid parameters must be specified. (See Snyder 1987 and Wandsnider and Dore 1995.)

Site Designations

A nonsite survey method was used to document the southern portion of the Monument highlighted in Map III-1. As depicted there, artifact densities are especially dense on those terraces in close proximity to the Niobrara as well as on ridge tops.

For management purposes, however, several high artifact density areas were singled out and assigned site numbers. These site designations were made *ex post facto* on the basis of artifact clustering. Clusters of three kinds of archaeological remains—chipped stone, historic artifacts, and features—were recognized and designated as sites. (See Map III-2.)

To distinguish chipped stone sites, a multi-pass *k*-means clustering algorithm, similar to that routinely used by archaeologists involved in spatial analysis (Kintigh and Ammerman 1983), was employed. The clustering algorithm PROC FASTCLUS (SAS 1985) operated on the grid coordinates of individual artifacts. In this manner, 26 clusters of chipped stone (Map III-2), that is, sites, were defined. Two of these artifact clusters were closely associated and have already been designated as 25SX152. Thus, 24 new sites (25SX251-25SX274) were recognized by the cluster analysis. The *k*-means algorithm is adept at finding circular clusters of artifacts but less able to distinguish non-circular clusters. By eye, an additional two clusters of chipped stone that were linear in shape were designated as sites (25SX286 and 25SX287). Artifacts not assigned to clusters were designated "isolated finds" and are depicted in Map III-3. Table III-3 summarizes the chipped stone sites.

Table III-3a. Chipped stone site summary: site characteristics. Note: site areas rounded to the nearest 100 m^2.

Site	Dimensions		Chipped Stone Frequency	Site Area (m^2)	Chipped Stone Density (/m^2)
	North (m)	East (m)			
25SX152	125	130	366	9900	0.037
25SX251	45	60	27	2500	0.01
25SX252	17	44	6	500	0.008
25SX253	48	29	23	1000	0.016
25SX254	29	57	20	1500	0.012
25SX255	48	48	9	2000	0.004
25SX256	5	12	6	50	0.096
25SX257	55	71	46	3500	0.011
25SX258	45	53	8	2000	0.003
25SX259	79	69	19	5000	0.003
25SX260	29	51	13	1000	0.009
25SX261	47	68	16	3000	0.005
25SX262	0.5	0.5	10	1	20
25SX263	22	19	9	400	0.021
25SX264	49	43	7	2000	0.003
25SX265	40	21	10	500	0.012

Table III-3a. (continued).

Site	Dimensions		Chipped Stone Frequency	Site Area (m^2)	Chipped Stone Density ($/m^2$)
	North (m)	East (m)			
25SX266	36	15	6	500	0.011
25SX267	48	28	26	1000	0.019
25SX268	30	85	34	2000	0.013
25SX269	48	54	7	2000	0.003
25SX270	88	53	16	4000	0.003
25SX271	41	81	5	3000	0.003
25SX272	36	55	25	1500	0.013
25SX273	78	37	11	2500	0.004
25SX274	61	62	23	3500	0.006
25SX286	50	25	8	1250	0.006
25SX287	50	10	6	500	0.012
IF			90		

Table III-3b. Chipped stone site summary: assemblage characteristics (AGT: Moss Agate; HUC: Hartville Uplift Chert; CLQ: Cloverly Quartzite; WRS: White River Group Silicate; UN1-3: Unidentified Lithic Material; see Chapter IV for a description of these materials).

Site	Chipped Stone Frequency	Proportion Material Type				Material Type Diversity	Flake/ Debitage Ratio	Tool/ Debitage Ratio	Comment
		Local Chert	Exotic Chert	Quartzite	Other Exotics				
25SX152	366	0.13	0.59	0.16	0.12	7	1.80	0.014	test excavations
25SX251	27	0	0.85	0.04	0.04	6	1.2	0.136	McKean projectile point; test excavation
25SX252	6	0	0.83	0	0.17	3	0.5	0.000	HUC dominates
25SX253	23	0.17	0.7	0.09	0.04	6	2.5	0.095	Late Archaic/Plains Woodland projectile point; test excavations
25SX254	20	0.15	0.2	0.65	0	5	2.8	0.052	CLQ dominates
25SX255	9	0.11	0.33	0	0.56	5	1.25	0.000	other exotic materials dominate
25SX256	6	0.17	0.83	0	0	3	2	0.000	HUC dominates
25SX257	46	0.13	0.76	0.07	0.02	6	1.39	0.079	HUC dominates
25SX258	8	0.13	0.63	0.25	0	4	1.67	0.000	HUC dominates
25SX259	19	0.21	0.79	0	0	2	2.8	0.000	HUC dominates
25SX260	13	0.08	0.85	0.08	0	3	3	0.083	HUC dominates
25SX261	16	0	0.88	0	0.06	4	1.67	0.000	HUC dominates
25SX262	10	0.5	0.4	0	0.1	3	0.25	0.000	AGT and HUC equal; ant hill context

Table III-3b. (continued).

Site	Chipped Stone Frequency	Proportion Material Type: Local Chert	Exotic Chert	Quartzite	Other Exotics	Material Type Diversity	Flake/ Debitage Ratio	Tool/ Debitage Ratio	Comment
25SX263	9	0.11	0.56	0.33	0	4	2	0.000	CLQ and HUC equal; test excavations
25SX264	7	0.57	0.43	0	0	3	0.75	0.000	AGT dominates
25SX265	10	0.1	0.6	0.2	0.1	4	2.33	0.000	HUC dominates
25SX266	6	0	1	0	0	2	0.2	0.000	HUC and WRS equal
25SX267	26	0.19	0.65	0.12	0.04	6	0.73	0.000	HUC primary
25SX268	34	0.18	0.71	0.09	0.03	6	1.46	0.063	HUC primary; test excavations
25SX269	7	0.29	0.43	0.29	0	3	0.75	0.000	
25SX270	16	0	0.56	0.19	0.25	5	2.75	0.067	HUC primary
25SX271	5	0.00	1.00	0.00	0.00	2	4.00	0.000	HUC and WRS equal
25SX272	25	0.12	0.56	0.2	0.12	5	0.47	0.000	HUC primary
25SX273	11	0.55	0.27	0.09	0.09	5	0.29	0.222	AGT dominates
25SX274	23	0.48	0.39	0.09	0.04	5	0.83	0.045	AGT dominates
25SX286	8	0.13	0.50	0.25	0.13	5	2.50	0.140	
25SX287	6	0.00	0.83	0.17	0.00	2	0.50	0.000	
IF	90	0.21	0.58	0.12	0.06	9	1.05	0.110	isolated chipped stone

In the southern portion of the Monument, Kay (1975) found three clusters of rock cairns, which he designated 25SX158, 25SX159, and 25SX161. We relocated 25SX159 and 25SX161 (and recorded more cairns at each than previously noted by Kay; see Appendix E). In the southeast portion of the Monument, we also located a series of two rock cairns, which are likely those Kay (1975) recorded as 25SX158. We recorded them at a location about 350 m south of the location given by Kay (1975: Figure 1), however. Finally, one additional series of rock cairns not described by Kay (1975), in the eastern portion of the southeastern part of the Monument, was noted and designated as site 25SX282. Table III-4 summarizes information about the cairn sites. See Appendix E for a more detailed description.

In addition to clusters of chipped stone and rock cairns, we also noted four clusters of historic artifacts as well as the gravestone of J. H. Cook (25SX285). A foundation and well was associated with one of the historic artifact scatters at 25SX283 (the Kelley homestead). The other clusters, too, were assigned site numbers (25SX283-285, 25SX288-289; see Table III-5). (Note that the Bone Cabin was not assigned a site number during this survey.) See Map III-2 for site locations and Appendix F for descriptions of artifacts.

It should be noted that in his 1975 survey, Kay (1975:36-39) identified 25SX162 as a potential site on the basis of the series of soils found exposed here. He noted no artifacts at this location and none were noted in 1994.

In the southern portion of Agate Fossil Beds National Monument, then, 32 new sites were designated. These sites are above and beyond the four that Kay (1975) reported for this area in 1975. As well, 116 artifacts (89 chipped stone and 27 historic artifacts) were considered isolated finds (Map III-3). The isolated find chipped stone assemblage is summarized in Table III-6. In Chapter V, it is contrasted with the artifacts located in high artifact density areas, that is, sites.

One last observation deserves mention. Kay (1975), Olinger (1980), and Clark

Table III-4. Cairn sites.

Site	Number of Cairns	Arranged over a Distance of	Comment
25SX158	2	250 m	location reported here differs from Kay (1975:Figure 1)
25SX159	3	200 m	Kay (1975:33) reported 1 cairn here
25SX161	2	50 m	Kay (1975:33) reported 1 cairn here
25SX282	3	300 m	not noted by Kay (1975)

Table III-5. Historic sites.

Site	Dimensions East (m)	Dimensions North (m)	Artifact Count	Area (m^2)	Density ($/m^2$)	Comment
25SX283 (Kelley homestead)	14.5	11.0	3+	160.0	0.019	foundation and well with screen mesh and glass bottles
25SX284	4.0	4.0	10	16.0	0.625	tin cans, metal strips, glass, pipe
25SX285	1.0	1.0	0	1.0	0	J. H. Cook gravestone
25SX288	13.0	26.2	4	340.0	0.012	wood, tin cans, glass, concrete
25SX289	17.0	7.0	7	120	0.058	tin cans with plank
IF			27			wooden planks, tin fragments, wood and metal harness piece, gas can, tractor part

Table III-6. Summary of isolated chipped stone assemblage. (See Chapter IV for a detailed description of chipped stone materials.)

Material Type		Chipped Stone Artifacts			Total
		Tool	Flake	Debris	
Local Chert	AGT	0	6	13	19
Exotic Cherts	HUC	6	20	12	38
	SJH	1		1	2
	WRS		6	6	12
	Total	7	26	19	52
Quartzite	CLQ	2	5	4	11
Exotic Others	OBS				0
	UN1		3		3
	UN2		1	1	2
	Other			2	2
	Total	0	4	3	7
Total		9	41	39	89

(1993) have all reported small amounts of obsidian at some Monument sites. They speculated that the source of this material was Yellowstone's Obsidian Cliff to the northwest. During the 1994 and 1995 field seasons, we also documented several pieces of obsidian. Geochemical analyses by Richard E. Hughes (see Appendix C) on the obsidian flakes recovered during 1994 and 1995 indicate that these materials come from two obsidian flows at Malad (Idaho) and Jemez (New Mexico). According to Hughes, obsidian from these sources circulated throughout the Plains areas, especially during the Late Prehistoric and Protohistoric time periods. At the Slaughterhouse Creek site, a Protohistoric site located in an oxbow of the White River near Crawford, Nebraska, Bozell and Ludwickson (1988) also reported small amounts of obsidian from the Malad source in Idaho.

1995 Test Excavations

Given the information obtained during the 1994 season, test excavations were carried out at selected chipped stone sites in 1995. Sites with a high tool to debitage ratio as well as a relatively high density of total artifacts were determined to be the most appropriate locations for test excavations. As well, sites in locations not previously examined by

Clark (1993), for example, on ridge tops, were given high priority. A final consideration in site selection was the presence of projectile points and the lithic material type percentages.

The sites chosen for test excavation included 25SX152 (with the largest count of artifacts), 25SX251 (with a McKean point found in association with a small cluster of chipped stone), 25SX253 (a chipped stone cluster dominated by Hartville Uplift Chert and associated with a Late Archaic / Late Prehistoric projectile point), and 25SX273 (a small cluster of chipped stone dominated by Moss Agate). Upon relocation, 25SX273 was found to be essentially a surface scatter and was therefore considered no further. In its place, site 25SX268, a scatter dominated by Hartville Uplift Chert and Moss Agate, and located on a small terrace close to the Niobrara River, was selected.

The excavation crew included a crew chief and three archaeological technicians (see Appendix A). The test excavations were completed over a period of 13 days, from 26 July to 7 August 1995.

Upon being relocated during 1995, the sites were resurveyed at a 5-m transect interval. While the sites had been completely collected in 1995, other materials had come to the surface in the intervening year and these were flagged. Using the 1994 coordinate system, the perimeter of each site as established in 1995 was mapped with the Lietz-Sokkisha EDM. Test excavation units, all of them 1 x 1 m, were situated so as to sample the center and periphery of the site surface scatter.

A total of 20 1-x-1-m excavation units were excavated in the summer of 1995. At site 25SX152, a total of 11 1-x-1-m test excavation units were placed so as to bisect the center of the artifact scatter. At all other sites, three test units were excavated.

Test units were excavated using shovels and trowels in 10-cm levels. All sediment was screened through 1/4" screen. A standard sample of 3000 g of sediment was taken from the SW corner of each excavation spit. This sample was screened through 1/16" screen to identify small reduction debris, pressure flakes, and other retouch materials. In the following tables, "macroartifact" refers to those artifacts recovered in situ or in the 1/4" screen; "microartifact" refers to those recovered from the 1/16" screened 3000 g sample. No flotation samples were collected or processed. Test units were excavated until bedrock was encountered or until a culturally sterile layer below 50 cm was reached. All chipped stone was bagged by 10-cm levels and field observations were logged. Rodent burrows, changes in sediment, nature of the bedrock, and soil profiles were noted for each test unit.

Units were excavated by two-person crews with one person shoveling and the other person screening. On average, a two-person crew could excavate and record approximately 3 10-cm levels in one hour.

Test unit depths varied considerably, ranging from 20 to 80 cm below the surface. The average test unit depth was 44 cm, but test units at 25SX253 and 25SX268 were much deeper than those at 25SX152 and 25SX251.

Almost 800 pieces of chipped stone were recovered during excavation. The average test unit yielded approximately 30 pieces of chipped stone, varying from 0 to 102 artifacts. In addition to chipped stone, small amounts of fire-altered rock and bone were also recovered. In

contrast to Clark's (1993, 1994) earlier excavations, no identifiable features were discovered.

Site 25SX152

Site 25SX152 is located on a lower terrace of the Niobrara River where the visitor trail begins to climb towards University and Carnegie hills. The site was first described by Marvin Kay in 1975. The cluster analysis of the 1994 survey data recognized two generally tight clusters of artifacts with an intervening scatter of artifacts. These clusters and scatters of chipped stone were lumped to conform with the spatial extent of 25SX152 defined by Kay in 1975.

Eleven test units were excavated at 25SX152 (Figure III-2). In general, they revealed that there was very little horizonation in the sediments here. The topsoil consists of a layer of wind-blown loess, which lay on top of limestone bedrock. This loess was as shallow as 20 cm in some test units (e.g., Test Unit 2) and had a maximum depth of 50 cm at Test Unit 9. Figure III-3 represents well the stratigraphy seen at each of the 11 test units. The test units are summarized in Table III-7.

Site 25SX152 had the largest variety of lithic material present of any of the sites tested during the 1995 season (Table III-8). Chipped stone material present at the site included Hartville Uplift Chert (HUC), Moss Agate (AGT), White River Group

Table III-7. 25SX152 test unit excavation summary.

Unit	Artifacts		10-cm Levels	Comment
	Macro	Micro		
1	47	13	4	1 biface
2	14	1	2	no obvious rodent disturbance
3	57	38	4	1 projectile point
4	65	33	3	
5	60	20	3	obsidian flake recovered; 1 core
6	6	6	3	no obvious rodent disturbance
7	8	4	3	bedrock cobbles at base
8	4	5	3	flakes appear associated with rodent burrow
9	41	16	5	1 piece of bone
10	2	0	3	HUC flake shows heat-treatment
11	81	22	4	2 obsidian flakes; 2 pieces of bone; 1 core

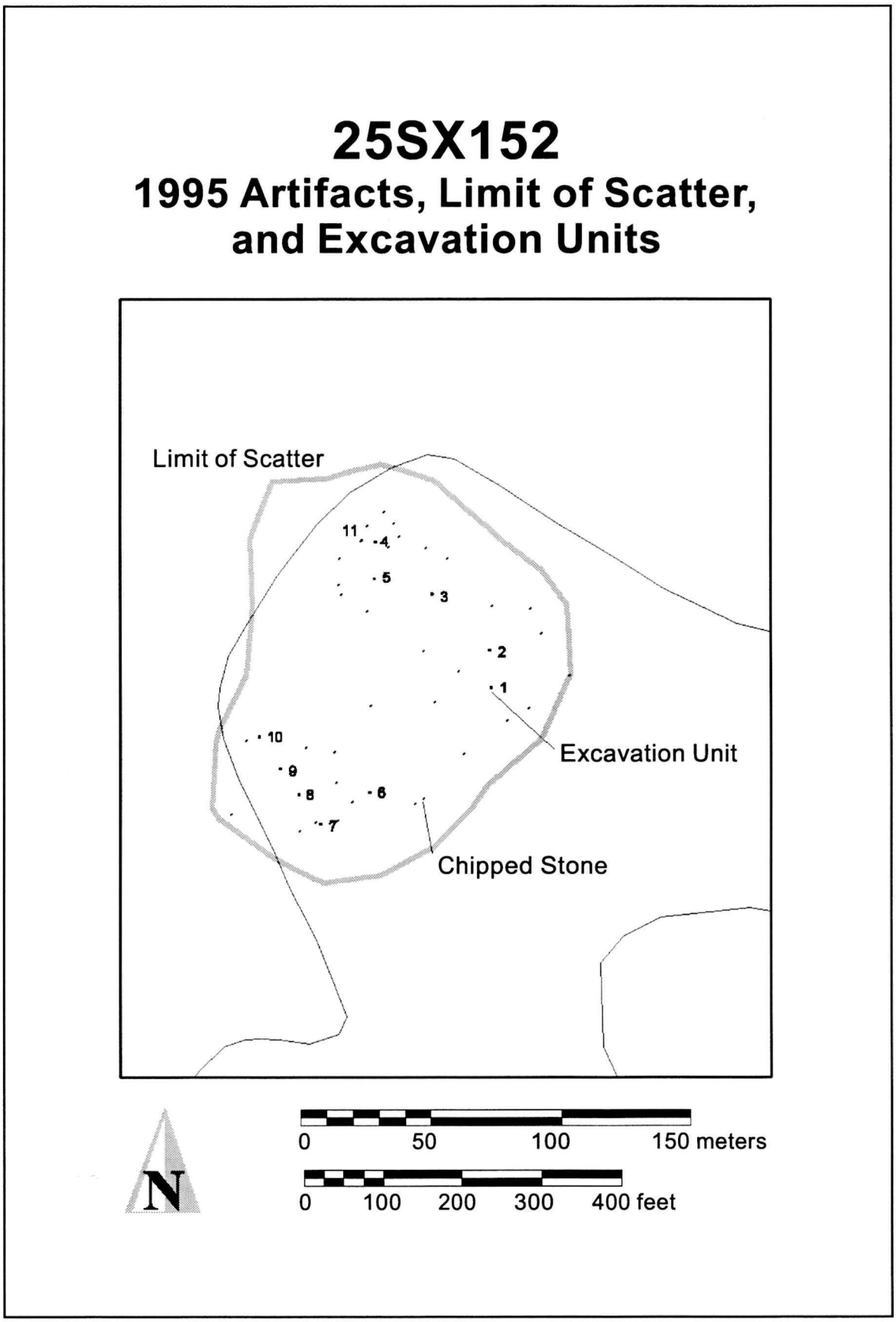


Figure III-2. 25SX152 excavation units.

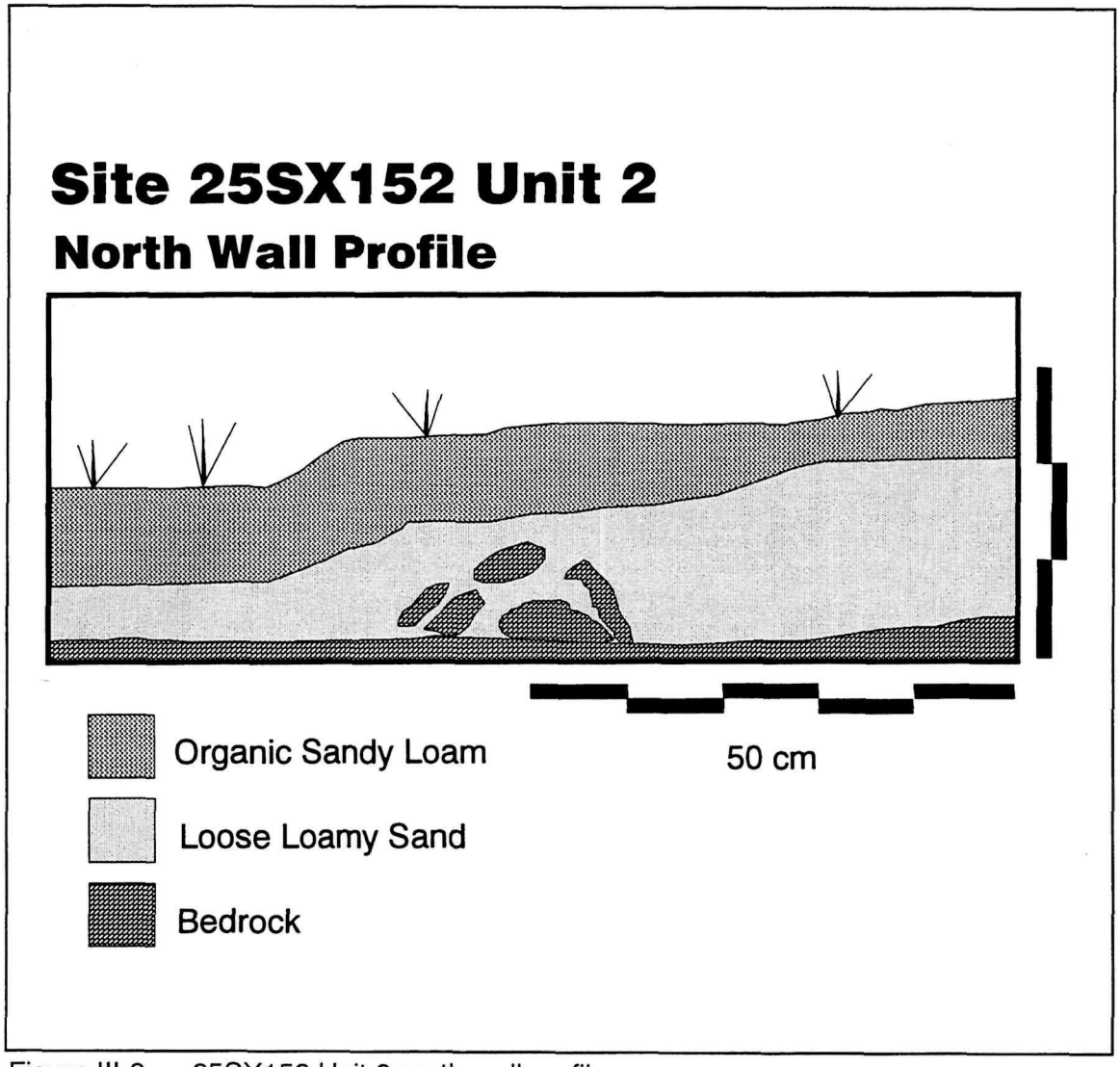


Figure III-3. 25SX152 Unit 2 north wall profile.

Silicates (WRS), Cloverly Quartzite (CLQ), small quantities of obsidian (OBS) and an unidentified lithic material (UN3). (See Chapter IV for detailed chipped stone descriptions.) The majority of the chipped stone material was HUC, but some units contained large quantities of AGT. Three projectile points were found at 25SX152, including two complete side-notched points and a midsection of a Cody or Eden point. This Cody/Eden point type is often used as an indicator of the Cody complex, which Frison (1991) dates from 9000-8400 BP. If sustained, this is the first evidence of the Cody complex found in the Monument. While this projectile point may indicate a Paleoindian presence on the Niobrara River, it may also represent recycling from other deposits.

The small quantities of obsidian recovered at 25SX152 are also small in size (approximately 2 cm [almost 1 in] in maximum dimension) and are without cortex. This small size and lack of cortex would be consistent with their transportation from a distant primary source, rather than from a secondary cobble source in the vicinity of Agate Fossil Beds NM. Geochemical analyses by Hughes (Appendix C) sourced these

Table III-8. 25SX152 excavated assemblage summary.

Material Type		Macroartifacts			Microartifacts (/3000g)			Total
		Tool	Flake	Debris	Tool	Flake	Debris	
Local Chert	AGT	1	43	42		8	10	104
Exotic Cherts	HUC		141	18		64	12	235
	SJH		4	3		2		9
	WRS		19	7		8	1	35
	Total	0	164	28		74	13	279
Quart-zite	CLQ	2	42	17		29	6	96
Exotic Others	OBS		3			1		4
	UN1	3	29	2		13	1	37
	UN2		5	7		2	1	15
	Total	3	37	9		16	2	56
Total		6	286	96	0	127	31	546

obsidian fragments to central New Mexico and to southeast Idaho.

No one single obvious cultural horizon was noted in the units excavated at 25SX152. Indeed, as indicated in Figure III-4, maximum artifact yields by weight (also by count, not graphed here) came from the first level in some units (e.g., Test Unit 4), from intermediate levels in other units (e.g., Test Units 3 and 5), and from the terminal levels in still other units (e.g., Test Units 9 and 11). Moreover, attempts by James Doolittle (from the Washington office of the NRCS) to locate subsurface features at 25SX152 with ground-penetrating radar were unsuccessful. Thus, it appears that the stratigraphy at 25SX152 has been heavily affected by a variety of depositional and post-depositional processes. Artifacts may have been deposited on a fairly active surface that was subject to both episodes of sedimentation and erosion. This hypothesis is supported by the fact that chipped stone was found in the cracks of the bedrock at depths of 20 to 50 cm beneath the surface. Either the artifacts were deposited when the bedrock was exposed or they may have filtered down over time through the sediments that mantle the bedrock.

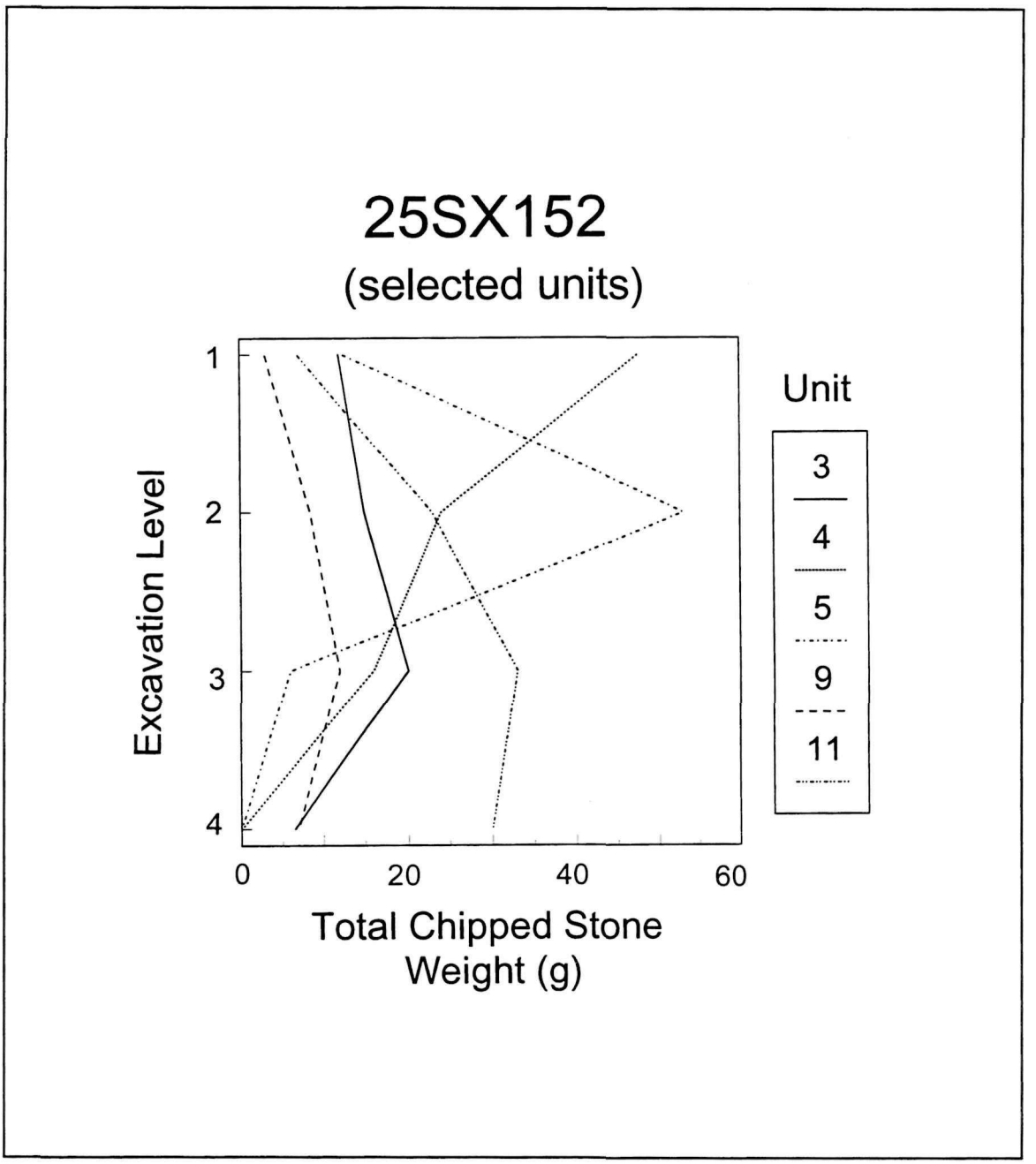


Figure III-4. Total chipped stone weight by level for selected 25SX152 units.

25SX251

Site 25SX251 is located on a high ridge in the southwest portion of the Monument. Three test units were excavated here (Figure III-5). These units extended to a depth of at most 30 cm, although either bedrock or heavily compacted sediment was encountered before reaching this depth (Figure III-6). No artifacts were recovered from any unit (Table III-9). It appears that the artifact scatter at 25SX251 was surficial in nature.

