Projectile Points at 45LI224

Confederated Tribes of the Colville Reservation

History/Archaeology Program

Prepared by, Eric Gleason, Jacqueline Cheung, Brenda Covington

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Contains Sensitive Information –

Note: Views presented in this report do not necessarily reflect those of the sponsor agencies. Any statements of policy or legal interpretation made by the author are not necessarily binding upon BPA or Reclamation and do not necessarily represent the opinions of BPA or Reclamation.
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Introduction

Site 45LI224 is situated within the Plateau Culture Area, in north central Washington State and includes a dense and discrete lithic scatter, exposed and reworked by Lake Roosevelt reservoir induced erosion. The discrete lithic scatter manifests as a lagged out gravel ridge in the drawdown zone and is where most artifacts have been observed and collected. Artifacts thus far collected from the surface of the site are documented in Table 1.

Table 1. All Surface Collected Artifacts from 45LI224, Categories and Counts Based on Repository Inventory.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Debitage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>122</td>
<td>CCS, Mudstone, Quartzite, Granitic</td>
</tr>
<tr>
<td>Projectile Point Base</td>
<td>1</td>
<td>4</td>
<td>9</td>
<td>4</td>
<td>18</td>
<td>CCS</td>
<td></td>
</tr>
<tr>
<td>Biface</td>
<td>5</td>
<td>1</td>
<td>21</td>
<td>20</td>
<td>47</td>
<td>Basalt, Mudstone, CCS</td>
<td></td>
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<tr>
<td>Projectile Point</td>
<td>2</td>
<td>1</td>
<td></td>
<td>3</td>
<td></td>
<td>CCS, Andesite</td>
<td></td>
</tr>
<tr>
<td>Projectile Point Mid-Section</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>CCS</td>
<td></td>
</tr>
<tr>
<td>Core</td>
<td></td>
<td>14</td>
<td>3</td>
<td>17</td>
<td></td>
<td>Mudstone, CCS</td>
<td></td>
</tr>
<tr>
<td>Bifacial Retouched Flake</td>
<td></td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
<td>CCS</td>
<td></td>
</tr>
<tr>
<td>Utilized Flake</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td>CCS</td>
<td></td>
</tr>
<tr>
<td>Unifacially Retouched Flake</td>
<td></td>
<td>5</td>
<td>3</td>
<td>8</td>
<td></td>
<td>CCS</td>
<td></td>
</tr>
<tr>
<td>Shell</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td>Mussel Shell</td>
<td></td>
</tr>
<tr>
<td>Cobble Tool</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td>Basalt, and Unknown</td>
<td></td>
</tr>
<tr>
<td>Hammerstone</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td>Quartzite, Basalt</td>
<td></td>
</tr>
<tr>
<td>Scraper</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td>CCS</td>
<td></td>
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<tr>
<td>Tabular Knife</td>
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<td></td>
<td>1</td>
<td></td>
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<td>11</td>
<td>1</td>
<td>179</td>
<td>259</td>
<td>451</td>
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</tbody>
</table>

Archaeological and Historical Services were the first to collect an artifact from the site, a projectile point base, (initially documented as a biface fragment) in 1996 while conducting initial site inventory and documentation (Galm et. al 1996:5.4). During brief site revisits in 2015, CCT H/A crews observed and collected a complete Windust style projectile point (see Appendix A – Artifact photographs, Figure 5), as well as a larger lanceolate style projectile point or knife (Appendix A – Artifact photographs, Figure 6), and several other projectile point and biface fragments. In 2017, during the field testing project and a subsequent revisit, 179 artifacts were observed on the ground surface and collected. In 2018, another 259 artifacts were observed on the ground surface and collected.

Most of the surface exposed artifacts were recovered from the gravel ridge area of the drawdown zone. The gravel ridge area of the site is a particularly dynamic part of the drawdown zone environment. The top of the gravel ridge is approximately 10 to 15 feet below 1290 ft AMSL/full pool. As such it is exposed by nearly every seasonal drawdown and occasionally during low water levels in late summer. Exposure can span up to
Projectile Points at 45LI224

6 or 7 months every year. When the gravel ridge is inundated, waves generated by wind and recreational boat use continue to rework exposed lag deposits and undercut the 1290 ft AMSL/full pool cutbank along the reservoir margin. Cyclic exposure and inundation cycles and associated erosion resulting in reworking of deposits begs the question of how much redistribution of artifacts within lag deposits has taken place, and, is it possible to determine if current artifact distribution reflects pre reservoir deposits and artifact distribution?

