First Evidence for Nicotiana (Tobacco) and its Human Use in Pleistocene North America

Daron Duke (daron@farwestern.com)
Far Western Anthropological Research Group https://orcid.org/0000-0001-8352-013X
Eric Wohlgemuth
Far Western Anthropological Research Group
Karen Adams
Crow Canyon Archaeological Center
Angela Armstrong-Ingram
Far Western Anthropological Research Group
Sarah Rice
HazAir
D. Young
Far Western Anthropological Research Group

Article

Keywords: Cultigens, Domestication Paths, Wishbone Site, Preservation Context, Hearth-side Activities, Deep-time Human Use, Plant Intoxicants

Posted Date: January 27th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-139445/v1

Version of Record: A version of this preprint was published at Nature Human Behaviour on October 11th, 2021. See the published version at https://doi.org/10.1038/s41562-021-01202-9.

First Evidence for *Nicotiana* (Tobacco) and its Human Use in Pleistocene North America

Daron Duke[1*], Eric Wohlgemuth[2], Karen R. Adams[3], Angela Armstrong-Ingram[2], Sarah K. Rice[1], D. Craig Young[4]

[1]Far Western Anthropological Research Group, Desert Branch, Henderson, NV, USA

[2]Far Western Anthropological Research Group, Davis, CA, USA

[3]Crow Canyon Archaeological Center, Cortez, CO, USA

[4]Far Western Anthropological Research Group, Great Basin Branch, Carson City, NV, USA

[*]Corresponding author: daron@farwestern.com

Summary. Current studies on cultigens emphasize the protracted and intimate human interactions with wild species that defined paths to domestication and, for certain plants, profoundly impacted humanity[1,2]. Tobacco (*Nicotiana*) is one such plant. Tobacco arguably has had more impact on global patterns in history than any other psychoactive substance, but how deep its cultural ties trace back is widely debated. Adding to the puzzle is whether the distribution of tobacco in North America occurred naturally or if humans themselves were responsible for its expansion across the continent[3]. Archaeological excavations at the Wishbone site, directed at the hearth-side activities of the early inhabitants of North America's desert west, have uncovered evidence for tobacco approximately 12,300 years ago, 9,000 years earlier than previously documented[4]. Here we detail the preservation context of the site, discuss its cultural affiliation, and consider the ways that the tobacco may have been used. Researchers have long suspected that human use extends earlier in time than can been readily demonstrated by such fragile remains[3–7], so the finding reinvigorates research on the driving cultural forces behind tobacco's use, cultivation, and subsequent domestication. This has implications for our understanding of deep-time human use of plant intoxicants, the intersection of non-food plant domestication with that of food crops, and the trajectory of selective, potentially independent,

interactions with tobacco from a broad cultural milieu in ancient North America to a place of worldwide cross-cultural significance.

Among the intoxicant plants preferred by humans, *Nicotiana* (tobacco) has perhaps had the most significant social and economic impact. Its historical rise as a globally important domesticate is directly tied to Western expansion and commerce, beginning with humble interactions between Spanish explorers and native peoples in the Americas. Tobacco now contributes to the enjoyment, traditional practice, and detriment of hundreds of millions of people worldwide[8]. Within indigenous North American culture, ethnographic and historical accounts indicate tobacco's use in all manner of ritual, medicinal, and social settings, and its power is richly ensconced in oral traditions[6,9–12]. Of North America's desert west, the location of the current study, the late tobacco specialist Joseph Winter[13] wrote: "Of all the native groups…the Paiute, Goshute, Shoshone, Washo, Kawaiisu, and Ute of the Great Basin best represent the ancient substratum of tobacco-using shamanism that evolved elsewhere into…complex tobacco-using religious systems." This relationship implies deep time, but how deep remains a vital question[3–5,7,14,15].