25SX253

Site 25SX253 is located on one of the lower terraces of the Niobrara (Map III-2). Here, three test units were excavated

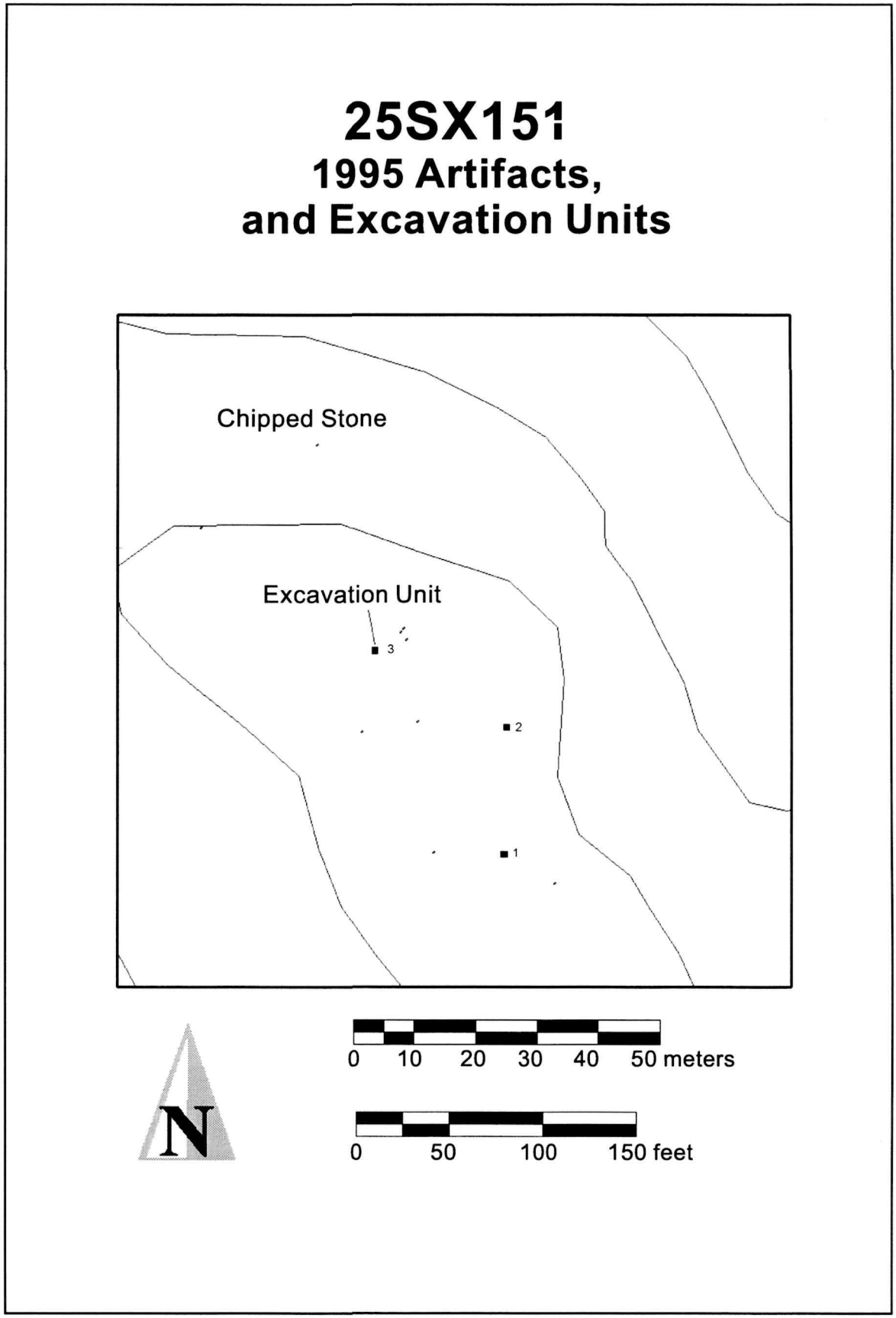


Figure III-5 25SX151 excavation units.

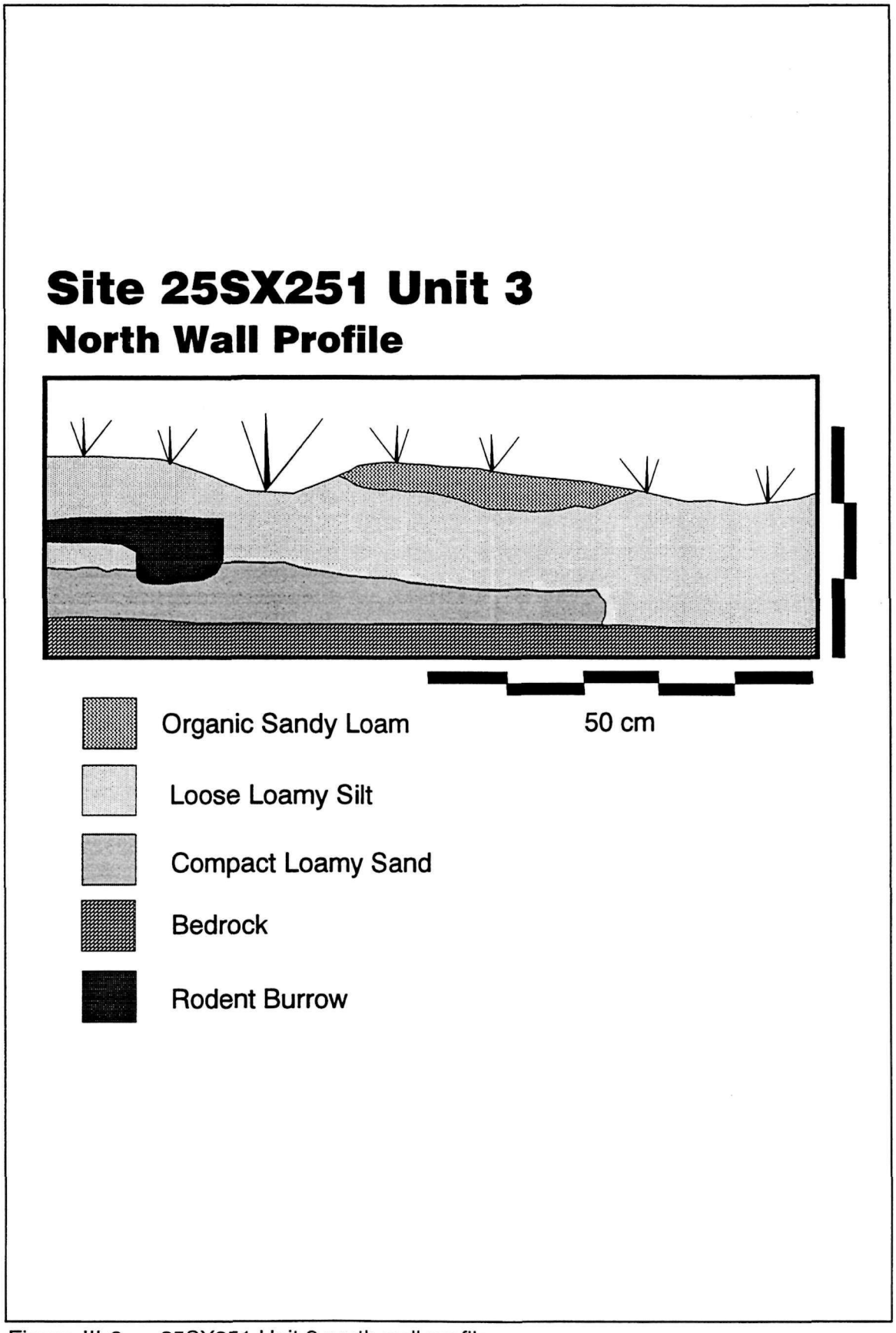


Figure III-6. 25SX251 Unit 3 north wall profile.

Table III-9. 25SX251 test unit excavation summary.

Unit	Artifacts	Levels	Comment
1	none	3	bedrock at 23 cmbs
2	none	3	
3	none	3	sediment heavily indurated at 23-30 cmbs

(Figure III-7). They revealed that cultural deposits are deeply buried, extending down to a depth of 80 cmbs, with most of the cultural material concentrated at 50 to 60 cmbs (Figures III-8 and III-9). This finding is likely owed to the location of this unit on one of the lower terraces of the Niobrara where the apparently very active surface precluded the development of a soil. Large amounts of macro-chipped stone were recovered from each of Test Units 1 and 2, and Test Unit 3 produced only 5 large pieces of chipped stone (Table III-10).

The chipped stone recovered here was composed almost exclusively of HUC (Table III-11). Artifacts included a biface (Test Unit 1; depth 60 cm) and a number of large flakes (Test Units 1 and 2). In addition, pieces of bone (one up to 15 cm in length) and fire-altered rock were also found, which suggests that this particular location may have well-preserved and culturally interesting materials. As Figure III-10 indicates, artifact densities are highest in levels 5 and 6, lending further support to this statement.

Remote-sensing survey by James Doolittle (Washington, D.C. NRCS) was undertaken on a volunteer basis in September 1995, i.e., after test excavations had already been completed. In a 100-m^2 area, ground-penetrating radar identified three anomalies (Figure III-11). One anomaly was located near Test Unit 1, where chipped stone but no

Table III-10. 25SX253 test unit excavation summary.

Unit	Artifacts		10 cm Levels	Comment
	Macro	Micro		
1	33	20	8	auger probe to 1.3 mbs revealed no other artifacts
2	36	5	8	11 pieces of bone and 2 pieces of FCR from Level 5
3	5	5	8	

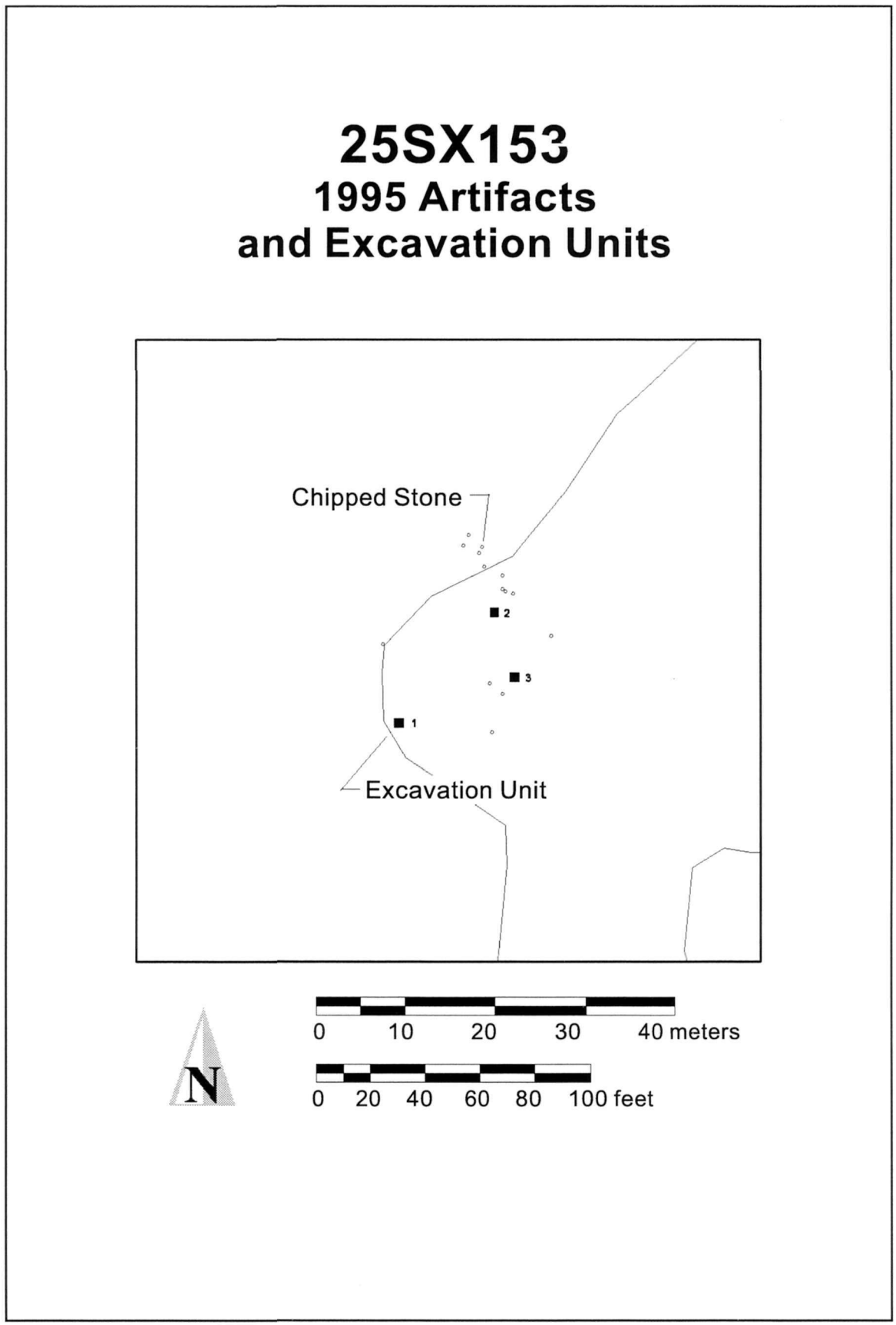


Figure III-7 25SX153 excavation units.

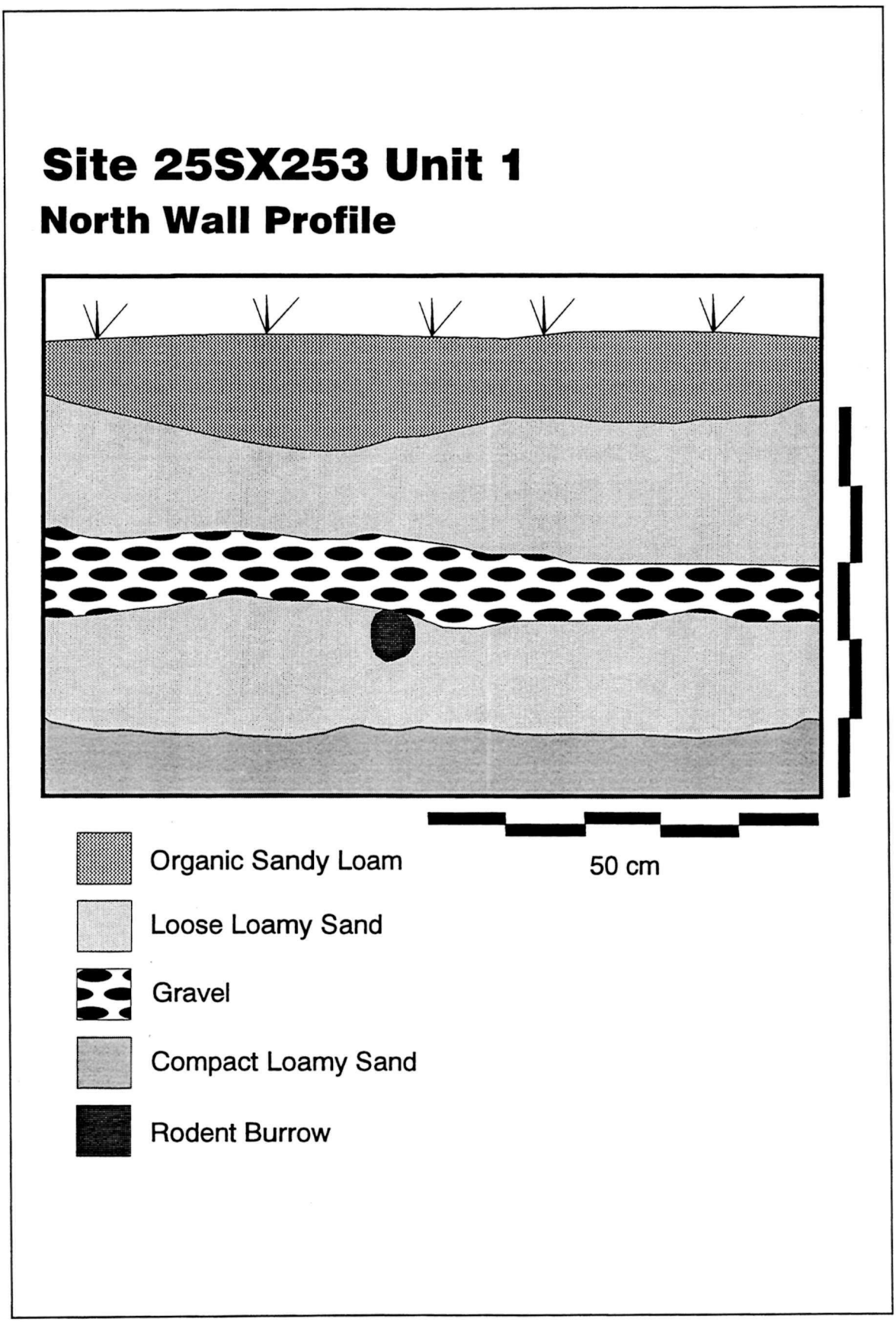


Figure III-8. 25SX253 Unit 1 north wall profile.

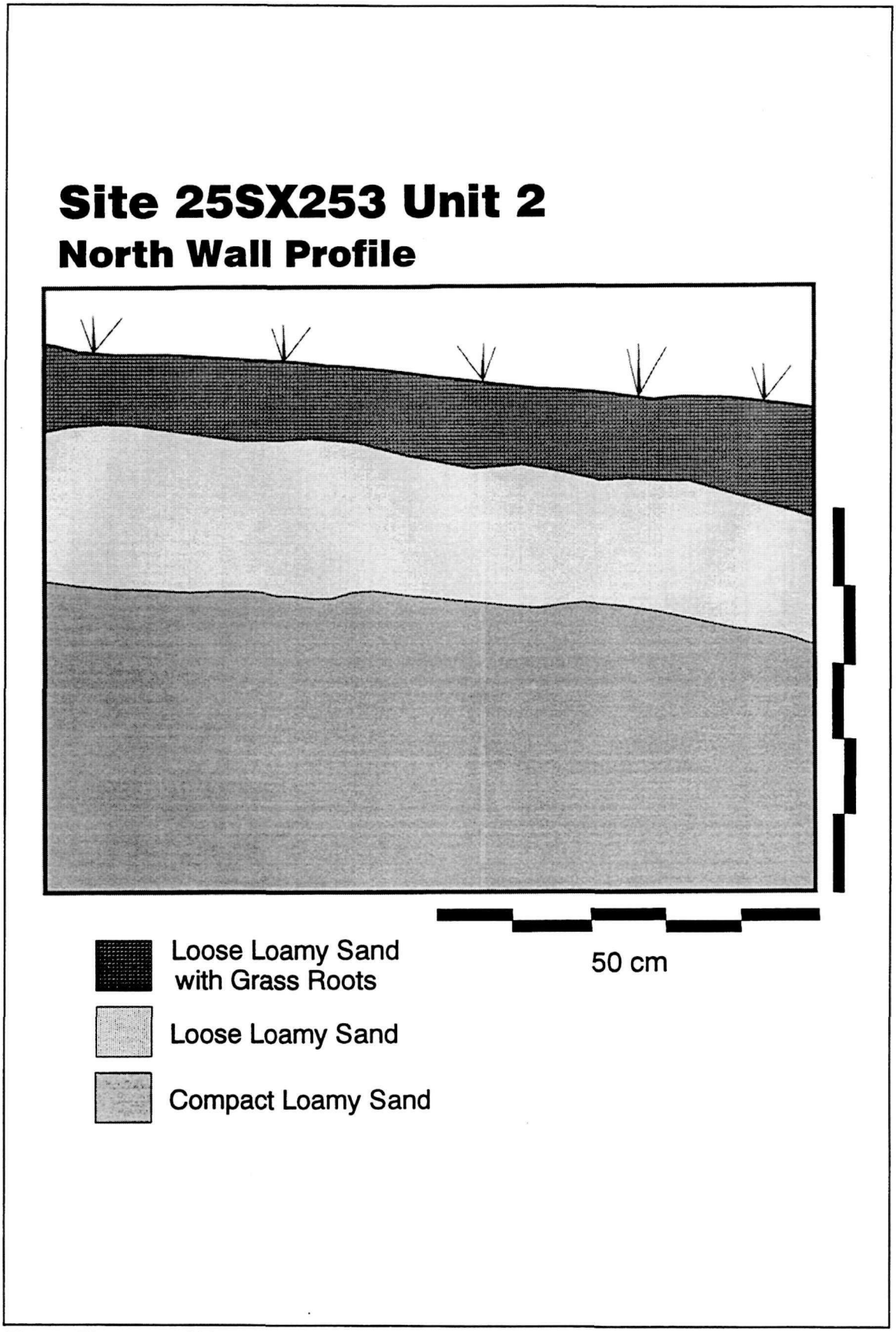


Figure III-9. 25SX253 Unit 2 north wall profile.

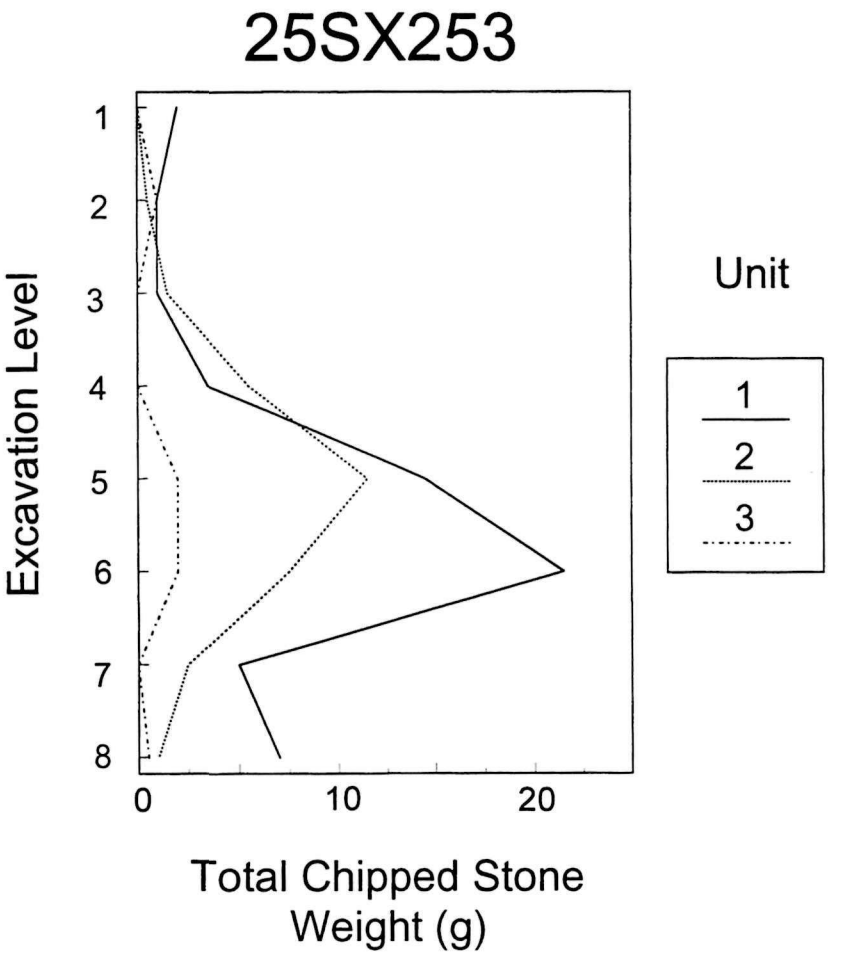


Figure III-10. Total chipped stone weight by level for all 25SX253 units.

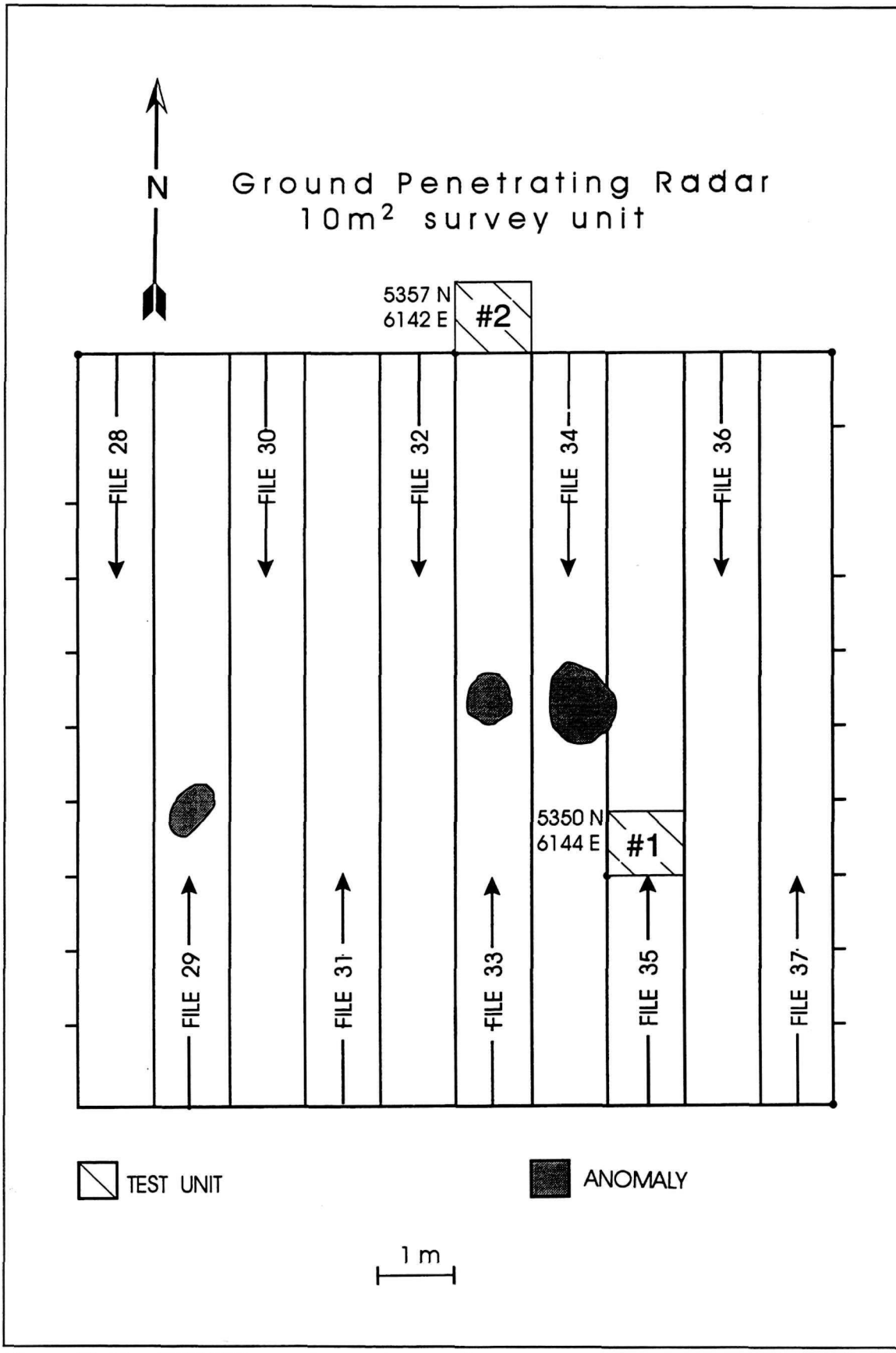


Figure III-11. 25SX253 remote sensing results.

Table III-11. Summary of 25SX253 excavated assemblage (by count).

Material Type		Macroartifacts			Microartifacts (/3000g)			Total
		Tool	Flake	Debris	Tool	Flake	Debris	
Local Chert	AGT	0	2	1	0	1	0	4
Exotic Cherts	HUC	2	56	10		26	2	96
	SJH							0
	WRS							0
	Total	2	0	10	0	26	2	96
Quart-zite	CLQ	0	2		0	0	0	2
Exotic Others	OBS							0
	UN1		1			1		2
	UN2							0
	Total	0	1	0	0	1	0	2
Total		2	61	11		28	2	104

other cultural materials were recovered. In Test Unit 2, fire-altered rock was noted, yet ground-penetrating radar identified no anomalies in this area.

25SX268

25SX268 is located just east of 25SX253, also on a low terrace above the Niobrara River (Map III-2). Three test units were excavated here (Figure III-12), which established that deeply buried cultural deposits occur (e.g., Figures III-13 and III-14). No paleosols or features were found, however, and high artifact densities seem to occur in levels 3 through 5 (Figure III-15). Either these deposits have been subject to vertical displacement or, perhaps several depositional events are represented here.

A number of large HUC flakes were found at this site as well as at least one case of heat-treated HUC and bone (see Tables III-12 and III-13).

Excavation Summary

The subsurface testing described above and carried out by Clark (1993, 1994) indicates that for some areas within the Monument there is a substantial subsurface component. Ridge-top locations (e.g., site 25SX251) not surprisingly have little subsurface expression. On apparently active transport surfaces, such as that on which 25SX152 is located, soils have not

Table III-12. 25SX268 test unit excavation summary.

Unit	Artifacts		10-cm Levels	Comment
	Macro	Micro		
1	34	22	6	1 piece of bone in level 4
2	15	18	6	bone in levels 3, 5, and 6
3	30	8	7	bone in levels 5, 6, and 7

formed or have eroded away, and herethere is poor preservation of bone and the lack of deposits with easily interpreted spatial structure. Especially in the southwestern portion of the Monument, some of the low terraces of the Niobrara are backed by tablelands. Here, the tablelands shed sediment and archaeological deposits were apparently more rapidly buried, at least compared with the terraces in the southeastern portion of the Monument. In this area,

Table III-13. Summary of 25SX268 excavated assemblage.

Material Type		Macroartifacts			Microartifacts (/3000g)			Total
		Tool	Flake	Debris	Tool	Flake	Debris	
Local Chert	AGT	0	8	4	0	1		1
Exotic Cherts	HUC	1	47	3		33		4
	SJH							
	WRS		2					
	Total	1	49	3	0	33		5
Quart-zite	CLQ	0	10	1	0	4		1
Exotic Others	OBS							
	UN1		2			4		
	UN2			1				
	Total	0	2	1	0	4		0
Total		1	69	9	0	42	6	127

then, there is great potential for good preservation of bone and other fragile remains as well as high-integrity deposits, as demonstrated by excavations at 25SX253 and 25SX268.

In addition, subsurface testing has documented the high subsurface densities of artifacts at these sites. Projecting from the test units excavated at 25SX152, which yielded an average of 35 artifacts, the subsurface component here contains a minimum of 175,000 artifacts (35 artifacts/unit X 5000 sq m). For 25SX253 and 25SX268, estimates of 6,500 and 11,250 for the subsurface assemblages are obtained. Assemblages of this size would seem to represent either a number of ephemeral occupation events or a single occupation event that was either of several weeks in length or involved more than a nuclear family.

SUMMARY

In sum, the surface and subsurface assemblage recovered in the southern portion of Agate Fossil Beds NM consists of a variety of materials commonly found on the northern High Plains. The assemblage is dominated by chipped stone, and other materials—historic artifacts, bone, and so forth—are found to a much lesser degree. The ten cairns noted here are reported on in Appendix E. The historic artifacts noted during survey are described in Appendix F. In the following two chapters, the chipped stone assemblage is described and analyzed to yield information about prehistoric human activities in Agate Fossil Beds NM.

NOTE

[1] The data generated as a result of this project are available by request to the NPS Midwest Archeological Center in Lincoln, Nebraska.

