Domestic campsites and cyber landscapes in the Rocky Mountains

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The dwellings of prehistoric Native North Americans are amongst the hardest archaeological structures to find and characterise – they leave only a shallow ring of stones. But the authors show that, when recorded to modern levels of precision, these tipi-stances contain a wealth of information. The stone rings are mapped in detail by hand, and located by GPS, their hearths are located by fluxgate survey and sampled for radiocarbon dating, and the results displayed in layered maps on GIS. Different social groups had different floor plans, so that, even where artefacts are missing, the movement of peoples can be dated and mapped. The results also bring to the fore the great cultural value of these, the dominant monument types of Bighorn Canyon National Recreational Area.

Keywords: North American Plains, Central Rocky Mountains, GIS, GPS, stone circles, architecture, multi-scalar, households, technology, landscape, hunter-gatherers, contract archaeology, Section 106 compliance

Stone circles on the Northwestern Plains

> *'You have perhaps noticed on the northwestern plains, circles of stones or small boulders, varying in size from twelve to twenty and more feet in diameter. They were used to weight down the lower edges of lodge skins, to prevent the structure being blown over by a hard wind, and when camp was moved they were simply rolled off the leather' (Schultz 1907: 63).*

Stone circles, or tipi rings, are recognised as one of the only forms of preserved native domestic architecture on the North American Plains. Prior to the historic use of wooden

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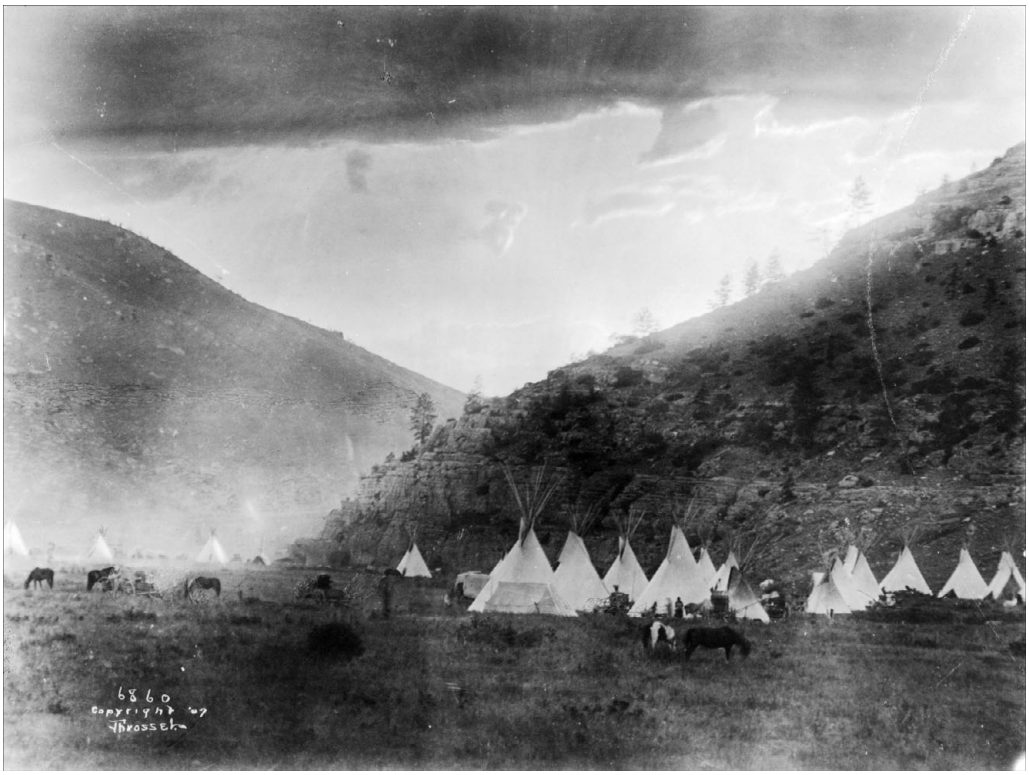

Figure 1. Home of the Mountain Crows, probably in Montana, tipis, horses and wagons occupying a flat clearing along a valley floor c. *1907. Photograph by Richard Throssel, Denver Public Library, Western History Collection (X-31210).*

stakes as tent pegs (Wissler 1908; Grinnell 1923), Plains Indians often used stones as tipi weights, especially in areas with plenty of rocks (Hind 1860; Grinnell 1892; MacLean 1897). Once the tent was removed, the stones stayed in place, preserving the footprint of the dwelling (Figures 1 and 2).

In an area like the Great Plains, that is dominated by archaeological discussions of Palaeoindians, bison hunting and animal butchering (Frison 1991), tipi rings are one way to study a wider range of hunter-gatherer activities. Stone circles allow archaeologists to determine social and economic organisation, use of space, ideology and daily lives (Reher 1983; Banks & Snortland 1995; Oetelaar 2000). While researchers recognise the potential of stone circles to contribute to larger anthropological research questions (Kehoe 1958; Davis 1983), these features have often been dismissed because they frequently lack associated artefacts and reliable chronological control. For example, only 1% of nearly 3000 stone circle sites in the state of Wyoming in Scheiber's (1993) thesis were securely dated. We believe, however, that stone circles constitute a rich source of information that supplies abundant archaeological data while also linking contemporary native people to their history and cosmovision through oral traditions (McCleary 1997; Oetelaar & Oetelaar 2006; Noble 2007; Zedeño 2008).