Given the dynamic reservoir environment, and the realm of adverse effects to which 45LI224 is subjected, erosion and artifact displacement is inevitable and obviously evident. However, artifacts collected from the gravel ridge all have sharp edges, show no obvious impact scars or evidence of dulling that could indicate extensive translocation, and some retain a calcium carbonate coating on what would have been their in situ lower surface. Given the frequency of site revisits and the aforementioned characteristics, it is likely these artifacts were exposed relatively recently and their morphology has suffered limited impact.

Discussion

Surface collection at 45LI224 started in 1996, and, to date, 451 artifacts have been collected, the majority of which are lithic debitage. However, 31 artifacts (7% of the surface collection) have been identified, either in the field or at the Repository, as complete or fragmentary projectile points with diagnostic elements. During a post field examination of artifact photographs, an additional six (6) artifacts were identified as possible diagnostic projectile point fragments, preforms, or knives. Combined, this brings the total number of surface collected artifacts with diagnostic elements to 37, approximately 8% of the total surface collection. Photographs of 36 of these projectile points and bifaces are grouped together in a single illustration, Figure 1, at slightly smaller than actual size. After grouping the photographs of the artifacts together in the single illustration, 24 of the 36 artifacts were determined to contain sufficient elements to assign a point type or style designation.

The following discussion of the projectile points recovered to date from 45LI224 is a preliminary review and compilation of existing data. As recommended in the testing report (Gleason et al. 2020) and explained in the discussion below, in order to understand the lithic assemblage at 45LI224 relative to similar sites and assemblages in the region, a complete and rigorous lithic analysis is critical.

By looking at scaled photographs of these 36 artifacts (Figure 1) it becomes apparent that this collection is dominated by stemmed projectile points and projectile point fragments. The two mostly complete projectile points in this collection, artifacts 2015-001 and 2015-006, both have contracting stems and slight to nonexistent shoulders. Most of the fragments (n=27) appear to be basal fragments, although it is sometimes difficult to ascertain the orientation of a fragment based solely on a photograph. Of the basal fragments, 151 are limited to the stem or basal section, being either broken below the shoulder of the point, or from points with a very weak or nonexistent shoulder. The other 12 basal fragments2 retain evidence of a shoulder. The two midsection fragments shown in Figure 1 (2015-11, 2018-157) have indistinct shoulders. Another projectile point midsection in the collection, 2018-215 (Appendix A – Artifact photographs, Figure 7), has no shoulders and is not diagnostic, and thus is not shown in Figure 1. The three complete leaf shaped bifaces (2017-013, 2017-213, 2018-153) in the collection could be projectile points, knives, or preforms. Two fragments also appear to be from similar sized bifaces (2017-051, 2018-036).

Figure 1. Grouped illustration of 45L1224 artifacts identified as diagnostic projectile points, projectile point fragments, possible projectile fragments, and bifacial preforms or knives.
The diagnostic lithic assemblage and style of most of the projectile points is consistent with the Windust Phase of the Columbia Plateau as defined in 1970 by Frank C. Leonhardy and David G. Rice and refined by Rice in 1972. In *The Windust Phase in Lower Snake River Region Prehistory*, Rice describes and compares the assemblages recovered from three early archaeological sites in the Lower Snake River Region: Windust Cave (45FR46), Marmes Rockshelter (45FR50), and Granite Point (45WT41). The locations of these sites in relation to 45LI224 and to several other Windust age sites is depicted in Figure 2. Rice looked at an assemblage of 1,328 artifacts recovered from the lowest deposits of the three sites. No dates were available for the collection from Windust Cave, however the stylistically contemporaneous components of the two other sites were radiocarbon dated to 10,000–8,000 BP (11,500–8,900 cal BP). Rice looked at 229 projectile points (136 complete and 93 basal fragments) from these sites, and divided them into 24 separate groups based on their morphology; examining traits such as the presence or absence of shoulders, and the shape of the blade, stem, and base. He also examined the flaking pattern, cross section, and material type (1972:36). E. S. Lohse (1985, 1994) condensed Rice's 24 groups into three subtypes, which he designated as Windust A, B, and C (Figure 3).