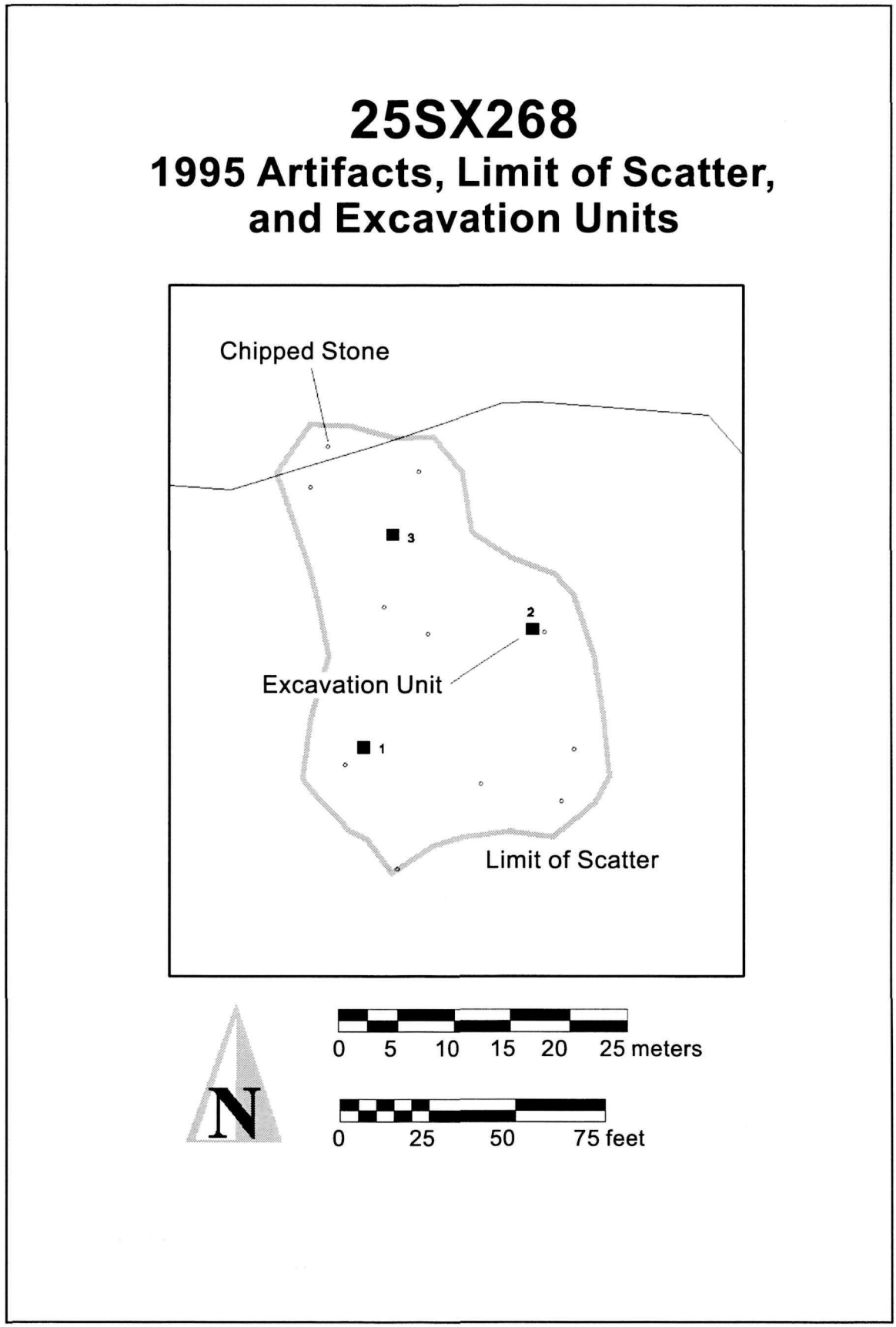


Figure III-12. 25SX268 excavation units.

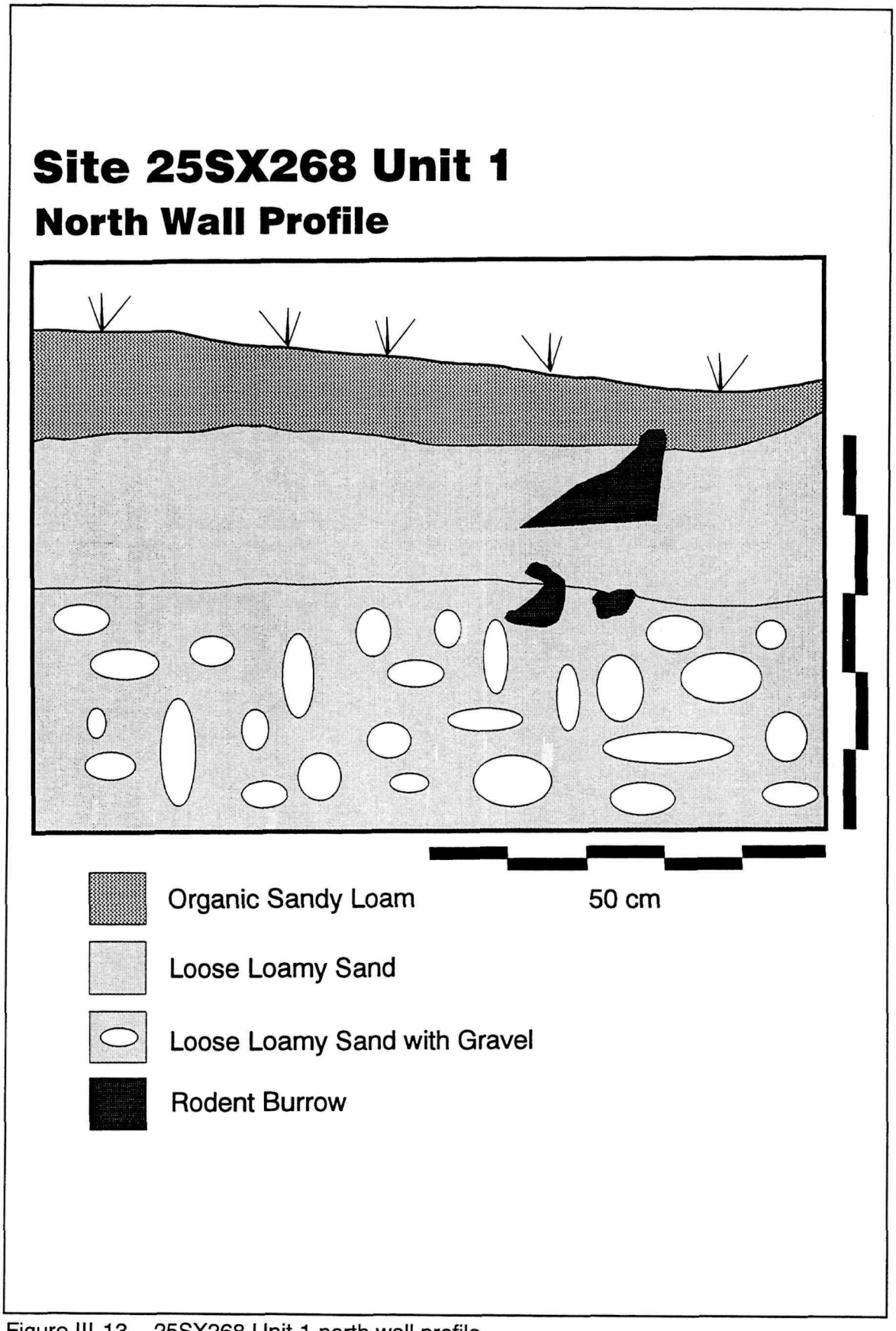


Figure III-13. 25SX268 Unit 1 north wall profile.

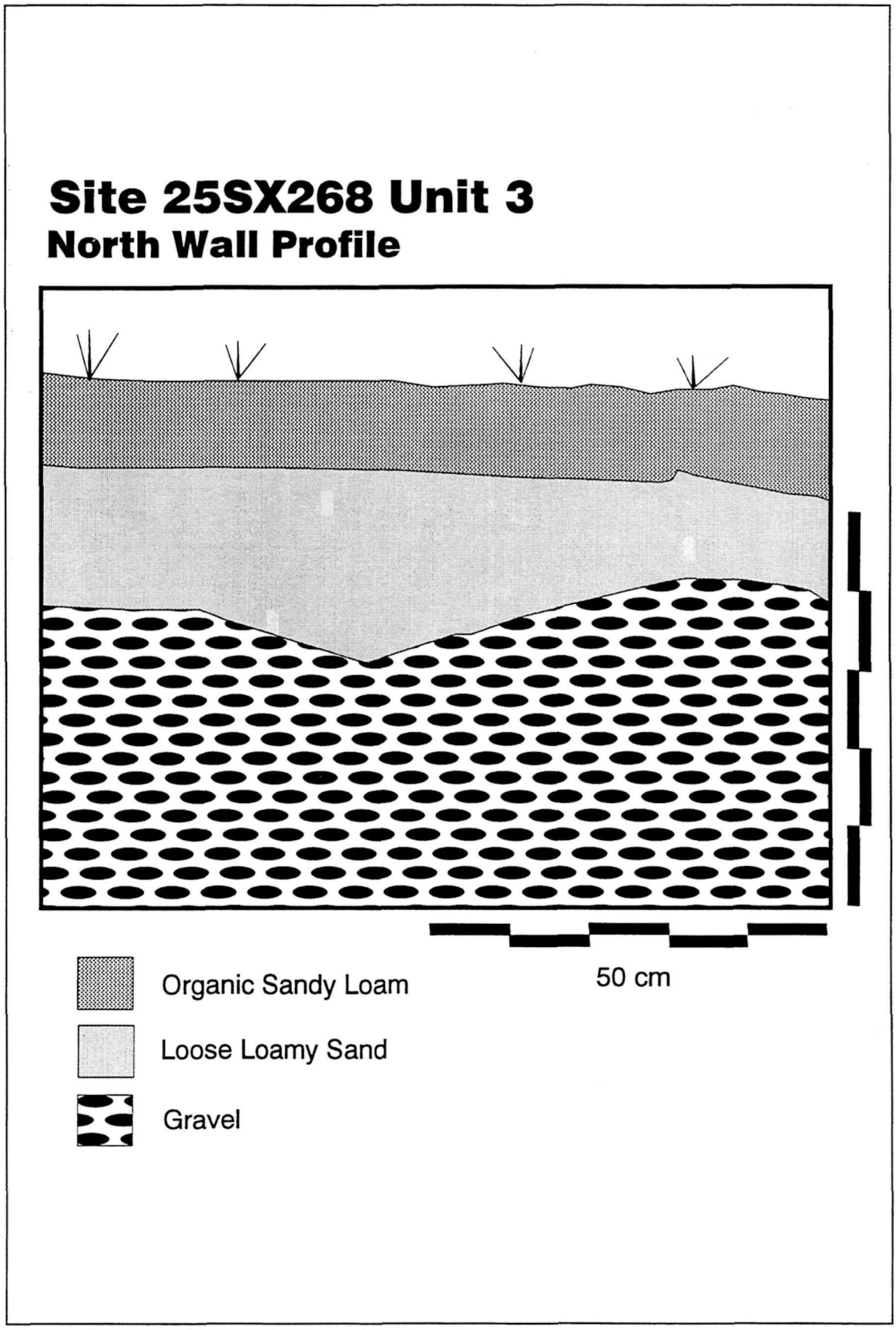


Figure III-14. 25SX268 Unit 3 north wall profile.



Figure III-15. Total chipped stone weight by level for all 25SX268 units.

CHAPTER IV
CHIPPED STONE AND PREHISTORIC MOBILITY AT AGATE FOSSIL BEDS NM

George H. MacDonell and LuAnn Wandsnider

Many times during the year the prehistoric human group had to pack up all personal belongings and move. A dry year resulted in different patterns of distribution of plant and animal resources, and the human groups had to respond accordingly... Major climatic changes would have resulted in long-term events that changed the entire settlement pattern.

It seems likely that a prehistoric family group of hunters and gatherers may have moved camp as many as 50 to 100 times during the year...Ultimately the prehistoric Plains family left a large number of campsites of differing duration, intensity, and purpose, manifested by differing amounts of cultural evidence (Frison 1991:12-13).

INTRODUCTION

Recent studies of the Northwest Plains (Frison 1991; Kornfeld 1994) and the northern High Plains (MacDonell 1996) have emphasized the degree to which this area in the past supported a variety of highly unpredictable resources. In this sea of relative unpredictability, various rare places on the landscape would have offered relatively more predictable (although likely not abundant) resources. Pine Bluffs (Reher, personal communication 1993) and the Black Hills (Kornfeld 1994), both in ecotone settings afforded by abrupt elevational changes, are two such situations. Another is that of the western Niobrara River, by dint of the availability here of reliable water in a semi-arid grassland. The position of Agate Fossil Beds NM on the western Niobrara affords an opportunity to examine the role of this place with its presumed relatively (emphasis on relatively) more predictable larder. In this chapter, we rely on the surface and subsurface chipped stone assemblage referred to in the preceding chapter address this issue.

We begin by briefly characterizing the High Plains environment in terms of patches with different properties and then discuss the ability of the chipped stone assemblage to monitor aspects of prehistoric mobility and subsistence. We next describe the lithic landscape of the High Plains and then turn to a consideration of the chipped stone assemblage at Agate Fossil Beds NM. After presenting an overview of the assemblage, it is, first, compared to other assemblages from well-reported sites on the High Plains and, second (and more speculatively), considered in terms of its temporal aspects. We conclude with a series of observations about the chipped stone assemblage at Agate Fossil Beds NM and what it tells us about prehistoric High Plains hunter-gatherers.

THE HIGH PLAINS ENVIRONMENT

Kornfeld (1994) and MacDonell (1996) have recently presented models of hunter-gatherer subsistence and mobility for the western Black Hills (Kornfeld) and

northern High Plains (MacDonell). Both of these models are derived from current bodies of theory—ecological theory (Pianka 1974; summary in Kelly 1995), in the case of Kornfeld, and landscape ecological theory (see Forman and Godron 1986; Naveh and Lieberman 1994), in the case of MacDonell—and take into consideration the inferred characteristics of the paleoenvironment for these respective areas.

Working from these slightly different bases, both authors reach similar conclusions. They note that this portion of the Great Plains historically received on the average low-to-moderate precipitation with high interannual variation. The High Plains lie in the rainshadow of the Rocky Mountains. The mountains block Pacific Ocean moisture and the air descending the eastern slope of the Rockies reaches this area as a dry air mass (Colville and Myers 1965; Tannehill 1947). A study by Karl and Koscielny (1982) found that of the nine climatic regions in the United States, the West North Central region (consisting of western Nebraska, Wyoming, the Dakotas, and sections of Colorado, Montana, and Idaho) had the most variability in annual precipitation. When droughts occurred in this region, they were often of much longer duration than in other regions (Figure IV-1). In historic periods, great droughts in the 1890s and 1930s caused full-scale emigration from many farming communities in the area (Thornthwaite 1941). Clearly, drought has always been a possibility in the vicinity of Agate Fossil Beds NM. Dry years, low-quality grasses, and harsh winters can have extremely damaging effects on grazing animals and consequently, their predators (Frison 1991; Reher 1977). It is therefore likely that hunter-gatherers in the region would have had a variety of subsistence and mobility strategies for coping with the variable environment. Moreover, these strategies likely varied significantly between highly productive years and periods of drought.

Other aspects of ecological patch variation are important, as discussed in greater detail by MacDonell (1996). Vegetation patches in this region are moderate in size, the result of the interaction between moderate-scale (i.e., on the order of square kilometers) landforms (each supporting different floral and faunal communities) and large-scale (hundreds of square kilometers) air masses that seasonally dominate this area. Along the western Niobrara, smaller scale vegetation patches, controlled by the flood plain for example, also are found.

In addition to patch size, we can also speak of the temporal predictability with which resources might be found in a particular patch. Today, the majority of the rainfall in the area occurs during the spring. Grazing animals in the region depend heavily on the grasses produced after the spring rains, when fat stores depleted by the long, hard winter are replenished (Osborn 1993). During the spring of most years, animals are distributed evenly across the landscape as the grasses are productive almost everywhere. However, as the hot days of summer arrive, water resources become scarce. It is during this period that bison, for example, seek shade and wallowing areas. High places with breezes become attractive and some animals near the mountains move to higher elevations (Frison 1991). During the summer, animals tend to congregate in these predictable areas. As fall approaches animals begin to store fat in preparation for the winter. During the fall, the animals are at their prime in terms of fat content

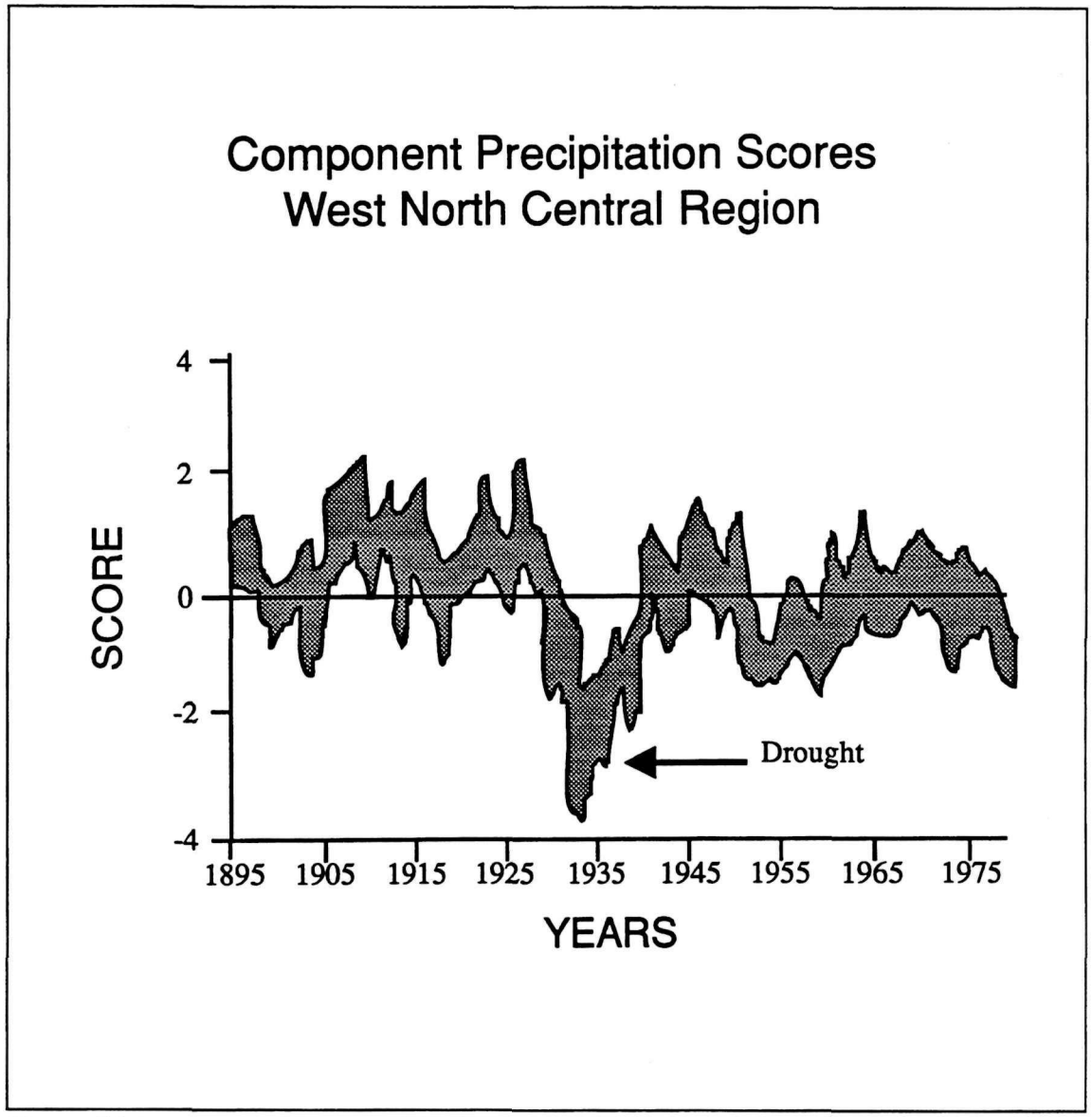


Figure IV-1. Component precipitation scores (a measure of drought) for the northern Great Plains (from Karl and Koscielny 1982).

and at this time they would be quite attractive to hunters (Frison 1991). Thus, there are certain locations on the landscape where, contingent on the availability of forage, water, shade, wallow areas, etc., animals such as bison and antelope may be anticipated. As emphasized by Frison (1991), prehistoric peoples were well acquainted with these habits and used this knowledge to their advantage.

The spatial predictability of resources is also important. On the High Plains, Bamforth (1988:3) has emphasized the uniformity of the landscape, while Kornfeld (1994) has noted the high diversity of Plains habitat owed to changes in elevation, proximity to water, and so forth. This discussion of patchiness has been largely conducted in relativistic terms, and we continue with that tradition here by noting the lack of variation in topography in the vicinity of Agate Fossil Beds NM relative to places like the Black Hills. The Niobrara River,

then, stands out as one water-rich location on this somewhat featureless landscape that potentially served as a magnet for fauna and their predators. This area may have been viewed as a location where a predictable suite of resources could be found, even during dry years.

How did these patch characteristics change with past environmental change? We presently lack detailed studies of the Late Pleistocene and Holocene environment at Agate Fossil Beds NM, so it is difficult to speak to this issue. As discussed below, however, it appears that the main prehistoric occupation of the western Niobrara at Agate Fossil Beds occurred during the Late Archaic and Late Prehistoric, a time by which the modern climatic pattern was in place. As has been documented for the American Southwest, "modern climate" incorporates a great deal of variation in moisture and temperature associated with, for example, the Little Climatic Optimum and the Little Ice Age (Euler et al. 1979). It is likely the case that the northern High Plains endured a similar, if not more dramatic (given its interior continental location), range of variation.

From this characterization of the past and present environment, Kornfeld (1994) and MacDonell (1996) go on to derive expectations for the organization of prehistoric mobility and subsistence practices (Table IV-1). They anticipate that prehistoric groups here would have been generally small in size (around the magic number of 25; see Kelly 1995) and highly mobile, and would have relied on a very broad diet that included, but was not exclusively oriented to, bison. (While Frison [1991] offers a similar assessment, most of his work has emphasized the highly visible bison bone beds, which, according to Kornfeld and MacDonell, may represent a rather small part of the foraging picture in the vicinity of the Black Hills.) Given the very high interannual variability in resource structure, people likely rapidly developed a diverse cultural repertoire of responses (Gunn 1994) to both "good" and "bad" years. That is, people would have had a variety of fall-back strategies on which to rely when the rains failed to come or stayed too long. The work of Dyson-Hudson and Smith (1978) suggests that little territoriality should be seen here, although Cashdan's (1983, 1984) work with human groups in semi-arid environments suggests that territory defense may be of a kind of social prescription rather than active patrolling.

Table IV-1. Northern High Plains hunter-gatherer organization

Small group size
Large annual range
Social prescription or low territoriality
Highly mobile
Diverse diet
Diverse subsistence strategies

Given this model describing High Plains hunter-gatherers, what should we expect to see in the archaeological assemblages from Agate Fossil Beds NM, which, given its location on the western Niobrara, may represent a virtual oasis in semi-arid grassland? Here at Agate Fossil Beds, annual group aggregations may have occurred, along with continual visits by smaller groups. Because of dependable water here, this segment of the landscape may have been defended as part of a specific group territory or groups may have agreed to joint use of the area. We expect little evidence of prolonged

residential stays here but instead expect evidence for countless occupation events by very mobile hunter-gatherers. Groups may have come here to target a suite of riparian resources, and this may be reflected in the material culture. Conversely, this portion of the western Niobrara may have been but one among many stops on an annual foraging circuit. In this latter situation, a very mobile people may have outfitted themselves with a very versatile and light-weight technology. This latter option should also be visible archaeologically. More specific expectations for the chipped stone assemblage are discussed below.

CHIPPED STONE AND PREHISTORIC HIGH PLAINS HUNTER-GATHERERS

Having established some preliminary expectations for past hunter-gatherer behavior at Agate Fossil Beds NM, how can the chipped stone recovered there help us to evaluate this model? In discussing the potential of chipped stone for interpreting aspects of prehistoric subsistence and mobility, it is useful to move from general, theoretical statements to specific dimensions, as nicely articulated by Chatters (1987). We consider two dimensions here: range, as monitored by source-find distances; and strategic flexibility, as reflected in choice about material types and in the nature of the curated technology.

Range

Range refers to the size of an area utilized by a group over some specified length of time (Binford 1983; Sampson 1988). This dimension of mobility is best measured archaeologically by examining lithic source distributions and correlating them with the percentage of various lithic material types in an assemblage. Several assumptions must be warranted in order to directly relate lithic materials and range size. One such assumption is that lithic raw material collection is embedded in subsistence activities and the annual round. Another assumption is that people are drawing their lithic material from a source with well-defined characteristics that allow the distinction between primary and secondary geological contexts (see Luedtke 1976 and Meltzer 1984). (In the following, we address the use of secondary cobble beds as possible sources of the lithic material at Agate Fossil Beds NM.) A final assumption is that trade is minimally involved in the movement of lithic material across the Plains. As discussed below, this latter assumption appears suspect during the Late Prehistoric and Protohistoric time periods.

Strategic Flexibility

A number of researchers have called attention to how the lithic material and the nature of the curated technology relate to strategic options in tool production. For example, Bleed (1986) distinguishes between reliable and maintainable tools as defined in terms of both tool form and also the physical properties of the lithic raw material. A reliable tool is one that is over-designed to insure that it functions properly (in a specific manner) under any circumstances. A maintainable tool is one that can be repaired easily or quickly adapted to serve a variety of needs (Bleed 1986). Certain materials may be better suited for one or the other type of tool. In cases where only one type of lithic material is available to a hunter-gatherer group, people are limited to utilizing whatever material is at hand. However, in cases where materials suited for both types of tools are available, the type of technological strategy employed by a hunter-gatherer group may provide an indication of their overall human adaptive

strategy (including subsistence and mobility). Groups that utilize reliable tools are most likely moving to a known location to hunt a predictable prey, while groups who practice encounter hunting in unpredictable environments would be more likely to employ maintainable tools that could be adapted to meet a number of unforeseen needs.

In addition, Kelly (1988b) has suggested that biface technology represents a means of maximizing tool potential while minimizing carried weight. The biface allows for versatility as well as a large supply of sharp edges. Bifaces can be used as tools, or as cores to produce flake tools. They have a long use-life in that they are extremely durable but they can be used to quickly produce a sharp edge (Kelly 1988b). Bifacial blanks are useful in terms of hunter-gatherer mobility because they can be used to create whatever tool is necessary (useful in unpredictable environments) and they provide a great number of tools with a minimal amount of carried weight. By examining debitage types and ratios it is possible to identify past reduction strategies. In turn, a biface-oriented technology suggests subsistence strategies designed for versatility and responsiveness.

Thus, to approach an understanding of both prehistoric range and the breadth of strategic options for which people designed their technological repertoire requires information on lithic material type, technological form, and so forth. Using definitions and protocols described by Camilli (1983), Cotterell and Kamminga (1987), Crabtree (1982), and Sullivan and Rozen (1985), the chipped stone assemblage from Agate Fossil Beds NM was therefore examined with respect to material type, debitage type, amounts of cortex, size and weight, and other attributes (see Appendix G).

THE HIGH PLAINS LITHIC LANDSCAPE

In order to use an archaeological chipped stone assemblage to draw inferences about past mobility, territoriality, and so forth, it is important to have a detailed understanding of the lithic landscape, i.e., the distribution of lithic materials and the qualities of those materials. Some of these qualities include chipped stone quantity, knapping quality, edge durability, accessibility, raw material size, and physical attributes (Kelly 1988a, 1988b; Larralde 1990).

The lithic sources available in the vicinity of Agate Fossil Beds are numerous and varied (Figure IV-2) and can be distinguished by their various macroscopic properties, as described here. Mississippian and Pennsylvanian age limestone produced high-quality cherts with exposures in the Hartville Uplift and the Black Hills (Francis 1991; Miller 1991). The Hartville Uplift is the site of the best known and largest quarry in the area, Spanish Diggings. This quarry complex is located near Lusk, Wyoming, approximately 50 km (30 mi) west of Agate Fossil Beds NM. The chert available at this site in southeastern Wyoming is known as Spanish Diggings or Hartville chert. Here, it will be referred to as Hartville Uplift Chert (HUC). It is easily recognizable by its caramel, tan, or brown color and its characteristic black dendritic inclusions (Francis 1991).

The Cloverly formation in eastern Wyoming is the source of massive amounts of quartzite lithic material, also available at the Spanish Diggings quarry area (Francis 1991; Reher 1991; Duguid and Bedish 1968). This material is often referred to as Spanish Diggings quartzite but, following the conventions that are developing in North America for

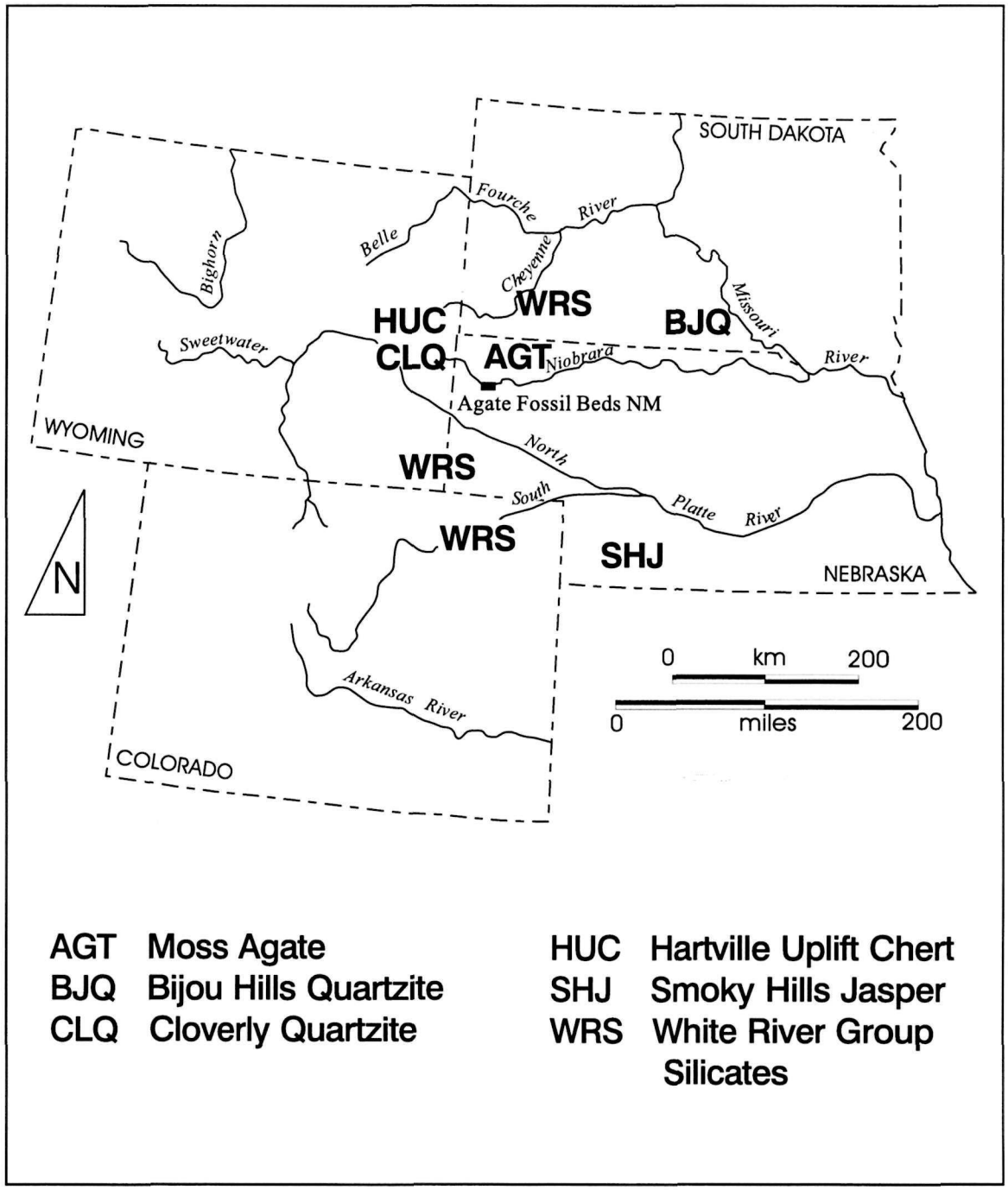


Figure IV-2. Primary lithic sources on the northern High Plains (from Francis 1991; Hoard et al. 1993; Holen 1991; Miller 1991).

designating raw material sources, will be called Cloverly Quartzite (CLQ) here. This material ranges in color from tan and maroon to pink and gray. It is all very fine grained and highly workable.

Within the boundaries of Agate Fossil Beds a low-quality material known as Moss Agate (AGT) is found. Some previous research (Clark 1993, 1994) has referred to this material as Upper Harrison Formation. This material occurs in thin lenses within the limestone bluffs along the Niobrara. It ranges in color from

clear yellow and caramel to opaque white and frequently contains black dendritic inclusions. It fractures naturally into angular pieces that are frequently misidentified as chipped stone. However, there is some evidence that this material was used for flake and tool production (Carlson and Peacock 1975).