In this paper, we present a case study from the high-altitude desert at the western edge of the North American Plains (Figure 3). Nomadic hunter-gatherers occupied this region for thousands of years and left behind numerous indicators of their campsites, preserved as rock rings throughout the Rocky Mountain West and interior prairies. At Bighorn Canyon National Recreation Area (BICA) the sites form archaeological landscapes that are continuous throughout the 485km^2 of the park and provide a perfect opportunity for the study of settlement. This work primarily uses a non-invasive surface mapping technique, with minimum impact on the sites themselves.

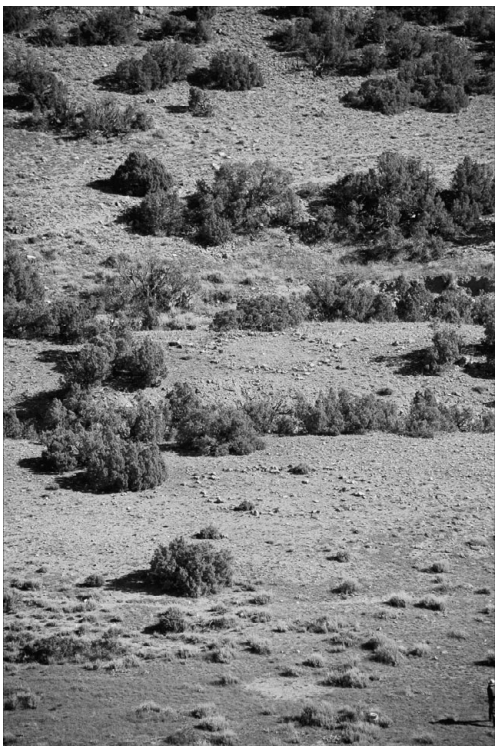

Figure 2. Surface visibility at Two Eagles stone circle site.

Stone circle archaeology

Nearly 4000 stone circle sites have now been documented in the state of Wyoming, with densities as high as 2.5 sites per square mile (Wolf 2008: 36). The sites are most often encountered and recorded through Section 106 (of the National Historic Preservation Act) compliance, although a few researchers continue to emphasise stone circles in their long-term investigations (Oetelaar 2003; Dooley 2004; Knapp *et al.* 2008; Reher & Weathermon 2008). The enthusiasm of the early 1980s, as to the anthropological potential of surface domestic stone architecture (Davis 1983), has dwindled in the published literature, and Section 106 contractors often write that nothing further can be learned from single sites (Scheiber 1993). These reports typically lack quantitative data that could be used for comparative purposes. Measurement and reporting are not standardised, and feature maps are often not provided. The perception that stone circle sites have limited research potential is based on low artefact frequencies, the shallow nature of deposits and difficulty in identifying associated groups of structures, i.e. settlements (Dooley 2004; Wolf 2008).

New recording guidelines have been established in the state of Montana (Montana State Historic Preservation Office 2002) and are being developed in the state of Wyoming (Wolf 2008), in order to improve data quality and consistency. The association of features in extended space is a key research target, but recognising area-wide patterns is challenging due to the nature of contract archaeology, which typically follows linear corridors. Area excavation is very rare in any context and, the few examples that do exist serve as reminders of the issues that could be addressed within a careful problem-oriented strategy (Olson 2001). In Wyoming, only seven stone circle sites were excavated between 1996 and 2005.

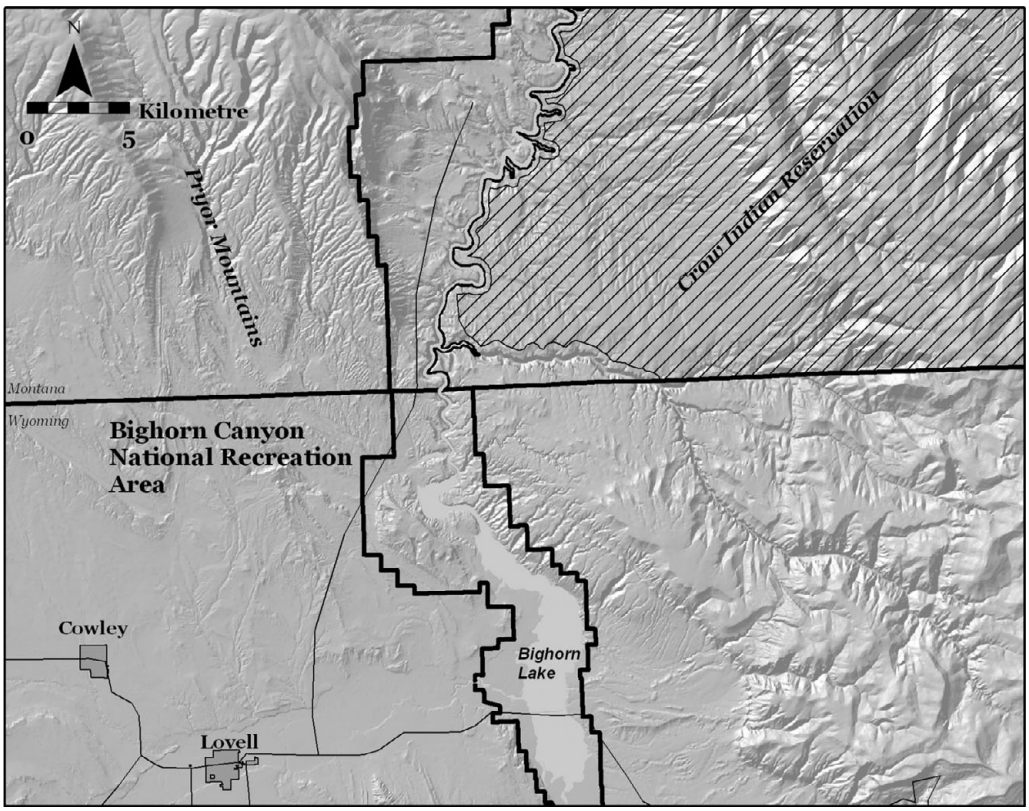

Figure 3. Map of Bighorn Canyon National Recreation Area and adjacent areas.

