Supporting Online Material for

A Terminal Pleistocene Child Cremation and Residential Structure from Eastern Beringia

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Site Formation and Disturbance

General characteristics of the sediments and soils at USRS are summarized in Table S1 and Figs. S1-S2 (*S1*). Four lithostratigraphic units defined at the site consist of: Unit I, >640 cm thick (260-900+ cm BS) fine-to-medium laminated sand; Unit II, 20 cm thick (244-260 cm BS) massive silt; Unit III, 2-4 cm thick (240-244 cm BS) medium sand; and Unit IV, 240 cm thick (0-240 cm BS) massive silt. Alluvial medium-to-coarse sands and gravels were observed in lower interdunal areas at a depth of ~200 cm BS. These descriptions confirm our observation that the dune ridge rests on an alluvial terrace of the Tanana River.

Observed soils at the site are confined to the upper silt deposits (Units IV) and are indicative of forest- and shrub tundra-derived soils (Typic Cryochrept and Cryorthents, respectively; *S4*) typically formed in subarctic regions on areas of well-drained substrates with sedimentation over 1 m. A series of forest soils are present in the upper 60-70 cm of the sediment column. A modern Subarctic Brown Forest soil is represented by the greatest amount of soil horizonation (OA-B-BC horizons) at the site with the upper 60 cm of sediments. In some areas this soil is welded with at least two older buried incipient forest soils (Bwb1 and Bwb 2 horizons). They are well expressed in the pit and house excavation area between 25-50 cm BS and likely represent the establishment of the spruce forest in the region during the Holocene around 9000 cal BP (*S5-7*). Horizon boundaries within these upper forest soils (above the cultural components) range from clear to abrupt in distinctness with topography of the boundaries consistently wavy to slightly irregular; these features typically expresses seasonally frozen active layer processes (cryoturbation) that affect forest soil horizons within subarctic regions.

The stratigraphy of paleosols below 80 cm BS in the Main Block and 50 cm BS in the house and pit feature area indicate little or no cryoturbation or other homogenization mechanism (e.g., pedoturbation, bioturbation) suggesting these features were not substantially affected by post-depositional disturbance (Fig. S1). A discontinuous Ab horizon (Ab3), designated Paleosol 2 (P2), is situated ~80 cm BS in the Main Block and ~50 cm BS in the house and pit feature area, overlying the top of the fill and house floor by 5-15 cm. P2 developed by 10,170-9790 cal BP coinciding with a period in the pollen record at nearby Birch Lake that displays a rise in *Populus* (*S6-7*), and may relate to the establishment of a deciduous forest and beginning of forest soil development at USRS. P2 boundaries are clear to abrupt in distinctness and wavy to slightly irregular in topography likely due to minor cryoturbation and pedoturbation.

At least six variably expressed dark yellowish brown discontinuous Ab horizons (Ab4), we refer to as Pedocomplex P1, occur between 80 and 260 cm BS in the Main Block. These paleosols are similar to Typic Cryothents observed at the Broken Mammoth, Swan Point, and Mead sites (*S8*); they coincide with pollen zone at Birch Lake, which is indicative of shrub tundra vegetation (*S6-7*). The most prominent of these lower Ab4 horizons is a soil couplet (P1a and P1b) dating between 10,500 and 11,240 cal

BP; the soils likely date to the older end of this range based on stratigraphy and presence of younger soil-derived exogeneous carbon (i.e., humic acids) from upper soils, probably Ab3 (see discussion of radiocarbon data in these supplemental data). This pedocomplex underlies Component 3 in the main excavation area by 10 cm. The house floor overlies the pedocomplex by approximately 40 cm, but the pit feature may have truncated part of this pedocomplex. These soils are level across the site with smooth and very abrupt to abrupt horizon boundaries that indicate little to no disturbance in this part of the lower soil column. Spatially limited faunalturbation (krotovinas) and microfaulting were observed in the excavations 4 m to the west of the house and pit feature and between 225 and 282 cm BS in depth; this location is >1 m below the lowest Ab4 soil (P1a) and the house and pit features (*S9*). In sum, in the house and pit feature area, the effects of turbative agents appear limited to the upper 50 cm of forest soils, i.e., above Ab3, well above these features.