White River Group Silicates (WRS) have also been found at Agate Fossil Beds. These materials have been identified by a number of different names including Flattop Chalcedony, Scenic Chalcedony, West Horse Chert, and Kimball Chert (Hoard et al. 1993; Clark 1994). The sources for this material are found throughout South Dakota, northeast Colorado, southeastern Wyoming, and the southern panhandle of Nebraska. It is virtually impossible to distinguish one material type from the other using macroscopic analysis. The White River Group material identified at the Monument is light tan to white with white inclusions. The nearest quarry sources for this material are the Table Mountain area (approximately 90 km [55 mi] to the south) and the West Horse Creek area of South Dakota (approximately 110 km [65 mi] north of Agate Fossil Beds).

Small traces of obsidian (OBS) have been recovered at the Monument. This clear, smooth, black material is easily recognizable but very rare in both survey and excavation assemblages (Clark 1994). This obsidian has been sourced to lava fields in Idaho and New Mexico (see Appendix C).

Smoky Hills Jasper (SHJ), also known as Republican River Jasper, has been found in small quantities at the Monument. It is a soft and sometimes banded material that is easily knapped. The Smoky Hills Jasper found at Agate Fossil Beds is yellow in color, but the material has been known to occur in browns, reds, whites, and greens. The nearest source of Smoky Hills Jasper is the chalk formations along the Republican River in southern Nebraska (Holen 1991) approximately 550 km (330 mi) south of the western Niobrara.

In addition to these distinguishable lithics, small quantities of three different unidentifiable materials (UN1, UN2, UN3) have also been located within the Monument boundaries.

ANALYSIS OF PAST HUNTER-GATHERER MOBILITY AND SUBSISTENCE AT AGATE FOSSIL BEDS NM

With this understanding of the lithic landscape in the vicinity of Agate Fossil Beds NM, we now focus on issues of prehistoric range and strategic flexibility along the western Niobrara as reflected in the chipped stone assemblage. After presenting an overview of the Agate Fossil Beds chipped stone assemblage, we compare this assemblage with those from other well-reported sites in the vicinity and then consider the change in lithic material use through time as evident in the projectile point assemblage.

Agate Fossil Beds Chipped Stone Overview

In this section, we describe some of the characteristics of the Agate Fossil Beds NM chipped stone assemblage recovered through survey and excavation during 1994 and 1995. A profile of the raw materials present here, their sources (whether primary or secondary), and the relatively high occurrence of cherts are each described and commented upon.

Raw Material

Nine different raw materials from at least ten different sources compose the chipped stone assemblage from Agate Fossil Beds NM (Figure IV-3). Hartville Uplift Chert is the most common lithic material type in the Agate Fossil Beds assemblage. This caramel-colored chert makes up 47% by weight and 54% by count of all lithics collected during the 1994 and 1995 field seasons. The nearest primary source for Hartville Uplift Chert is the Spanish Diggings quarry region near Lusk, Wyoming (approximately 50 km [30 mi] west of Agate Fossil Beds).

The second largest component of the assemblage is the locally available Moss Agate (AGT). It constitutes 19%, by weight, and 16%, by frequency, of the chipped stone assemblage. Cloverly Quartzite (CLQ) (also found at the Spanish Diggings quarry complex) is the third largest contributor to the assemblage, with 15% of the total weight and 14 % of the total frequency. Other materials present in the assemblage are White River Group Silicates (WRS), Smoky Hills Jasper (SHJ), three different unidentified materials (UN1, UN2, UN3), and trace occurrences of obsidian (OBS; sourced to both Malad [Idaho] and Jemez [New Mexico]).

Primary vs. Secondary Lithic Sources?

Were the materials used by past visitors to Agate Fossil Beds obtained from primary or secondary lithic sources? That cobble sources in northwestern Nebraska were used is quite possible. For example, one well-known deposit of glacial till in the area is Sugar Loaf Butte, approximately 60 km (36 mi) north of Agate Fossil Beds near Crawford, Nebraska (Carlson and Peacock 1975; Butler 1994). This area contains a number of fist-sized cobbles of various lithic materials.

To determine if cobbles served as the sources of raw material at Agate Fossil Beds, we considered the amount of cortex found on the lithic debris. Cobbles such as those found at Sugar Loaf Butte have a characteristic waxy cortical rind. When these cobbles are flaked, the resulting debris contains a large percentage of primary flakes.

All lithic material collected during 1994 and 1995 at Agate Fossil Beds was examined for traces of cortex. The percentage of cortex on the dorsal side of each flake or piece of debris was recorded. These percentages were then used to describe flakes as primary (more than 50% cortex on the dorsal face), secondary (less than 50% cortex on the dorsal face), or tertiary (no cortex) (Cotterell and Kamminga 1987; Crabtree 1982). By looking at the amount of cortex on the Agate Fossil Beds lithics and comparing the results by weight of each lithic material type, it is clear that there is no significant difference in the flake types for any of the materials except for the locally available Moss Agate (Figure IV-4). This result suggests two possibilities. For one, cores from either primary or secondary sources were heavily reduced and the lack of cortex is a poor indicator of source. Alternatively, sizeable cores from primary but not secondary sources were transported. Because of the lack of other Chadron Formation cobble material types at Agate Fossil Beds NM, we suspect that primary lithic sources in eastern Wyoming were visited for raw material.

Strategic Flexibility

Hartville Uplift Chert and Cloverly Quartzite outcrop very close to each other in the vicinity of the Spanish Diggings

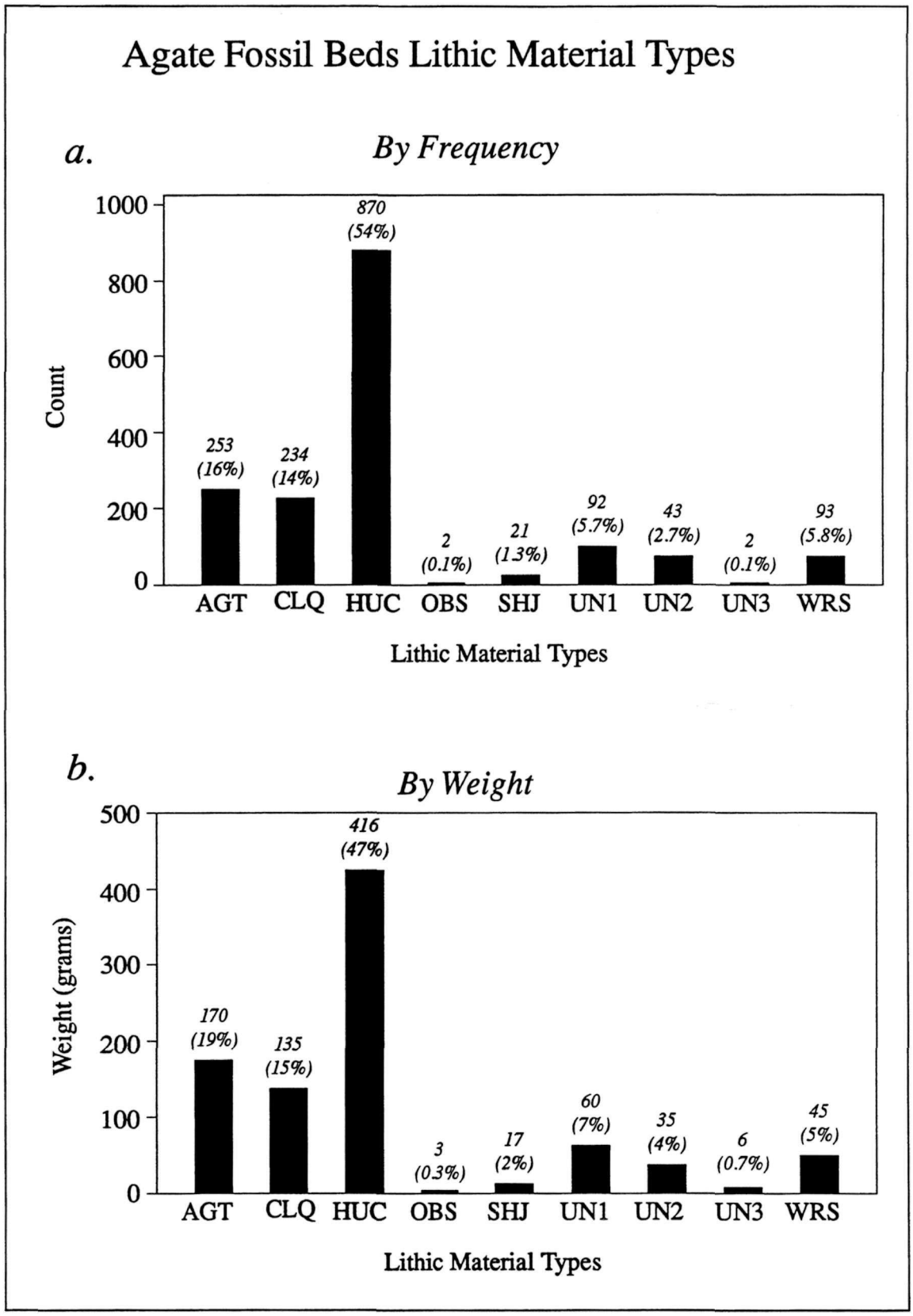


Figure IV-3. Percent lithic material types at Agate Fossil Beds NM (a) by frequency and (b) by weight.

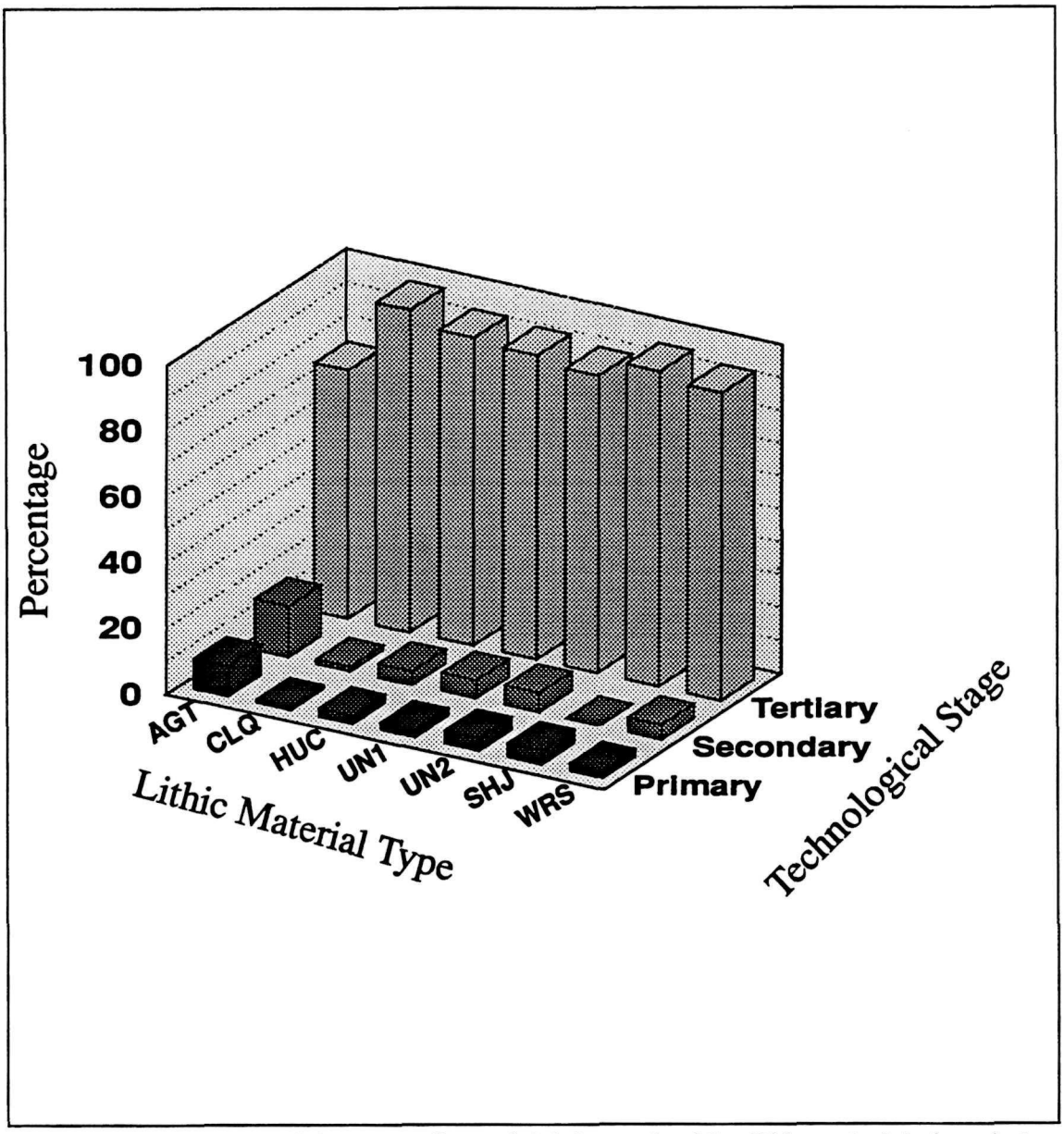


Figure IV-4. Percent flake types (by weight) for each of the lithic materials found at Agate Fossil Beds NM.

quarry complex. It is likely that prehistoric people had equal access to both materials. However, in the Agate Fossil Beds assemblage, we see a predominance of Hartville Uplift Chert (47% by weight), especially compared with Cloverly Quartzite (15% by weight). It therefore appears that hunter-gatherers consciously selected Hartville Uplift Chert rather than Cloverly Quartzite. Why might this be the case?

The concepts of reliable and maintainable tool materials, mentioned above, are useful here. Cloverly Quartzite could be described as a more reliable tool-making material; it is less likely to break during use. Some disadvantages of Cloverly Quartzite are the fact that edges produced with it are not very sharp, especially in comparison with a material like obsidian. Therefore, a bifacial tool made of Cloverly Quartzite would be

sturdy but without sharp edges. Hartville Uplift Chert could be classified as a maintainable tool-making material. It is easier to work with and holds a sharper edge than Cloverly Quartzite. However, Hartville Uplift Chert is a material that would become dull relatively quickly and would, compared with Cloverly Quartzite, be prone to breaking. Therefore, Hartville Uplift Chert would not be the ideal material to use if the upcoming tool-use activities were known to require sturdy tools.

It appears that the people utilizing the western Niobrara region were less interested in reliable tools. They appear, instead, to have focused their tool material selection on Hartville Uplift Chert, a material that could be easily adapted into whatever tool they required as they moved across the landscape. This result suggests that people were designing their technology to be very flexible and able to be adapted to the situation at hand.

This selection of a maintainable over a reliable material type can be contrasted with the lithic materials used at the Vore site, a Late Prehistoric bison kill site in northeastern Wyoming, approximately 250 km (150 mi) north of Agate Fossil Beds NM. Groups participating in the bison kill are believed to have "geared-up" for the event by going to well-known quarries such as Spanish Diggings (Reher and Frison 1980). The dominant material type in the Vore site lithic assemblage is Cloverly Quartzite, which makes up from 46 to 100 % of the chipped stone for the 10 site levels. The percentages of all types of chert in the Vore assemblage are very small. This fact suggests that the people who aggregated at Late Prehistoric bison kills knew that they would require sturdy tools in order to process the large quantities of bison that they would take at the jump site. Therefore, they chose a reliable tool-making material, Cloverly Quartzite, and ignored the highly maintainable Hartville Uplift Chert.

Another aspect of the lithics recovered from Agate Fossil Beds that seems to support the idea of people consciously choosing a maintainable material is the fact that a number of Hartville Uplift Chert bifaces have been found at the Monument. Kelly (1988b) suggests that people utilize bifaces when they operate in a highly variable environment. The biface can be used to create whatever tools are necessary as the human group moves across the landscape, encountering food resources that present themselves. The biface is ideal for this type of strategy because it minimizes carried weight while maximizing the potential number of edges that can be produced. A total of 18 bifacial preforms or "blanks" have been discovered by archaeological investigations at Agate Fossil Beds (Figure IV-5; also gives unifaces). Most of these bifaces (n = 11; or 61% of all bifaces) are made of Hartville Uplift Chert with fewer examples of Cloverly Quartzite bifacial blanks (n = 6; or 33.3% of all bifaces). Therefore, it appears that people moving through the western Niobrara region carried bifaces of both material types but utilized the maintainable material, Hartville Uplift Chert, in this area of unpredictable resources.

Comparison with Other Assemblages

How does the general Agate Fossil Beds NM assemblage compare with assemblages from other well-reported sites nearby? We looked at well-reported assemblages from both nearby and more distant sites, with surface and buried contexts and also single and multiple components. Considered here are chipped stone assemblages from the Ray

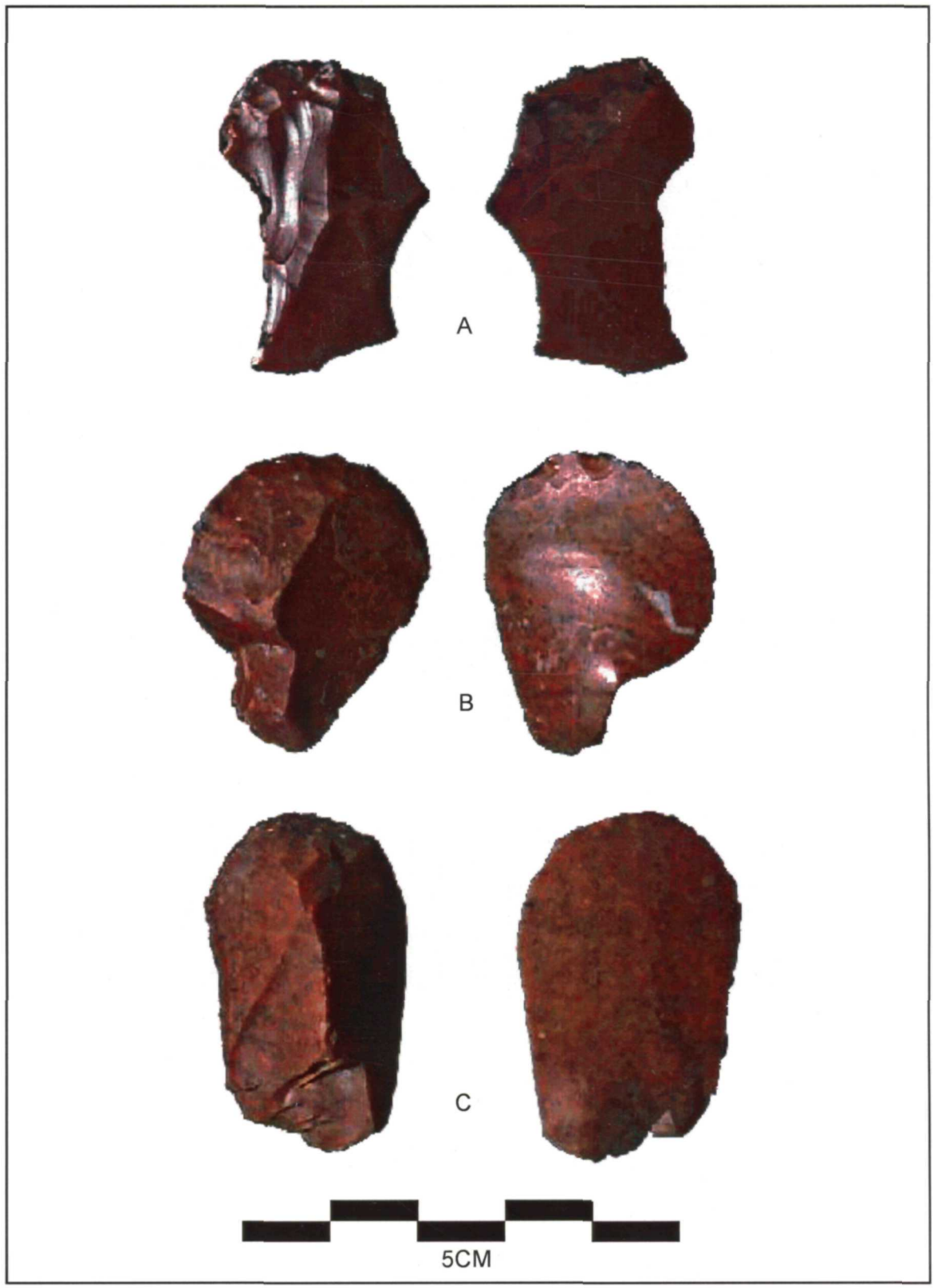


Figure IV-5a. Unifacial tools collected during the 1994-1995 field seasons at Agate Fossil Beds NM. A. AGFO 1994 25SX151 2-62; B. AGFO 1994 2-83; C. AGFO 1994 20-21.

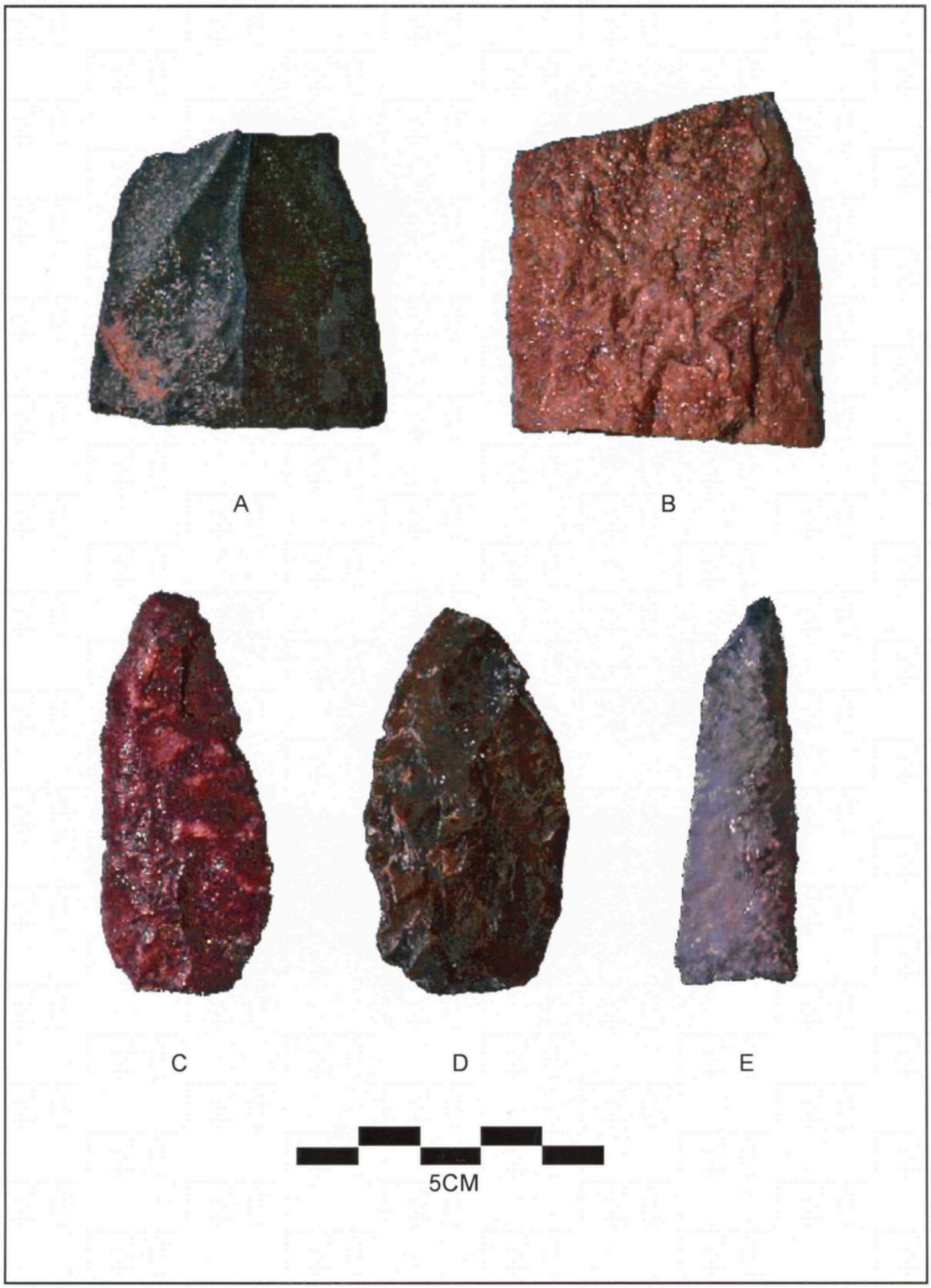


Figure IV-5b. Bifacial tools collected during the 1994-1995 field seasons at Agate Fossil Beds NM. A. AGFO 1994 3-112; B. AGFO 1994 6-209; C. AGFO 1994 25SX260 2-82; D. AGFO 1995 25SX253 1-6-23; E. AGFO 1994 25SX270 18-60.

Long site at Angostura Reservoir (an Angostura age site; Wheeler 1995), the Hudson-Meng site (an Alberta age site; Agenbroad 1978), the Harney site (a McKean age site; Wheeler 1995), and Late Prehistoric materials from the Slaughterhouse Creek site (a Coalescent tradition age site; Bozell and Ludwickson 1988) (Figure IV-6).

Ray Long Site

The Ray Long site (39FA65) is an Angostura age occupation site in the Angostura Reservoir region of South Dakota. The site is important because it contained a number of buried hearths as well as diagnostic projectile points. The site was excavated by the Missouri Basin Project in 1948 through 1950 and yielded a charcoal sample with an uncalibrated radiocarbon date of 9380 ± 500 (Wheeler 1995:440). Faunal remains were few and could not be identified. Lithic materials from components B and C of the Ray Long site are believed to be contemporaneous and will be used here to assess the lithic material type percentages.

The lithic materials present at this Paleoindian age site are overwhelmingly represented by fine-grained quartzite of a variety of colors. This material is Cloverly Quartzite from either Spanish Diggings quarry or a similar Cloverly lithic exposure that is located closer to the Angostura reservoir. Much smaller quantities of chalcedony, chert, jasper, and Moss Agate are also present in the assemblage (Figure IV-7).

Hudson-Meng

The Hudson-Meng site (25SX115) is an Alberta age bison bone bed located in Sioux County, Nebraska. It was originally excavated by Larry Agenbroad from 1968 to 1970 (Agenbroad 1978) and more recently has been examined by Larry Todd and David Rapson (Todd 1995). Deposits here are currently interpreted as representing a natural catastrophic death assemblage of about 600 bison with later occupations contributing faunal and chipped stone materials.

For our purposes here, we will rely on the lithic materials identified by Huckell (1978). The lithic debitage at Hudson-Meng consists primarily of a chert macroscopically identified as Knife River Flint. (A subsequently recovered projectile point was microscopically examined and determined to come from a chert source near Scenic, South Dakota [Larry Todd, personal communication 1996]; it is not clear if the material recovered by Agenbroad should be reassigned to this source as well.) Huckell (1978) also reported smaller quantities of Red Jasper, Brown Jasper, and much smaller quantities of quartzites and cherts. The projectile points recovered from the site also consist primarily of Knife River Flint with lesser quantities of quartzite and chert (Huckell 1978)(Figure IV-7).

Harney Site

The Harney site (39FA10) is a McKean age site (Middle Archaic Period) located in the Angostura Reservoir area of South Dakota (Wheeler 1995). The site consists of three components of chipped stone as well as a number of rock-filled hearths. Faunal remains were rare here, but two specimens were identified as *Bison bison*. The majority of the lithic material at this site consists of fine-grained quartzites, likely Cloverly Quartzite, with lesser quantities of cherts and chalcedonies (Figure IV-7).

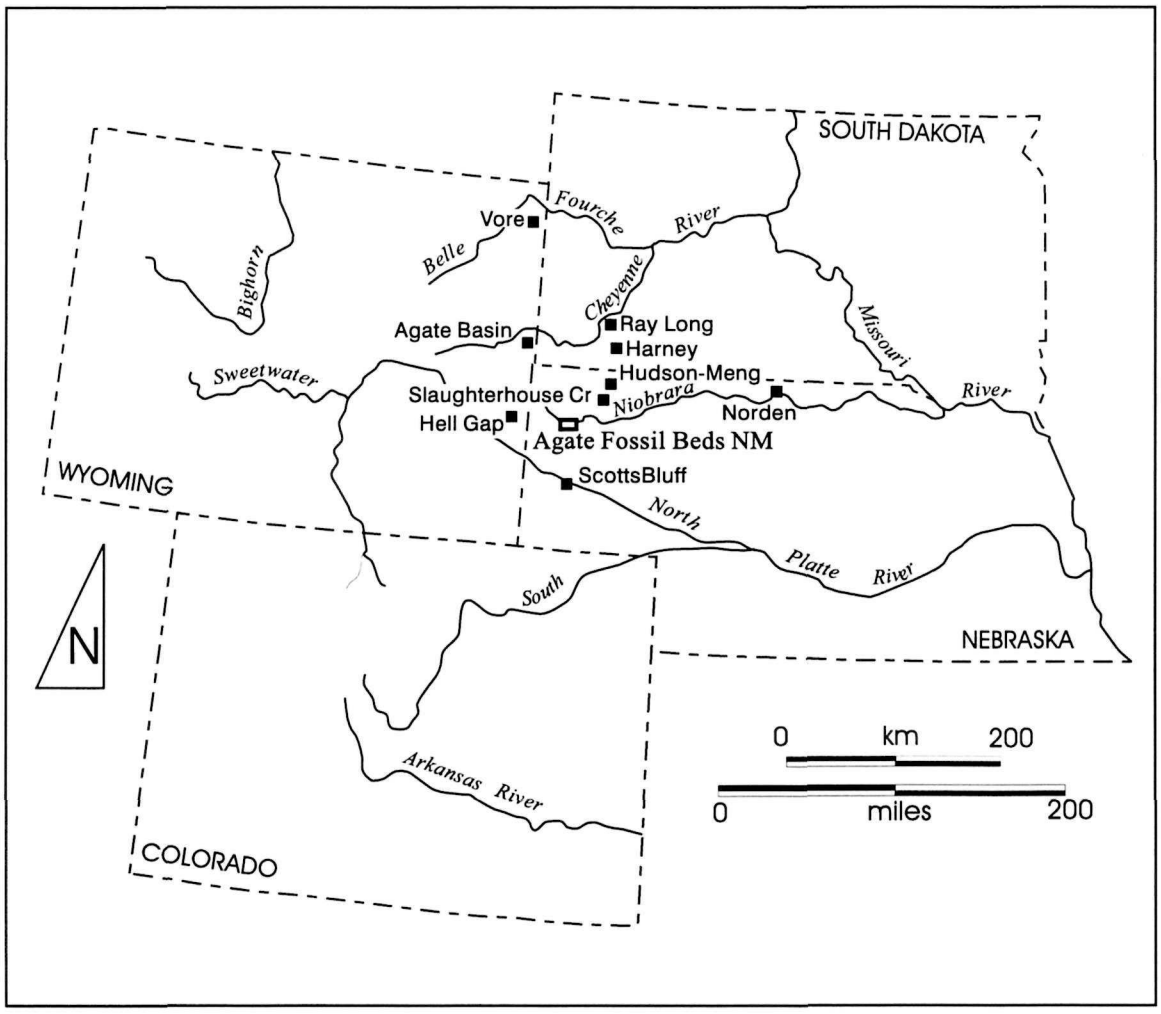


Figure IV-6. Prehistoric sites from which comparative chipped stone assemblages are derived.