But with recent advances in spatial technology, it is possible to appreciate wider patterns and apply small targeted excavations to solving particular problems. Our work at Bighorn Canyon has afforded us the opportunity to test such an approach and examine broad patterns of landscape use and change through time.

Bighorn Canyon archaeology

Bighorn Canyon was established as a National Recreation Area in 1966 after the construction of the nearby Yellowtail Dam flooded the Bighorn River (Figure 4). The northern half of the park is largely encircled by the Crow Indian Reservation. It is well-known for its natural beauty, the Pryor Mountain wild horse herd, a successful bighorn sheep re-introduction programme, and a $13 000 000 per year recreational fishing industry. However, the cultural significance of the area is largely unrecognised. Most archaeology in the park was conducted between 1941 and 1974 as part of the River Basin Surveys in advance of dam construction (Husted 1969) or as mitigation for the trans-park road (Good & Loendorf 1974) (Figure 5).

In fact, stone circle sites represent one of the greatest archaeological resources managed by the park. Stone circle campsites are often closely associated with the Bad Pass Trail,

Figure 4. Overview of Bighorn Canyon.

Figure 5. Stone circle campsite located adjacent to the trans-park road.

an important prehistoric and historic travel corridor between the Bighorn Basin and High Plains to the south and the unglaciated Missouri Plateau to the north (Loendorf & Brownell 1980). Just over 19km (12 miles) of the Bad Pass Trail have been documented in the park with over 500 stone cairn markers (Wisehart 2005) (Figure 6).

Between 1968 and 1974, more than 120 stone circle sites were documented in the vicinity of Bighorn Canyon (Loendorf & Weston 1983), totalling more than 1800 individual rings. Loendorf and Weston (1983) excavated stone circles at two sites but obtained no chronological data. They attributed sparse or absent artefact assemblages at sites along travel corridors to brief occupations. Because modern travel routes follow aboriginal ones, we propose instead that the variation is a product of a century of recreational artefact collection and not aboriginal practice. We have documented numerous collectors' piles, left by individuals who collected all visible surface artefacts, culled those that were desirable, and deposited the rest in random piles. While earlier studies illustrate the magnitude of the task faced by archaeologists in documenting stone circles within the park, the results from the early 1980s do not accurately reflect the kinds of questions that can be answered through an integrated research agenda using multiple scales of analysis.

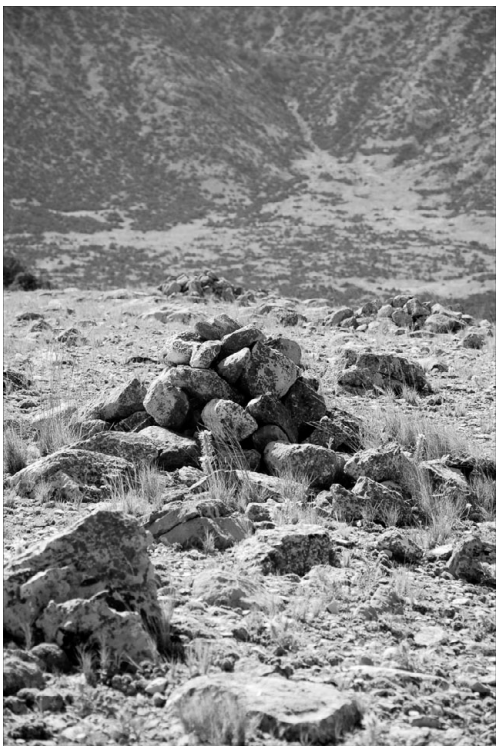

Figure 6. Cairns on the Bad Pass Trail.

Design

We designed a methodology for recording stone circles at Bighorn Canyon with the intent of addressing several research questions and management concerns. Using GIS, we created a cyber landscape consisting of stone circles, artefacts and other features. Although part of our methodology is a standard practice of field recording in some areas of the world (i.e. on-site use of computers and GPS devices) (McPherron *et al.* 2008), it is not standard or typical in much of North America, especially at shallow surface sites not dominated by monumental architecture, and certainly not at this scale of precision (sub-centimetre accuracy of individual stones).

Data collection is first aimed at addressing research questions regarding Plains Indian domestic life, household organisation and landscape formation. The late prehistory and history (*c*. AD 1500-1900) of the Central Rocky Mountains and Northwestern Plains was a socially dynamic era, with tribes such as the Crow and Shoshone migrating into the area

and claiming new territories as their traditional homelands (Nabokov & Loendorf 2004). We specifically question how migrant communities create a sense of place (Basso 1996) and how ethnic groups maintain their social identities during times of change, especially during increased contact with Europeans and Americans and continuing into enforced reservation settlement. These broad social issues should be manifested at the local and domestic level, preserved materially by stone circle architecture and related archaeological signatures. Bighorn Canyon is in the middle of the traditional Crow homeland as defined in the mid-nineteenth century.