Site Chronology

USRS stratigraphy is linked by a series of 20 ^{14}C dates, consistent across the site (Table S2). Component integrity is high, demonstrated by thin vertical distributions of flat-lying lithics and faunal remains and ~20-90 cm of sterile sediments between components. Both cultural feature and stratigraphic dates are available for Components 2 and 3, cultural feature dates for Component 1, and stratigraphic dates for Component 4 (*S7*).

Component 1 is situated 230 cm below surface and within Unit 2 (Lower Loess), about 1 meter below Component 2 within Unit 2. Cultural materials consist of lithics and faunal remains associated with a hearth feature, Feature 2. Two hearth charcoal fragments were identified as willow (*Salix* sp.); one was a twig split and sent to two labs, both yielding contemporaneous ages. A third, cross-check sample of willow was also contemporaneous. All three dates were contemporaneous ($t = 4.37$, $\chi^2 = 5.99$, $df = 2$, with $\alpha = 0.05$) and average 11,320±30 BP (13230-13120 cal BP) (*S10*).

Component 2 is situated ~135 cm BS in direct association with Paleosol 1b (Ab4), and lies about 35 cm below Component 3. Cultural materials consist of lithics with a thin unimodal vertical distribution associated with a single hearth feature, Feature 6. Two hearth charcoal samples (*Amelanchier* sp. and Populus/Salix group, possibly *Populus* sp.) yielded contemporaneous ages ($t = 4.37$, $\chi^2 = 3.84$, $df = 1$) and average 10,140±40 BP (11980-11620 cal BP). Four additional stratigraphic dates from Paleosol 1b are somewhat younger, ranging from 9290±50 BP to 9720±50 BP. We reject the two youngest ages, as one sample on unidentifiable wood charcoal (Beta-286268) was redated (Beta-288416) yielding a statistically different and older age ($t = 41.0$, $\chi^2 = 3.84$, $df = 1$). The alkali-soluble fraction of this sample (Beta-288418) was ~ 400 ^{14}C years younger than the alkali-insoluble fraction, thus indicating potential for contamination by younger exogenous soil-derived carbon. One possible cause of the discrepancy in the two split alkali insoluble ages is the incorporation of younger materials from overlying sediments, particularly if the laboratory pretreatments did not remove all contaminants. The other younger age (Beta-288418) has not yet been re-dated. Given the stratigraphic separation

of Ab3 and Ab4 and the large suite of concordant dates, the hearth charcoal assays are considered to date Component 2.

Component 3 is situated ~100 cm BS in the Main Block and ~80 cm BS in the cremation area, and may be associated with a weak paleosol in the former area. All Component 3 remains are in the same stratigraphic position, 14-20 cm below Paleosol 2 (Ab3). Cultural material consists of lithics and faunal remains associated with the house (elements include Features 4, 7-8, 11-12) and pit (Feature 5) described in the main text (Fig. S2) and three features interpreted to be outdoor hearths (Features 1, 3, and 9). Given that there are no significant differences (see below) in tree and short-lived shrub species (*Populus balsamifera* and *Salix* sp.), we consider old wood effect to be minimal. Two of these hearth features (1 and 3) are directly linked through a lithic tool refit. Seven radiocarbon dates have been run on three features, three on the cremation pit, and two each on hearth Features 1 and 3, and several dates are contemporaneous. All three cremation pit dates, two on charcoal at the base of the pit and one on charcoal at the top of the fill, are contemporaneous ($t = 1.12$, $\chi^2 = 5.99$, $df = 2$), yielding an average of 9990±30 BP (11620-11280 cal BP). This nearly overlaps with the Feature 1 crosscheck dates, which are contemporaneous with each other ($t = 0.80$, $\chi^2 = 3.84$, $df = 1$), and average 9690±40 BP (11220-10870 cal BP). Feature 3 crosscheck dates are not contemporaneous with each other ($t = 0.80$, $\chi^2 = 3.84$, $df = 1$), but one of these two dates (Beta-280914) overlaps with the cremation feature. Thus, of these seven dates, we consider one (Beta-286265) as anomalous.

