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The Debarard Earth Oven (48AB3354): See Koenig et al., this issue.

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THE DEBARARD EARTH OVEN (48AB3354): HOT ROCK COOKING IN THE LARAMIE BASIN

by
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ABSTRACT

In April 2021, an earth oven feature was identified eroding from a Laramie River terrace (48AB3354). The oven consists of a thick zone of charcoal and carbon-stained sediment overlain by a layer of fire-cracked sandstone, all within a shallow depression and capped by alluvium. Below the feature were several unburned fragments of large mammal bone, but no other artifacts were observed. Although no formal testing was conducted, the feature was profiled and samples were collected for radiocarbon dating and Zooarchaeology by Mass Spectrometry (ZooMS). Results demonstrate the feature was used during the Late Prehistoric period (633-532 cal BP), and the fragmentary faunal remains were bison (*Bison bison*). The estimated size of the earth oven heating element at AB3354 is similar to other earth ovens from Albany County (<100 kg of rock), which are all substantially smaller than the larger earth ovens likely associated with bulk geophyte processing in western Wyoming. This relatively small size, combined with the presence of large mammal bones, suggests the oven at AB3354 may have been used as a meat oven for cooking large ungulates—akin to other earth ovens in Albany County. Additional research of earth oven features in southeast Wyoming can evaluate whether meat ovens are more common in the Laramie Basin than ovens for cooking geophytes and other plant resources.

INTRODUCTION

In April 2021, a hearth feature eroding out of the eastern bank of the Laramie River was reported to Todd Surovell. Upon visiting the site, the presence of burned sandstone overlaying a thick zone of charcoal and carbon-rich sediment indicated the feature was not a hearth but rather an earth oven used for pit-cooking foods (Black and Thoms 2014). The DeBarard earth oven (48AB3554), named after the landowner, is approximately one-meter in diameter and contains 50-100 kg of Frontier Sandstone. These dimensions are fairly large for features in the Laramie Basin, but substantially smaller than the large geophyte ovens of Western Wyoming and the Pacific Northwest (Francis 1995; Thoms 1989). The AB3554 feature is also more informal compared to the slab-lined, cylindrical ovens found across much of the state (Smith et al. 2001; Smith and McNees 1999; Thompson and Pastor 1995). We profiled the earth oven at AB3554 and documented the stratigraphic context, noting several large mammal bones within the feature and stratigraphically below the pit fill. No chipped-stone artifacts were observed, and no artifacts or ecofacts which may have been associated with the cooked foods were observed above the heating element. Importantly, we also recognized the nearest source of the Frontier Sandstone used as the heating element as approximately 800 meters from the site.

Because a relatively small sample of earth ovens from the Laramie Basin have been analyzed, charcoal was collected for radiocarbon dating and a sample of bone was collected for Zooarchaeology by Mass Spectrometry (ZooMS) analysis (Buckley et al. 2009). The radiocarbon date of (633-532 cal BP) places the use of the feature in the latter part of the Late Prehistoric Period (Kornfeld et al. 2010). The large bone fragment collected from beneath the feature can be classified as bison (*Bison bison*) based on ZooMS spectra peak alignment, and given the stratigraphic positioning, we suspect these faunal remains were associated with a previous oven firing rather than random alluvial ecofacts. Based

on the overall size of the oven and the association with bison remains, we suspect the DeBarard earth oven was a re-used meat oven rather than a feature for cooking tubers or geophytes. Although additional formal testing would be necessary to fully evaluate this hypothesis, there is clear evidence at the Joe Miller site (AB18; Burnett et al. 2008) that earth ovens were used to bulk process large game associated with mass kills in the Laramie Basin. If the DeBarard oven is indeed a meat oven, then it is also plausible an extensive Late Prehistoric site may be present within the alluvial terrace.

EARTH OVEN FEATURES IN WYOMING

Earth oven cooking features—frequently referred to as roasting pits—are common occurrences in the archaeological record of Wyoming and are perhaps best-recognized from the concentrations of fire-cracked rock (FCR) or fire-altered rock (FAR) which are the remnants of earth oven heating elements (Black and Thoms 2014). Earth ovens are layered arrangements of heated rocks, packing material, food, and an earthen cap which cook food underground in a moist environment through a process called hydrolysis: the breakdown of complex molecules via the uptake of a water molecule (Wandsnider 1997:4). In most instances, rocks are heated in a fire to serve as a heating element, green packing material and food are placed above the rocks once the wood has burned away, and the feature is sealed with a thick layer of earth (Black and Thoms 2014:208-209). The cooking temperature within an earth oven is generally maintained near 100°C, which allows foods with complex carbohydrate chains the required cooking time to successfully convert indigestible carbohydrates into digestible components (Thoms et al. 2018; Wandsnider 1997).