Secondly, the project also addresses management concerns by collecting data that will be directly transferred to the current park GIS and by creating a database that includes spatial datasets along with individual attribute data on features and artefacts. This work establishes protocols for documenting stone circles throughout the park and region. Since stone circle sites are the primary archaeological resource at Bighorn Canyon, standardised data collection protocols are particularly relevant as the park prepares for large-scale data recovery projects designed to mitigate the imminent impacts of development. Our work at Bighorn Canyon is also part of a joint Indiana University (Bloomington, IN) and Northwest College (Powell, WY) archaeological field school that provides student training.

Method

Mapping

Since 2005, the authors have developed and implemented a multi-stage data collection methodology that allows us to conduct analysis at complementary levels. First, recorders draw accurate plans of each stone circle (Figure 7). Making individual feature maps is quick and efficient with the 'tipi-quick' method: a painted protractor on a board set in the middle of the ring, together with a tape give angle and distance for each individually-drawn stone. Although some archaeologists have eliminated hand-drawn plans from their recording systems, we believe it is both an essential skill for students to master and that it captures information that cannot be duplicated with digital equipment or photography alone.

We then use Magellan (formerly Thales) ProMark 3 single-frequency Global Positioning System (GPS) receivers to locate the individual stones, features and artefacts (Scheiber *et al.* 2008). We average 6mm accuracy vertically and horizontally (post-processed) with this data recovery system. We thus bring the precision already established for excavation at bonebeds and rockshelters of the North American Plains and Europe to surface architecture and activity areas. Locational data are uploaded on-site to ESRI ArcGIS software on a laptop computer.

One of the biggest advantages of GPS is the sub-centimetre precision of data points, with co-ordinates tied directly into the UTM system not just to local site grids. One of the biggest disadvantages is that the data from base and rover receivers must be reconciled and merged, although the use of dual-frequency RTK systems eliminates the need to post-process. In addition, the fixed base station co-ordinate data must be corrected against continuously operating reference stations (CORS), accessible via the Internet and only available with a satellite uplink in remote field camps.

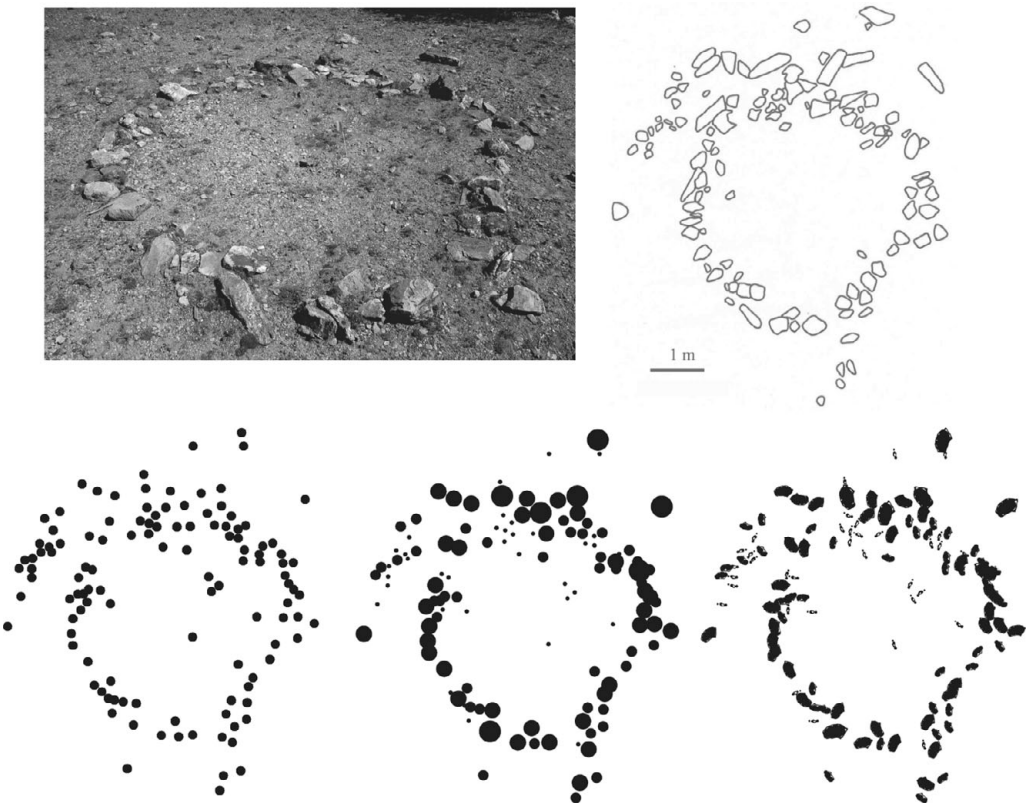

Figure 7. Visual representations of a tipi ring (BICA 08-02-SC1): photograph (top left), plan view map (top right), and electronic representations representing each rock (bottom left: unscaled circles; bottom middle: scaled circles based on graduated symbols of maximum length classified into four classes; bottom right: scaled rock shapes based on maximum length and rotated by rock orientation).

Attribute data (context and feature)

Team members record descriptive information for each rock, feature and artefact using hand-held Personal Data Assistants (PDAs) (Dell Axim X51v). PDA data recording is an efficient, high-speed process that reduces human transcription error and provides immediate compatibility with software programs like Microsoft Access. The Windows Mobile version of Access (Data on the Run) allows researchers to create drop-down menus to record qualitative data such as artefact type, which again reduces typing errors. PDA attribute collection covers a wide range of descriptive and quantitative data for each stone circle, including diameters, orientations and the presence or absence of doorway openings and associated features such as cooking hearths (Table 1). The attribute and coordinate data for each object are later merged into one database. In addition to traditional visual representations of stone circles through photographs and hand-drawn maps, the electronic data can be manipulated to highlight different attributes of the circle (Figure 7), depending on choice of scale and orientation.