Component 4, consisting of a few lithic flakes, is situated ~80 cm below surface in the Main Block in direct association with Paleosol 2 (Ab3), and about 20 cm above Component 3. Both samples (from trees and shrubs, *Populus tremuloides* and *Salix* sp.) from Paleosol 2 are contemporaneous ($t = 0.22$, $\chi^2 = 3.84$, $df = 1$), and average 8870±30 BP (10170-9790 cal BP), providing effective upper limiting ages for Component 3.

The bottom of Bwb2 has a single assay, dating to 7600±40 BP (8510-8340 cal BP), providing a lower limiting date on the formation of the upper Bwb horizons, which are welded together and exhibit evidence of cryoturbation in the Main Block, but are more distinct in the cremation area (see Fig. 2 of the main article).

In sum, the concordant suite of ^{14}C dates, the mix of short-lived shrubs and tree species yielding similar ages in various contexts suggesting minimal old wood effect, and the clear stratigraphy that can be followed over many meters provide secure chronological controls on the components at USRS.

Human Remains

The posterior-most portion of the child's occipital is black in color (Munsell 2.5Y 2.5/1), with a sharp line of demarcation to brown/gray (2.5Y 6/1-2) (Fig. S3). This pattern of coloration indicates that the individual was positioned on his/her back in the cremation fire. Specifically, the black color corresponds to a cooler temperature, likely from contact with the soil in the pit base and, hence, incomplete organic combustion; the brown/gray portion of the occipital, indicative of a higher temperature with greater organic burning, would have been exposed to a hotter part of the fire (i.e., elevated above the pit base).

Overall dental eruption (*S14*) is most consistent with an age of 3 years ± 1 year. Individual tooth formation is supportive of this estimate. The method of Liversidge and Molleson (*S15*) yields a minimum age of 1.98 ± 0.31 years based on full closure of the lower left deciduous central incisor's root apex (i.e., their grade of H2); open root apices of both upper deciduous second molars indicates a maximum age of 3.48 ± 0.69 years (between G-H1). As noted in the text, age estimates from other deciduous tooth roots using this method are between 2.38 ± 0.35 to 2.87 ± 0.53 years. Moorrees et al. (*S16-17*) derived tooth formation standards for both deciduous and permanent teeth. Their charts for male children suggest the minimum age is roughly 1.9 years ± 8 months for the lower right deciduous first molar, whose anterior root is not fully closed (between their grade of A1/2-C). However, their maximum age, based on crown formation in the lower permanent first premolar crowns (see Fig. S4) is around 4+/-1 years (between C1/2-3/4); other ages using this method lie between 2 to 3 years – with most near the higher end of the range.

With regard to the child's possible biological affinity, several dental morphological traits are suggestive (though see caveats in the text concerning assessment of affinity in individuals). Slight shoveling, approximately ASUDAS Grade 2 (Fig. S5), and double shoveling are evident in the unerupted permanent upper incisors and canines, respectively. These and other diagnostic traits (*S18*), including what would likely have been a large (ASUDAS 2+) deflecting wrinkle and anterior fovea, on the undeveloped permanent lower left first molar crown (Fig. S4), are consistent with the Sinodont pattern of Northeast Asians and Native Americans (*S19*).

References and Notes

S1. Soil descriptions follow national conventions established by *S2*, modified by *S3*

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S10. Dates were calibrated using Calib 6.0 (*S11*) and IntCal09 (*S12*). Pooled mean ages are calculated following (*S13*) for assays that are statistically similar.

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Table S1. General Description of Stratigraphy at Upward Sun River.