Each time an earth oven is built and fired, it is disassembled to remove the cooked food and ready the pit for reuse (Black and Thoms 2014:209). This process of oven reuse can generate substantial debris rings around a single oven pit, primarily in the form of spent cooking stone (FCR too small to retain heat), but also ash, charcoal, and the charred and uncharred remains of foodstuffs. Larger accumulations associated with earth ovens are termed burned rock middens, roasting pits, or earth oven facilities (Koenig and Miller 2023).

Based on archaeological, ethnographic, and contemporary records of Indigenous foodways, earth ovens in Wyoming were used to cook a variety of plant and animal resources, including sego lily (*Calochortus nuttallii*), biscuitroot (*Lomatium* sp.), camas (*Camassia* sp.), onion (*Allium* sp.), bison (*Bison bison*), elk (*Cervus canadensis*), bear (*Ursus* sp.), pronghorn (*Antilocapra americana*), and rabbits (Eckles and Wedel 1999; Francis 1995; Millington and Burnett 2008; Smith et al. 2001; Smith and McNees 1999; see also Rood [2018] for possible rock-less rabbit ovens). The variation of Wyoming oven features, from the smaller, cylindrical features to larger, informal ovens, likely corresponds to the different foods cooked. For instance, the cylindrical ovens (slab lined and not) were likely associated with small-scale geophyte or meat cooking (Joyce et al. 2022; Smith et al. 2001; Smith and McNees 1999; Wandsnider 1997) whereas the larger features are for bulk processing geophytes or large faunal resources (Francis 1995; Millington and Burnett 2008; Page 2017). Regardless of the variation in size, earth ovens are an important technology because they convert the fatty, starchy, or inulin-rich resources into digestible fats and carbohydrates (Thoms et al. 2018; Wandsnider 1997). This technology opened new subsistence resources to Indigenous peoples across North America (Thoms 2009), and earth ovens became increasingly important within domestic and non-domestic settings throughout the Holocene (Koenig and Miller 2023).

ALBANY COUNTY EARTH OVENS

Within Albany County, two sites provide the best sample of excavated earth oven features (Table 1): China Wall (AB1) and Joe Miller (AB18). The earth ovens from both sites, identified here as informal, shallow pits containing FCR, are fairly small (<1 m diameter) with total FCR masses ranging from 0.75-89 kg (Figure 1). Most features (23 of 27) date from ca. 1000-2000 cal BP, and none of the features at AB1 or AB18 are of the cylindrical variety. The earth ovens at the Joe Miller site are associated with the fragmentary remains of at least 11 elk and four pronghorn (Kennedy and Burnett 2008), suggesting the features were used to cook meat. Ethnographically, the use of earth ovens for cooking different meats is common (Wandsnider 1997:Table 5), and

Table 1: Summary of Earth Ovens Excavated from the China Wall (AB1) and Joe Miller (AB18) Sites.[a]