Table 1. Major data categories recorded in each level of analysis.

Individual rock data (ROCK)	
Log number	Feature number
Site number	Maximum length (cm)
UTM easting	Maximum width (cm)
UTM northing	Long axis orientation (1-180°)
Elevation	Material
Individual stone circle data (STONE CIRCLE)	
Log number	Number of courses
Site number	Opening (present/absent)
UTM easting (centre of feature)	Opening orientation (1-360°)
UTM northing (centre of feature)	Opening width (cm)
Elevation (centre of feature)	Internal architecture (present/absent)*
Feature number	Internal architecture type
Maximum diameter (cm)	External architecture (present/absent)*
Minimum diameter (cm)	External architecture type
Long axis orientation (1-180°)	Percentage of buried stones
Short axis orientation (1-180°)	
Individual artefact data (ARTEFACT)	
Log number	Maximum length (cm) (tools)
Site number	Maximum width (cm) (tools)
UTM easting	Maximum thickness (tools)
UTM northing	Platform (present/absent)
Elevation	Platform type (plain, bevelled, faceted)
Artefact class (chipped stone, fauna, etc.)	Dorsal scars (number)
Lithic type (projectile point, flake, tool)	Historic artefact type
Lithic material	Animal taxa
Lithic size grade	Animal element

*This variable set is repeated as necessary to account for multiple types of internal/external architecture present.

Remote sensing

Geophysical survey provides an important window into subsurface deposits and has become a low-cost alternative for identifying archaeological signatures without area excavations. Contracted geophysical specialists conduct gradiometry surveys using a fluxgate gradiometer. Data are collected in 0.5m transects, with eight samples collected per linear metre for an overall data sample density of 16 samples per square metre. This step is particularly informative for guiding excavation decisions as it measures the differential magnetic properties of cultural features (stone circles and fire hearths) buried within unmodified geological matrices (Jones & Munson 2005). Subtle differences in properties of the alluvial sediments, bedrock and stones used for tipi rings make differentiating hearths and other features difficult, but overall this is a critical step in the program (Figure 8). We have also experimented with ground penetrating radar and electric resistivity at more deeply buried sites.

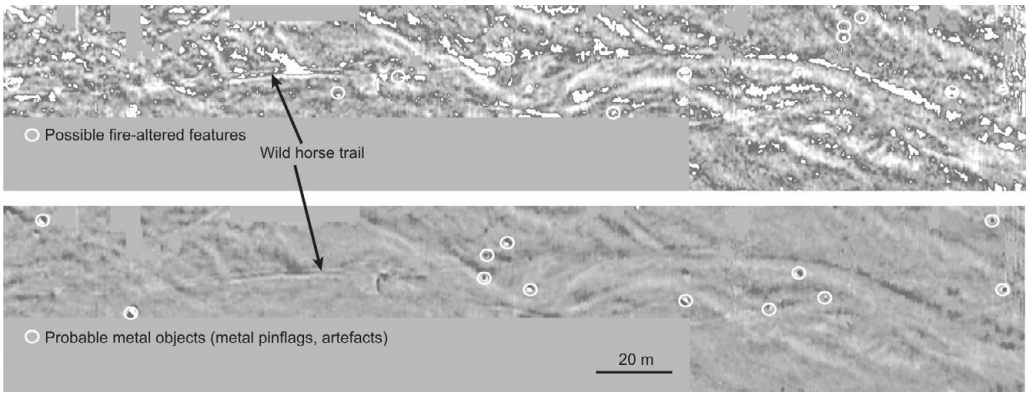

Figure 8. Gradiometry overview of BICA 08-01 showing possible archaeological features and artefacts.

Targeted excavation

Small-scale excavations allow the collection of datable charcoal samples from domestic hearths, located by remote sensing and surface observation. Typically no more than 15m^2 are excavated per site. Each 1m^2 unit is subdivided into hand-excavated 50cm^2 quads. All artefacts greater than 20mm maximum diameter, and all feature rocks and charcoal are mapped *in situ* using a total station electronic distance measurer (EDM), which is tied into the UTM grid. All excavated sediments are screened through 1/8" mesh hardware cloth. Shallow deposits generally mean that the units are no more than 5 to 15cm deep.

Results

Since 2005, we have recorded 9287 rocks from 143 stone circles and 108 other features at eight sites. We consider these sites to be part of a single archaeological landscape along documented travel segments of the Bad Pass Trail. Site boundaries are artificial at best, and counting the number of features per site is misleading. In addition, we documented attribute data on 1854 stone tools and lithic debitage. Geophysicists from Archaeo-Physics have surveyed 25 700m^2 with subsurface remote sensing equipment. We performed limited excavations within 13 stone circles, revealing occupations that span between 2500 and 300 years ago.

We are now in a position to characterise domestic landscapes within the study corridor. Variability in maximum and minimum diameters provides estimates of tipi size and potential number of occupants. Physical dimensions demonstrate the shape of the tipi base by comparing the ratio of minimum to maximum lengths. Tipi size is important in part because it is generally assumed that tipis became larger with the introduction of the horse during the eighteenth century. However, this is not necessarily the case, since other mobility factors, settlement strategies and social factors probably also influenced tipi size through time (Scheiber 1993). The shape of the base is relevant because only some Plains Indian tribal groups such as the Crow, Shoshone and Blackfeet historically used a four-pole tipi foundation (Driver 1969), which creates a more circular floor plan compared to the oval shape produced by a three-pole foundation. The average ratio of the minimum to maximum

diameters (shape) is 96%, which suggests a more circular than oval floor plan consistent with four-pole foundations. This variable is one way to explore ethnic identity at Plains hunter-gatherer campsites. The four poles of the Crow tipi symbolically represent the boundaries of their traditional homeland, further cementing the everyday relationship between domestic life and cosmology.