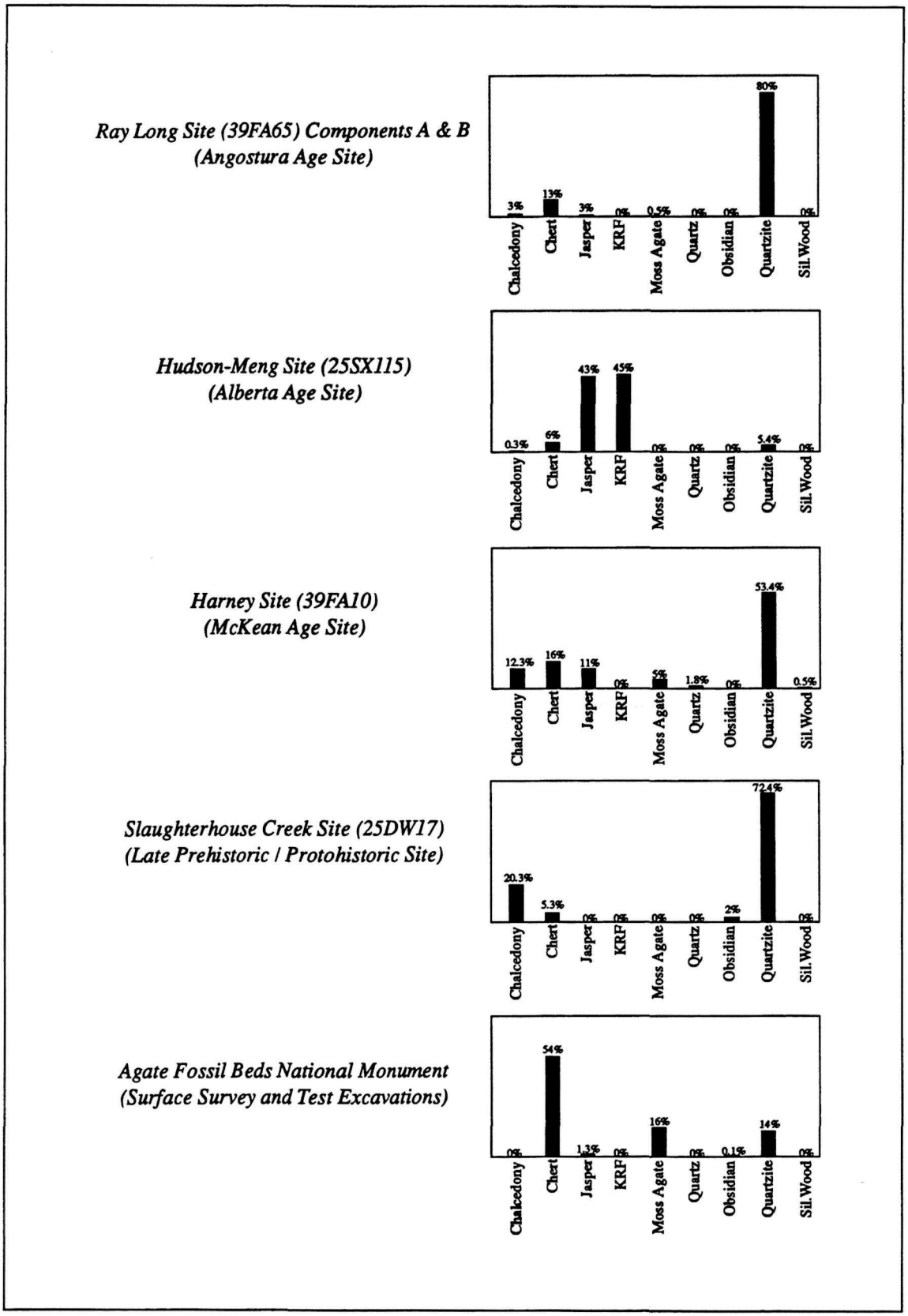


Figure IV-7. Lithic material type percentages (by frequency) at sites in the immediate vicinity of Agate Fossil Beds NM.

Slaughterhouse Creek

The Slaughterhouse Creek site (25DW17) is a single-component Late Prehistoric/Protohistoric hunting camp located near Crawford, Nebraska. The site contains chipped stone, pottery, bone, and charcoal. Researchers interpreted the site as representative of seasonal hunting and lithic acquisition.

The chipped stone recovered at the Slaughterhouse Creek site is over 72% Cloverly Quartzite with 20% chalcedony, and only 5% Hartville Uplift Chert. Additional lithic materials present include other types of chert and a small percentage of obsidian (Bozell and Ludwickson 1988) (Figure IV-7).

As is clear from this comparison, the high percentages of Hartville Uplift Chert found at Agate Fossil Beds NM are not present in any of the lithic assemblages from nearby archaeological sites. Several factors may be responsible for this pattern. One factor, already suggested above, is that most of the Agate Fossil Beds material was introduced by mobile hunter-gatherers with a versatile chert-based chipped stone technology designed to allow them to respond to a variety of resource opportunities. Such a technology may also have been in use by visitors to the Hudson-Meng site (hence the relatively high amounts of cherts present). Where bison processing occurred, heavier duty materials, like Cloverly Quartzite, were employed, as at Slaughterhouse Creek and perhaps also the Ray Long and Harney sites.

The Agate Fossil Beds lithic material type percentages are also unique when compared to the raw material profiles for other assemblages from within the region (Figure IV-8). Cultural deposits from Scotts Bluff NM, only 100 km (60 mi) south of Agate Fossil Beds, have a much different lithic material makeup (Griffin 1991). Scotts Bluff lithic scatters have a high percentage of Cloverly Quartzite with lesser percentages of Hartville Uplift Chert (CLQ = 57%, HUC = 7%). This stands in marked contrast to Agate Fossil Beds, which has high percentages of Hartville Uplift Chert and lesser quantities of Cloverly Quartzite (CLQ = 15%, HUC = 47%).

The bison kill sites in the region vary considerably in lithic percentages depending on age as well as location. The Agate Basin bison bone bed, a Paleoindian site in eastern Wyoming, contains primarily Knife River Flint (Reher and Frison 1980; Frison 1991; Frison and Stanford 1982). The Hawken site, an Altithermal bison kill, contains a wide variety of lithic materials including various cherts and quartzites, with no material dominating the assemblage. McKean age bison kills in the Northwestern Plains (Powder River, Powers-Yonkee, Buffalo Creek, and Kobold II) contain primarily Powder River Basin materials (Reher and Frison 1980). Late Prehistoric bison kills such as the Glenrock and Vore bison bone beds, are primarily dominated by Cloverly Quartzite with very small percentages of Hartville Uplift and other types of cherts (Reher and Frison 1980).

Sites farther east along the Niobrara river, such as those in the Norden study area near Valentine, Nebraska, have a completely different lithic makeup than Agate Fossil Beds NM. Lithics in the Norden area consist primarily of Bijou Hills Quartzite, Marsland Chert, and Silicified Wood with no significant occurrences of Hartville Uplift Chert or Cloverly Quartzite (Pepperl and Falk 1983). This major difference in lithic assemblages suggests that Agate Fossil Beds assemblages were associated more with the Northwest Plains of Wyoming

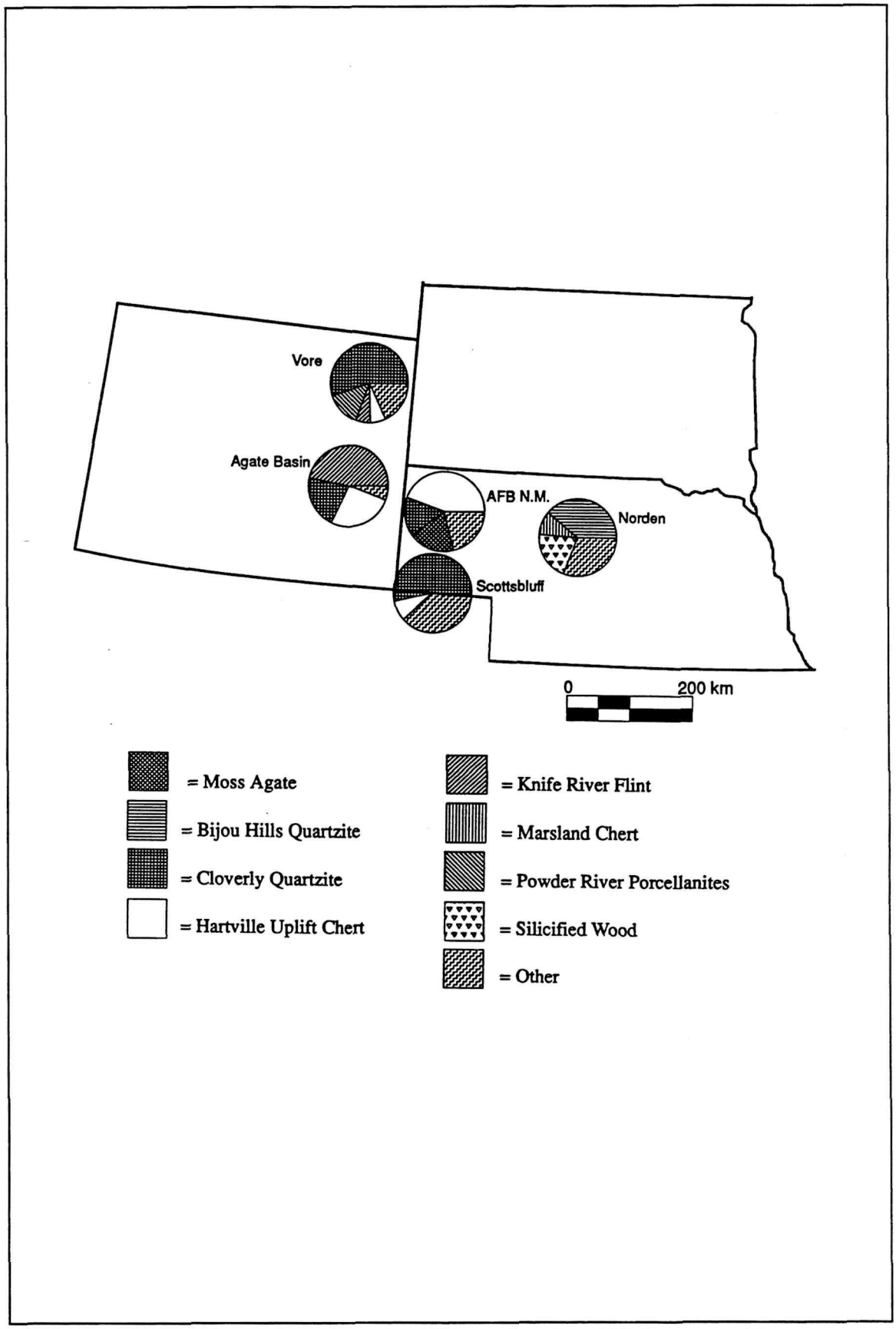


Figure IV-8. Lithic material percentages from other Great Plains assemblages.

rather than with the eastern Niobrara and Missouri River areas.

In sum, the gross chipped stone assemblage from Agate Fossil Beds NM is interesting for its relatively high proportions of Hartville Uplift Chert debitage and bifaces. From this finding, two observations follow. First, at least for some segment of prehistory, both Agate Fossil Beds and the Hartville Uplift Chert outcrops were found within the range of whatever groups are responsible for the deposits at the Monument. The distance between the Monument and this source is only 50 km (30 mi), well within the distances traveled annually by hunter-gatherers, as summarized by Kelly (1983).

Secondly, at the Monument, the use of Hartville Uplift Chert was emphasized over that of the Cloverly Quartzite, even though both materials were likely equally available at nearby locations. This fact, coupled with the emphasis on a biface technology, suggests that groups were gearing up for maximal tool-kit flexibility. While this tool kit may also have included quartzite components, it was the chert component that was brought into use at Agate Fossil Beds NM. A corollary to this observation is that the need for heavy-duty materials was not often felt at Agate Fossil Beds NM (but, see Chapter V for a discussion on this point), perhaps because small- to moderate-sized animals, rather than bison, for example, were the prey commonly taken here.

Change in Lithic Material Use over Time

Reher and Frison (1980) and Ingbar (1985) have noted a change in chipped stone material type frequency through time, which they relate to changes in group range and the degree of participation in social networks within which trade might occur. It is useful to examine the Agate Fossil Beds chipped stone assemblage to see if a similar change over time is present here.

To approach this issue, it is important to acknowledge the poor quality of temporal control we have for most of the surface deposits from Agate Fossil Beds. Moreover, the test units excavated here have revealed that there is little stratigraphy within the Monument sediments. And, archaeological deposits appear mixed because of rodent activity and, in some places, erosion. Chipped stone projectile point types, however, provide a gross measure of temporal control. Here, we have used them to consider changes in chipped stone material use.

A total of 16 projectile points have been found by researchers working at Agate Fossil Beds NM (Figure IV-9, for projectile points recovered during the 1994 and 1995 seasons). These tools range in age from Paleoindian to Plains Village time periods (Table IV-2). It is important to emphasize that this is a very small sample size and that additional temporal control, perhaps using techniques designed for extracting chronological information from surface deposits (see Beck 1994), is highly desirable. Nevertheless, several patterns deserve mention.

The oldest stone tool found in the Monument is the midsection of a Cody age projectile point (Cody/Eden) located by excavations during the 1995 field season. This point is made of an unidentifiable dark gray banded material (UN3). During the 1994 and 1995 Agate Fossil Beds investigations, only two pieces of this chipped stone material were found.

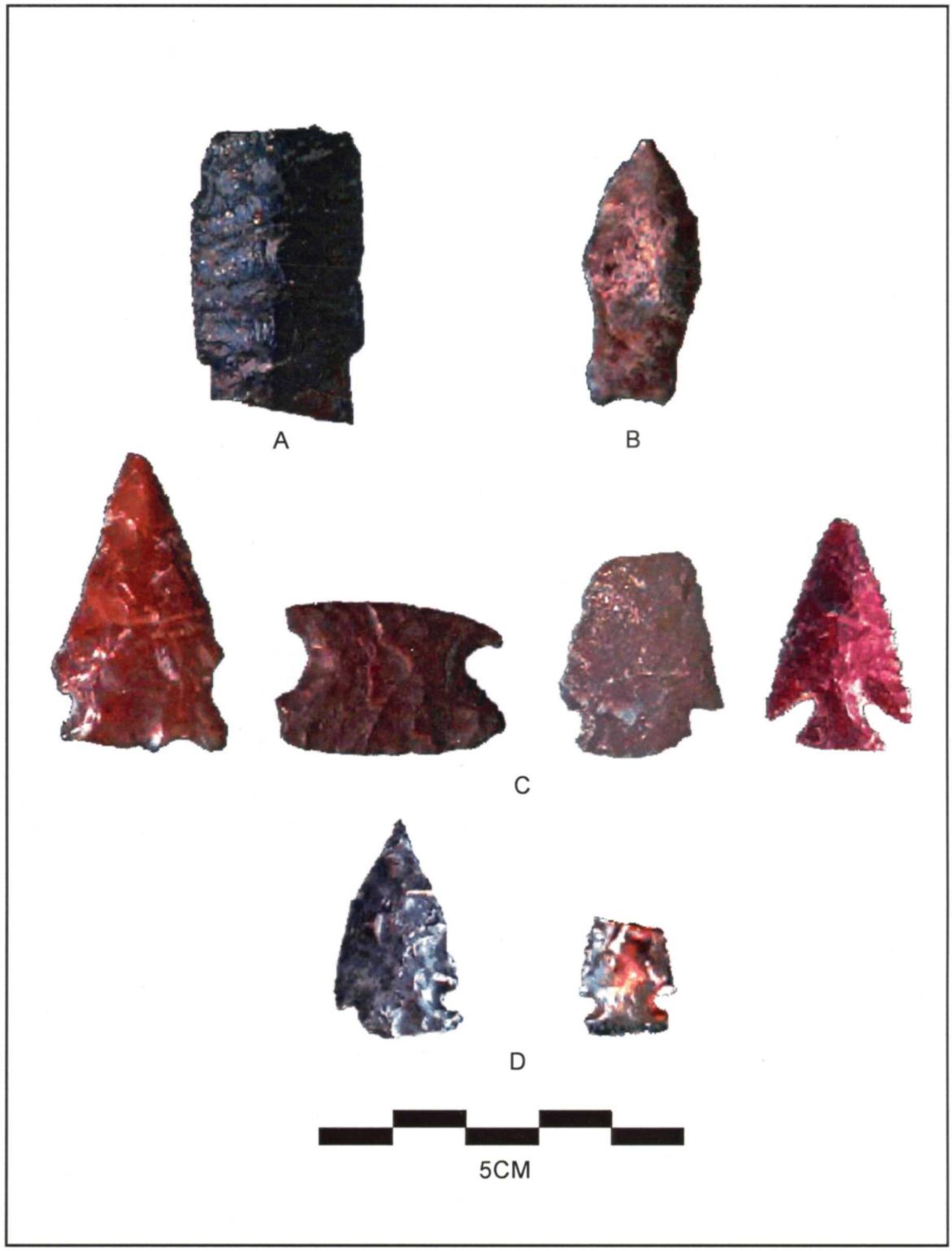


Figure IV-9 Projectile points collected during the 1994-1995 seasons at Agate Fossil Beds NM. A. Eden/Cody point (AGFO 1995 25SX152 2); B. McKean point (AGFO 1994 25SX251 1-16); C. Corner-notch Late Archaic/Late Prehistoric points (AGFO 1994 25SX253 3-105, AGFO 1994 3-111, AGFO 1994 2-202, AGFO 1994 2-107); D. Side-notch Late Prehistoric/Protohistoric points (AGFO 1995 25SX152 3, AGFO 1995 25SX152 3-3-51.

Table IV-2. Summary of Agate Fossil Bed NM projectile points, by type and material type.

Time Period	Projectile Point Types	Lithic Materials	Site	Reference
Paleoindian	Cody/Eden	UN3	25SX152-0-0-3	
			25SX157	Clark 1994
Early Archaic				
Middle Archaic	McKean	WRS	94-1-16 (25SX251)	
			25SX498	Clark 1993
Late Archaic and Late Prehistoric	Corner Notched	HUC	94-3-111 (IF)	
			94-3-105 (25SX253)	
		CLQ	94-2-107 (IF)	
	Besant?		94-2-202 (IF)	
	Avonlea?	AGT	25SX157	Clark 1993
	Pelican Lake?		25SX469	
			25SX459	
			25SX157	Clark 1994
			25SX157	
			25SX163	Olinger 1980
Terminal Late Prehistoric/ Protohistoric	Small Side Notched	AGT	25SX152-3-3-51	
		CLQ	25SX152-0-0-2	
		Reworked UN3	25SX479	Clark 1993

The next oldest projectile points found in the Monument are McKean or Middle Archaic in age. Two McKean projectile points have been found at Agate Fossil Beds, one during the 1994 field season and one recorded by Clark (1993). Both of these tools were made from the same White River Group silicate material. This lithic material is light tan and white in color.

The next group of projectile points are believed to be Late Archaic and Late Prehistoric in age. This group consists of corner-notched points that are over 3 cm in length. This group makes up the largest part of the projectile point assemblage with 10 tools. Four of these points were collected during the 1994 field season, five were recorded by Clark (1993; 1994), and one by Olinger (1980). Of the Late Archaic and Late Prehistoric projectile points found at Agate Fossil Beds, seven of them are made of Hartville Uplift Chert, two of Cloverly Quartzite, and one of the locally available Moss Agate.

The final group of artifacts consists of small side-notched projectile points. These tools are believed to be Plains Village or Historic in age. There are three

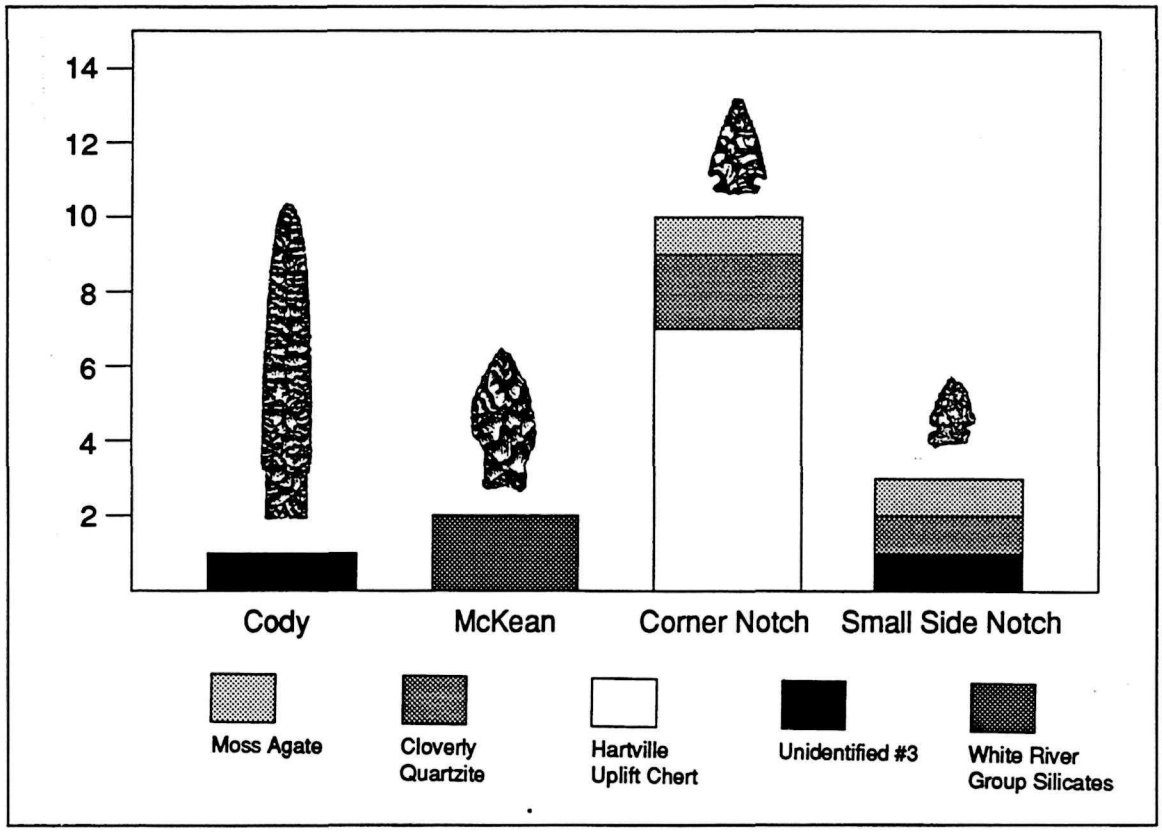


Figure IV-10. Agate Fossil Beds NM projectile point frequency by lithic material.

projectile points in this category; two collected during the 1995 Agate Fossil Beds investigations and one recorded by Clark (1993). One of these tools is made of the local Moss Agate, one of Cloverly Quartzite, and one appears to be a reworked portion of the Paleoindian point made of Unidentified #3 material (UN3).

By grouping the Agate Fossil Beds projectile points by time period and examining their lithic material type, it appears that there is a distinct change in the lithic materials used over time (Figure IV-10). An unidentified exotic lithic material appears to have been brought from a great distance during Paleoindian times. During the Middle Archaic, McKean projectile points, made of a White River Group Silicate material from a source 90 to 100 km (50 to 60 mi) away, were introduced. The Late Archaic and Late Prehistoric tools are represented by Hartville Uplift Chert and Cloverly Quartzite, both of which have a primary source area approximately 50 km (30 mi) west of the Monument. The Plains Village/Historic component of the projectile point assemblage appears to consist of locally available lithic material as well as reworked stone from local lithic scatters. This would be consistent with the interpretation that the range size of the groups utilizing the western Niobrara was continually decreasing throughout prehistory (Figure IV-11), moving from distant and exotic materials to local and even scavenged lithic debris.

This interpretation of shrinking range sizes over time is dependent on the ability of projectile points to accurately represent the use of various material types over time. In order to investigate the relationship between projectile points and other debris of the same material types,

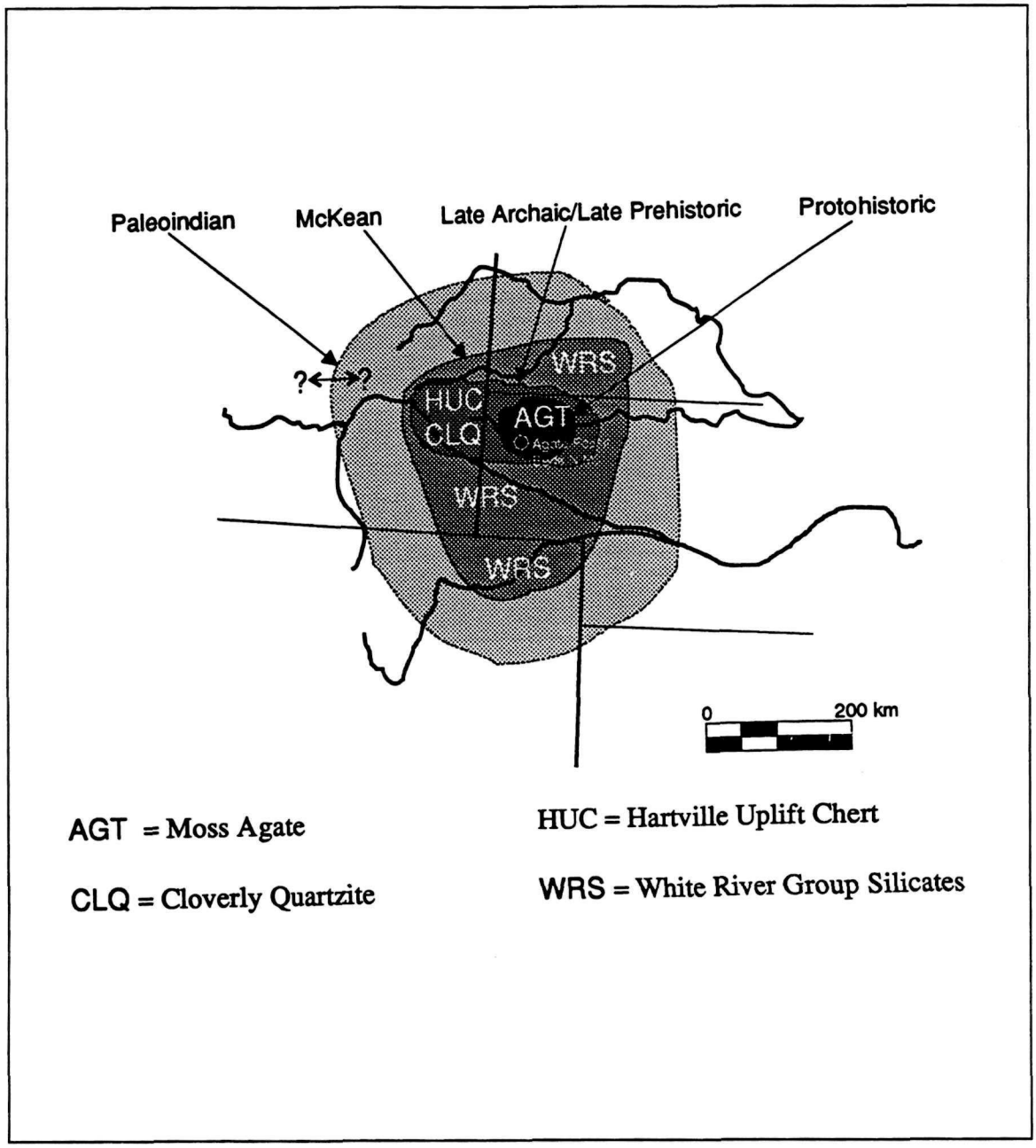


Figure IV-11. Speculative model describing range size change through time as inferred from Agate Fossil Beds NM chipped stone assemblage.

the tool to debitage ratio was calculated for each of the lithic materials represented. This relationship should aid in understanding the degree to which core materials were curated and reduced. Locally available materials should have higher frequencies of both debitage and tools.

There is a clear trend in the ratio of tools to debitage for all but two of the material types in the Agate Fossil Beds lithic assemblage from 1994 and 1995 (Figure IV-12). The only two materials that do not conform to this linear relationship are UN3 and Moss Agate, which deviate in expected ways. The UN3 group consists

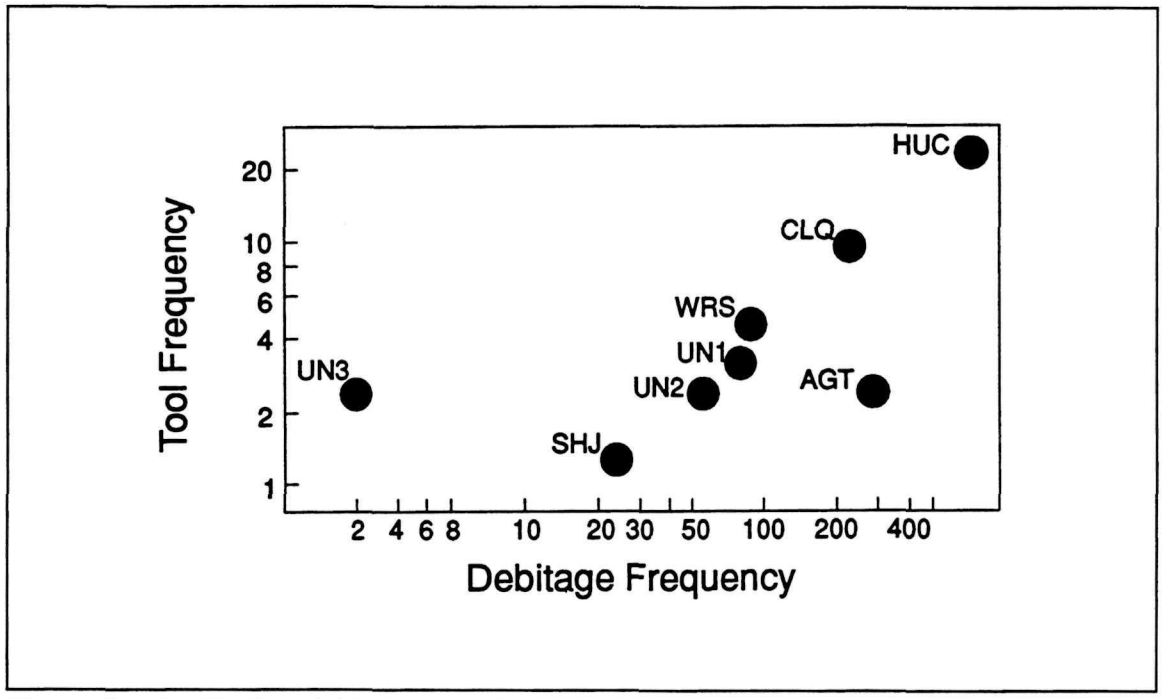


Figure IV-12. Tool-to-debitage ratio for all lithic materials recovered from Agate Fossil Beds NM.

of only two pieces of chipped stone, both of which are tools, the highly curated Paleoindian point and the reworked section of that same point into a side notched projectile. This circumstance gives the UN3 group an unusually high ratio of tools to debitage. The Moss Agate material type has a low ratio of tools to debitage. This is expected because the Moss Agate is locally available at Agate Fossil Beds and some of the lithics identified as debris may actually be naturally fractured rock.

The regular relationship between tools and debitage for most lithic materials recovered here is odd for it suggests a very stable relationship between a number of different parts of the lithic use and discard system. For example, it appears that prehistoric people relied on similar modes of core and tool curation no matter the material and that the relationship between tool refurbishment and discard was stable for all but the two deviating materials.