Inextricably related is the question of whether people expanded the range of this endemically South American plant across North America or if they found it distributed much as today. Because archaeological material has so far been the only botanical indicator[16,17], distinguishing natural from cultural dispersal is challenging. Researchers have proposed several hypotheses. One non-cultural possibility is that the widespread dispersal of tobacco was post-Pleistocene, when warming and drying conditions allowed for natural expansion of wild tobacco species from southern Mexico[3,14]. This timing post-dates the arrival of people, who appeared south of the continental ice sheets in coastal and neighboring inland areas by at least 16,000 calibrated years before present (cal BP)[18,19]. Another hypothesis is that humans would have recognized tobacco's intoxicant properties shortly after their arrival into southern continental

52 regions, and having antecedent knowledge of other psychoactive plants, fostered its spread
53 northward by various means of transport, ground disturbance, and cultivation[3]. There are no
54 direct data to support these theories, and scholars have also worked back from the known
55 association of tobacco with a host of domesticated plants and agrarian economies[17,20,21]. Recent
56 finds of nicotine residue on smoking pipes provide the prior earliest demonstrated use of tobacco
57 at ca. 3,300 cal BP [4]. This is in a pre-agricultural context in the southeastern United States, where
58 the record of pipes, for tobacco or otherwise[7], extends back to ca. 5,000 cal BP. Residues on
59 smoking pipes in the Pacific Northwest date to 1,200 cal BP or more[7,15]. In the Great Basin and
60 adjacent areas, where agriculture was never adopted, tobacco seeds have been found in cultural
61 contexts dating as early as ca. 1,750 cal BP[22]. If tobacco was available in western North America
62 when humans arrived, then there should be deep-time archaeological associations that further
63 narrow the period within which any human-based mechanisms of dispersal could play out.

64 **The Wishbone Site**

65 Archaeological excavations at the Wishbone site (42TO6384) have yielded evidence for
66 tobacco and its human use at approximately 12,300 cal BP[23]. Four charred *Nicotiana* seeds (Fig.
67 1) were found among the contents of an intact cultural hearth. The site is a hunter-gatherer camp
68 consisting of stone and bone artifacts surrounding the hearth and eroding from the mud flats of
69 the Great Salt Lake Desert (GSLD). The area is now an open playa, but the site is situated
70 alongside relict landforms of the Old River Bed Delta (ORBD) (Fig. 2), a once sprawling
71 marshland (>1,000 km^2) that existed between approximately 13,000 to 9,500 cal BP[24,25]. During
72 this time, the ORBD served as a primary habitat draw for people in the region, who camped on
73 the intervening dry landforms between wetland water bodies. The dating of the site is based on
74 three radiocarbon age estimates on pieces of charred *Salix* sp. (willow) wood from the hearth fill,

as detailed in Methods. These provide a combined radiocarbon age estimate for the hearth of 10,390 ± 20 BP, which calibrates to a median probability age of 12,270 cal BP with a 95 percent confidence range of 12,480-12,060 cal BP. Willow was likely the best marshland fuelwood option on the ORBD.

The site is culturally affiliated with an archaeological complex known as the Western Stemmed technological tradition, within what is now native Shoshonean-speaking Goshute territory. This tradition is largely restricted to western North America at the Pleistocene-Holocene transition and is recognized by a series of stemmed projectile point styles, with the oldest style, Haskett, identified among the hearth-associated artifacts at the Wishbone site. Haskett points are lanceolate-shaped spear tips[26,27] that date as early as ~13,000 cal BP[28]. This date is contemporaneous with the Clovis style, of the fluted point tradition, which is widely recognized across the continent[29]. Haskett artifacts in dry shelter sites near the GSLD demonstrate use in the area beginning sometime between 12,900 and 12,500 cal BP [30,31]. Both Haskett and Clovis represent large-game hunting technologies used by highly mobile hunter-gatherers, on the order of several hundred kilometers a year[23,32,33], and the earliest technologically distinctive cultural traditions in the sparsely populated continental interior[34].