The Bighorn Canyon tipi rings show considerable variation, with maximum diameters ranging from 160 to 854cm (Table 2). Minimum diameters range from 130 to 790cm. Smaller sizes may have served as the bases for structures that functioned as other than primary residences, such as sweat lodges, children's tipis and dog tipis. Some of the larger rings may represent ceremonial and community structures. The mean maximum and minimum diameters for the 143 analysed tipi rings are 577 and 522cm, respectively. Historic tipis, as recorded by early ethnographers during the nineteenth and early twentieth centuries, generally ranged from 14 to 16 feet (426 to 488cm) in diameter (Scheiber 1993). Future studies will examine temporal changes in stone circle size.

Data for the long axis and doorway orientations are explored through the use of rose diagrams, which display variance within radial data sets (Mardia 1972; McPherron & Dibble 2007) (Figure 9). The average long axis of all recorded stone circles is 166°, a south-south-east direction, most closely aligned with the midwinter sunrise. This pattern may be due to prevailing north-westerly winds, maximising sun warmth, camp orientation (facing inside a camp circle), topography (facing along a ridge or stream), ethnic affiliation and structure type. The orientations of the aggregated data set ($n = 144$) is only slightly significant ($p = 0.04$). As a point of comparison, Neolithic communal tombs often face the midsummer sunrise (Hoskin 2008) and Neolithic long houses are sometimes oriented to the geographic area of that community's origins (Bradley 2001). The recognisable doorways are commonly positioned perpendicular to the long axis, although only 37% of the rings have definite openings. The average doorway is located at 36°, a north-east direction. This orientation most closely represents the midsummer sunrise. The orientation of the recognisable doorways ($n = 54$) is highly significant ($p<0.01$).

Internal architecture is present in 43% ($n = 62$) of stone circles. Fire hearths are the most common form of internal architecture with 57 of the 62 documented architectural elements consisting of hearths. Hearths are less common outside of stone circles, constituting only 9% of the total external architecture. Stone alignments and cairns, thought to represent meat drying racks, are the most common type of external architecture.

Dating

Beta Analytic Laboratory dated charcoal from internal features at ten rings (Table 3). Every site under investigation is represented by at least one date. Although our sample is small, through decisions based on the integrated application of detailed surface mapping and remote sensing, we have dated 77% (10 of 13) of the stone circles tested through limited excavations. This is an unprecedented record of tipi campsite use by native peoples on the Plains, especially given the extremely low number (1%) of securely dated stone circle sites for the entire state of Wyoming. Multiple temporal assessments at single sites further demonstrate that these areas were probably occupied sequentially as opposed to at the same

Table 2. Summary statistics of key analytical variables of Bighorn Canyon stone circles.

a. Dimensions

	Minimum (cm)	Maximum (cm)	Mean (cm)	Median (cm)	Mode (cm)
Maximum diameter	160	854	577	575	560
Minimum diameter	130	790	522	530	550

b. Orientations

	Mean (degrees)
Long axis orientation	166.2
Doorway orientation	35.5

c. Architecture

	Frequency	%
Opening		
Present	53	37
Absent	90	63
Internal architecture		
Present	62	43
Absent	81	57
Internal hearth		
Present	57	40
Absent	86	60
External architecture		
Present	33	23
Absent	110	77
External hearth		
Present	13	9
Absent	130	91

time (Dooley 2004). The oldest ring dates to the Late Archaic period, 2500 years ago. Distinct patterns emerge at AD 700-1000 and AD 1300-1500, corresponding with the early Late Prehistoric and terminal Late Prehistoric (Figure 10). The increase in dated rings at these times may be due to increased regional population, increased use of the Bad Pass trail, and/or new migrants into the area. The later dates may correspond to Crow migrations from their Hidatsa homeland along the Missouri River in North Dakota (Frison 1967;

Table 3. Radiocarbon dates from Bighorn Canyon stone circles.

Sample no.	Lab no.	Sample type	$^{13}C/^{12}$ Ratio (‰)	Conventional age	Two sigma calibration (cal BP)*	Two sigma calibration (cal BC/AD)*
BICA-06-01-SC9	Beta 228081	Charcoal	−21.2	2510±50	2360-2750	800-410 BC
BICA-06-02-SC1	Beta 230306	Charcoal	−22.6	330±40	300-500	AD 1450-1650
BICA-06-02-SC3	Beta 228083	Charcoal	−21.7	360±40	310-510	AD 1440-1640
BICA-07-01-SC5	Beta 233441	Charcoal	−21.8	980±40	790-960	AD 990-1160
BICA-07-01-SC11	Beta 233442	Charcoal	−22.4	470±40	490-540	AD 1410-1460
BICA-07-01-SC17b	Beta 235406	Charcoal	−21.2	630±40	540-670	AD 1280-1410
BICA-08-01-SC8	Beta 247264	Charcoal	−24.8	550±40	510-640	AD 1310-1440
BICA-08-01-SC34	Beta 247265	Charcoal	−21.8	1180±40	980-1230	AD 720-970
BICA-08-01-SC36	Beta 247266	Charcoal	−20.4	1050±40	920-1050	AD 900-1030
BICA-08-01-SC42	Beta 247267	Charcoal	−20.8	450±40	470-540	AD 1420-1480

*Calibrated ages follow Stuiver *et al.* (2005) using the INTCAL04 dataset.