Lithostratigraphic Unit	Pedostratigraphy	Description
IV Upper Silt (Loess) (0-240 cmBS) mostly massive yellowish brown (10YR 5/4) to pale brown (10YR 6/3) silt; two fine sand laminations occur around 160-180 cmBS	O	2-18 cm thick; modern vegetative growth and slightly to moderately decomposed organics; abrupt and wavy boundary
	A	6-26 cm thick; dark brown (7.5YR 3/2) to yellowish brown (10YR 5/4) loam; abrupt and wavy boundary
	B	26-37 cm thick; dark yellowish brown (10YR 4/6) to yellowish brown (10YR 5/4) silt loam; welded onto and turbated with Bwb1 and Bwb2 at the eastern and western most edges of the house feature area and within most of the Main Block; clear and wavy boundary
	BC	4-10 cm thick; yellowish brown (10YR 5/6) silt to silt loam; slightly welded onto and turbated with Bwb2 and Ab1 (P2) at western end of the house feature excavation area; abrupt to clear and smooth to wavy boundary
	Bwb1	7-22 cm thick; brown (7.5YR 4/3 to 4/4) silt loam; abrupt to clear and smooth to wavy boundary
	Pedocomplex Bwb2 (Bwb2a and Bwb2b)	5-13 cm thick; brown (7.5YR 4/3 to 4/4) silt loam; slightly welded onto P2 at far eastern end of house feature excavation area; Bwb2 bifurcates above the pit feature in the house into two possibly two distinct horizons (Bwb2a and Bwb2b); abrupt to clear and smooth to slightly wavy boundary.
[Component 3]	Ab3 (Paleosol P2)	0.5-5 cm thick; dark yellowish brown (10YR 4/4) discontinuous Ab horizon; appears as a Bwb at its thickest point at the western edge of the structure excavation area; **contains Component 4**; lowest limit of field observed minor cryo- and pedoturbation at the site; very abrupt to abrupt and smooth to slightly wavy boundaries;
	Ab4 (Pedocomplex P1)	0.5-1 cm in thickness; at least six dark yellowish brown (10YR 4/4) discontinuous Ab horizons; P1a and P1b soil couplet are the best expressed of these six Ab2 horizons; P1a and P1b are separated by 5 cm of pale brown (10YR 6/3) unaltered silt; **contains Component 2**; very abrupt and smooth boundaries;
III Aeolian sand (240-244 cm BS)		2-4 cm thick; grayish brown (10YR 5/2) massive fine-to-medium sand; no lamination present; very abrupt and smooth boundary;
II Lower Silt (Loess) (244-260 cm BS)		16-20 cm thick; yellowish brown (10YR 5/4) to pale brown (10YR 6/3) massive silt; **contains Component 1**; very abrupt to abrupt and smooth boundary
I Aeolian sands (260-900 cm+ BS)		>640 cm thick; dark gray (10YR 4/1) to dark grayish brown (10YR 4/2) fine-to-medium laminated sand; yellowish brown (10YR 5/4) silt laminations at the upper contact with Unit II; laminations are generally <1 cm thick

Table S2. Radiocarbon assay data (ordered by strata and block; Block H refers to the cremation area)