If this stability is indeed the case (and we can think of no independent means to test this proposition), then several interesting observations follow. For one, as already noted, it appears that visitors along the western Niobrara River also were frequent visitors to the primary Hartville Uplift Chert area. Moreover, considering trends in projectile point material type, we can speculate that much of the Hartville Uplift Chert was brought into the Agate Fossil Beds area during the Late Archaic to Late Prehistoric time period.

CONCLUSION: HUNTER-GATHERER USE OF THE WESTERN NIOBRARA

On the basis of the preceding analysis, we can say a great deal about the past peoples who utilized the area that is now Agate Fossil Beds NM and also comment on ideas proposed by other High Plains researchers.

1. The diagnostic tools that have been recovered in the Monument indicate

that people have utilized the area from Archaic to historic times, and perhaps as early as the Paleoindian time period. It is interesting that evidence for mammoth utilization is not present here, given the apparent presence of mammoth habitat elsewhere on the High Plains (e.g., Lange-Ferguson [Hannus 1990] and Hot Springs [Agenbroad 1990]).

2. Projectile point frequencies suggest an increased utilization of the area during the Late Archaic and Late Prehistoric time periods. The relative abundance of these projectile points is especially notable given trends seen elsewhere on the Northwest Plains. For the Green River Basin, for example, Larralde (1990) reports relatively high frequencies of Late Prehistoric/ Protohistoric projectile points thought to have functioned as arrow points compared with earlier dart points. She interprets this trend in terms of increased curation and reuse of dart points compared with more fragile arrow points. As well, the time periods during which each of these Late Archaic/Late Prehistoric and also Late Prehistoric/Protohistoric projectile points were manufactured is roughly the same, i.e., about 1300 years. Thus, assuming that more recent projectile points have not been subjected to heavier collecting than other projectile points, the assemblage at Agate Fossil Beds NM appears especially rich with Late Archaic/Late Prehistoric projectile points, suggesting heavier hunting rates at this time.

3. Ingbar (1985), Reher (1985), and Reher and Frison (1980) all have recognized a continuing decrease in range size, perhaps due to population packing, from Paleoindian through Middle Archaic times. During the Late Prehistoric and Proto-historic, groups may have had restricted territories but through social networks, had developed access to distant sources of chipped stone, such as obsidian (see Vehik and Baugh 1994). At Agate Fossil Beds NM, although our temporal control is less than optimal, the chipped stone material assemblage supports this interpretation.

4. The physical qualities of the chipped stone material and the discovery of a number of bifacial blanks indicate that during the Late Archaic and Late Prehistoric time periods the hunter-gatherers of the western Niobrara were dependent on maintainable tools made of Hartville Uplift Chert that could be adapted for use in an unpredictable environment. The finding contrasts with that from various bison kill sites, where there is a higher use of Cloverly Quartzite, likely because it is a more reliable material (Reher and Frison 1980). Sturdy tools would have been necessary at large communal kills where a great deal of meat processing would be performed. Activities at these kill sites could easily be anticipated and therefore there would be ample opportunity to fashion sturdy tools out of a reliable lithic material such as Cloverly Quartzite.

Agate Fossil Beds NM, thus, functioned as a place with qualities different from other places on the Plains. It appears to have been visited by mobile people ready to take advantage of a variety of resource options, hence their chert-based, biface technology. Among these resource options, bison appear not to have featured greatly, as suggested by the relatively low amounts of Cloverly

Quartzite. Some bison bone has been found in buried contexts, however (see Appendix D; Clark 1993, 1994), indicating that bison and bison hunting were not foreign to this area.

Assuming that lithic material acquisition was embedded in the annual circuit and that our interpretation of Monument HUC and CLQ as derived from the primary source area 50 km away is correct, then we can estimate a minimum range of around 2500 km^2 (900 mi^2) for Late Archaic/Late Prehistoric High Plains hunter-gatherers. Whether this entire area was actually recognized as the specific territory of a group, however, can not be definitively stated. That lithic material profiles for other High Plains sites appear so distinctive, however, suggests that this is the case.

This investigation of the chipped stone assemblage from Agate Fossil Beds NM is far from exhaustive. There are a number of avenues that may be pursued for further insight into past human adaptation. For one, the lithic materials in the Cook collection hold high potential for investigation. Additionally, knowledge of paleoenvironmental data along the western Niobrara is extremely lacking. By contrasting changes in the environment over time with changes in lithic materials utilized and group range size, it may be possible to make more detailed interpretations regarding past mobility strategies. Therefore, more environmental data for this region is essential for more accurate interpretations of past activity.

CHAPTER V
PAST USE OF THE WESTERN NIOBRARA: CHIPPED STONE INTERASSEMBLAGE VARIATION AT AGATE FOSSIL BEDS NM

LuAnn Wandsnider and George H. MacDonell

INTRODUCTION

In the last chapter, we considered the chipped stone assemblage recovered in 1994 and 1995 and interpreted it in terms of gross patterns of use of the Monument by northern High Plains hunter-gatherers. In this chapter, we explore the variation seen between and among the site assemblages (and also the assemblage comprised of all isolated chipped stone). Our objective here is provide information that will assist in determining the eligibility of these sites for the National Register of Historic Places (see Chapter VI) and to advance tentative interpretations of the past use of this area, to which future research may speak.

INTERASSEMBLAGE ANALYSIS

Twenty-eight surface assemblages, defined as discussed in Chapter III and including the IF assemblage, are considered here. At any one site, it is likely that the chipped stone from the surface better represents the overall assemblage, than does the subsurface chipped stone, which may be from an individual depositional event. On the other hand, based on the projections made in Chapter III, the surface assemblages may represent only 0.3% sample of the total assemblage. For the purposes of this discussion, we assume that we are dealing with a random sample of this total assemblage and confine the analysis to the surface assemblages. In addition, we rely on frequency counts of chipped stone rather than chipped stone weight. Analyses presented in the previous chapter indicate that the two measures give redundant information; therefore, only the former is used. Finally, this analysis relies on the graphical display of assemblages with respect to several indices and to each other. Other analyses of this sort often rely on multivariate dimension reduction algorithms (e.g., factor analysis) to search for patterning. In the experience of one of us (LAW), such algorithms assume that the variation inherent to a set of data is monotonic and without steps. In fact, most archaeological data is ill behaved in this regard, and graphical analysis allows for patterns in assemblage variation to be better identified.

It is important to emphasize that these assemblages are not all equal. Some, like 25SX152, are undoubtedly palimpsest deposits, owed to many different occupation events that happened over a span of thousands of years. Others, like those on the ridges and slopes, have been differentially transported and eroded. In others, the sampling bias of rodents, discussed in Chapter II, may be more important. A complete analysis of these assemblages would consider these important factors, but, in the discussion that follows, they will be set aside.

This analysis seeks to identify some of the sources of variation responsible for the composition of these chipped stone assemblages. Obviously, many diverse processes, including technological decisions, demographic factors, occupation length, and so forth, are responsible for this variation (Chatters 1987; Nelson 1991). The focus here is on four interrelated dimensions.

Expedient vs. Curated Use of Core Material

The local Moss Agate (AGT) appears to be a low-quality chert occurring at several locations within the Monument. It has many inclusions, and the typical package in which it occurs is small and irregularly shaped. Conversely, cherts exotic to the Monument, principally HUC and WRS, appear to be imported to the Monument in a reduced form, as discussed in the analysis of cortex for these materials (Chapter IV). Thus, those assemblages with high amounts of AGT may represent the situational use of this resource when other materials were exhausted or to be conserved. This material may have been reduced before transporting, with the consequence that large amounts of debitage may be found in some assemblages.

Heavy- And Light-duty Activities

Kelly (1988a) highlights the differential durability and sharpness of obsidian, chert, and quartzite materials in general. He notes, that edges made of quartzite, for example, are more durable than those of obsidian, while obsidian edges are sharper than quartzite edges. Chert appears to hold edges that are both durable (but not as durable as quartzite) and sharp (but not as sharp as obsidian).

In an analysis of Archaic and Late Prehistoric chipped stone assemblages from throughout the intermountain basins of southwestern Wyoming, Wandsnider (1991) found recurrent covariation in quartzite and chert debitage that appeared related to the differential function of materials with different qualities of durability and sharpness. The lithic landscape in this area includes terrace cobbles of both chert and quartzite so, the difference in chipped stone composition appeared to be owed to deliberate selection and use. In these assemblages, chert debitage frequency varied greatly but quartzite debitage frequency did not. In interior basin assemblages, as chert debitage increased in frequency, so did fire-cracked rock (FCR) frequency, suggesting that both were tied to the same processing activities or to occupation length; quartzite debitage did not co-vary with FCR or chert. In this situation, she suggested that the different frequencies of chert and quartzite debitage relative to fire-cracked rock was owed to the relative frequency with which heavy-duty tasks (such as shelter construction, large animal butchery) vs. light-duty tasks (collecting and processing plant foods) occurred. In what follows, we also consider the relative frequencies of chert and quartzite in these terms.

Energy Density

Related to the latter, other work has considered the character of assemblages as it relates to energy density (Kneebone 1990; Wandsnider 1996), a composite measure of occupation length and number of resident individuals (Schiffer 1987). Yellen (1977), for example, observed that, all other things being equal, more diverse assemblages are created as the number of different kinds of events occurring at a location increases. In turn, the number of different events may be owed to the length of time a group spent at the location or to the

number of individuals in residence there.

Of course, the diversity of an assemblage may be related to its size (Jones et al. 1983), but, as Camilli (1988) and Osborn (1995) have demonstrated, this relationship is neither necessary nor uniform. Indeed, departures from this expected relationship between assemblage size and diversity signal important information about how the associated location was used. In this analysis, we will consider a simple measure of material diversity, the number of different material types present in an assemblage, to indicate a minimum number of reduction events.

In addition, given the quartzite-chert covariation reported for SW Wyoming, we might expect also that assemblages from short-term domestic occupations would have chipped stone assemblages that are in general sparse, but, with relatively high incidences of quartzite compared with chert. As occupation length increases, cherts would be added and may come to dominate the assemblage.

Scale of the Lithic Universe

The analysis of the projectile-point and chipped stone assemblage in the preceding chapter (see also Hughes' geochemical analysis of the obsidian in Appendix C) suggests that the lithic universe sampled by occupants of the western Niobrara changed dramatically through time. Early on, materials from unknown and perhaps distant sources are found. More recently, exotic materials, including obsidian from Idaho and New Mexico, were in circulation. Intermediate between these two times, materials from eastern Wyoming are found.

Most researchers assume that during Paleoindian times, chipped stone materials were moved from distant sources by their procurers and producers, and that the distance between material source and find is an indicator of the scale of Paleoindian mobility (Hoffman 1991; Tankersley 1991). During more recent time periods, trading systems are argued to be responsible for the appearance of exotic materials throughout the Plains (Vehik and Baugh 1994). Trading systems of continental scale (but undetermined organization) were in place by the end of the Archaic, but it is unclear if pedestrian materials such as Hartville Uplift Chert or Cloverly Quartzite participated in this trading system. In any event, by considering the assemblage material types, we are in a position to monitor the scale of the lithic landscape sampled by individuals who created these assemblages.

In the following, we consider the chipped stone assemblages with respect to these several dimensions of variation. The values employed in the following analysis are given in Table III-3 and include proportions of local cherts, exotic cherts, quartzites, and other exotic materials. Also used is the tool to debitage ratio, the flake to angular debris ratio, and a material diversity index. This analysis does not make use of information on chipped stone reduction since the analysis presented in the preceding chapter revealed little variation in this area.

Expedient vs. Curated Core Material

Figure V-1 graphs the AGFO chipped stone assemblages according to their respective proportions of exotic chert (HUC, SHJ, and WRS) and quartzite. Two distinct clusters are seen. One cluster includes those assemblages trending along an inverse diagonal, and the other includes those with both low amounts of quartzite and exotic cherts. The latter group of assemblages (25SX255,

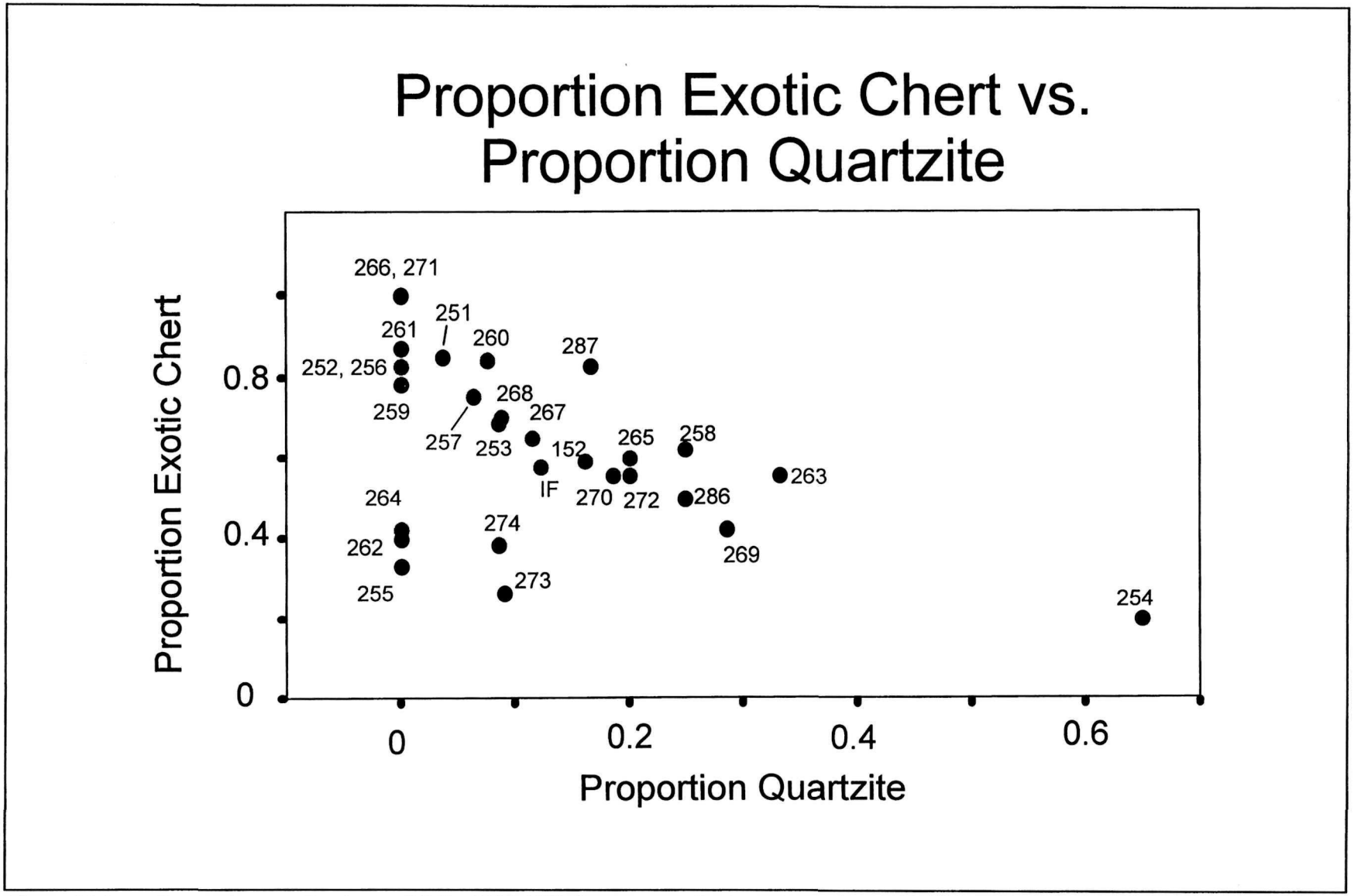


Figure V-1. Proportion exotic cherts (HUC, SHJ, WRS) vs. quartzite (number refers to site number, i.e., 25SX___).

25SX262, 25SX264, 25SX273, and 25SX274) are dominated by AGT. The distinct break between these two clusters is owed to the fact that the latter assemblages are made up of 40 to 50% AGT and 30 to 40% exotic chert, with low (or no) amounts of quartzite. It should be noted as well that except for 25SX274, the assemblage sizes are fairly small, i.e., less than 11 artifacts. (25SX262 was designated on the basis of a large number of small flakes documented on an ant hill.)

The exotic cherts were brought into the Monument as partially reduced bifaces, while the local AGT was reduced at in the Monument, as indicated by the flake to angular debris ratio (see also Chapter IV). Sites with high proportions of AGT also have very low flake to angular debris ratios, and the converse is also true ($r = -0.39$, $p = 0.04$).

As Map V-1 shows, the sites at which relatively high frequencies AGT occur are found in the western portion of the Monument, where sources likely occur.

Heavy- vs. Light-Duty Activities

In Figure V-2, the proportion of the assemblage comprised by quartzite is considered. Several trends are evident here. First, there is a group of 10 sites with low or no quartzite, including 25SX251, 25SX252, 25SX255, 25SX256, 25SX259, 25SX261, 25SX262 (represented by ant hill flakes), 25SX264, 25SX266, and 25SX271. In addition, there is another group of sites for which small assemblages have high proportions of quartzite and larger assemblages high proportions of other materials.

Site 25SX152 is an outlier of this latter group. It has a very large assemblage size (n=366) but only moderate amounts of quartzite. This finding is consistent with an interpretation that 25SX152 was used on a number of occasions for short-term light-duty activities. Alternatively, this area may have been used frequently during the Late Archaic or early Late Prehistoric, when we suggest (Chapter IV) materials from eastern Wyoming were predominantly deposited.

The Isolated Find chipped stone assemblage also appears as an outlier of this latter group, which is to be expected. Isolated flakes or angular debris may represent very short-term tool refurbishment or knapping episodes, rather than extended domestic activity, and so the fact that relatively high quantities of chert dominate this assemblage is not unexpected. Other analyses of isolated chipped stone have shown that these artifacts are usually tools and tend to be made of high-quality cherts or obsidian (Wandsnider 1988).

Finally, 25SX254 appears as an anomaly with very high amounts of quartzite present. This site may be owed to a retooling or another unknown event. An analysis of interassemblage variation cannot deal well with anomalies of this sort, except to note that they exist.

Energy Density

As discussed above, two indicators of energy density have been used by chipped stone analysts. Material diversity is one measure and is graphed against assemblage size in Figure III-3. Three patterns are apparent here. First, the log-linear relationship between frequency and material diversity described by Jones and colleagues (1983) and others is evident in these data: small assemblages are composed of just a couple of material types; in large assemblages, six different materials are present. Both the large assemblage size and high diversity value may reflect more knapping events, which

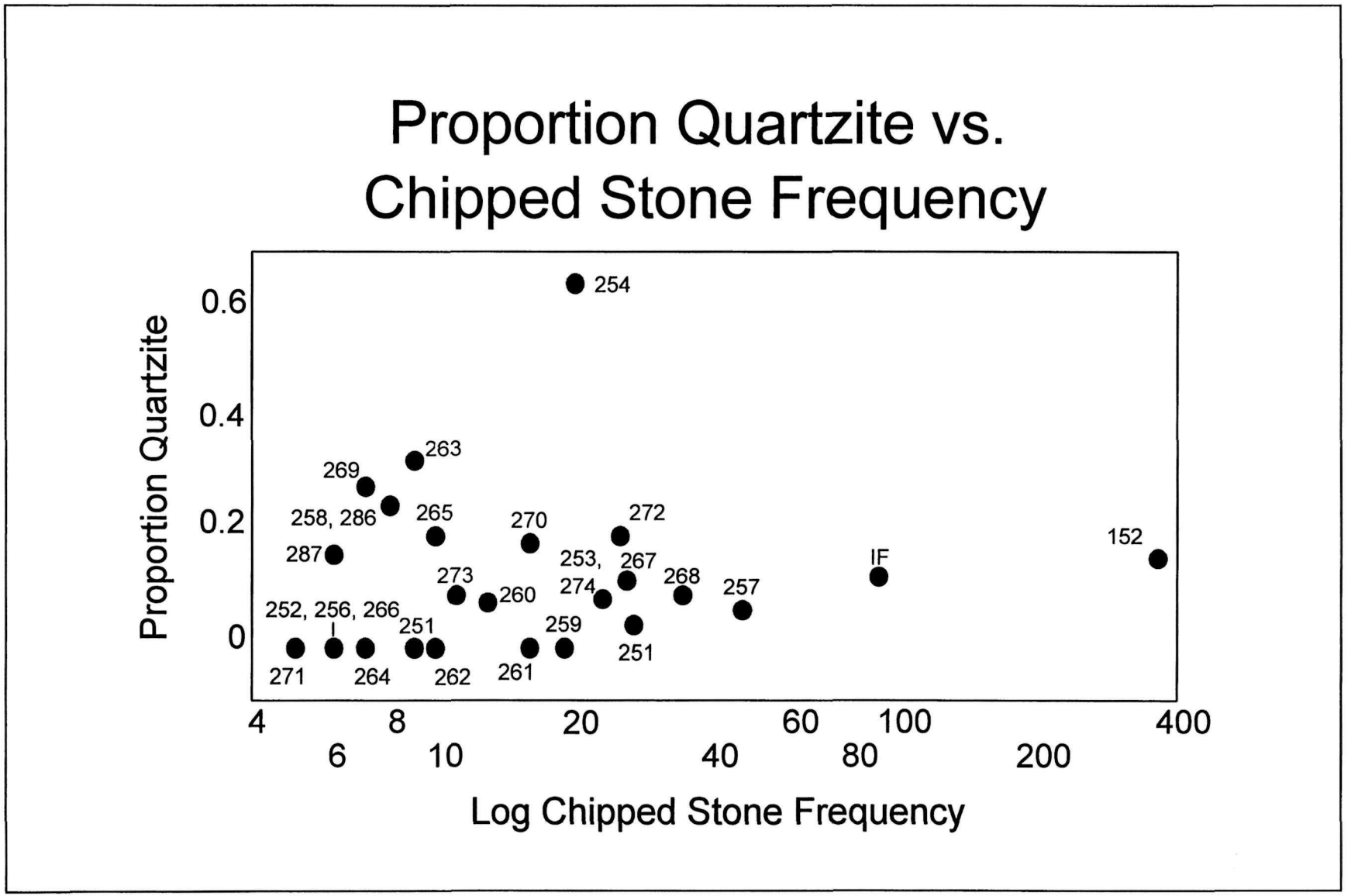


Figure V-2. Proportion of assemblage quartzite vs. total assemblage frequency (number refers to site number, i.e., 25SX___).

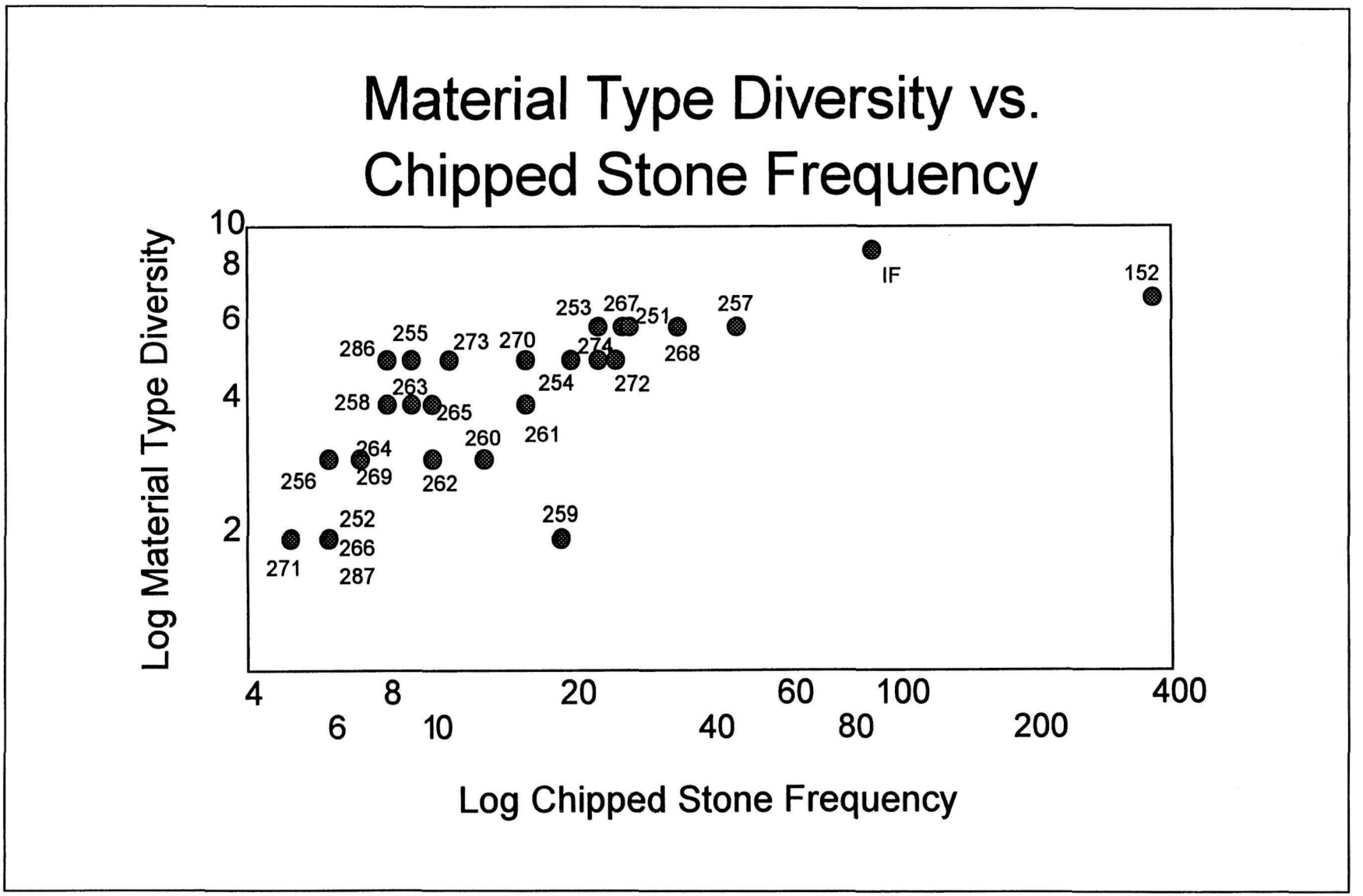


Figure V-3. Total assemblage frequency vs. material diversity (number refers to site number, i.e., 25SX___).

may have occurred during the extended occupation of these locations. Alternatively, more knappers knapping may be responsible. The Isolated Find assemblage, with a diversity of 9 and an assemblage size of 89, further reflects the expected relationship.

There are two clusters of sites that depart from this expected relationship, however. Sites 25SX152 and 25SX259 have, relative to their assemblage size, low material diversity. In the case of 25SX152, this finding is consistent with other results reported above, which suggest that it was the site of repeated shorter-term occupation events, rather than one or a few extended events. 25SX259 may represent a similar situation.

Finally, six sites have higher than expected material diversity. 25SX255, 25SX258, 25SX263, 25SX265, 25SX273, and 25SX286 may have been created through the actions of a task group engaged in tool refurbishment, wherein the edges of curated tools (made from a variety of materials) were sharpened. Alternatively, these sites may be from the Late Prehistoric or Proto-historic occupation of the Monument, when exotic materials appear to have been in circulation.

In addition to material diversity, the relationship between quartzite and the total chipped stone assemblage was suggested as sensitive to domestic energy density. In Figure V-2, several sites (25SX263, 25SX269, 25SX287) are indicated as having small assemblage sizes, but high proportions of quartzite. Heavy-duty activities accompanied by few light-duty activities may have occurred here. For example, perhaps shelters were erected or bison butchery was undertaken here. In contrast, sites 25SX251, 25SX253, 25SX257, and 25SX268, with moderate assemblage sizes and lower proportions of quartzite, may have seen a relatively higher proportion of light-duty tasks, compared with heavy-duty tasks. That a range of activities and energy densities (either shorter or longer occupation lengths and/or smaller or larger group sizes) may be represented here is indicated by the distribution between these two extremes.

Moreover, Figure V-2 seems to show two or three linear relationships of the type just described. It is unclear whether these apparently different tendencies are an artifact of using percentages to describe the assemblage, thereby constraining the values of the various indices.

Scale of the Lithic Universe

The final aspect of interassemblage variation to be considered here is that part involving other exotic material types. Materials not originating in the Monument and not coming from eastern Wyoming, that is, the materials for which sources have not been identified (UN1, UN2, and UN3) as well as obsidian, appear to be associated with very early and very late events in the Monument (see preceding chapter). Let us consider the composition of assemblages with these exotic materials.

Figure V-4 graphs assemblages in terms of their overall proportions of chert and quartzite. When these two values do not add up to 1, the difference represents the proportion of exotic materials occurring in the assemblage. Several patterns are evident. The previously discussed pattern, i.e., the inverse relationship between chert and quartzite materials, is evident as is the cluster of sites first described in Map V-1, with no quartzite in their respective assemblages. 25SX255 appears as an obvious outlier with no quartzite and less than 50% of the

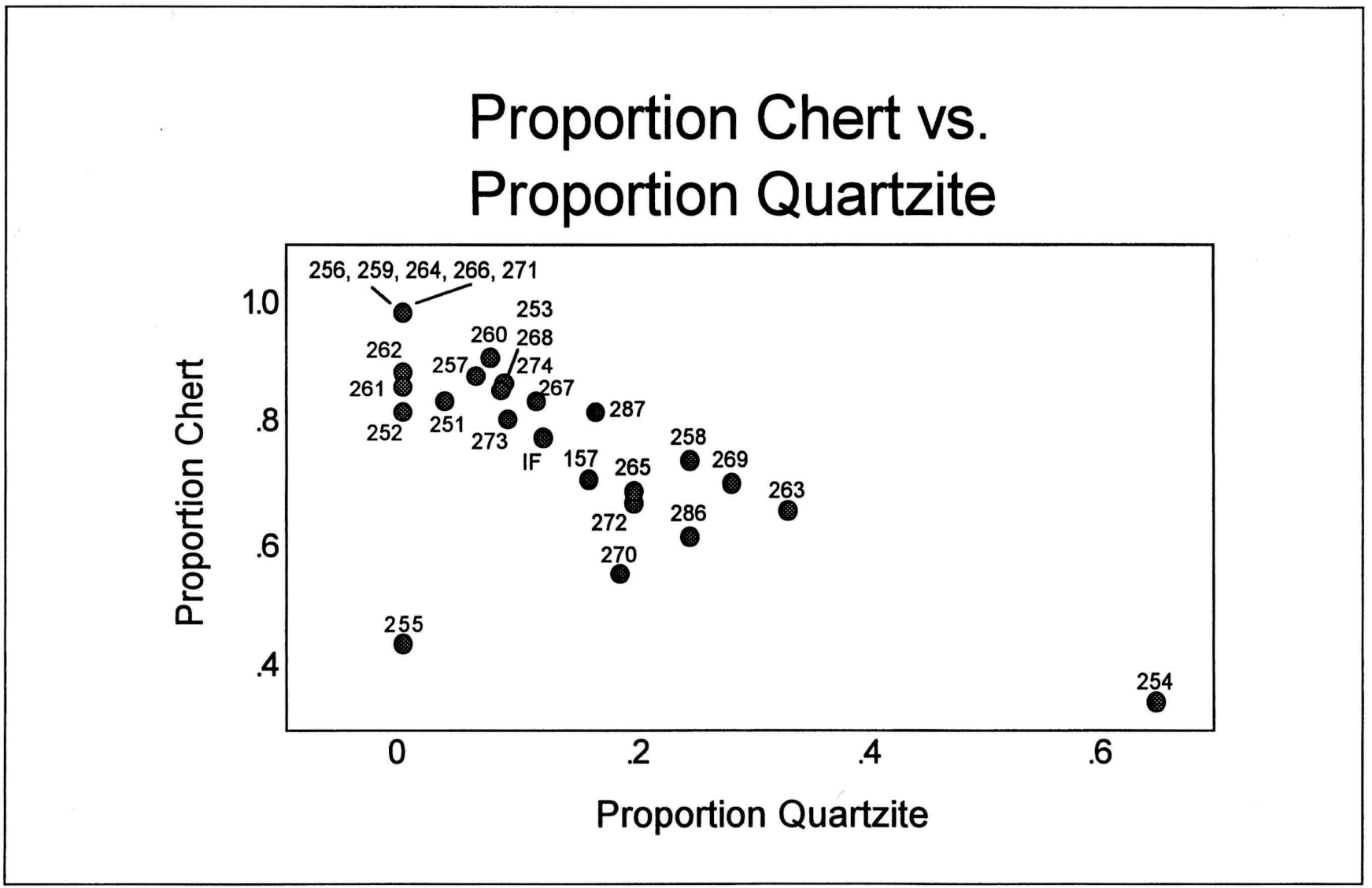


Figure V-4. Proportion of assemblage chert (AGT, HUC, SHJ, WRS) vs. quartzite (CLQ) (number refers to site number, i.e., 25SX___).

assemblage owed to local or nearby chert sources. In fact, five of the nine artifacts occurring here are from an exotic source. This sample size is very small, however, and it may be that the debitage is all from the same set of knapping events.