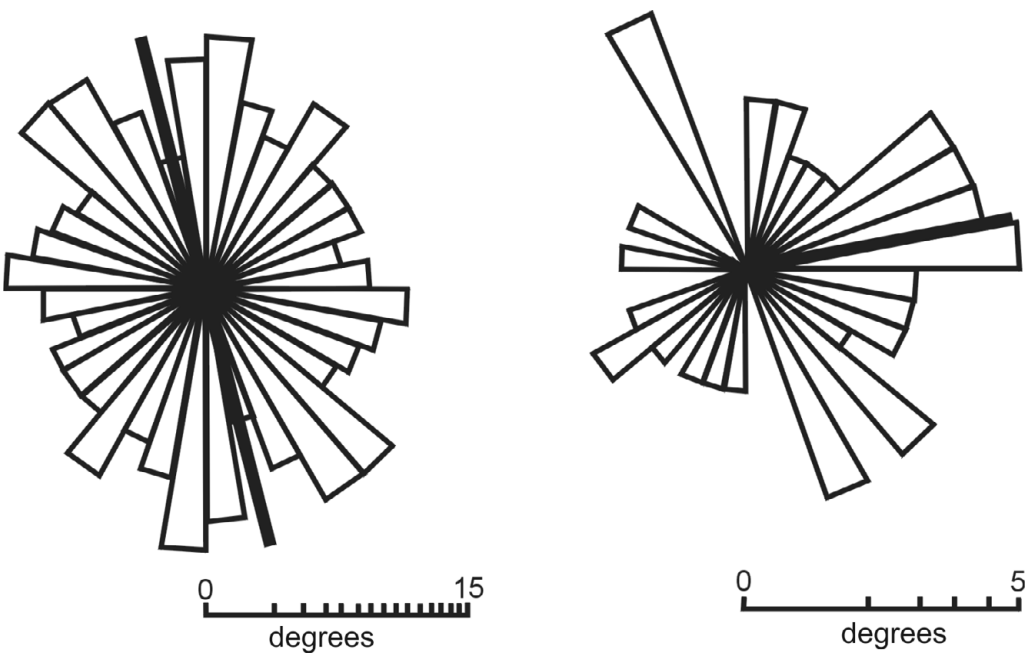

Figure 9. Rose diagrams: long axis orientations (X = 166°) (left); doorway orientations (X = 36°) (right).

Wood & Downer 1977; Medicine Crow 2000). The overall pattern of dated stone circle sites at Bighorn Canyon follows the general trend for dated stone circles in the state of Wyoming, in which the majority are dated to the Late Prehistoric post 1500 years ago, more specifically 500-1000 BP (AD 950-1450). Rock, artefact and stone circle data overlaying digital orthophoto imagery in GIS provides interesting results relating to camp organisation, distance to resources, topographic variation and potential site disturbance (Figure 11).

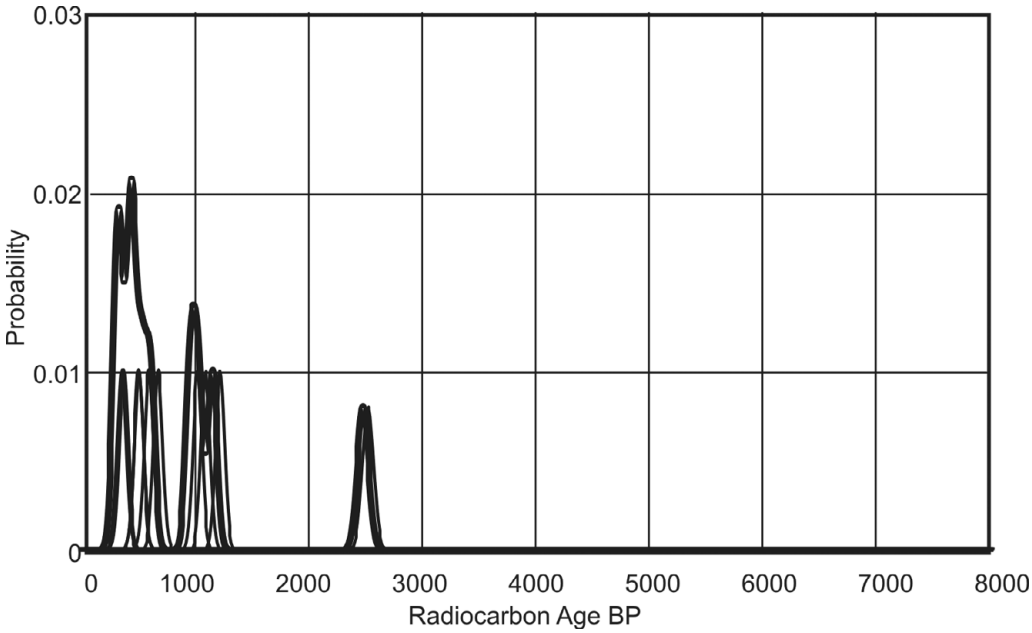

Figure 10. Radiocarbon-age bar chart.