![Figure 2. Map of Washington State showing Western Stem Tradition sites mentioned in the text.](image)

Both Rice and Lohse recognized that Windust was not the sole stemmed point in the early assemblages of the West, and more specifically of the Columbia Plateau. Together these points have been more broadly referred to as part of the Western Stemmed Tradition (WST). E. S. Lohse and Coral Moser (2014) identified five distinct point styles in the WST of the Columbia Plateau, these are the three variations of Windust (A, B and C), together with points first identified at two other type sites, Lind Coulee (45GR97) in Washington's channeled scablands, and Haskett (10PR37) in eastern Idaho. These point types and their identifying morphological traits described by Lohse and Moser as elements of the WST, are used in this report to assign point types to the 45LI224 collection. Types identified as Windust A points are shouldered with a straight to
slightly contracting stem and a straight base. Windust B points are also shouldered with a straight or slightly contracting stem, however they have a concave base. Windust C points do not have a shoulder, instead having a smooth transition from the blade to a contracting stem with a markedly concave base. Lind Coulee points consist of “...stemmed forms and shouldered forms with straight to contracting basal margins, and convex bases”, while Haskett points are “...large lanceolate points with long contracting stems and slightly convex bases” (Lohse and Moser 2014:52).

![Figure 3. Stylized outlines of the three Windust subtypes based on Lohse (1985, 1994).](image)

The WST began on the Columbia Plateau by at least 13,000 cal BP and extended to 11,000 cal BP, with a terminal date that is traditionally extended to 9,000 cal BP (Brown et al 2019:488-489). David Rice (1972:vi) postulated that the Windust Phase assemblages were evolutionarily descendent from the Lind Coulee assemblage, however this was from a time when the Lind Coulee site was thought to significantly predate the Windust era sites. Later dating firmly established a contemporaneous age for the Windust and Lind Coulee assemblages (WSU 2020). Recent findings at several early sites in the Pacific Northwest suggest that Haskett style points found at sites in Oregon (Paisley Cave, 35LK3400) and Idaho (Cooper’s Ferry, 10IH73) likely represent the earliest diagnostic points of the WST (Brown et al 2019:487, Jenkins et al 2012). Haskett points found at Sentinel Gap (45KT1362), located some 200 miles downstream on the Columbia River from 45LI224, date to 11,900 cal BP (10,200 BP). However, it should also be noted that Lohse and Moser (2014:Figure 2) show Haskett style points as post-dating both Lind Coulee and Windust style points.

The majority of the projectile points and projectile point fragments observed at 45LI224 are examples of points typical of the Windust type series of the WST (Figure 1, Table 2). The complete point, 2015-006, is Windust A, the other complete point, 2015-001, is the only definitive Windust C point on the site. The nearly complete point fragment, 2017-116, is Windust B. The other Windust point base fragments are a mix of Windust A3 (n=8) and Windust B4 (n=6).

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However, Windust type series projectile points are not the only points found at 45LI224, several (n=8) of the point base fragments appear to be more typical of Hasket, or even perhaps Lind Coulee style points\(^{5}\), with steeply contracting stems and narrow convex bases, these are illustrated in the fourth row of Figure 1. These fragments all have contracting stems and narrow convex bases, elements that are present in both Hasket and Lind Coulee type points (Lohse and Moser 2014:Figure 2).

The dominance of basal, and basal and midsection, fragments in the collection indicate that the site occupants were rejuvenating darts for reuse and discarding and replacing points that were too damaged. The sheer number of discarded points at the site suggests that the site may have been used over an extended time frame, perhaps revisited seasonally over several years, or perhaps used once by a single large group.

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Table 2. Diagnostic Projectile Points Collected From 45LI224, Sorted By Type