Two series of site assemblages are arrayed in an inverse fashion in Figure V-4. The first includes 25SX260, 25SX287, 25SX258, 25SX269, and 25SX263. These assemblages are without any exotic obsidian or unidentified materials. The remaining sites, 25SX273, 25SX152, and so forth, do include these other exotic materials. In part, this pattern may represent a sampling phenomenon; the assemblage sizes of the first group, which range from 6-13, may be so small that rare events, such as the knapping of exotic materials, were not included here. It may also be the case that the upper set of sites represents assemblages created during occupations that occurred in the middle portion of the prehistoric sequence, when materials from eastern Wyoming appear to have dominated. The bottom set of sites, then, may be owed to either (or both) early and terminal occupation of the area. That 25SX251, at which a McKean projectile point (usually interpreted as Middle Archaic in age) was found, however, does not support this interpretation.

A final alternative may be that the upper set of sites represents single occupation events while those in the bottom set represent multiple occupation events. That projectile points usually assigned to the Paleoindian and Protohistoric time periods were recovered at 25SX152 (see preceding chapter) is consistent with this interpretation. (Conversely, as suggested in Chapter IV, the Cody/Eden point found at 25SX152 may represent a recycled piece of chipped stone material.)

SUMMARY

In summary, it is clear from this brief analysis that the amount of variation among and between assemblages is great and that because many factors are confounded, it is difficult to tease apart their differential effects on assemblage composition. Nevertheless, we have identified some provocative patterns in these assemblages that could be investigated by future analyses and other archaeological work. Table V-1 summarizes the assemblage interpretations described below.

Site 25SX254, dominated by quartzite, appears anomalous in its lack of chert material. Tools were recovered here, and this may be one of several sites in the Monument where tool replacement and refurbishment occurred. Further investigation of tool variation may help to address this issue.

Site 25SX255 appears anomalous in the very high amounts of exotic materials recovered there. Again, this may represent a location at which a single tool refurbishment event occurred and, by monitoring this location, damaged and discarded tools may be recovered.

Site 25SX262 and 25SX264 are sites dominated by AGT. These sites may be owed to the expedient collection and use of local AGT to augment in-hand tool kits or to replace damaged tools.

Another set of sites is unique by virtue of the low incidence of assemblage quartzite. Quartzite appears to play a role in heavy-duty activities and such activities may occur more frequently in

either domestic or butchery contexts. The lack of quartzite at 25SX252, 25SX256, 25SX261, 25SX266 and 25SX271 (as well as at 25SX262 and 25SX264, mentioned above) suggests that these locations were used for non-domestic activities or at least activities that did not involve the use of a durable material like quartzite. The generally low material diversities of these assemblages is consistent with an interpretation that they are owed to short-term events or events contributed to by few individuals.

Two sites, 25SX259 and 25SX152, display low material type diversities, given their assemblage sizes, and may represent places that were repeatedly utilized by groups for short-term purposes. The generally dense nature of the surface deposit at 25SX152 as well as the range of projectile points found there support the interpretation that the terrace on which 25SX152 is located has been visited on a variety of occasions over the last several thousand years.

The remaining suite of sites appear to have been used for purposes that involved heavy-duty quartzite tools and may have been used over a range of time spans. Sites such as 25SX286 and 25SX263, with large amounts of quartzite and low amounts of chert, may have been used for domestic activities over a short span of time. Conversely, sites such as 25SX253 and 25SX273, with low amounts of quartzite and high amounts of chert, and relatively high numbers of tools, may be owed to occupations that were of longer duration or incorporated more individuals. Alternatively, people at these sites may have been involved in gearing up for an activity like bison hunting, in which sturdy quartzite tools may have been desired.

Map V-1 maps the sites according to the interpretations made above. On the ridge tops, sites like 25SX251 and 25SX273, with tools and with relatively low amounts of quartzite as well as chert, are found. Sites with high amounts of the local AGT predominantly occur in the western portion of the Monument, where source materials are found. Sites without quartzite, interpreted here as resulting from non-heavy-duty activities, occur in a variety of settings, both on ridge tops and terraces. Similarly, sites with quartzite, suggesting that tools for heavy-duty purposes were made and perhaps used there, are found throughout the southern portion of the Monument.

In the preceding chapter, we focused on changes in prehistoric mobility. Here, we have attempted to look at the internal variation of these assemblages in an effort to appreciate other aspects of past behavior. Clearly, these efforts would benefit from more temporal information about when these assemblages were created. Future work at Agate Fossil Beds NM may profitably explore some of the artifact dating methods discussed by the contributors to Beck (1994).

The other important conclusion this analysis supports is that all chipped stone assemblages are not equal. The assemblages at Agate Fossil Beds NM display patterned variation, underscoring what is already widely appreciated, that prehistoric peoples addressed the High Plains landscape using a limited set of

strategies that may have changed situationally and through time. A consideration of chipped stone assemblages from points on the landscape with both similar and dissimilar arrays of resources would aid in our increased understanding of the prehistoric use of the High Plains.

Table V-1. Summary of assemblage interpretations.

Site	Assemblage Interpretation
25SX152	recurrent, moderate energy intensity use
25SX251	heavy-duty activities with moderate energy density (however, low N)
25SX252	non-domestic; tool refurbishment
25SX253	heavy-duty activities with moderate energy density
25SX254	tool refurbishment; dominated by quartzite
25SX255	tool refurbishment?; dominated by exotic materials
25SX256	non-domestic
25SX257	heavy-duty activities with moderate energy density
25SX258	heavy-duty activities with low energy density; single use?
25SX259	reused location
25SX260	heavy-duty activities with moderate energy density
25SX261	non-domestic

Table V-1. (continued).

Site	Assemblage Interpretation
25SX262	non-domestic; dominated by AGT (ant hill context)
25SX263	heavy-duty activities with low energy density; single use?
25SX264	non-domestic; dominated by AGT
25SX265	heavy-duty activities with low energy density
25SX266	non-domestic
25SX267	heavy-duty activities with moderate energy density
25SX268	heavy-duty activities with moderate energy density
25SX269	heavy-duty activities with low energy density
25SX270	heavy-duty activities with low energy density
25SX271	non-domestic activities
25SX272	heavy-duty activities with low energy density
25SX273	heavy-duty activities with moderate energy density
25SX274	heavy-duty activities with moderate energy density
25SX286	heavy-duty activities with low energy density

CHAPTER VI
CONCLUDING OBSERVATIONS ON THE MANAGEMENT OF AGATE FOSSIL BEDS NM CULTURAL RESOURCES

LuAnn Wandsnider

This report concludes with several observations that may be useful to those making management decisions about the cultural resources at Agate Fossil Beds NM and on the efficacy of a landscape approach to cultural resource management. The first set of observations considers the eligibility of sites located within the survey area for the National Register of Historic Places. A second set of observations addresses management issues. Finally, I reflect on the utility of a landscape approach to cultural resources inventory for management purposes.

ELIGIBILITY FOR NOMINATION TO THE NATIONAL REGISTER

As Clark (1993:27) observes, an evaluation of the potential for a specific site to yield significant information is a subjective undertaking. It depends on what we as a society value at any one point in time and also the state of the discipline of archaeology and the kinds of questions about the past it values. It also depends on the state of our specific knowledge about the cultural resources and their state at, for example, Agate Fossil Beds NM. Because of Clark's (1993, 1994) work and the results described herein, we are in a position slightly better than that of Clark to offer some suggestions.

In reviewing the properties documented during the course of this work, it is helpful to consider three gross categories, cairn sites, chipped stone sites, and historic sites.

Cairn Sites

During the 1994 field season, 10 cairns were documented at sites 25SX158, 25SX159, 25SX161, and 25SX282 and others were noted in the unsurveyed area that included Carnegie and University Hills. These cairns have not been investigated through disassembly or excavation, and the nature of any associated subsurface cultural materials is presently unknown. Comparison of the cairns with photographs made by Kay in 1975 suggest that the cairns appear to be enduring. As noted by Volf (Appendix E), Clark (1993:27), and Kay (1975), we lack knowledge about the function of these features and about the relative occurrence of such features along (as well as away from) the Niobrara River.

As recently pursued by landscape archaeologists (e.g., contributors to Lock and Stančič 1995 and also Yamin and Bescherer Metheny 1995; see also Krause 1995), such features, when considered as a population of features with respect to the landscape, have high potential for yielding significant information about the prehistoric cultural landscape. For example, Krause (1995) considers the landscape context, visibility,

field of view, and so forth in discussing the role played by tumuli in the organization of the prehistoric cultural landscape. Because of the potential for these features to be similarly informative, the cairn sites should be considered eligible for the National Register of Historic Places, perhaps as an archaeological district.

Chipped Stone Sites

In the current study, three classes of chipped stone scatters were documented. By class, the eligibility of these sites for nomination is:

(1) Those on ridge tops with a shallow subsurface expression (25SX251, 25SX254, 25SX260, 25SX263, 25SX267, and 25SX273). In addition to being shallow, these sites are generally small and contain few artifacts. Nevertheless, they are located on prominent points with a commanding view of the Niobrara valley as well as of the landscape in general. In an age without telecommunications to rapidly access information about the world, such places played a critical role in allowing people to monitor their environment. In addition, from personal interaction with members of the Native American community, I know that such prominent points likely also played an important role, both historically and possibly also prehistorically, in Native American spiritual life. For these two reasons, sites at these locations (and perhaps even the ridge tops themselves) should be considered eligible for nomination to the National Register.

(2) Those on erosional terrace surfaces (25SX152, 25SX255, and 25SX266), in the eastern portion of the study area. These sites are visible primarily because of the actions of rodents and other surface processes. As a result, surface artifact densities are high here, but deposits vary in depth, appear to have moderate to low spatial integrity, and only archaeological materials with the durability of chipped stone have survived. By themselves, these sites contribute only modestly to our understanding of the past use of Agate Fossil Beds NM. As demonstrated in the preceding chapters, when considered with respect to each other and to other sites both within and outside the Monument, however, they do contribute significant information about the prehistoric use of Agate Fossil Beds NM. Continued surface survey of these sites, which are actively being "renewed" by rodents, for example, may allow the efficient recovery of additional information. As well, fragments of a Paleoindian period projectile point, the unequivocally earliest known for the Monument, were recovered from this active context at 25SX152. For these reasons, these sites are eligible for nomination to the National Register of Historic Places.

(3) Those on aggrading terrace surfaces (25SX252, 25SX253, 25SX256, 25SX257, 25SX258, 25SX259, 25SX261, 25SX262, 25SX264, 25SX265, 25SX268, 25SX269, 25SX271, 25SX272, 25SX274, and 25SX286), especially in the western portion of the study area. Sites in this last class appear to have the highest

integrity and best preservation of less durable items like bone. Sites in this class may contribute significantly to our evolving understanding of Great Plains prehistory.

We have little temporal information for these chipped stone sites. With the advances being made in dating items in surface contexts (e.g., see contributions to Beck 1994), however, this problem will hopefully become less intractable in the coming decades.

Historic Sites

The remaining historic sites are eligible for nomination to the National Register using several different criteria.

Cook gravestone (25SX285). The Cook gravestone is associated with an individual who was important to the history of this area, John H. Cook. On this basis, it is eligible for nomination to the National Register.

Kelley Homestead (25SX283) and other historic sites (25SX284, 25SX288, and 25SX289). The Kelley Homestead and the remaining historic sites may be considered eligible for nomination to the National Register on the basis of their potential contribution to an understanding of historic ranching and homesteading, and, perhaps more importantly, bone-mining activities that occurred within the Monument.

A final observation on the eligibility of the sites reported upon here bears mentioning. Because these sites have already received some amount of scientific scrutiny, an important investment has been made in them. This scrutiny has by no means exhausted the information potential of these sites. Thus, these sites have gained significance (if that is possible) by virtue of the baseline attention they have received. In that they exist in a protected environment, they are ideally situated to be carefully monitored for the next several decades. For this additional reason, they are eligible for nomination to the National Register of Historic Places.

MANAGEMENT RECOMMENDATIONS

The following management recommendations repeat some of the concerns expressed by Clark (1993:29).

(1) Because of the special nature of the archaeological record on Carnegie and University Hills, and therefore the special knowledge about bone-mining activities and landscape recovery needed to properly assess this area, we accorded this area low priority during the 1994. Clearly, given the traffic these areas receive, systematic archaeological attention is required in these areas.

(2) Several sites (25SX252, 25SX256, 25SX268, and 25SX287) are on the erosional slopes of the lowest terraces of the Niobrara. At present, the Niobrara River is flowing in a northerly portion of its flood plain and these sites are not in imminent danger. However, the Niobrara has changed course in the past, as evidenced by abandoned meanders. Should this happen again, these sites may be in danger of being undercut.

(3) The sites located on lower terraces in the western portion of the study area are relatively deeply (i.e., up to 1 to 2 m [3 to 6 ft] deep) buried. Therefore, should subsurface disturbance be considered along any of these terraces,

archaeological materials without a surface expression should be expected and excavation activities should be closely monitored by an archaeologist.

(4) The sites (especially 25SX152) located in the eastern portion of the study area are in danger of being vandalized because of the relatively high artifact and visitor density here. Stupka-Burda (1995) has recently undertaken research in the domain of anticipating and controlling vandalism. Through controlled experimentation at Yellowstone National Park, she reported low levels of vandalism in vegetated areas and higher levels of vandalism in high traffic areas. Her findings, while not surprising, offer possible avenues for controlling vandalism, should other Monument policies permit the encouragement of denser vegetation here or the rerouting of traffic flow.

(5) The historic sites, 25SX283, 25SX284, 25SX285, 25SX288, 25SX289, are probably the most fragile resource in the Monument today. Their subsurface expression is likely shallow and they contain materials (stone, wood, cans, glass) that may be destroyed or damaged by an intense fire. Therefore, should controlled burns be prescribed for this area, these sites should be protected.

(6) The value of specific cultural properties changes as research questions evolve. To support this inevitable evolution, it will be useful to disseminate, to the extent possible, the primary data collected through this (and also Clark's 1993 and 1994) work. Publication is one avenue for dissemination; another is the World-Wide Web. A Web-based Great Plains regional clearinghouse of archaeological digital data could serve the discipline of archaeology, permitting, for example, a critical comparison of Agate Fossil Beds NM remains with those from Hell Gap, the Oglala National Grasslands, Pine Bluffs, and other High Plains locations. Because of the expertise of its staff, the NPS Midwest Archeological Center is in a unique position to support such a endeavor.

REFLECTIONS ON DISTRIBUTIONAL APPROACHES TO CULTURAL RESOURCE MANAGEMENT

The inventory work described in this report relied upon distributional field methods to document the archaeological landscape. In terms of producing information immediately useful to resource managers, this distributional approach offers both advantages and disadvantages.

The disadvantages include the fact that distributional approaches are relatively expensive in terms of acreage surveyed. With the resources allocated to this inventory, a standard pedestrian site survey would have covered the entire Monument. In addition, as currently understood, managers need to be able to make decisions about discrete places rather than about landscapes (but see Church 1997). Because distributional archaeological data emphasize the continuous nature of archaeological landscape distributions and also the high information potential of both low and high density areas, the data it yields may be viewed as intractable for management purposes.

The advantages of this approach, however, are several. For one, the item-based documentation of the archaeological landscape means that analytic units can be defined in any number of ways to meet any number of questions, of which only a few were considered here (Shott 1992). That is, the increased research potential of archaeological materials documented in this fashion

imbues them with increased value, contributing to their eligibility for nomination to the National Register of Historic Places.

A second advantage speaks to the bias inherent to site approaches. Site-based inventory techniques adequately represent high-density clusters but drastically under-represent isolated occurrences (Wandsnider and Camilli 1992). Compared with dense artifact concentrations at sites, a relatively higher proportion of the isolated occurrence assemblage is composed of tools, which generally yield more information about the past use of an area (Wandsnider 1988). As is evident in Table III-3b, this same pattern is also present in the chipped stone assemblages from Agate Fossil Beds NM (compare IF with site assemblages).

Finally, the distributional approach readily lends itself to the current discussions on ecosystem management, although the exact nature of the integration between the two (i.e., distributional archaeology and ecosystem management) remains to be sorted out (Church 1997).

In the end, thus, I argue that the high quality of the information obtained using distributional methods warrants its continued use in a management context. The current application of distributional archaeological methods to the archaeological landscape at Agate Fossil Beds NM clearly would benefit from closer integration of the archaeological data base with other geographic information on geomorphology, species distributions, hydrology, and so forth. Future applications of distributional archaeology should pay special attention to this deficiency.

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APPENDIX A
FIELD CREW PERSONNEL

1994 Crew Members (Official Initials):

Heidi Athan (HA!)
Mat Dooley (MAD)
Jennifer Galindo (JLG; crew chief)
Sloan Hart (MSH)
John Kennedy (JFK)
Brian Koba (BJK)
Dana John (DMJ)
George Macdonald (GHM; crew chief)
Vergil Noble (VEN; supervising archaeologist)
Christina Periera (CAP)
Greg Rouse (GJR)
Kathleen Russell (KDR; crew chief)
Miles Scalorbrin (MKS)
William Volf (WJV)
LuAnn Wandsnider (LAW; supervising archaeologist)
Sherry Waters (SMW)

1995 Crew Members (Official Initials):

Ann Bauermeister (AB)
Corey Cashmere (CC)
George Macdonald (GM; crew chief)
Brian Medow (BM)
Vergil Noble (VN; supervising archaeologist)

APPENDIX B
FIELD DATA RECOVERY CODES

Field Data Recovery Codes

The following codes are adapted form the Hudson-Meng coding scheme developed by University of Wyoming archaeologists.

NORTH (Grid North)

EAST (Grid East)

ORT (Orientation in degrees; 0-359)

INC (Inclination in degrees; 0-90)

PRO (provenience point; point on the artifact that was mapped)

CT	center
DS	distal end
E	east
EG	edge
LT	lateral edge
N	north
NE	northeast
NW	northwest
PR	proximal end
S	south
SE	southeast
SW	southwest
US	unspecified
W	west

UP (Face [or portion of the artifact facing] Up)

BI	biface (no distinguishing face)
DL	dorsal face
DO	dorsal face
EG	edge
PR	proximal end
UN	unknown
US	unspecified
VN	ventral face

CLS (Artifact Class)

BN	bone
CH	charcoal
CN	cairn
CR	ceramic
CS	chipped stone
HB	historic brick
HF	historic foundation
HG	historic glass
HM	historic metal
HO	historic other
OT	other
RK	rock
US	unspecified

AT (Artifact Type)

ANG	angular debris
BIF	biface
CR	core
ES	end scraper
FK	flake
PP	projectile point
SC	scraper
SS	side scraper
UF	utilized flake
US	unspecified

MAT (Material Type)

CH	chert
QT	quartzite
OT	other

SEG (Segment)

CO	complete
DS	distal
ME	medial
PR	proximal
US	unspecified

MLEN (Maximum Length in mm)

BR (Burned)

STR (Storage)

IS	in situ
RM	removed (modify to reflect curation location)

IN (Recorders Initials; see Appendix A)

CONTEXT (Context)

AH	ant hill
EA	eroded area
FBMC	unknown
RBBD	rodent burrow exposure
SF	surface
US	unspecified

APPENDIX C
GEOCHEMICAL ASSAY OF OBSIDIAN ARTIFACTS

Richard E. Hughes

METHODS AND TECHNIQUES

Laboratory investigations were performed on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray fluorescence spectrometer equipped with a rhodium (Rh) x-ray tube, a 50 kV x-ray generator, with microprocessor controlled pulse processor (amplifier) and bias/protection module, a 100 MHz analog to digital converter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 150 eV resolution (FWHM) at 5.9 keV in a 30mm^2 area. The x-ray tube was operated at 35.0 kV, .25 mA, using a .127 mm Rh primary beam filter in a air path to generate x-ray intensity data for the trace elements zinc (Zn Kα), gallium (Ga Kα), rubidium (Rb Kα), strontium (Sr Kα), yttrium (Y Kα), zirconium (Zr Kα) and niobium (Nb Kα). Barium (Ba Kα) intensities were generated by operating the x-ray tube at 50.0 kV, .35 mA, with a .63 mm copper (Cu) filter, while titanium (Ti Kα), manganese (Mn Kα) and total iron ($Fe_2O_3^T$) intensities were generated by operating the x-ray tube at 15.0 kV, .30 mA with a .127 mm aluminum (Al) filter. Deadtime-corrected analysis time for each sample appears on the data table. Extremely small specimens were analyzed using a .25 mm^2 primary beam collimator, and resulting data were normalized through application of a sample mass-correction algorithm. Livetime for each analysis was greatly extended in all instances when primary beam collimation was employed. X-ray intensities were converted to concentration estimates employing a least-squares calibration line established for each element from analysis of up to 26 international rock standards certified by the U.S. Geological Survey, the U.S. National Institute of Standards and Technology (formerly National Bureau of Standards), the Geological Survey of Japan, and the Centre de Recherches Petrographiques et Geochimiques (France). Further details pertaining to x-ray tube operating conditions and calibration appear in Hughes (1988a).

Trace element measurements in Table C-1 are expressed in quantitative units (i.e. parts per million [ppm] by weight), and matches between unknowns and known obsidian chemical groups were made on the basis of correspondences (at the 2-sigma level) in diagnostic trace element concentration values (i.e., ppm values for Rb, Sr, Y, Zr, Nb and when necessary, Ba, Ti, Mn, and $Fe_2O_3^T$) that appear in Baugh and Nelson (1987), Hughes (1984; 1988b, c), Hughes and Nelson (1987), Nelson (1984), Newman and Nielsen (1985), and Shackley (1995). I consider artifact-to-obsidian source (geochemical type) reliable if diagnostic mean measurements for artifacts fall within 2 standard deviations of mean values for source standards. The term "diagnostic" is used here to specify those trace elements that are well-measured by x-ray fluorescence, and whose concentrations

show low variability *within* a source and marked variability *across* sources. Diagnostic elements, then, are those whose concentration values allow one to draw the clearest geochemical distinctions between sources (cf. Hughes 1993). Although Zn and Ga ppm concentrations also were measured and reported for each specimen, they are not considered "diagnostic" because they do not usually vary significantly across obsidian sources (see Hughes 1982, 1984). This is particularly true of Ga, which occurs in concentrations between 10-30 ppm in many parent obsidians. Zn ppm values are infrequently diagnostic; they are always high in Zr-rich, Sr-poor peralkaline volcanic glasses, but otherwise they do not often vary significantly between sources. The trace element composition measurements in Table C-1 are reported to the nearest ppm to reflect the resolution capabilities of non-destructive energy dispersive x-ray fluorescence spectrometry. Resolution limits of the present x-ray fluorescence system for the determination of Zn is about 3 ppm; Ga about 2 ppm; for Rb about 3 ppm; for Sr about 3 ppm; Y about 2 ppm; Zr about 3 ppm; and Nb about 2 ppm (see Hughes [1994] for other elements). When counting and fitting errors (the "±" value in Table C-1) for a sample are greater than calibration-imposed limits of resolution, the larger number is a more conservative indicator of composition variation and measurement error arising from differences in sample size, surface and x-ray reflection geometry.

RESULTS

One specimen, an isolated find near site 25SX152, matches the trace element "signature" of Cerro del Medio volcanic glass, located in the Jemez volcanic field of northern New Mexico. This obsidian was conveyed widely in late prehistoric (protohistoric) times in Oklahoma, Texas (Baugh and Nelson 1987:Table 3), and Nebraska (Baugh and Nelson 1988: Table 3, 86). Both samples analyzed from 25SX152 share the distinctive chemical fingerprint of obsidian of the Malad, Idaho chemical type (Hughes 1984: Table 3). Malad obsidian (see Nelson 1984: Figure 1) also had a wide distribution in late prehistoric (protohistoric) times; it has been identified in late contexts in Nebraska (Baugh and Nelson 1988) and as far southeast from the source as Oklahoma (Baugh and Nelson 1987) and Texas (Hester et al. 1986).

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Table C-1. Geochemical data for obsidian flakes from sites in Agate Fossil Beds NM.

Catalogue No.	Trace and Selected Minor Element Concentrations											Source
	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Fe	$Fe_2O_3^T$	
Unit 18- Art 52; 1994; IF; surface	61 ± 6	16 ± 3	149 ± 3	5 ± 3	42 ± 2	148 ± 3	45 ± 2	nm	500 ± 14	435 ± 13	1.08 ± 0.12	Cerro del Medio, NM
25SX152; Unit 0-Art 1; 1995; surface	38 ± 3	15 ± 3	115 ± 3	64 ± 3	33 ± 2	84 ± 3	13 ± 2	1403 ± 14	nm	nm	nm	Malad, ID
25SX152; Unit 11- Art 78; 1995; surface	47 ± 4	21 ± 3	137 ± 3	75 ± 3	37 ± 2	91 ± 3	15 ± 2	1456 ± 16	nm	nm	nm	Malad, ID

All values in parts per million (ppm) or, for total iron, weight percent (%) composition; ±=pooled expression (in ppm) of x-ray counting uncertainty and regression fitting error at 600 seconds livetime; nm=not measured.

APPENDIX D
BONE ELEMENT DESCRIPTION

Jennifer L. Galindo

INTRODUCTION

The following describes the bone material recovered during 1994 surface survey and 1995 test excavations of four archaeological sites at Agate Fossil Beds National Monument. A single bone fragment was recovered during the 1994 intensive survey. In addition, faunal skeletal material was recovered from three of the four sites excavated in 1995: 25SX152, 25SX253, and 25SX268. (Three 1 X 1 m units were excavated at site 25SX251, however, no archaeological material was recovered here.)

Bone elements with distinguishing characteristics were identified by comparing the skeletal element to modern faunal skeletons in the collections of the Nebraska State Historical Society and the University of Nebraska State Museum. The identifications were made with the help of Nebraska State Historical Society archaeologist John R. Bozell and University State Museum Collections Manager Tom LaBedz.

The archaeological collections recovered during the 1994 surface survey resulted in one bone fragment weighing 10.28 grams. The archaeological collections recovered during the thirteen days of fieldwork in 1995 resulted in a total of 52 mammal bones or bone fragments weighing a total of 248.72 g and one bird bone fragment. Site 25SX253 had the most bone by weight, a total of 129.99 g (19 pieces). Site 25SX268 had a total of 96.01 g (28 pieces) of bone. At site 25SX152, a total of 22.72 g (8 pieces) of bone were recovered.

RESULTS

A total of 127.89 g of bone from a large mammal was identified. Included in this large mammal bone assemblage is one complete *Bison* first phalange, one fragment of a deer/antelope first phalange, and one partial deer/antelope thoracic or lumbar vertebrae. Also included are four tooth enamel fragments, four possible pieces of horn core, and 52.61 g of unidentified long bone fragments.

A total of 0.62 g of bone from a small mammal were identified. Included in this small mammal bone assemblage is an incisor, molar, and left proximal and distal ends of a humerus of pocket gopher. Also included are a prairie dog right acetabulum (hip joint), a third phalange (toe) of a jack rabbit, a complete caudal bone of an unidentified small mammal, and nine fragments (.15 g) of unidentified rodent bones.

Twenty-seven additional bone fragments (7.76 g) are mammal bone fragments too small to be identified further. One fragment of an unidentified bird bone was also found.

Phalanges and tool fragments comprise a large proportion of the identifiable bone assemblage. In that these are relatively dense bones and resist erosion to a much greater degree than, for example, cranial bones, suggests that recent bone

preservation here, especially on terraces and slopes that have seen repeated bouts of erosion and aggradation, is very poor. This finding is in contrast to the very favorable preservation seen in deposits with early mammal remains, for which Agate Fossil Beds NM is so famous. In addition, the high proportion of the identifiable bone assemblage that is represented by rodents of various kinds indicates the importance of these animals in the ecosystem of the monument today and as a contributor to the modern archaeological surface.

Isolated Find from 1994 Surface Survey

Unit 17

Surface Artifact #304 -- One bone fragment from a large mammal. Weight=10.28 g.

Site 25SX152

A total of eight bone fragments, weighing a total of 22.80 g, were recovered during excavation of eleven 1 X 1 m units at this site (Table D-1). Identified skeletal parts consist of a tooth of a large mammal, a long bone of a bird, and a vertebra of a deer of antelope. Of the eleven 1 X 1 m units excavated, only units 5, 9, and 11 yielded bone material. Chipped stone artifacts were recovered from all eleven units.

Unit 5:

Level 3 (20-30 cm below surface) Artifact # 73 -- Three fragments of a large mammal tooth. Total weight = 1.91 g.

Unit 9:

Level 2 (10-20 cm below surface) Artifact #13 -- Unidentified large mammal bone fragment weighing 19.47 g. Has fresh looking "cut marks," probably from trowel or shovel used in excavation.

Unit 11:

Level 1 (0-10 cm below surface) Artifacts #10, #11, & #12 -- Two tiny unidentified bone fragments weighing .01 g each. One unidentified bird long bone fragment weighing 0.08 g.

Level 4 (30-40 cm below surface) Artifact #98 -- Thoracic or lumbar of *Odocoileus* or *Antilocapra* (deer or antelope) weighing 1.32 g.

Site 25SX253

A total of nineteen bone fragments, weighing a total of 129.99 g were recovered during excavation at this site (Table D-2). None of the bone fragments have been positively identified beyond that they are from a large mammal. Three 1 X 1 m units were excavated at this site; however, bone was found only in unit 2. Thirteen of the 14 large mammal bones found were from 40 to 50 cm below the ground surface. All bone material occurred between 40 and 70 cm deep. Chipped stone artifacts were recovered in all three units excavated at this site. Unit 2 level 5 (40-50 cm deep) contained the largest number of artifacts (26 pieces of chipped stone and three fire-cracked rock) however, chipped stone occurs throughout all levels. The skeletal parts represented are dominated by long bone fragments.

Unit 2:

Level 5 (40-50 cm below surface) Artifact #16 -- Four pieces of possible horn core. The two larger pieces

Table D-1. Summary of bone assemblage from 25SX152.

Unit	Depth Below Surface (cm)	Species or Class	Weight (g)
5	20-30	large mammal	1.91
9	10-20	large mammal	19.47
11	0-10	bird	0.08
11	0-10	unid. bone	0.01
11	0-10	unid. bone	0.01
11	30-40	deer/antelope	1.32

(3.46 and 1.84 g) fit together. The two smaller fragments weigh 0.10 and 0.16 g. Nine large mammal long bone fragments weighing a total of 122.73 g. The horn core and long bone fragments could be bison or cow, likely bison.