A diverse cultural assemblage is present at the site, providing behavioural context for the find. Within the hearth fill, there were one of two Haskett point fragments, 586 burned waterfowl bone fragments, three avian gastroliths (gizzard stones), and 10 pieces of stone toolmaking debris. Surrounding the hearth, the excavation yielded over 20,000 fragments of waterfowl bone food refuse (mostly Anatidae), various stone tools, additional toolmaking debris, a human-made incised mammal bone object, the other half of the Haskett item from the hearth fill, and a complete Haskett specimen (Fig. 3). Several of the bones exhibit tool cutmarks. A few medium-

and large-mammal bone fragments were also found. All these materials were largely contained within a three-meter radius but decreased substantially after one meter, a pattern common for fireside activities.

The *Nicotiana* seeds were identified in 0.5-millimeter grade and 0.4-millimeter flotation residues from the central hearth fill (Fig. 4). That they were preserved at all in such an early site is attributed to the distinctive subsurface context of the GSLD. Geomorphological investigations suggest the hearth had been buried by continued ORBD sediment deposition following the Pleistocene habitation but before desiccation of the wetlands in the Early Holocene, ca. 9,500 cal BP. Eolian and alluvial processes have been peeling sediment layers away since that time, just now reaching the hearth. Beneath the ground surface, cultural deposits stay in a largely undisturbed and sealed fine silty clay matrix. This matrix represents a waterlogged and nearly anaerobic substrate[35] that remains intact except at the deflating surface where wet-dry cycles and seasonal water affect and destroy archaeological materials, and the wind carries away the lightweight fragments. The hearth was being exposed at this erosional interface. The sediments surrounding the hearth and similar Pleistocene-age paleoenvironmental control samples from the site vicinity were also examined; no tobacco seeds were found, only the seeds of wetland plants. Full macrobotanical results are presented in Methods.

Nicotiana is readily identifiable at the genus level, but species identification is challenging given overlapping morphological attributes[17,36–38]. The Wishbone site seeds closely resemble *N. attenuata* Torr. Ex S. Wats. (coyote tobacco), which in the Great Basin is both common[17] and documented to have been tended by indigenous peoples[10,13,39,40]. The other relevant regional species are *N. quadrivalvis* Pursh (Indian tobacco), and *N. obtusifolia* M. Martens & Galeotti (desert tobacco), formerly *N. trigonophylla*[41].

Cultural versus Natural Deposition

Seeds identified in prehistoric hearths usually represent human use unless attributable to natural factors. We considered two alternative hypotheses to the interpretation that the *Nicotiana* seeds were culturally deposited: 1) they represent the stomach contents of ducks cooked in the hearth; and/or 2) they were included as a fire fuel source or were introduced naturally and burned. To the first alternative, *Nicotiana* is not part of the avian diet. Nicotine and other alkaloids are variably unpalatable and/or toxic to many vertebrate animal species[42]. Also, regional *Nicotiana* is found upland in rocky outcrops and adjacent areas, in stark contrast to the open marshland context—i.e., waterfowl food supply—of the ORBD and immediate site vicinity. Nevertheless, we surmise that the internal organs of the cooked birds were present in the hearth, so the possibility of incidental inclusion was addressed. Whole-bird cooking, a favored method by native peoples in the region[43], is suggested by the presence of gastroliths (gizzard stones) and bones from the lower legs and feet, which were likely deposited from discarded entrails and body parts. The hearth also contained *Potamogeton* spp. (pondweed) seeds, a subaqueous dietary staple for many Anatidae species and an unlikely food target for people, in relative abundance compared to our paleoenvironmental control samples.