<table>
<thead>
<tr>
<th>Catalog #</th>
<th>Artifact #</th>
<th>Description</th>
<th>Point Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-001</td>
<td>N/A</td>
<td>Complete point, broken tip, no shoulder, contracting stem, concave base with slight “ears.” CCS</td>
<td>Windust C</td>
</tr>
<tr>
<td>2015-006</td>
<td>N/A</td>
<td>Complete point, broken tip, distinct shoulders, contracting stem, slightly convex base. Basalt</td>
<td>Windust A</td>
</tr>
<tr>
<td>2015-004</td>
<td>N/A</td>
<td>Fragment, distinct shoulders, short contracting stem, straight base. CCS</td>
<td>Windust A</td>
</tr>
<tr>
<td>2015-007</td>
<td>N/A</td>
<td>Fragment, may have been reworked into a scraper. One shoulder, straight stem, straight to slightly convex base. CCS</td>
<td>Windust A</td>
</tr>
<tr>
<td>2015-008</td>
<td>N/A</td>
<td>Fragment, distinct shoulders, straight stem, straight to slightly convex base. CCS</td>
<td>Windust A</td>
</tr>
<tr>
<td>2015-009</td>
<td>N/A</td>
<td>Fragment, slightly contracting stem and straight base. CCS</td>
<td>Windust A</td>
</tr>
<tr>
<td>2017-214</td>
<td>214</td>
<td>Fragment, slightly contracting stem and convex base, similar to Lind Coulee point? CCS</td>
<td>Windust A/Lind Coulee?</td>
</tr>
<tr>
<td>2018-188</td>
<td>330</td>
<td>Fragment, midsection and stem, distinct shoulders, straight stem, straight base. CCS</td>
<td>Windust A</td>
</tr>
<tr>
<td>2018-205</td>
<td>347</td>
<td>Fragment, one distinct shoulder, slightly contracting stem, straight to slightly convex base. CCS</td>
<td>Windust A</td>
</tr>
<tr>
<td>2018-206</td>
<td>348</td>
<td>Fragment, one distinct shoulder, contracting stem, straight to slightly concave base. CCS</td>
<td>Windust A</td>
</tr>
<tr>
<td>2015-010</td>
<td>N/A</td>
<td>Fragment, straight stem with concave base. CCS</td>
<td>Windust B</td>
</tr>
<tr>
<td>2017-009</td>
<td>009</td>
<td>Fragment, contracting stem with concave base. CCS</td>
<td>Windust B</td>
</tr>
<tr>
<td>2017-119</td>
<td>119</td>
<td>Fragment, straight to slightly contracting stem with concave base. CCS</td>
<td>Windust B</td>
</tr>
<tr>
<td>2018-059</td>
<td>204</td>
<td>Fragment, midsection and base with distinct shoulders and short slightly contracting stem, concave base.</td>
<td>Windust B</td>
</tr>
<tr>
<td>2018-089</td>
<td>234</td>
<td>Fragment, straight to slightly expanding stem, slightly concave base. CCS</td>
<td>Windust B</td>
</tr>
</tbody>
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Projectile Points at 45LI224

<table>
<thead>
<tr>
<th>Catalog #</th>
<th>Artifact #</th>
<th>Description</th>
<th>Point Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018-121</td>
<td>266</td>
<td>Fragment, straight to slightly contracting stem, slightly concave base. CCS</td>
<td>Windust B</td>
</tr>
<tr>
<td>2015-002</td>
<td>N/A</td>
<td>Fragment, perhaps one shoulder, contracting stem with pointed convex base. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
<tr>
<td>2017-025</td>
<td>25</td>
<td>Fragment, contracting stem with narrow convex base. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
<tr>
<td>2017-031</td>
<td>31</td>
<td>Fragment, contracting stem with pointed convex base. Could be a point tip instead of a base. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
<tr>
<td>2017-060</td>
<td>60</td>
<td>Fragment, contracting stem with narrow convex base. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
<tr>
<td>2017-085</td>
<td>85</td>
<td>Fragment, contracting stem with narrow convex base. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
<tr>
<td>2017-175</td>
<td>175</td>
<td>Fragment, contracting stem with narrow convex base. Could be a biface tip. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
<tr>
<td>2018-057</td>
<td>202</td>
<td>Fragment, contracting stem with narrow convex base. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
<tr>
<td>2018-197</td>
<td>339</td>
<td>Fragment, contracting stem with narrow convex base. CCS</td>
<td>Haskett/Lind Coulee</td>
</tr>
</tbody>
</table>

The wide variety of WST point styles represented in the 45LI224 assemblage is also of some interest. There are nearly equal numbers of Windust A, B, and Haskett style points, and a single Windust C, represented in the projectile points at 45LI224. There is no clear evidence in the projectile point assemblage of a post WST use of the site. Does this variety simply represent a diverse and varied set of tools simultaneously in use, or does it represent an evolutionary shift over time, suggesting a period of use at the site that spans the entirety of the WST? Chatters et al. (2012:43) describe that “…WST people were mobile foragers who created a diverse array of composite implements to use during a highly patterned but widely ranging subsistence round that emphasized big game,” a notion, at least partially supported by the diverse projectile point assemblage at 45LI224.

The radiocarbon date of 8684 ± 93 cal BP (Beta Analytic Laboratory number 528368, Appendix B – Beta Analytic Radiocarbon dates and University of New Mexico Radiocarbon date) from sediment derived from the intact buried cultural horizon suggests a late WST use of the site. The only faunal fragment thus far recovered from the cultural horizon was subjected to minimally destructive radiocarbon dating. It has, so far, yielded two dates that are in conflict with both the sediment sample radiocarbon date and the typological time span of the projectile points from the site. The first bone date was 3830 ± 60 cal BP, the second date from the same bone was 4510 ± 60. Possible sources for error in these bone dates is discussed in the radiocarbon laboratory report, copied in Appendix B – Beta Analytic Radiocarbon dates and University of New Mexico Radiocarbon date.