Site	Feature	Age (RCYBP)	cal BP (95.4%)[b]	cal BP Median	Dimensions (cm)	Estimated Volume (m^3)	FCR mass (kg)	FCR Density (kg/m^3)	FCR Count	Lithic Count	Bone Count
AB1	1	3760±70	4403-3924	4129	46x42x8	0.02	39	2523.29	47	9	5
AB1	2	1380±40	1355-1177	1299	70x70x25	0.12	39	318.37	90	8	21
AB1	14	1160±70	1267-930	1077	65x65x23	0.10	14	144.07	n/a	3	15
AB1	15	1660±60	1700-1404	1545	56x36x14 (truncated)	0.03	14	496.03	71	1	14
AB1	16	1330±60	1349-1078	1243	43x14x7	0.00	0.75	177.98	26	1	0
AB1	18	1220±60	1284-978	1141	73x45x11 (truncated)	0.04	13.5	373.60	62	1	0
AB1	21	2560±70	2779-2369	2619	65x44x10	0.03	21.5	751.75	85	0	0
AB1	22	1780±80	1886-1518	1670	37x40x? (truncated)	0.00	2	1351.35	32	0	0
AB1	25	1640±40	1688-1408	1515	57x80x5	0.02	n/a	n/a	5	1	5
AB1	26	620±40	660-545	602	64x30x15	0.03	n/a	n/a	4	2	4
AB1	29	1840±80	1930-1548	1749	51x?x23 (truncated)	0.06	19.5	325.96	25	0	4
AB1	30	2000±60	2111-1749	1934	70x60x9	0.04	28	740.74	19	0	4
AB1	32	1190±70	1273-959	1110	40x25x5	0.01	1.75	350.00	n/a	0	0
AB1	33	1720±70	1745-1412	1612	58x40x7	0.02	2	123.15	n/a	0	0
AB1	34	1580±70	1687-1313	1462	50x42x7	0.01	1.5	102.04	n/a	7	1
AB1	35	640±70	685-525	607	46x42x8	0.02	1	64.70	n/a	0	0
AB1	36	1390±60	1392-1176	1304	72x60x10	0.04	6	138.89	n/a	2	4
AB1	37	1940±70	2048-1705	1862	50x50x7	0.02	3.5	200.00	n/a	2	0
AB1	38	1010±70	1062-744	909	41x38x5	0.01	n/a	n/a	2	0	0
AB1	40	1770±60	1820-1537	1655	50x45x7	0.02	1.75	111.11	n/a	1	1
AB1	41	1350±60	1362-1127	1265	50x50x11	0.03	4.5	163.64	n/a	0	0
AB1	42	1450±60	1515-1276	1344	50x50x15	0.04	13	346.67	n/a	7	1
AB1	43	1270±60	1296-1065	1200	60x65x11	0.04	9.25	215.62	n/a	1	0
AB18	1	1510±40	1515-1307	1383	96x86x21	0.17	89	513.34	258	n/a	n/a
AB18	2	1735±35, 1780±40, 1560±70	1705-1545 1775-1546 1574-1305	1623 1657 1448	53x39x31	0.06	22.75	355.04	104	n/a	n/a
AB18	3	1680±35	1698-1420	1572	82x75x23	0.14	40	282.79	141	n/a	n/a
AB18	4	--	--	--	63x53x11	0.04	9.3	253.21	31	n/a	n/a
AB18	5	1605±35	1542-1401	1473	59x52x20	0.06	26.75	435.95	218	n/a	n/a
AB18	6	--	--	--	69x54x28	0.10	15.25	146.17	69	n/a	n/a
AB18	7	1610±40	1567-1389	1476	73x61x14	0.06	18.6	298.35	141	n/a	n/a

[a] Data compiled from Burnett and colleagues (2008) and Waitkus (2013).

[b] 95.4% confidence intervals from OxCal 4.4 (Bronk Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