Lab	Material	Context (block and depth)	$\delta^{13}C$ (‰)	Conv. age (BP)	Calibrated age (IntCal09) (2 σ cal BP)
Beta-280581	charcoal (*Juniperus* sp.)	Bottom of B horizon, H, 47 cm BS	-23.9	7600±40	8508-8343
Dates associated with Component 4					
Beta-232392	charcoal (*Salix* sp.)	Paleosol 2, Main, 78 cm BS	-23.3	8880±40	10,179-9789
Beta-280582	charcoal (*Populus* sp., probably *P. tremuloides*)	Paleosol 2, H, 57 cm BS	-26.3	8850±50	10,168-9736
Beta-219656	charcoal	From test pit, 76 cm S	-24.8	9360±70	10,756-10,299
Dates Associated with Component 3					
Beta-220218	hearth charcoal (*Salix* sp.)	Feature 1 hearth, Main, 100 cm BS	-24.8	9650±60	11,200-10,775
Beta-280913	hearth charcoal (*Populus balsamifera*)	Feature 1 hearth, Main, 100 cm BS	-25.2	9720±50	11,242-10,830
Beta-286265	hearth charcoal (*Populus balsamifera*)	Feature 3 hearth, Main, 100 cm BS	-25.4	9030±40	10,248-10,163
Beta-280587	hearth charcoal (*Populus balsamifera*)	Feature 3 hearth, Main, 100 cm BS	-24.1	10130±50	12,012-11,408
Beta-280584	Pit charcoal (*Populus/Salix*, probably *Populus* sp.)	Feature 4 top of backfill of cremation pit, H, 80 cm BS	NA	9920±80	11,705-11,201
Beta-280585	Pit charcoal (*Populus balsamifera*)	Feature 5 cremation pit, H, 85 cm BS	-24.0	9990±50	11,705-11,261
Beta-280586	Pit charcoal (*Populus balsamifera*)	Feature 5 cremation pit, H, 85 cm BS	-23.4	10020±50	11,753-11,261
Dates associated with Component 2					
Beta-286266	charcoal (*Populus* sp.)	Paleosol 1b, Main, 135 cm BS	-22.6	9220±40	10,500-10,257
Beta-280914	hearth charcoal (*Amelanchier* sp.)	Feature 6 hearth, Main, 135 cm BS	-25.0	10090±50	11,966-11,397
Beta-286267	hearth charcoal (possibly *Populus sp.*)	Feature 6 hearth, Main, 135 cm BS	-24.8	10180±50	12,063-11,630
Beta-286268	charcoal (indeterminate) (split 2)	Paleosol 1b, H, 115 cm BS	-25.1	9310±40	10,653-10,303
Beta-288416	charcoal (indeterminate) (split 2)	Paleosol 1b, H, 115 cm BS	NA	9720±50	11,242-10,830
Beta-288418	alkali soluble portion of Beta-288416	Paleosol 1b, H, 115 cm BS	NA	9290±50	10,647-10,285
Beta-232393	charcoal (*Salix* sp.)	Paleosol 1b, Main, 135 cm BS	-22.6	9670±40	11,204-10,796
Dates associated with Component 1					
AA-76863	hearth charcoal (*Salix* sp.) (split 1)	Feature 2 hearth, Main, 230 cm BS	-26.8	11250±60	13,297-12,954
Beta-232394	hearth charcoal (*Salix* sp.) (split 1)	Feature 2 hearth, Main, 230 cm BS	-26.9	11300±40	13,294-13,105
Beta-233316	hearth charcoal (*Salix* sp.)	Feature 2 hearth, Main, 230 cm S	-25.1	11420±60	13,414-13,147