The collection locations of the 2017 and 2018 stylistically diagnostic projectile points is depicted in Figure 4. As can be seen, all but one of these projectile points were observed on the gravel ridge area of the site in a displaced lagged out context. It is unknown if the observed location of these artifacts bears an association with their primary depositional location, and if so, to what extent; the distribution of projectile points by style...
seems to suggest it does not. All three identified point types are scattered and mixed across the gravel ridge area in a portion of the site where exposed, lagged gravel deposits are impacted by waves and reworked.

Figure 4. Distribution map of diagnostic projectile points collected from the 45LI224 site surface in 2017 and 2018 shown by projectile point type.

The projectile points thus far collected from 45LI224 indicate the site is one of a handful of rare, early sites in Washington, and the only confirmed/accepted WST site along this section of the Columbia River. The projectile point assemblage at the site contains all of the points that are identified as forming the WST assemblage in the Columbia Plateau. Intact cultural deposits remaining at the site add context to artifacts displaced by reservoir induced erosion, and have provided an initial radiocarbon date to confirm the antiquity of the site. As stated earlier, this is just a preliminary examination of the projectile point assemblage collected from 45LI224, a thorough and comprehensive analysis of the entire lithic assemblage of the site should be conducted.
References and Works Cited


Appendix A – Artifact photographs

Figure 5. 45LI224, Windust style projectile point (CAT# 45LI224 2015-001), collected from the site in April 2015 (adapted from Cheung 2015:13 Figure 6).
Figure 6. Stemmed argillite lanceolate projectile point (CAT# 45LI224 2015-006) observed in the drawdown zone at 45LI224 in May 2015. 2015 Site Condition Monitoring photo #235.

Figure 7. Projectile point midsection (CAT# 45LI224 2018-215) observed in the drawdown zone at 45LI224 in May 2018. Translucent, white, cryptocrystalline silicate projectile point midsection measuring 22 mm tall by 23 mm wide.
Appendix B – Beta Analytic Radiocarbon dates and University of New Mexico Radiocarbon date
June 26, 2019

Mr. Guy Moura
Confederated Tribes of the Colville Reservation
P.O. Box 150
Nespelem, WA 99155
United States

RE: Radiocarbon Dating Results

Dear Mr. Moura,

Enclosed is the radiocarbon dating result for one sample recently sent to us. As usual, specifics of the analysis are listed on the report with the result and calibration data is provided where applicable. The Conventional Radiocarbon Age has been corrected for total fractionation effects and where applicable, calibration was performed using 2013 calibration databases (cited on the graph pages).

The web directory containing the table of results and PDF download also contains pictures, a csv spreadsheet download option and a quality assurance report containing expected vs. measured values for 3-5 working standards analyzed simultaneously with your samples.

The reported result is accredited to ISO/IEC 17025:2005 Testing Accreditation PJLA #59423 standards and all pretreatments and chemistry were performed here in our laboratories and counted in our own accelerators here in Miami. Since Beta is not a teaching laboratory, only graduates trained to strict protocols of the ISO/IEC 17025:2005 Testing Accreditation PJLA #59423 program participated in the analysis.

As always Conventional Radiocarbon Ages and sigmas are rounded to the nearest 10 years per the conventions of the 1977 International Radiocarbon Conference. When counting statistics produce sigmas lower than +/- 30 years, a conservative +/- 30 BP is cited for the result. The reported $d^{13}C$ was measured separately in an IRMS (isotope ratio mass spectrometer). It is NOT the AMS $d^{13}C$ which would include fractionation effects from natural, chemistry and AMS induced sources.

When interpreting the result, please consider any communications you may have had with us regarding the sample. As always, your inquiries are most welcome. If you have any questions or would like further details of the analysis, please do not hesitate to contact us.

Our invoice will be emailed separately. Please forward it to the appropriate officer or send a credit card authorization. Thank you. As always, if you have any questions or would like to discuss the results, don’t hesitate to contact us.