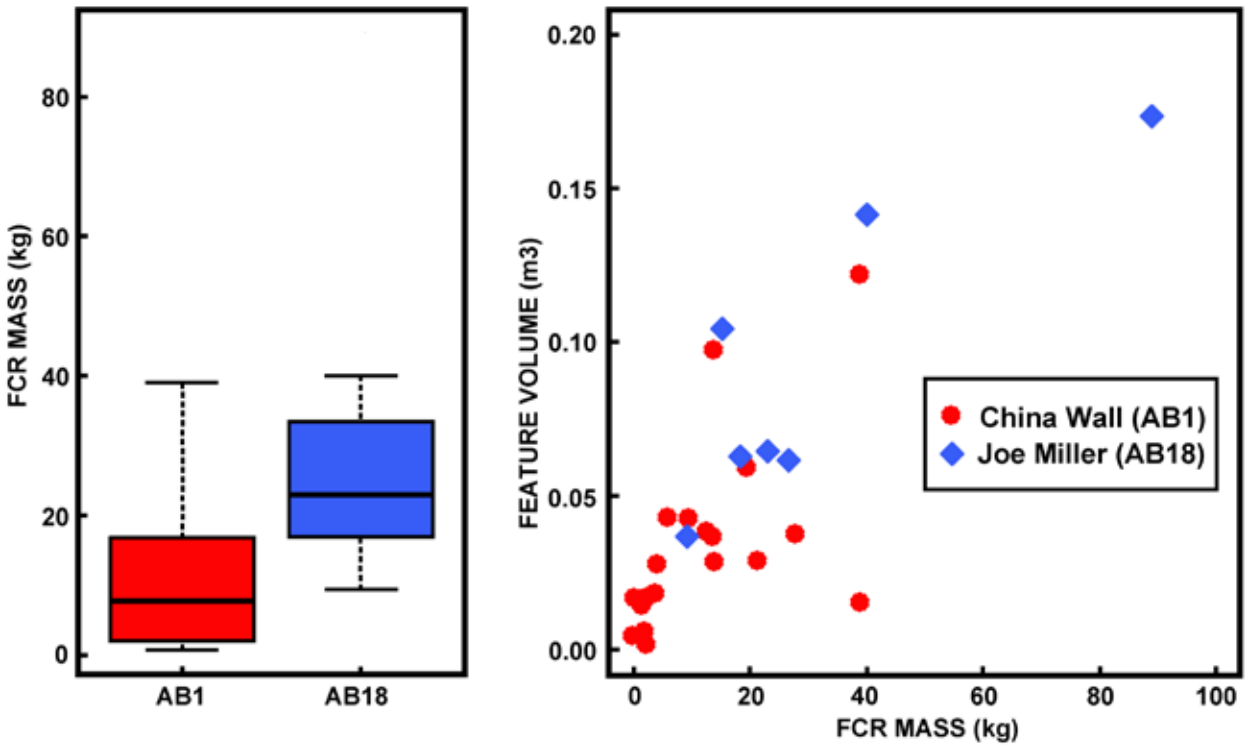

Figure 1: Sizes of excavated earth oven heating elements at China Wall (AB1) and Joe Miller (AB18). These features are substantially smaller than the large geophyte ovens in western and northwestern Wyoming, some of which contain nearly 300 kg of rock (Francis 1995).

feature size should likely correspond with either the total volume of meat (more meat, bigger oven) or the fat content (higher fat, bigger heating element; Wandsnider 1997). Since the faunal assemblage at Joe Miller suggests primarily the same type of resource (elk), it is likely the variable sizes of the heating elements (~15-89 kg of FCR) either corresponds with varying quantities or specific elements.

Most features at China Wall are smaller than those at the Joe Miller site (<15 kg FCR) suggesting they were likely used to cook small quantities of meat or starchy geophytes which require short cooking times rather than longer cooking times associated with large quantities of food or inulin-rich geophytes (Smith et al. 2001; Thoms et al. 2018; Wandsnider 1997). However, there are five features at China Wall (Features 1, 2, 21, 29, and 30) which have the same size heating elements as Joe Miller. The size of the heating elements combined with the presence of high densities of burned and calcined medium to large mammal bones (deer, antelope, bison, sheep, and possibly elk; Wassil et al. 2013) indicated at least some of the China Wall features were used to cook larger quantities or specific cuts of meat. The association between earth ovens and faunal remains in Albany County is markedly different than the cylindrical features in other areas of Wyoming where a lack of faunal remains can be used to infer plant processing (Smith et al. 2001:171).

AB3354: THE DEBARARD EARTH OVEN

The DeBarard Earth Oven was identified eroding out of the right bank of the Laramie River in southern Albany County (Figures 2 and 3). The T1 terrace is roughly two meters in height, with terrace sediments composed primarily of bedload alluvium (coarse sands and fine gravels), with a moderately well-developed soil on the modern ground surface. The earth oven is located about 75 cm beneath the current surface.

The feature itself measures approximately 120 cm wide by 30 cm in depth (Figure 4), although its upper contact appears to be erosional so it could have been deeper during use. The bottom of the feature/oven pit boundary is identifiable based on the sediment change from course-grained Laramie River alluvium to carbon-stained, fine-grained organic material. This zone of charcoal and carbon