Level 6 (50-60 cm below surface) Artifact #35 -- Four unidentified bone fragments weighing a total of 0.77 g.

Level 7 (60-70 cm below surface) Artifact # 42 -- Two unidentified mammal bone fragments weighing 0.93 g.

Site 25SX268

A total of twenty eight mammal bones or bone fragments, weighing a total of 96.01 g, were recovered during excavation of three 1 X 1 m units at this site (see Table D-3). Skeletal parts of pocket gopher (*Thomomys/Geomys*), jackrabbit (*Lepus* sp.), bison (*Bison bison)*, prairie dog, and either deer or antelope (*Odocoileus* or *Antilocapra*) were identified. Bone was found in all three excavation units here. Large mammal bones were found in units 1 and 2 from 10-50 cm below ground surface. Pocket gopher and unidentified rodent bones were found in unit 3, 50-60 cm below the ground surface. Chipped stone artifacts were found in all three units excavated at this site from 0 to 70 cm below the surface. The identifiable bone elements recovered from this site are dominated by toes and teeth.

Unit 1:

Level 2 (10-20 cm below surface) Artifact #11 -- Tooth enamel fragment of a large mammal. Weight = 0.22 g.

Level 4 (30-40 cm below surface) Artifact #32 -- Unidentified large mammal bone fragment. Weight = 18.28 g.

Level 5 (40-50 cm below surface) Artifact #47 -- Unidentified large mammal

bone fragment. Weight = 14.86 g.

Unit 2:

Level 3 (20-30 cm below surface) Artifact #8 -- Five unidentified mammal bone fragments. Three are burned.

Level 5 (40-50 cm below surface) Artifacts #29 and #31 -- Complete 1st phalange (proximal phalanx) of *Bison bison*. It has been gnawed by rodents. Weight = 55.20 g. Two unidentified bone fragments. Weight = 0.46 and 0.03 g. Right acetabulum of a small or immature prairie dog. Weight = 0.18 g.

Level 6 (50-60 cm below surface) Artifact #36 -- Distal end of 1st phalange of *Odocoileus* or *Antilocapra* (deer or antelope). It was broken into two pieces (now glued together). It is too small of a fragment to distinguish between deer and antelope. Weight = 0.79 g. Three unidentified mammal bone fragments. Weight = 0.31, 0.32, & 0.43 g.

Unit 3:

Level 5 (40-50 cm below surface) Artifacts #24 & #31 -- Six unidentified mammal bone fragments. Weight = 0.13, 0.02, 0.01, 0.02, 0.04, 0.07 g. Complete caudal bone of small mammal. Weight = 0.02 g.

Level 6 (50-60 cm below surface) Artifacts #35 & #41 -- Lower incisor (0.12 g), molar (0.04 g), left proximal (0.01 g) and left distal (0.06 g) ends of humerus of *Thomomys/Geomys* (pocket gopher). The left proximal end of the humerus was from an immature animal indicated by the unfused epiphyses. Nine unidentified rodent sized bone fragments weighing a total of 0.15 g. One unidentified mammal (but not rodent) bone fragment weighing 0.13 g.

Level 7 (60-70 cm below surface) Artifact #43 & #44 -- Two unidentified mammal bone fragments weighing 2.40 and 0.26 g. Burned distal phalange of *Lepus* sp. (jackrabbit) weighing 0.04 g.

Table D-2 Summary of bone assemblage from 25SX253.

Unit	Depth Below Surface (cm)	Species or Class	Weight (g)
2	40-50	large mammal	3.46
2	40-50	large mammal	1.84
2	40-50	large mammal	0.10
2	40-50	large mammal	0.16
2	40-50	large mammal	16.34
2	40-50	large mammal	2.12
2	40-50	large mammal	1.48
2	40-50	large mammal	0.40
2	40-50	large mammal	1.12
2	40-50	large mammal	0.58
2	40-50	large mammal	0.52
2	40-50	large mammal	0.12
2	40-50	large mammal	0.05
2	50-60	large mammal	0.42
2	50-60	mammal	0.18
2	50-60	mammal	0.13
2	50-60	mammal	0.04
2	60-70	mammal	0.87
2	60-70	mammal	0.06

Table D-3. Summary of bone assemblage from 25SX268.

Unit	Depth Below Surface (cm)	Species or Class	Weight (g)
1	10-20	large mammal	0.22
1	30-40	large mammal	18.28
1	40-50	large mammal	14.86
2	20-30	unid. mammal	1.41
2	40-50	bison	55.20
2	40-50	unid. mammal	0.46
2	40-50	prairie dog	0.18
2	40-50	unid. bone	0.03
2	50-60	deer/antelope	0.79
2	50-60	unid. mammal	0.31
2	50-60	unid. mammal	0.32
2	50-60	unid. mammal	0.43
3	40-50	unid. mammal	0.13
3	40-50	unid. mammal	0.02
3	40-50	unid. mammal	0.01
3	40-50	unid. mammal	0.02
3	40-50	unid. mammal	0.04
3	40-50	unid. mammal	0.07
3	40-50	small mammal	0.02
3	50-60	pocket gopher	0.12

Table D-3. (continued).

Unit	Depth Below Surface (cm)	Species or Class	Weight (g)
3	50-60	pocket gopher	0.04
3	50-60	pocket gopher	0.01
3	50-60	pocket gopher	0.01
3	50-60	unid. rodent	0.01
3	50-60	unid. rodent	0.01
3	50-60	unid. rodent	0.01
3	50-60	unid. rodent	0.01
3	50-60	unid. rodent	0.03
3	50-60	unid. rodent	0.04
3	50-60	unid. rodent	0.02
3	50-60	unid. rodent	0.02
3	50-60	mammal	0.13
3	50-60	unid. bone	0.02
3	60-70	mammal	2.40
3	60-70	mammal	0.26
3	60-70	jackrabbit	0.04

APPENDIX E
CAIRN DESCRIPTION

William J. Volf

CAIRNS ON THE PLAINS

Rock cairns found across the Great Plains have served a variety of functions. Lines of cairns have been associated with bison jumps in Wyoming and Montana (Frison 1991:357). Cairns have also been used to mark commonly used trails as well as the location of springs and lithic resources located along trails (Blakeslee and Blasing 1988). Caldwell and Carlson (1954) have documented the use of cairns during vision quests. Kay (1975:32-33) notes that 20th-century sheep herders and Army surveyors constructed cairns. And, geologists and surveyors may have introduced such features onto the landscape as well, using them as temporary markers (e.g., Schramm and Cook 1921:5).

AGATE FOSSIL BEDS NM CAIRN DESCRIPTIONS

Ten cairns and two possible cairns were discovered and documented during the 1994 pedestrian survey at Agate Fossil Beds NM (Map E-1). The cairns have not been disassembled nor were excavations conducted in their vicinity. See descriptive summary in Table E-1.

As reported by Kay (975), these cairns are generally small and low and located on prominent ridges and buttes to either side of the Niobrara River.

Cairns 1, 2, and 3 are all located upon the same ridge in the southeastern corner of the monument. Kay (1975) does not mention these cairns, and because of their close proximity to one another, they have been designated as site 25SX282. Cairn 1 is the northernmost cairn on the ridge; Cairns 2 and 3 lie to the south. Cairn 1 (Figure E-1) is also the largest of these three cairns with a diameter of 162 cm and a height of 34 cm. The largest of the 28 exposed rocks are on the outside, with medium and smaller rocks located towards the center of the cairn. Additionally, a small skunkbrush plant grows from the center of the cairn. It should be noted that no other skunkbrush grows in the immediate area. No artifacts were found in conjunction with the cairn.

Cairn 2 is about 40 m south of Cairn 1 and contains at least 30 rocks ranging in size from 43x28x8 cm to 10x28x8 cm as well as many smaller rocks fragments within niches between the larger rocks. In the immediate area of the cairn, a segment of barbed wire was found.

Cairn 3 (Figure E-2) contains at least 38 rocks of notable size and many smaller broken rock fragments. The larger rocks are primarily located on the eastern half of the 148-cm-diameter cairn, with the bulk of the western half comprised mainly of the smaller rock fragments. It appears that the cairn may have been initially formed by building a base of sediment and fragments and then placing larger rocks upon this foundation. No artifacts were found in association with this cairn.

Cairns 4 and 5 (Figures E-3 and 4) are located approximately 250 m apart upon the same ridge top. Both cairns contain rocks that are covered with an orange

lichen (*Xanthoria elegans*, Kay 1975:32). Cairn 4 is just meters from the edge of the ridge upon which it is located, providing a spectacular view to the east and north. The majority of rocks contained within the cairn are of uniform size. Locally occurring silicate material—the moss agate—appears to occur naturally here with several broken pieces scattered along the base of the cairn. No identifiable flakes were found, however.

It is likely that Cairns 4 and 5 represent site 25SX158, which was recorded by Kay in 1975. However, his location for these cairns is approximately 250-300 m north of the location presented here. Kay was working with an 1899 15' topographic sheet for the monument and may have had problems locating ridges and cairns because of this.

Cairns 6, 7, and 8 are all located on a crest of a north-south oriented ridge. This location was designated as 25SX159 by Kay (1975), who reported only one cairn. It is unclear which of the three cairns located during the 1994 survey was reported by the earlier survey, although Kay's map (1975: Figure 1) would seem to indicate that Cairn 8 had received his attention. Cairn 6 (Figure E-5) was observed to contain only 6 rocks. Two .22 caliber casings with an imprinted "F" were found in association with this cairn.

Located about 25 meters to the north of Cairn 6, Cairn 7 appears as a slight mound of dirt with about 15 rocks embedded within it. This may not be a cairn as this portion of the plateau is eroded, with naturally occurring rock outcrops having a similar appearance. No artifacts were found near this cairn.

Cairn 8 is comprised of about 70 exposed rocks upon a boulder and sediment base. Skunkbrush is growing along the southern section of the cairn and patches of grass grow in spaces between the rocks. No artifacts were found to be associated with this cairn.

Cairns 9 and 10 (Figure E-6 and 7) are located atop the same ridge plateau about 50 m apart. At this location, designated as 25SX161 by Kay, Kay (1975) reported one cairn. From his description, it is unclear which cairn Kay recorded, although Cairn 10, the larger and more prominently placed of the two, is the likely candidate. Cairn 9 is composed of five rocks of relatively medium uniform size. The ratio between the height and diameter is roughly 1:2. Cairn 9 has no artifacts associated with it.

Cairn 10 is located to the east of Cairn 9 in a more exposed position. Forty-four exposed rocks were counted by the field crew during examination of this cairn. The majority of the rocks appear to be intact and are uniformly large in size in comparison with the smaller rocks located at the base of the cairn. Vegetation, consisting of grasses and wormwood, grows in areas where the larger rocks are absent. No artifacts were found in close proximity to this cairn.

CAIRN FUNCTION

The function of the cairns located on the Agate Fossil Beds National Monument is speculative at best. That these cairns might have served to guide bison to a jump, as described by Frison (1991), is not appropriate for several reasons. First, the distribution of the cairns, on the noses of ridges, is inconsistent with the models set forth by Frison. Additionally, cairn lines do not seem to converge. Thirdly, no positive evidence of bison procurement has been documented in the area.

It is possible that the Monument cairns marked trails or resources.

Similar to the cairns found by Blakeslee and Blasing (1988) along trails in the Deep Creek locality in central Kansas, the location of the AGFO cairns are on the ends of high ridges. The distance between cairns along the Deep Creek trail, however, is sometimes greater than a mile apart, whereas this is not the case with the AGFO cairns. As noted above, some cairns marked resources such as water and chipped stone material. No direct evidence for this occurrence was noted during the 1994 survey; future survey of adjacent areas could speak to this possibility.

Caldwell and Carlson (1954) report the use of cairns during vision quests among groups in the Columbia River basin of the American Northwest. They describe these features as rectangular, low piles of stone. Caldwell and Carlson also note that cairn locations were in regions remote from human occupation and were generally avoided. The general physical description of the cairns found offered by Caldwell and Carlson is similar to that for those found during the 1994 AGFO survey; however, the AGFO cairns differ in that the cairns are found in close proximity to likely habitation areas. Thus, the question of whether the AGFO cairns were used in association with spiritual activities remains unaswered.

Kay (1975:32-33) observes that relative dating based on lichen thickness and vitality suggests that the cairns at Agate Fossil Beds NM are relatively recent in age, i.e., less than 250 years old. He notes that they are not at all similar in morphology to cairns known to have been erected by sheep herders. On this basis, he suggests that the Agate Fossil Beds cairns were built by Native Americans fairly recently.

Schramm and Cook (1921:5) describe the construction of a benchmark east of the current Monument boundaries, which they used in their topographic mapping of the area. It is not impossible that some of the Monument cairns described by Kay as young may be owed to early surveyors and geologists.

Gaining chronological control of Monument cairns using thermoluminescence or lichen dating may help in determining who their authors were. As well, a systematic inspection of cairns along the Niobrara and on the High Plains may provide additional context, within the prehistoric and historic functions of cairns might be better appreciated.

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Table E-1. Cairns located during the 1994 survey of Agate Fossil Beds NM.

Cairn	Dimensions (cm)		Rock Attributes			Associated Artifacts	Site Designation
	Height	Diameter	Rock Count	Minimum Length (cm)	Maximum Length (cm)		
1	34	162	28	17	70	None	25SX282
2	15	93	30	10	43	Present	25SX282
3	15	148	38	8	31	None	25SX282
4	43	96	29	15	43	Present	25SX158?
5	25	156	29	13	50	Present	25SX158?
6	24	63	6	16	41	Present	25SX159?
7	9	114	15	5	20	None	25SX159?
8	41	227	70	8	33	None	25SX159?
9	27	48	5	27	35	None	25SX161?
10	35	138	44	10	42	None	25SX161?

? - Kay (1975) reported these sites. See text for a discussion of some problems with his designation.

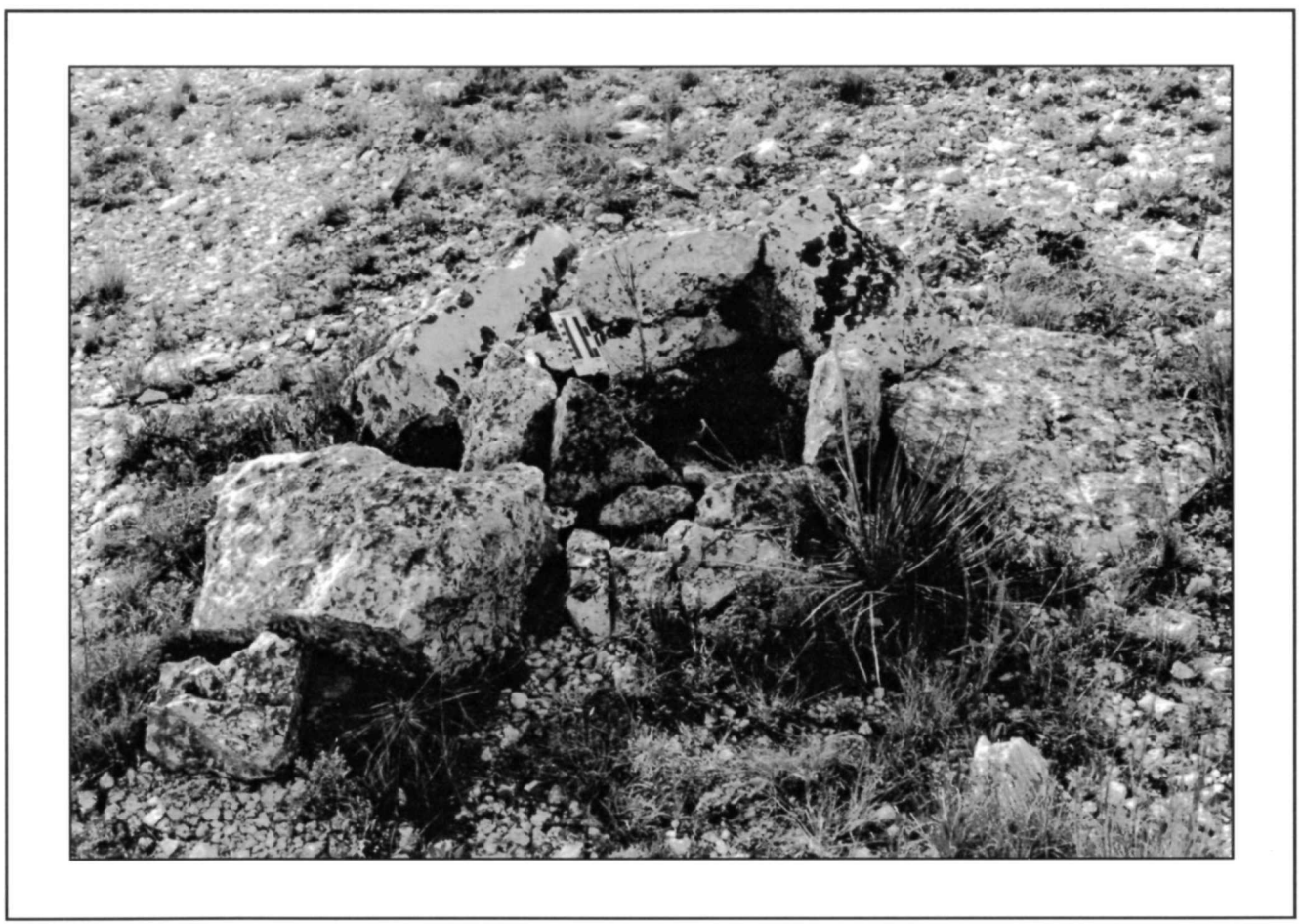


Figure E-1 Cairn 1, 25SX282 (facing northwest).

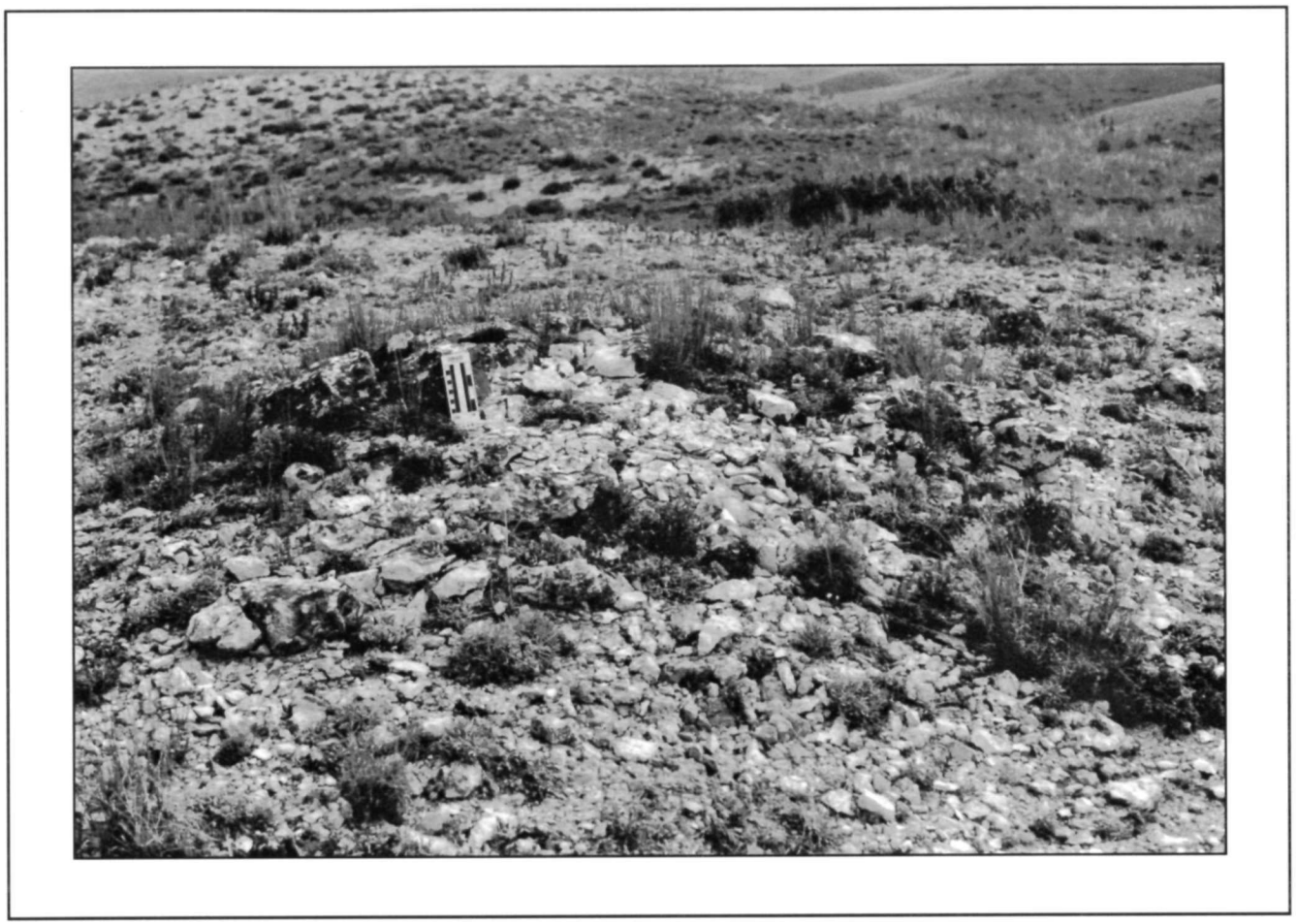


Figure E-2 Cairn 3, 25SX282 (facing west).



Figure E-3 Cairn 4, 25SX158 (facing northeast).



Figure E-4 Cairn 5, 25SX158 (facing west).

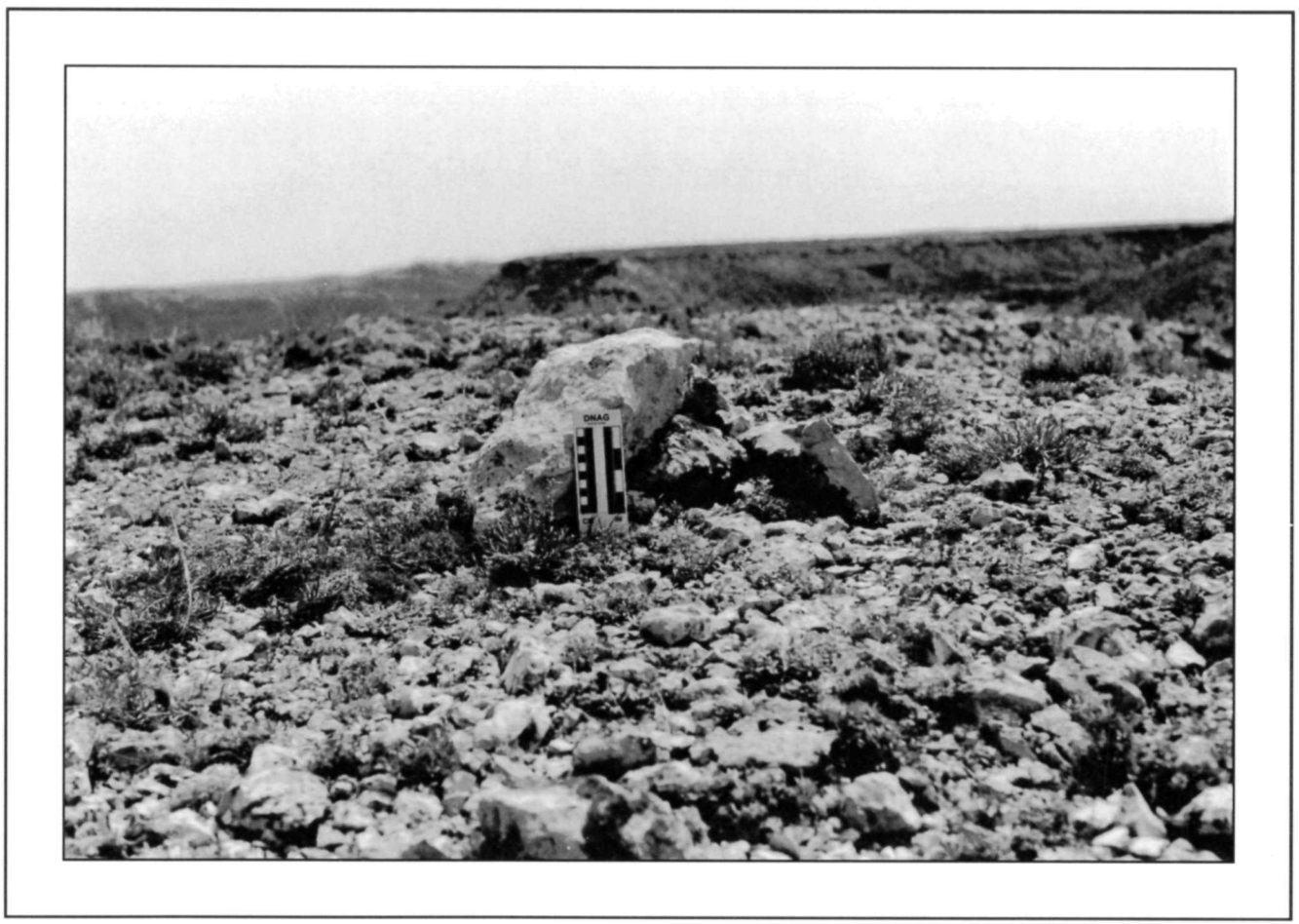


Figure E-5 Cairn 6, 25SX159 (facing east).



Figure E-6 Cairn 9, 25SX161 (facing west).

Figure E-7 Cairn 10, 25SX161 (facing north).

APPENDIX F
HISTORIC SITE AND ARTIFACT SUMMARY

LuAnn Wandsnider

A total of 52 historic and modern artifacts and 3 features distributed in 5 archaeological sites and 27 isolated finds were recorded during the 1994 pedestrian survey of Agate Fossil Beds NM. For the most part, these artifacts were cursorily described and left in place, since we had no special expertise with this class of archaeological materials. This appendix describes these materials.

HISTORIC ARTIFACTS

The historic artifacts included items of various materials. Metal artifacts—tractor parts, wire, and cans—were the most numerous, with wood scraps and then glass following in abundance (Table F-1).

As evident in Map F-1, the historic artifacts primarily are found in the east portion of the survey area and are notably absent from the western portion. This finding is consistent with the understanding that most of the historic bone-mining activities were located in and around Carnegie and University hills.

Also evident in Map F-1, metal artifacts are widely dispersed, relative to wooden and other artifacts. That such artifacts are involved in a wide variety of activities may be responsible for this pattern. It is not impossible, however, that other associated materials have decayed or been preferentially collected by avocational collectors.

A consideration of the 27 historic isolated finds reveals that scraps of wood dominate. A fragment of a wood and metal harness, a gas can, a tin drum, and tractor parts, as well as isolated cans, make up the remainder of the historic IF assemblage. Again, as these artifacts predominate in eastern part of the Monument, they are likely associated with historic bone-mining activities.

HISTORIC FEATURES AND SITES

Based on artifact frequencies and association with features, five historic archaeological sites were recognized.

25SX283 (Kelley Homestead)

The Kelley Homestead was designated as Site 25SX253. It consists of a foundation and well with relatively few associated artifacts, including metal screening and glass bottles. 25SX253 is distinctive by virtue of its location in the southwestern portion of the Monument, i.e., away from the center of bone-mining activities. Vegetation was very heavy here and it is likely that with devegetation, other artifacts would be exposed.

25SX284

Site 25SX284 refers to a tight cluster of artifacts that included tin cans, metal strips, glass, and a pipe. These artifacts were found on a low bench above the Niobrara (see Map F-1) with an excellent view of the Niobrara valley and the table and ridge system. 25SX284 may represent a historic age line camp or other ephemeral occupation.

25SX285

The gravestone of J. H. Cook was designated as 25SX285. It is located just off the Niobrara flood plain in high grass. No other associated artifacts were found.

Table F-1. Summary of historic artifacts.

Material	Frequency	Items
Ceramic	1	brick fragments
Glass	4	bottles, mason jar, brown glass
Metal	32	cans, can lids, aluminum tea kettle, wire mesh screen, gas can, wood and metal harness fragment, metal strips, buried pipe, bullet casing, tin drum, juice tin, barbed wire fragments, tin bucket, tractor part, fender
Wood	13	plank and plank fragments
Other	2	slab of concrete

25SX288

Site 25SX288 refers to a concentration of historic artifacts that include wood, tin cans, glass and concrete. It is located on a grassy hill slope below and northwest of Carnegie and University Hills in a survey unit that was not systematically surveyed. (As we traversed these units to visit artifacts that had been identified in other survey units, these artifacts were noted.) It is likely that other artifacts, perhaps derived from nearby bone-mining activities, exist in this area.

25SX289

The collection of tin cans with a plank was designated as 25SX289. This site is located just above the flood plain of the Niobrara River in a survey unit that was not systematically surveyed. These artifacts may be owed to historic bone-mining activities.

SUMMARY

The presence of historic remains in the southern portion of the Monument demonstrate that there is an archaeological signature to historic activities at Agate Fossil Beds NM. While I have suggested here that artifacts with an easterly provenance relate primarily to bone-mining operations, it is clear that homesteading and ranching activities may also have introduced these artifacts. As well, we know that Captain John Cook hosted many Sioux and Cheyenne visitors, who also may have contributed some of the items found here.

The systematic inspection of these remains in the context of a region-wide investigation of historic ranching and homesteading would be most revealing.

APPENDIX G
CHIPPED STONE ANALYTIC CODES

George H. MacDonell

Chipped Stone Codes

UNIT (Unit Number)

ITEMNO (Item Number)

UTMEAST (estimated UTM Easting; Zone 13)

UTMNORTH (estimated UTM Northing; Zone 13)

TYPE (Chipped Stone Type)

DB	debitage
FK	flake
OTH	other
TL	tool

STATUS (Flake Completeness)

CO	complete
BR	broken
FR	fragment

PORTION (Flake Portion)

DS	distal
NA	not applicable
ME	medial
PR	proximal

NEWMAT and **MATTYPE** (Material Type; MATTYPE is based on lithology and color; NEWMAT is an aggregation of MATTYPE that reflects material source)

AGT	Moss Agate (WT, CY, CC)
CLQ	Cloverly [Spanish Diggings] Quartzite (GQ, TQ, PQ, CQ, MQ, GT)
HUC	Hartville Uplift Chert (HUC, BR, RM)
OBS	obsidian (CB)
OTH	other
RED	red ochre
SHJ	Smoky Hills Jasper (YJ)
WRS	White River Group Silicates (TW, TZ)
UN1	unidentified 1 (TB, GB, PB)
UN2	unidentified 2 (PC, CW)
UN3	unidentified 3 (UN3)

SIZECLSS (Size Class)

1	0 - 10 mm
2	10 - 20 mm
3	20 - 30 mm
4	30 - 40 mm
5	40 - 50 mm
6	50 - 60 mm
7	60 - 70 mm

LENGTH (Length in mm)

WIDTH (Width in mm)

THICK (maximum Thickness in mm)

WEIGHT (Weight to the nearest 0.1 g)

EDGEANG (Edge Angle in degrees)

CORTEX (percent dorsal Cortex)

DFS (Dorsal Flake Scar Frequency)

EDTERM1-3 (Edge Termination)

BB	bend break
CB	compressed break
FE	feathered
ST	step fracture

MODIF (Modification)

FK	flaked
NO	none
PF	pressure flaked

COMMENT (Comment)

(Files may contain other fields carried over from in-field coding)