Sincerely,

[Signature]

Chris Patrick Director
## REPORT OF RADIOCARBON DATING ANALYSES

**Guy Moura**  
Confederated Tribes of the Colville Reservation

**Report Date:** June 28, 2019  
**Material Received:** June 17, 2010

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<th>Laboratory Number</th>
<th>Sample Code Number</th>
<th>45LJ224 2017 TU2 Cat 211</th>
<th>7880 +/- 30 BP</th>
<th>IRMS 013C: -23.9 o/oo</th>
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<tr>
<td>Beta - 528368</td>
<td></td>
<td></td>
<td>(94.0%)</td>
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<td>(1.4%)</td>
<td></td>
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<td></td>
<td>6828 - 6542 cal BC</td>
<td>(8777 - 8591 cal BP)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>6907 - 6888 cal BC</td>
<td>(8856 - 8837 cal BP)</td>
</tr>
</tbody>
</table>

**Submitter Material:** Organic Sediment/Goytja  
**Pretreatment:** (organic sediment) acid washes  
**Analyzed Material:** Organic sediment  
**Analysis Service:** AMS-Standard delivery  
**Percent Modern Carbon:** 37.49 +/- 0.14 pMC  
**Fraction Modern Carbon:** 0.3749 +/- 0.0014  
**D14C:** -025.05 +/- 1.40 o/oo  
**Delta14C:** -828.17 +/- 1.40 o/oo (1560-2,019-00)  
**Measured Radiocarbon Age:** (without d13C correction): 7860 +/- 30 BP  
**Calibration:** BetaCal3.21, HPD method: INTCAL13

Results are ISO/IEC 17025:2005 accredited. No sub-contracting or student labor was used in the analyses. All work was done at Beta in 4 in-house NEC accelerator mass spectrometers and 4 Thermo IRMs. The "Conventional Radiocarbon Age" was calculated using the Libby half-life (5568 years), is corrected for total isotopic fractionation and was used for calendar calibration when applicable. The Age is reported to the nearest 10 years and is reported as radiocarbon years before present (BP). "present" = AD 1950. Results greater than the modern reference are reported as percent modern carbon (pMC). The modern reference standard was 99% the 14C signature of NIST SRM 4990C (modern wood). Quoted errors are 1 sigma counting statistics. Calculated signatures less than 30BP on the Conventional Radiocarbon Age are conservatively rounded up to 30. d13C values are on the material itself (not the AMS) d15O, d13C and d18N values are relative to VPDB-1. References for calendar calibrations are cited at the bottom of calibration graphs pages.
BetaCal 3.21

Calibration of Radiocarbon Age to Calendar Years

(HPD: INTCAL13)

(Variables: $\delta^{13}C = -23.9$ o/oo)

Laboratory number Beta-528368

Conventional radiocarbon age $7880 \pm 30$ BP

95.4% probability

- (94%) 6828 - 6642 cal BC
- (1.4%) 6907 - 6888 cal BC

8777 - 8591 cal BP
(8856 - 8837 cal BP)

68.2% probability

- (68.2%) 6786 - 6652 cal BC

8716 - 8601 cal BP

Database used INTCAL13

References

References to Probability Method

References to Database INTCAL13
Quality Assurance Report

This report provides the results of reference materials used to validate radiocarbon analyses prior to reporting. Known-value reference materials were analyzed quasi-simultaneously with the unknowns. Results are reported as expected values vs measured values. Reported values are calculated relative to NIST SRM 4990B and corrected for isotopic fractionation. Results are reported using the direct analytical measure percent modern carbon (pMC) with one relative standard deviation. Agreement between expected and measured values is taken as being within 2 sigma agreement (error x 2) to account for total laboratory error.

Report Date: June 26, 2019
Submitter: Mr. Guy Moura

QA MEASUREMENTS

Reference 1
Expected Value: 0.42 +/- 0.04
Measured Value: 0.33 +/- 0.02 pMC
Agreement: Accepted

Reference 2
Expected Value: 96.69 +/- 0.50 pMC
Measured Value: 96.77 +/- 0.23 pMC
Agreement: Accepted

Reference 3
Expected Value: 129.41 +/- 0.06 pMC
Measured Value: 129.44 +/- 0.37 pMC
Agreement: Accepted

COMMENT: All measurements passed acceptance tests.