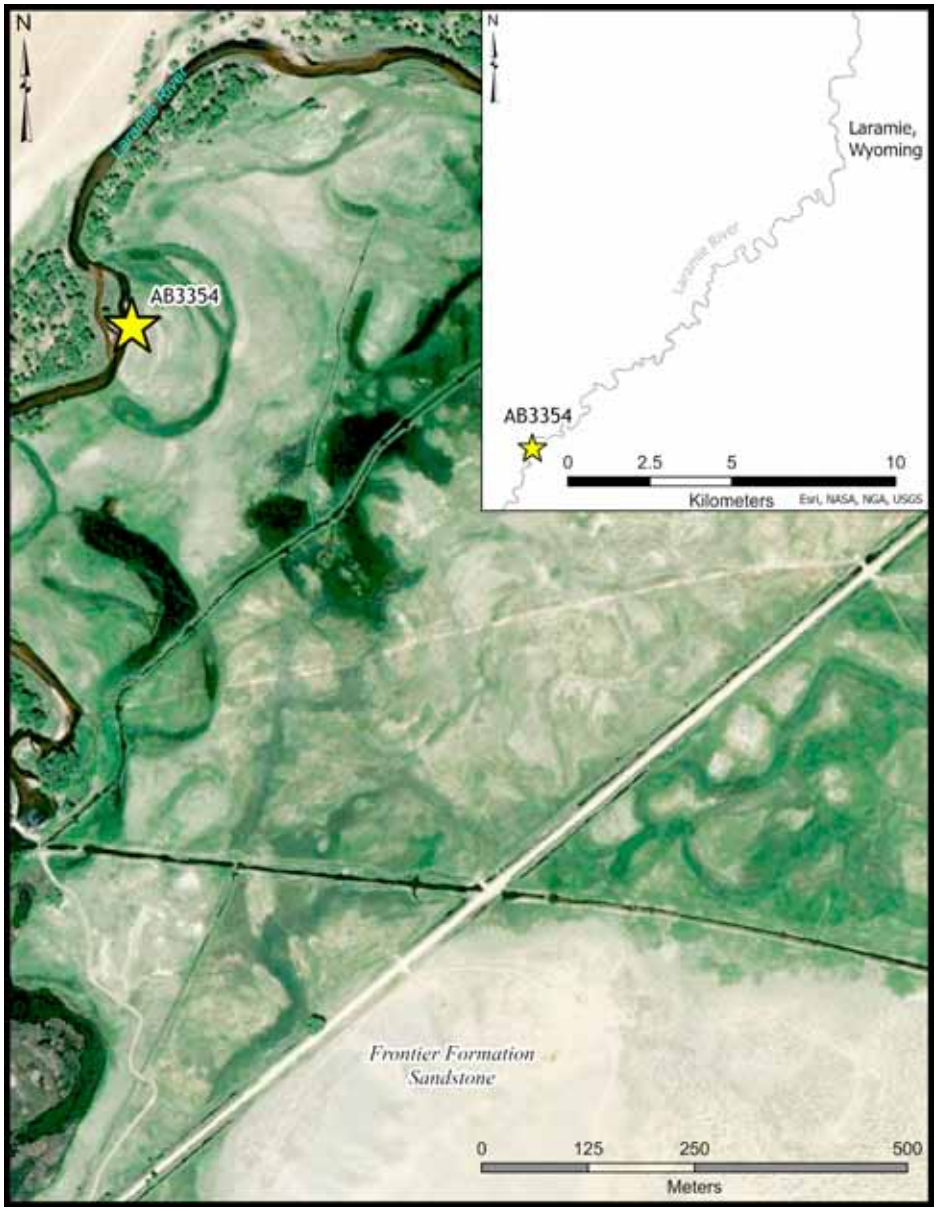

Figure 2: Location of AB3354 relative to Laramie, Wyoming (inset) and the relationship between AB3354 and likely source of the sandstone rock used as the heating element.

staining averages five cm thick, and is overlain by at least 15 large, burned, angular, carbon-stained sandstone clasts. An additional 18 sandstone rocks were found in sloughed material on the face of the terrace. Based on the amount of FCR observed, we estimate the total rock mass within the feature is between 50-100 kg. Importantly, the sandstone is not available in the immediate site area but likely originated from an outcrop of Frontier Sandstone located about 800 m southeast (Figure 2).

The only other artifacts/ecofacts identified were three pieces of large mammal bone (identified in the field as large ungulate) observed in the fill beneath the large sandstone clasts. We did not observe bone at any other location in the terrace, and based on the close spatial association with the feature, we are interpreting these bones as evidence of what was cooked in a previous oven. In other words, the bones are likely from a previous oven built in the same pit, and the bones were left in the bottom of the pit before the documented oven was constructed. This also demonstrates the repeated use of the DeBarard feature, which is common with earth oven technology (Black and Thoms 2014). The low temperatures

Figure 3: View of AB3354 facing east. Feature is visible in cutbank center near the tape.

beneath oven fires may not burn or carbonize bones from previous events (Hladek 2022), explaining the unburned nature of the recovered bone fragments. This lack of carbonization at the bottom of a thermal feature contrasts sharply with temperatures and carbonization of organic material within the fire's combustion zone (Bach 1997).