Regarding the second alternative, *Nicotiana*'s use by people as fuel is improbable because tobacco is an annual or biennial plant lacking woody tissue that burns quickly and cannot generate a fire of enough strength or duration for most cooking. Another incidental possibility is from wildland fires, which presumes the presence of *Nicotiana* in the Pleistocene. The local range of desert species of *Nicotiana* within its modern distribution can increase quickly after wildfires, a fact exploited by Native people who sometimes used controlled burns to enhance its yield[10,13,36], but, human-induced or not, the plants would only be expected to expand

144 within their normal habitat, not across the ORBD marshes. Possible tobacco habitat lies 13
145 kilometers to the northeast on Wildcat Mountain, a small, isolated mountain protruding from the
146 mud flats (Fig. 1). Otherwise, 24 kilometers separate the site to the nearest desert uplands at the
147 basin margin. Finally, we examined macrobotanical remains from our paleoenvironmental
148 control samples and found only seeds from plants common to Great Basin wetlands.
149 *Potamogeton* is more abundant in the hearth than the controls, supporting the case for duck
150 stomach contents, but there is no evidence for *Nicotiana*. Introduction of *Nicotiana* by natural
151 agents is not a parsimonious explanation for its presence at the Wishbone site.

152 **Manner of Human Use**

153 We cannot determine for certain the precise manner of human use for the tobacco at the
154 site, but there are a few considerations for narrowing down the range of possibilities. The data
155 suggest use as a fireside activity along with food preparation, consumption, and tool use among
156 mobile hunter-gatherers at distance from natural tobacco habitat. The finding of seeds implies
157 emphasis on leaves and flowering stems, the parts with the intoxicant effect. Seeds are the
158 tobacco parts preserved most often in the archaeobotanical record, but non-germinated seeds
159 carry no nicotine[44]. Because seeds are small and easily caught up by the sticky hairs of the plant,
160 they could be incidentally included when leaves and stems with attached flowering parts are
161 harvested. This is consistent with the archaeological record and preparation methods by native
162 groups in the Great Basin[45,46].

163 The growing dataset of nicotine residues from precontact pipes indicates that tobacco
164 smoking was common[4,6,7,15,21], but the chewing and/or sucking of plugs, pinches, and quids was
165 also practiced[36,47]. Smoking might introduce seeds by the discard of unused portions of undesired
166 dry remnants. Quids—wads of plant fiber containing tobacco to be chewed and/or sucked—have

been found in regional dry caves and shelters. In on regional example, Arizona's Antelope Cave, seeds and fragments of capsules, calyxes, pedicels, stems, and leaves were found in 90 percent of the quids examined[47]. Seeds from quid use could have been deposited by being spat or by expended quids being tossed into the fire.

Implications of Deep Time Tobacco Use

In the Great Basin, people lived as hunter-gatherers through Euroamerican contact, with their most common foray into plant cultivation being with tobacco. At the Wishbone site, this plant was brought from its upland habitat into the center of a large basin wetland early in the human experience in the Americas. The data suggest that wild *Nicotiana* species were already available consistent with their modern distribution when people arrived and begs the question of whether tobacco's intoxicant properties were identified independently throughout the Americas.

The find recalibrates research on the adoption and eventual domestication of tobacco, putting some 10,000 years of human use before the efflorescence of agriculture in North America and the domestication of *N. tabacum* and *N. rustica* alongside a host of food crops. This has important implications for examining how long-term cultural relationships with intoxicants shape and respond to further developments. Tobacco's early use lends to the interpretation that there is nothing inevitable about domestication. Rather, tobacco's long heritage with humans, entailing both use and abuse, represents one view from the sociocultural side of an intensification process that manifest itself differently according to local socioeconomic incentives and pressures. With its rich history in Western commerce, influence, and cross-cultural impact, tobacco is uniquely suited to examining this process through a connection to many societal facies since the Pleistocene.