Validation: [Signature]
Date: June 26, 2019
Radiocarbon Sampling and Dating Report – August 12, 2020

Brenda Covington | Archaeologist
History/Archaeology Program
Confederated Tribes of the Colville Reservation
P.O. Box 150 | Nespelem, WA 99155

Client Sample Designation: 45L124 2017.204

OAS Sample Label (used for internal records): Bone 204

OAS CO₂ Sample Number(s): 190805c-1; 190806c-1

ETH AMS Sample Number(s): 103876.1; 104589.1

Dating Results:

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Radiocarbon age (± years)</th>
<th>δ₁³C %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETH 103876.1</td>
<td>Bone 204 190805c-1</td>
<td>3,830  60</td>
</tr>
<tr>
<td>ETH 104589.1</td>
<td>Bone 204 190806c-1</td>
<td>4,510  60</td>
</tr>
</tbody>
</table>

Discussion:

The specimen was photographed as received (Figure 1) and was cleaned with six distilled water rinses with ultrasonication, loosening and removing adhering sediment. There was no cloudiness after the sixth cleaning, and the bone was dried in a 40°C oven and re-photographed (Figure 2). The specimen was then rinsed and ultrasonicated twice to saturate the bone with distilled water, and it was placed in 1 ml of phosphate buffer solution (pH 8) and ultrasonicated. If humic acid contamination is present in a specimen, the clear solution turns brown to pale yellow, depending on the amount of contamination. In this case, the solution remained clear, indicating no apparent contamination. The specimen was rinsed twice in distilled water then ultrasonicated twice in distilled water to remove absorbed phosphate buffer solution. The specimen was placed on a porcelain support and dried in preparation for plasma oxidation (Figure 3).

Figure 1. Bone 204 as received at OAS. Image background is millimeter graph paper.

Plasma oxidation at the OAS laboratory is described in detail in Rowe et al. 2017. A significant advantage of this approach is that plasma oxidation occurs at energy levels below the dissociation threshold of carbonates. The carbon composition of carbonates therefore does not contribute to the radiocarbon sample, and no pretreatment is required for carbonate contaminant removal.
Figure 2. Bone 204 after cleaning with distilled water.

Figure 3. Bone 204 in a porcelain support prior to plasma oxidation sampling.

The specimen was placed in a vacuum chamber which was then evacuated to a pressure of circa $10^{-4}$ Torr (high vacuum). Low pressure argon was introduced, and the specimen was bathed in a low-energy argon plasma (100 watts of radio frequency [RF] energy, resulting in a within-chamber temperature of circa 108°C). The argon plasma scours the chamber and specimen surfaces, knocking free any “sticky” atmospheric CO$_2$ molecules that would be modern contamination during radiocarbon dating. By itself, an argon plasma will not initiate chemical oxidation. However, the RF energy and the warmth of the argon plasma can cause the release of bound water in specimens, and the combined argon-water plasma can initiate some oxidation. In the case of Bone 204, system pressure changes suggested that it is likely that water release and argon-water oxidation did occur during the first argon plasma, evolving as much as 100 µg of carbon in the form of CO$_2$ from both sticky and oxidized sources.

Negligible CO$_2$ (<0.1 µg of carbon) was detected after the third argon plasma cleaning, and after evacuation to $10^{-6}$ Torr, low pressure oxygen was introduced. Plasma energy was held at 10 watts for 50 minutes, and approximately 100 µg of carbon were collected for dating (190805c-1). After collection and evacuation, a second charge of low pressure oxygen was introduced to the chamber. A 15 watt plasma was maintained for 45 minutes, and approximately 98 µg of carbon were collected as a second dating sample (190806c-1).

The specimen showed slight bleaching when it was removed from the sampling chamber after the two plasma oxidations (Figure 4).
The first sample collected was submitted to ETH, Zurich, for direct AMS dating of the carbon dioxide. The result (3,830±60) was younger than the anticipated age of early Archaic or older. The calibrated result is presented in Figure 5.

Figure 4. Bone 204 after plasma exposure.

Due to the disparity between expected and actual dating results, the second CO₂ sample was then submitted to ETH for AMS isotope measurement and dating. Its age is older (Figure 6) and is sufficiently older (4,510±60 BP) that the difference between the two dates is beyond what could be expected from measurement error if two separate samples had been collected from specimen carbon of a single age.
Figure 6. Tree-ring calibration of the 4,510±60 BP radiocarbon age for the second sample of Bone 204 (190805c-1, ETH 104589.1).

The younger age from the initial CO₂ extraction (sample 190805c-1) could result from modern carbon contamination of the bone surface compared to the second CO₂ extraction (sample 190806c-1). To estimate the magnitude of the possible “modern 1950 contamination” of carbon of the specimen, we use the modified approach of Mock and Waterbolk (1985:27-28). This approach calculates contamination in terms of fractional ¹⁴C activity.

\[
X = \frac{\left(F^{14}C_{\text{contaminated sample}} - F^{14}C_{\text{no contamination}}\right)}{\left(F^{14}C_{\text{contamination source}} - F^{14}C_{\text{no contamination}}\right)}
\]