Figure Captions

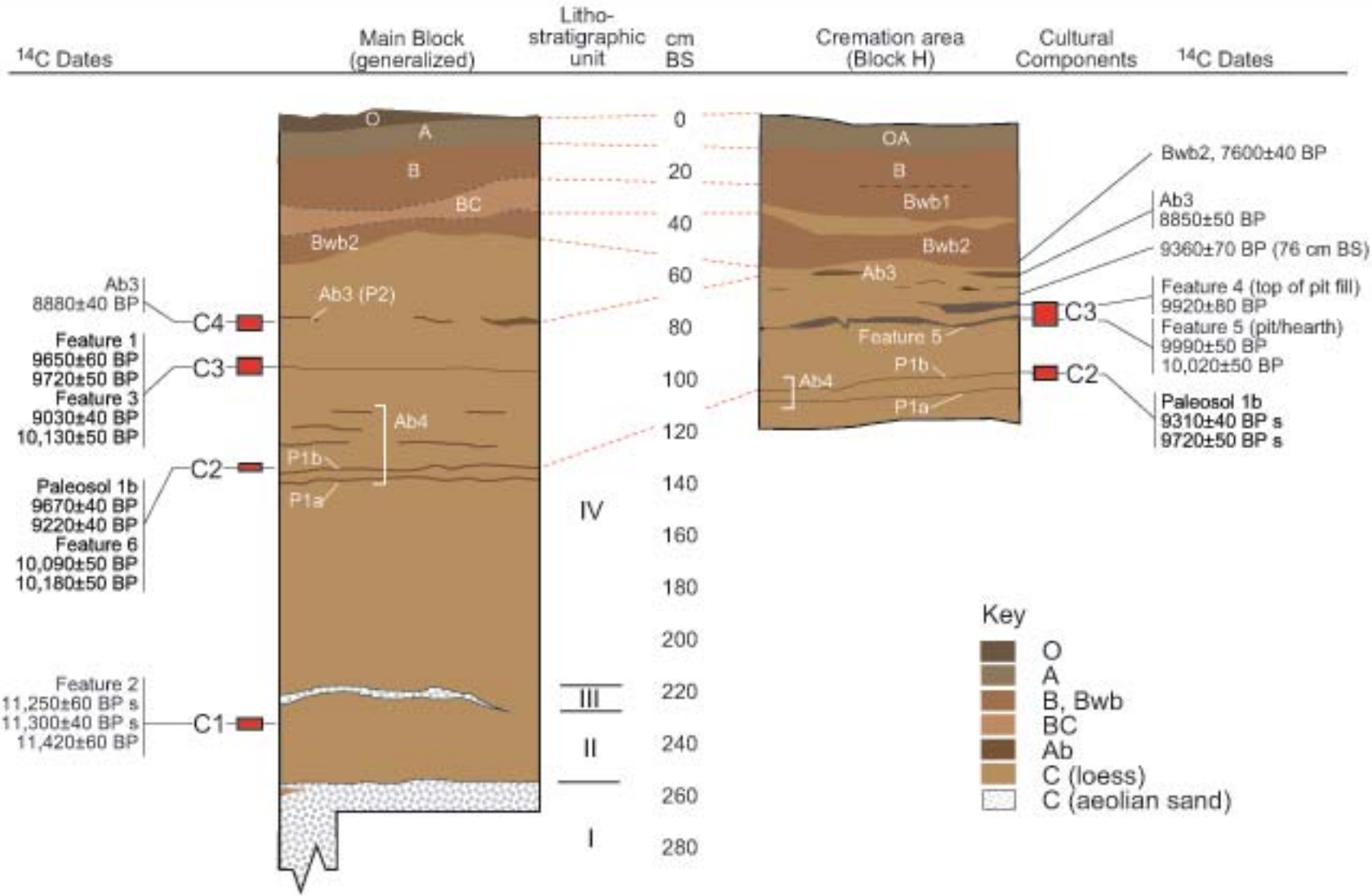
Fig. S1. Generalized stratigraphic profiles for the Main Block and Cremation Area (Block H). Note: Paleosols P1a, P1b, and P2 are nearly continuous between the Main Block and cremation area.