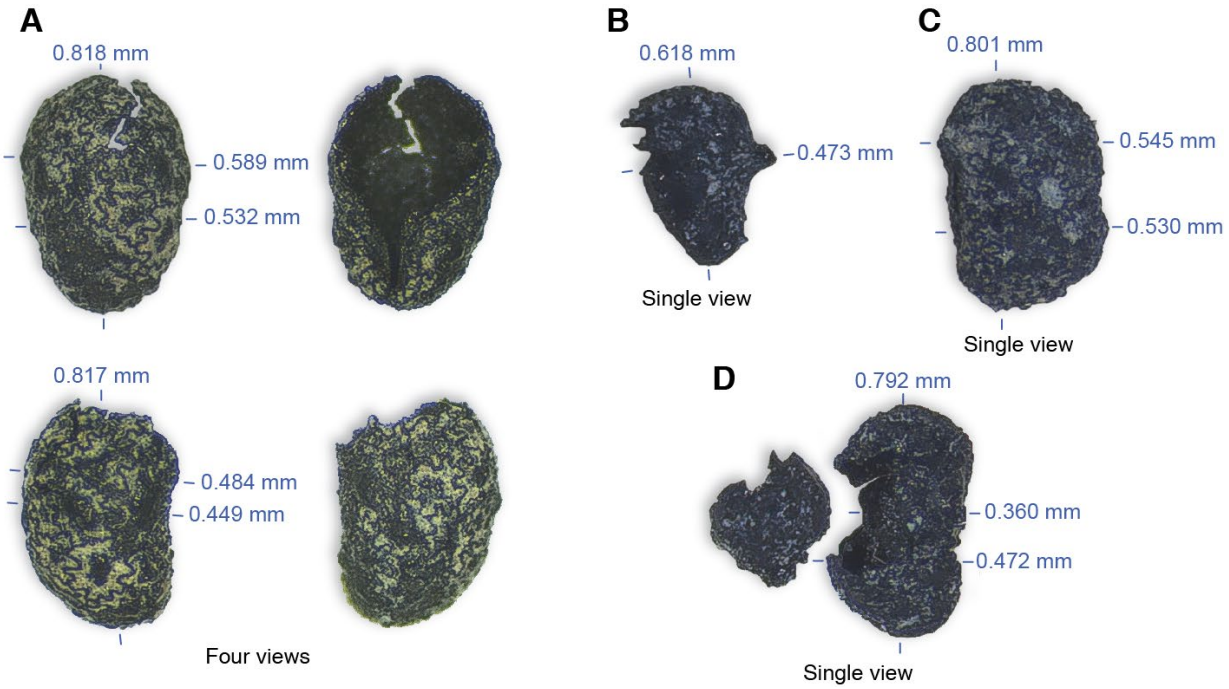
References

1. Allaby, R. G., Fuller, D. Q. & Brown, T. A. The genetic expectations of a protracted model for the origins of domesticated crops. *Proceedings of the National Academy of Sciences of the United States of America* **105**, 13982–13986 (2008).
2. Larson, G. *et al.* Current perspectives and the future of domestication studies. *Proceedings of the National Academy of Sciences of the United States of America* **111**, 6139–6146 (2014).
3. Winter, J. C. Food of the Gods: Biochemistry, Addiction, and the Development of Native American Tobacco Use. in *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer* 305–328 (University of Oklahoma Press, 2000).
4. Carmody, S. *et al.* Evidence of tobacco from a Late Archaic smoking tube recovered from the Flint River site in southeastern North America. *Journal of Archaeological Science: Reports* **21**, 904–910 (2018).
5. Fitzpatrick, S. M. & Merlin, M. D. Introduction: Drugs from a Deep Time Perspective. in *Ancient Psychoactive Substances* (ed. Fitzpatrick, S. M.) 1–19 (University Press of Florida, 2018).
6. Rafferty, S. M. Prehistoric Intoxicants of North America. in *Ancient Psychoactive Substances* (ed. Fitzpatrick, S. M.) 112–127 (University Press of Florida, 2018).
7. Tushingham, S., Snyder, C. M., Brownstein, K. J., Damitio, W. J. & Gang, D. R. Biomolecular archaeology reveals ancient origins of indigenous tobacco smoking in North American Plateau. *Proceedings of the National Academy of Sciences of the United States of America* **115**, 11742–11747 (2018).
8. *WHO Report on the Global Tobacco Epidemic, 2019*. https://www.who.int/teams/health-promotion/tobacco-control/who-report-on-the-global-tobacco-epidemic-2019 (2019).
9. *Perspectives on the Archaeology of Pipes, Tobacco and other Smoke Plants in the Ancient Americas*. (Springer International Publishing, 2016). doi:10.1007/978-3-319-23552-3.
10. Fowler, C. S. Subsistence. in *Handbook of North American Indians: Great Basin, Volume 11* (ed. D'Azevedo, W. L.) 64–97 (Smithsonian Institute, 1986).
11. Turner, N. J. & Taylor, R. L. A Review of the Northwest Coast Tobacco Mystery. *Syesis* **5**, 249–257 (1972).
12. *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer*. (University of Oklahoma Press, 2000).
13. Winter, J. C. Traditional Uses of Tobacco by Native Americans. in *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer* (ed. Winter, J. C.) 9–58 (University of Oklahoma Press, 2000).
14. Goodspeed, T. H. *The Genus Nicotiana: Origins, Relationships, and Evolution of its Species in the Light of Their Distribution, Morphology, and Cytogenetics*. (Chronica Botanica, 1954).
15. Tushingham, S. *et al.* Hunter-gatherer tobacco smoking: earliest evidence from the Pacific Northwest Coast of North America. *Journal of Archaeological Science* **40**, 1397–1407 (2013).
16. Särkinen, T., Bohs, L., Olmstead, R. G. & Knapp, S. A phylogenetic framework for evolutionary study of the nightshades (Solanaceae): A dated 1000-tip tree. *BMC Evolutionary Biology* **13**, (2013).