(1)

where \( F^{14}C_{\text{contamination source}} = F^{14}C_{\text{bone}} = 1.0 \)

or where \( F^{14}C_{\text{contamination source}} = F^{14}C_{\text{bone}} = 0 \)

To calculate the fractional ¹⁴C activity use the fundamental radiocarbon decay equation

\[
p^{14}C = e^{-\lambda T}
\]

(2)

where \( p^{14}C \) is the fractional ¹⁴C activity of a given date in BP and \( T \) is a given date in years BP

Using this approach, we calculated the theoretical effect of modern carbon contamination on Bone 204, by assuming the date on sample 190805c-1 resulted from modern CO₂ contamination of the date on CO₂ sample 190806c-1.
Assumptions for calculation:

190805c-1 is the CO₂ sample assumed to be contaminated with modern carbon because it is both the first extracted and the younger of the two. Then T\textsubscript{contaminated sample} = 3830 \textsuperscript{14}C years BP (age measured at the ETH-AMS laboratory from CO₂ sample extracted at OAS). \( F^{14}C_{\text{contaminated sample}} \) is calculated according to equation (2) to be 0.6208 which is the value given by AMS lab as \( F^{14}C_{190805c-1} \).

190806c-1 is the CO₂ sample assumed to be uncontaminated by modern carbon because it is older of the two. Then \( T^{14}C_{\text{contaminated}} = 4510 \textsuperscript{14}C years BP \) (age given by AMS AMS laboratory from CO₂ sample extracted at OAS), \( F^{14}C_{\text{no contamination}} \) is calculated according to equation (2) to be 0.5704 which is the value given by AMS lab as \( F^{14}C_{190806c-1} \).

With these two assumptions,
\[
X = (F^{14}C_{\text{contaminated sample}} - F^{14}C_{\text{no contamination}}) / (F^{14}C_{\text{contaminated sample}} - F^{14}C_{\text{no contamination}})
\]
\[
X = (F^{14}C_{190805c-1} - F^{14}C_{190806c-1}) / (F^{14}C_{\text{modern contamination}} - F^{14}C_{190806c-1})
\]
\[
X = (0.6208 - 0.5704) / (1.0 - 0.5704)
\]
\[
X = 0.1173
\]

\( X_{\text{as a percent}} = 11.7\% \), i.e., CO₂ sample 190805c-1 would be composed of 88.3% CO₂ with the age 4510 BP and 11.7% modern contamination. So to get the younger age (assuming the older age were the true age) there would have to be about 12 percent modern carbon contamination.

If the specimen were contaminated only since excavation, then the calculation assuming \( F^{14}C_{\text{contamination}} = 1.0 \) would hold true. Contamination could be in the form of either absorbed modern carbon dioxide within the bone’s pore space or modern exchanged carbon within the organic molecular structure of the specimen. Our laboratory protocols minimize risk of any pore space contamination by running argon plasmas and letting the bone sit under high vacuum conditions for hours to days. This has been shown to be effective in other test cases. Potential contamination by molecular exchange is unlikely due to the careful handling and short time since excavation.

A more likely mechanism of contamination is that the molecular structure of the bone has exchanged some its carbon with ambient environmental carbon over the entire period from post-death to present. In this case, the assumption \( F^{14}C_{\text{contamination}} = 1.0 \) does NOT hold true and instead the value \( F^{14}C_{\text{contamination}} \) would be less than the 1.0 used to calculate \( X \). As a result, the fraction of contamination with ambient carbon (\( X \)) is likely greater than the reported 12 percent.

When applied to intact specimen, plasma oxidation is a surface biased radiocarbon sampling technique. Plasma oxidation sampling has documented the changing isotopic composition progressively within the mass of Bone 204. Since the first sample is younger than the second, surface diffusion of the contaminating carbon is implied by these dating results. Another possible interpretation of how plasma oxidation works is that it is preferentially sampling carbon from easily broken organic molecular bonds. If substitution happens at weak bond positions, the contaminating carbon may be oxidized preferentially, increasing the proportion of contaminating carbon in the first plasma oxidation. Progressive sampling would exhaust the weakly bonded contaminating carbon, and later plasma samples would be dominated by the carbon incorporated into stronger molecular structures. Assuming that the contamination source is also surface-biased and/or also is reflected in weak molecular structures, progressive sampling and dating should reflect a continuum of more-to-less contaminated carbon content.

Of the two dates reported here for the specimen, we believe that the older date is a better approximation of the age of Bone 204. However, based on either the surface or weak bond model of contamination, the true age of the animal at time of death is probably even older.

Eric Blinman, Marvin Rowe, and Shelby A. Jones
References