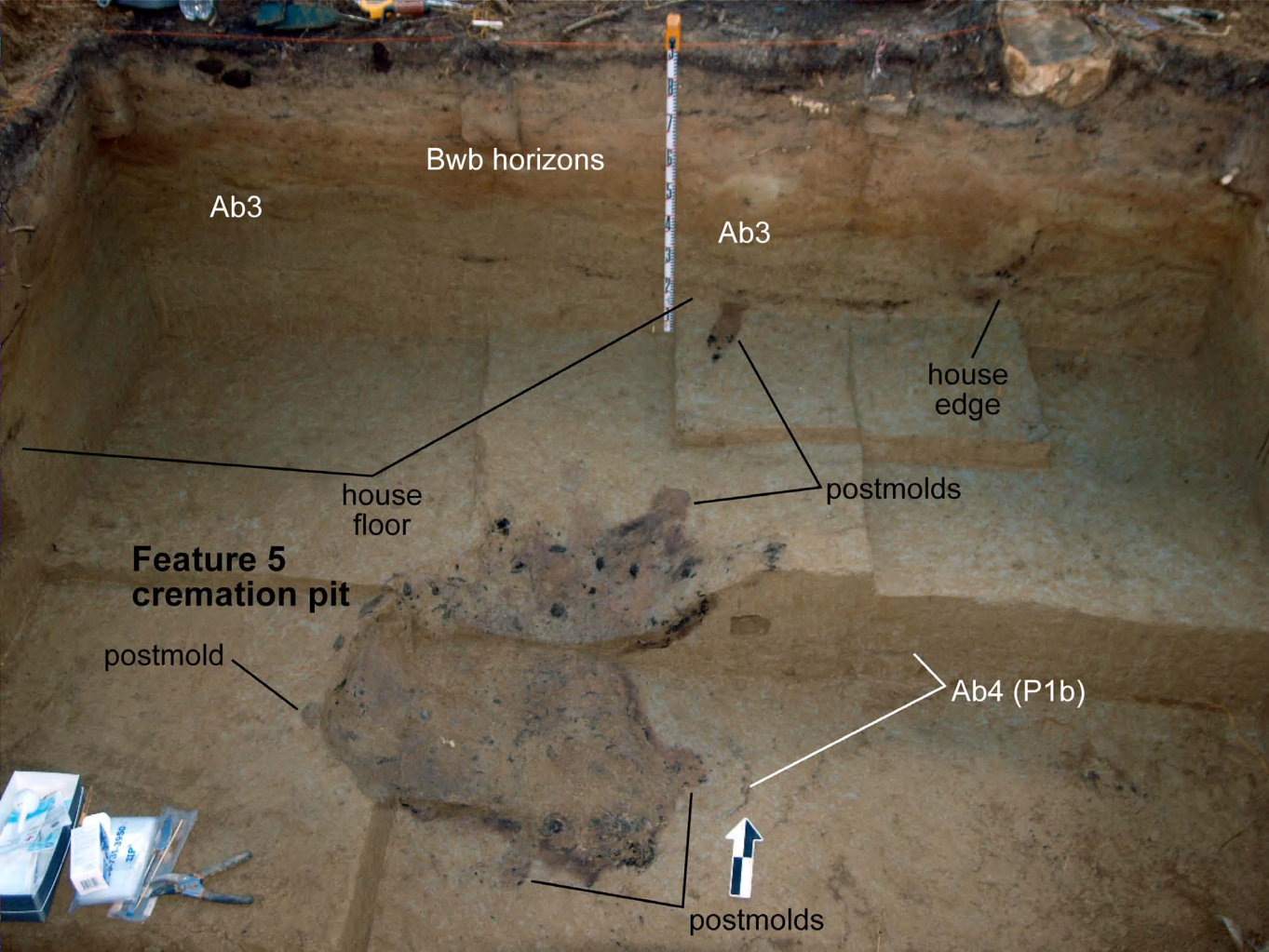
Fig. S2. Photograph of the burial pit and north wall stratigraphy during excavation. At this point, excavations have gone through the house floor to expose the pit/hearth in cross section and plan views. A single thin charcoal-stained surface extended from the edges of the pit/hearth to the north and west walls, marked ‘house floor’ and ‘house edge’.

Fig. S3. Posterior occipital fragment exhibiting differential burning indicative of body position in the cremation fire (see text for details).

Fig. S4. Unerupted permanent lower lateral incisors, canines, first premolars, and left first molar. Differential burning is evident by variation in color.

Fig. S5. Unerupted permanent upper incisor and canine fragments.


14C Dates
Main Block (generalized)
Litho-stratigraphic unit
cm BS
Cremation area (Block H)
Cultural Components
14C Dates
O
A
B
BC
Bwb2
Ab3 (P2)
Ab4
P1b
P1a
OA
Bwb1
Ab3
Feature 5
P1b
Ab4
P1a
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
IV
III
II
I
Ab3
8880±40 BP
C4
Feature 1
9650±60 BP
9720±50 BP
Feature 3
9030±40 BP
10,130±50 BP
C3
C2
Paleosol 1b
9670±40 BP
9220±40 BP
Feature 6
10,090±50 BP
10,180±50 BP
Feature 2
11,250±60 BP s
11,300±40 BP s
11,420±60 BP
C1
Bwb2, 7600±40 BP
Ab3
8850±50 BP
9360±70 BP (76 cm BS)
Feature 4 (top of pit fill)
9920±80 BP
Feature 5 (pit/hearth)
9990±50 BP
10,020±50 BP
C3
C2
Paleosol 1b
9310±40 BP s
9720±50 BP s
Key
O
A
B, Bwb
BC
Ab
C (loess)
C (aeolian sand)


Bwb horizons
Ab3
Ab3
house edge
house floor
postmolds
Feature 5
cremation pit
postmold
Ab4 (P1b)
postmolds


1 mm
2
3
4