17. Winter, J. C. Botanical Description of the North American Tobacco Species. in *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer* (ed. Winter, J. C.) 87–127 (University of Oklahoma Press, 2000).
18. Davis, L. G. *et al.* Late Upper Paleolithic occupation at Cooper's Ferry, Idaho, USA, ~16,000 years ago. *Science* **897**, 891–897 (2019).
19. Waters, M. R. Late Pleistocene exploration and settlement of the Americas by modern humans. *Science* **365**, (2019).
20. Wagner, G. E. Tobacco in Prehistoric Eastern North America. in *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer* (ed. Winter, J. C.) 185–201 (University of Oklahoma Press, 2000).
21. Raffety, S. M. Evidence of early tobacco in Northeastern North America? *Journal of Archaeological Science* **33**, 453–458 (2006).
22. Arkush, B. S. & Arkush, D. Aboriginal plant use in the central Rocky Mountains: Macrobotanical records from three prehistoric sites in Birch Creek Valley, eastern Idaho. *North American Archaeologist* (2020) doi:10.1177/0197693120967005.
23. Duke, D., Rice, S. K., Young, D. C. & Byerly, R. *The Playas Archaeological Inventory: 6,914 Acres on the Utah Test and Training Range Including Portions of the West Distal Delta of the Old River Bed and Test Excavations at the Wishbone Site (42TO6384), Tooele County, Utah*. (2018).
24. Duke, D. G. If the Desert Blooms: A Technological Perspective on Paleoindian Ecology in the Great Basin from the Old River Bed, Utah. *Department of Anthropology* (University of Nevada, Reno, 2011).
25. Madsen Dave N. Schmitt, and David Page, D. B. *The Paleoarchaic Occupation of the Old River Bed Delta*. *University of Utah Anthropological Papers 128* (The University of Utah Press, 2015).
26. Smith, G. M. *et al.* The Western Stemmed Tradition: Problems and Prospects in Paleoindian Archaeology in the Intermountain West. *PaleoAmerica* **6**, 23–42 (2020).
27. Duke, D. Haskett Spear Weaponry and Protein-Residue Evidence of Proboscidean Hunting in the Great Salt Lake Desert, Utah. *PaleoAmerica* **1**, 109–112 (2015).
28. Jenkins Loren G. Davis, Thomas W. Stafford Jr., Paula F. Campos, Bryan Hockett, George T. Jones, Linda Scott Cummings, Chad Yost, Thomas J. Connolly, Robert M. Yohe, Summer C. Gibbons, Maanasa Raghavan, Morten Rasmussen, Johanna L. Paijmans, Michael Hofr, D. L. Clovis Age Western Stemmed Projectile Points and Human Coprolites at the Paisley Caves. *Science* **337**, 223–228 (2012).
29. Waters, M. R., Stafford, T. W. & Carlson, D. L. The age of Clovis-13,050 to 12,750 cal yr B.P. *Science Advances* **6**, 1–12 (2020).
30. Bryan, A. L. Smith Creek Cave. in *The Archaeology of Smith Creek Canyon, Eastern Nevada* (ed. Touhy and D. L. Randall, D. R.) 162–253 (Nevada State Museum Anthropological Papers 17, 1979).
31. Goebel, T. & Keene, J. L. Are Great Basin Stemmed Points as Old as Clovis in the Intermountain West? A Review of the Geochronological Evidence. in *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler* (eds. Parezo, N. J. & Janetski, J. C.) 35–60 (The University of Utah Press, 2014).
32. Jones Charlotte Beck, Eric E. Jones, Richard E. Hughes, G. T. Lithic Source Use and Paleoarchaic Foraging Territories in the Great Basin. *American Antiquity* **68**, 5–38 (2003).