ZOOARCHAEOLOGY BY MASS SPECTROMETRY

ZooMS, first developed just over a decade ago, is a peptide mass fingerprinting method which extracts Type I collagen (COL1) from bone and provides the ability to perform taxonomic identification of trypsin-digested collagen using a matrix assisted laser desorption/ionization time-of-flight mass spectrometer (MALDI-TOF-MS; Buckley et al. 2009; Ritcher et al. 2022). This zooarchaeological method is a particularly useful approach to analyzing faunal assemblages where diagnostic osteological features are not present, as in the case with the bone fragment recovered from AB3354.

Traditional zooarchaeological analysis identified the bone fragment from AB3354 as "unidentified large ungulate." Therefore, the goal was to use this technique to provide a lower-level taxonomic identification of the faunal specimen and gain better insight into the subsistence economy of the individuals who built and used the DeBarard Earth Oven. The young age of the site combined with fairly rapid burial via alluvial deposition contributed to a well-preserved bone fragment with high molecular collagen which lent itself well to ZooMS analysis.

Following the minimally destructive protocols (Buckley 2009; van der Sluis et al. 2014; Welker et al. 2015), a small hole was drilled into the DeBarard bone fragment to obtain between 10-15 milligrams of bone needed for two ZooMS samples. Laboratory procedures involved demineralization; wash and humic acid removal; denaturing the collagen structure; digestion in protease (trypsin); and acidifying/purifying the sample. Both acid soluble and acid insoluble fractions of each sample were then spotted in triplicate onto a MALDI plate and run through the MALDI-TOF mass spectrometer. The location of peaks on the x-axis (mass to charge ratios) and the number of peaks associated with the produced archaeological spectra were directly compared to