Discussion and conclusions

While stone circles have been a topic of archaeological research in the western North American Great Plains since the 1950s, the passing decades have seen few advances in methodological applications and, subsequently, no refinements of interpretations. We show that applications of high-resolution mapping and surveying techniques combined with geophysical survey are capable of providing many of the baseline data required in archaeological interpretations that have been historically viewed as absent in stone circle sites. In particular, we show that it is possible to build occupational chronologies with which diachronic analyses of basic attribute data become more relevant. This ability is especially important at ephemeral sites like mobile hunter-gatherer campsites (see Seymour 2009). Tipi rings at Bighorn Canyon are primarily an early Late Prehistoric and terminal Late Prehistoric phenomenon, the latter likely associated with the Crow migration into the mountains and western plains of Wyoming and Montana. Most tipi rings are circular, reflecting the four-pole foundation used only by the Crow, Blackfeet and Shoshone. While we cannot conclusively assign these sites to a Crow ethnic affiliation, they figure centrally in notions of modern Crow social history and social geography.

We argue that domestic life in nomadic tipi camps is critical to the development and maintenance of social landscapes and identity, particularly among recent migrant communities such as the Crow. For example, the Crow word for prehistory, or something that happened in the past, is *Biiaakashissihipee*, translated as 'when we used stones to weigh down our lodges' (Tim McCleary *pers. comm.*). In Crow oral tradition, an individual named *Uuwatisee* or 'Big Metal' brought wood stakes to the people, thus signalling the beginning of a new era – the transition from stone to steel technology, and ultimately the end of a

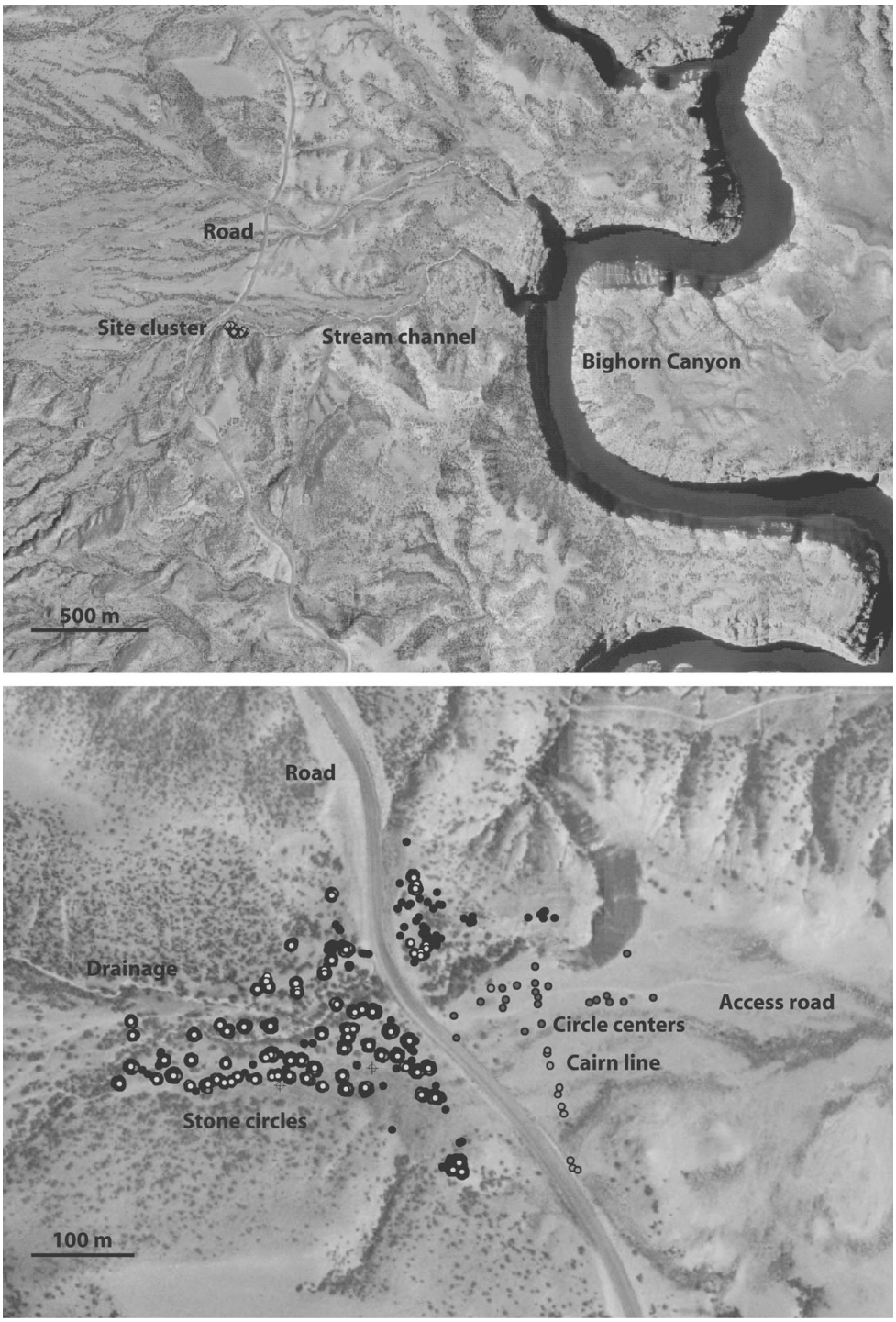

Figure 11. Locational data overlay on orthophoto maps (top: Mustang Flat site cluster at BICA-07-01; bottom: Two Eagles site details at BICA 08-01 and 08-02).

traditionally nomadic lifestyle (Old Coyote 1985). Stone circles act as mnemonic devices that link descendants to ancestors across space and time. Such actions, recounted through oral histories, are critical to modern notions of tribal identity. Although many of the stone circles at Bighorn Canyon may pre-date Crow migrations into the area, Crow ancestors certainly occupied some of the campsites. All of the circles in the park are at least metaphorically associated with the Crow, as the park is solidly part of their homeland.

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