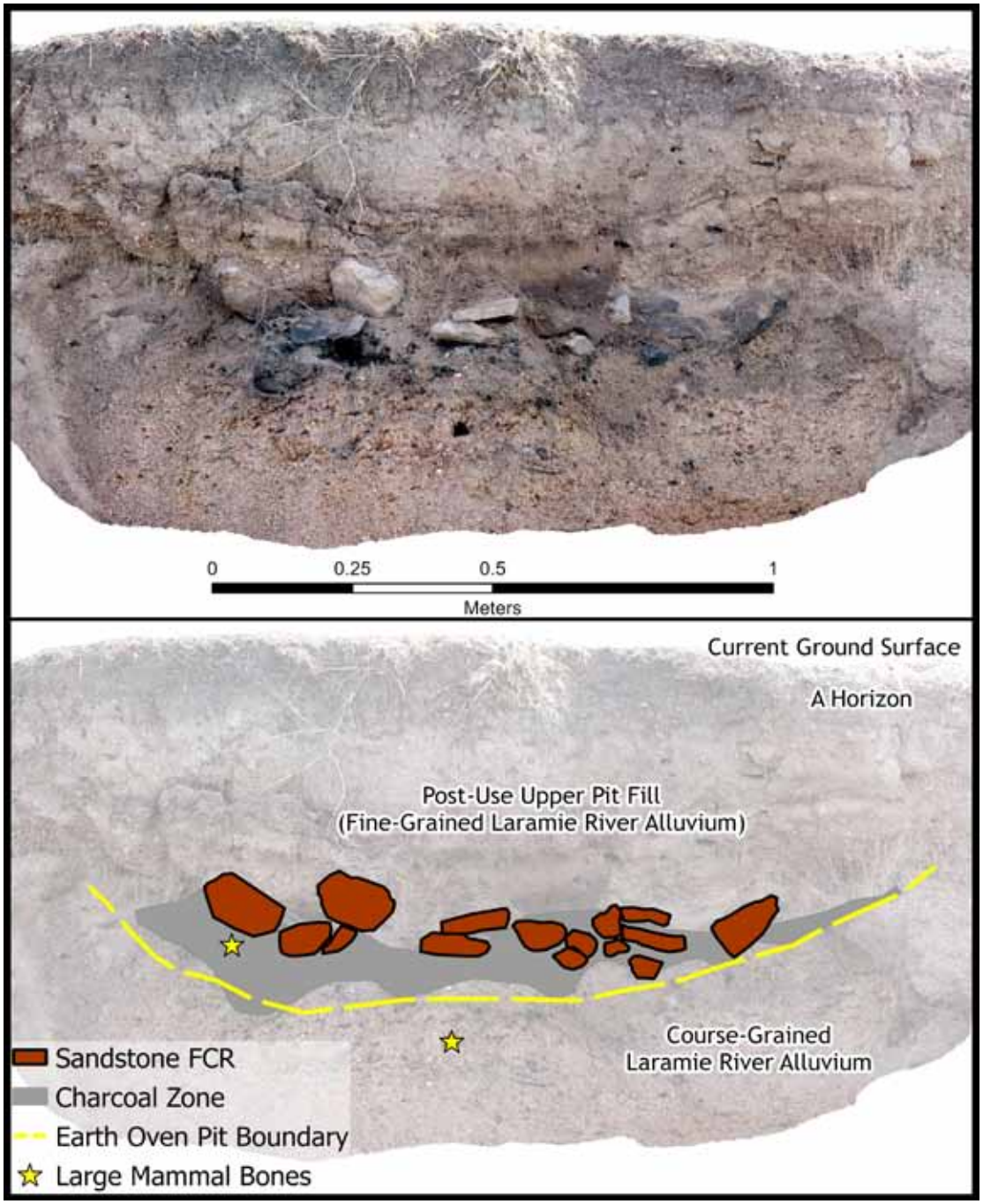

Figure 4: Top: Cross-section of feature eroding from Laramie River cut bank. Bottom: Feature profile showing relationship between sandstone FCR, charcoal, pit boundary, and large mammal bones.

spectra developed from known animal specimens compiled into a developing UW ZooMS reference database. Large ungulate spectra currently available for comparison within the UW ZooMS reference database include bison (*Bison bison*), pronghorn (*Antilocapra americana*), elk (*Cervus canadensis*), horse (*Equus ferus caballus*), caribou (*Rangifer tarandus*), mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), moose (*Alces alces*), camel (*Camelus bactrianus*), and cow (*Bos taurus*).

Twelve ZooMS spectra were produced from the AB3354 bone fragment. Nine of the twelve spectra are excellent in regard to their quality. One of the spectra produced by the acid soluble fraction

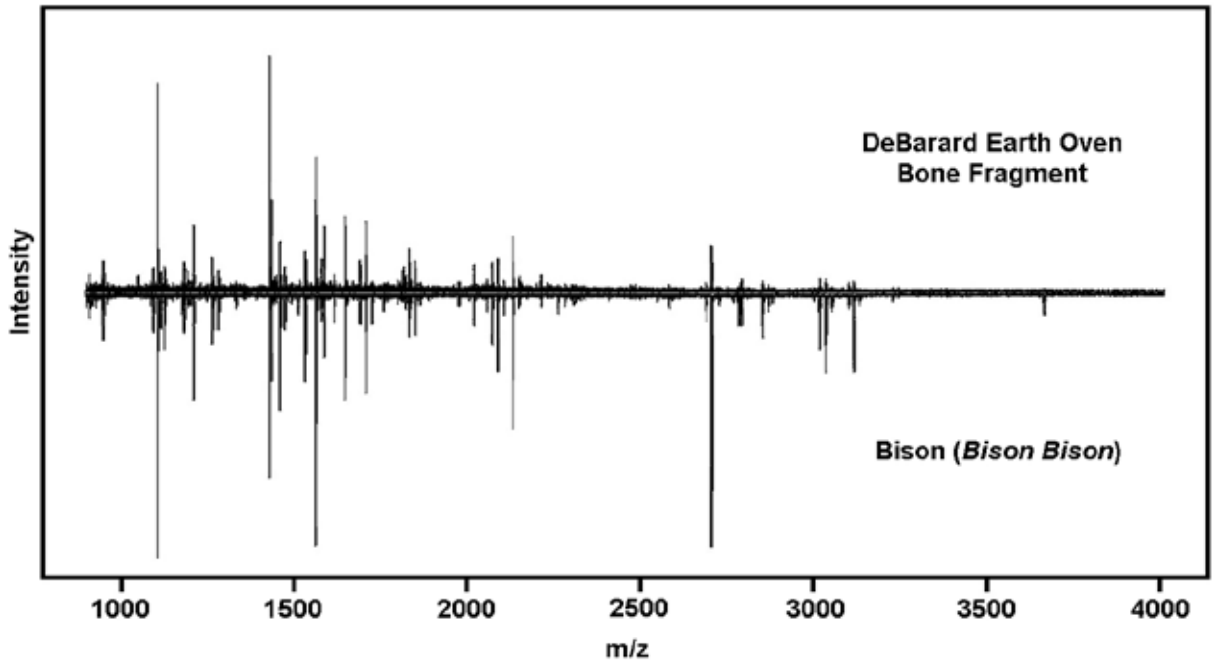

Figure 5: Butterfly graph displaying spectra for the DeBarard Earth Oven bone fragment and modern bison (Bison bison). Peak positions produced from AB3354 bone fragment strongly correspond with known collagen peptides associated with modern bison.

of the second sample contains the least amount of background noise. When a signal to noise ratio is set to 4, most peaks (97.22%) match with the location of known *Bison bison* spectral peaks within the UW ZooMS reference database (Figure 5). Higher signal to noise ratios (5-8) targeting the most intense spectra peaks produce results strongly suggesting peak alignment (100%) with bison. Furthermore, all spectra show peaks 1208, 1283 and 2854, peaks present in bison but absent from cervids. They also lack 1525 and 2901, peaks present in bighorn sheep but absent from bison. In summary, all nine spectra demonstrate with certainty this bone is bison (*Bison bison*).

DISCUSSION

Although no formal testing was conducted at AB3354, the feature is clearly an earth oven and not a hearth or stone boiling pit, based on presence of a thick layer of charcoal underlying a layer of sandstone FCR. A single sample of charcoal was AMS radiocarbon dated to 633-532 cal BP (D-AMS 2406-42007; 572±21 BP; carbonized cf. *Dasiphora fruiticosa*; Puseman 2021). The presence of a small, brushy shrubs in the oven corresponds with the frequent occurrence of quick burning fuel (such as sagebrush) within oven features (Thoms 2008:445). The age of the feature is roughly 1,000 years later than the features at the Joe Miller site but contemporaneous with earth ovens at the China Wall site (Table 1).

The AB3354 oven shares similar morphologies (~1 m diameter; 50-100 kg heating element) with probable meat ovens excavated at the Joe Miller and China Wall sites (Burnett et al. 2008; Eckles and Waitkus 2013), and the identification of bison via ZooMS suggests bison as the cooked food. In this scenario, we must consider the likelihood the DeBarard earth oven is either part of a larger camp or processing site, such as China Wall or the Herald Bergman site (AB3122; Allaun and Surovell 2019), or potentially associated with a primary kill site like Joe Miller or the Willow Springs Bison Pound (AB130; Bupp 1981). In either case, it is probable the bison was killed relatively close to the oven pit and explains why the Indigenous cooks traveled nearly a kilometer to acquire suitable rocks to serve as the oven heating element. This substantial investment in oven construction suggests the DeBarard oven—and those at Joe Miller—are likely associated with group aggregations and feeding larger numbers of people (Wandsnider 1997:14) rather than the

smaller, familial ovens found at many Wyoming sites (see Smith and McNees 1999).

CONCLUSION AND FUTURE RESEARCH

Earth ovens are an understudied, and under recognized, aspect of the Wyoming archaeological record which can provide important insight into past behaviors. The DeBarard Earth Oven (AB3354) is one of just a handful of described earth ovens from Albany County, and it is possible future research using remote sensing or shovel testing could identify a substantial buried archaeological component associated with the oven. Based on the morphology of the feature (~1 m diameter; 50-100 kg sandstone FCR) and the presence of bison bones, we suggest this feature was used for cooking meat. Meat ovens are known from the Northern Plains both ethnographically (Linderman 2002:139; Murdock 1934:268; Wandsnider 1997) and archaeologically (e.g., Brink and Dawe 2003), so it is not altogether unexpected the feature at AB3354 may have been used to cook meat. However, much of the archaeological literature on earth ovens is focused on use of these features for cooking plants (e.g., Black and Thoms 2014; Koenig and Miller 2023; Smith et al. 2001) which may bias our interpretations of feature use and ignores the fact earth ovens were used to cook a variety of foods.

The DeBarard Earth Oven also demonstrates more directed earth oven research must be conducted in Wyoming. There is ample literature examining how cook stones fracture given different types of cooking (e.g., earth ovens vs. stone boiling; Brink and Dawe 2003; Neubauer 2018), but we know little about the morphological variation of oven features in Wyoming. Documenting the variation of oven morphology across the state and through time can provide insight into the types and quantities of foods cooked (see Thompson and Pastor 1995:86-92). These types of analyses should be combined with laboratory (e.g., Joyce et al., 2022), experimental (e.g., Smith et al. 2001), ethnoarchaeological (e.g., Stark 2023), and oral traditions to provide a holistic understanding of earth oven cooking in Wyoming.

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