33. Kilby, J. D. An Investigation of Clovis Caches: Content, Function, and Technological Organization. *Department of Anthropology* vol. Ph.D. (University of New Mexico, 2008).
34. Beck and George. T. Jones, C. Clovis and Western Stemmed: Population Migration and the Meeting of Two Technologies in the Intermountain West. *American Antiquity* **75**, 81–116 (2010).
35. Holden, J. *et al.* Hydrological controls of in situ preservation of waterlogged archaeological deposits. *Earth-Science Reviews* **78**, 59–83 (2006).
36. Adams, K. R. & Toll, M. S. Tobacco Use, Ecology, and Manipulation in the Prehistoric and Historic Southwestern United States. in *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer* (ed. Winter, J. C.) 143–170 (University of Oklahoma Press, 2000).
37. Gunn, C. R. & Gaffney, F. B. *Seed Characteristics of 42 Economically Important Species of Solanaceae in the United States*. (United States Department of Agriculture, 1974).
38. Winter, J. C. Introduction to North American Tobacco Species. in *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer* (ed. Winter, J. C.) 3–8 (University of Oklahoma Press, 2000).
39. Adams, K. R. Prehistoric Reedgrass (Phragmites) "Cigarettes" with Tobacco (Nicotiana) Contents: a Case Study from Red Bow Cliff Dwelling, Arizona. *Journal of Ethnobiology* **10**, 123–139 (1990).
40. Rhode, D. *Native Plants of Southern Nevada*. (University of Utah Press, 2002).
41. Makings, E. & Solves, J.-P. Solanaceae Part Six: Nicotiana L. Tobacco. *Canotia* **14**, 54–62 (2018).
42. Aniszewski, T. *Alkaloids: Chemistry, Biology, Ecology, and Applications*. (Elsevier Science, 2015).
43. Fowler, C. S. *In the Shadow of Fox Peak: An Ethnography of the Cattail-Eater Northern Paiute People of Stillwater Marsh*. (United States Department of the Interior, Fish and Wildlife Service, Region 1, Stillwater National Wildlife Refuge. Cultural Resource Series 5, 1992).
44. Tso, T. C. & Jeffrey, R. N. Studies in Tobacco Alkaloids. I. Changes in Nicotine and Nornicotine Content in Nicotiana. *Plant Physiology* **31**, 433–440 (1956).
45. Murphey, E. V. A. *Indian Uses of Native Plants*. (Desert Printers, Inc., 1959).
46. Zigmond, M. L. Kawaiisu. in *Handbook of North American Indians: Great Basin, Volume 11* 398–411 (Smithsonian Institution, 1986).
47. Adams, K. R., Johnson, K. L. & Murphy, T. M. Prehistoric Puebloan yucca (Yucca) quids with wild tobacco (Nicotiana) contents: Molecular and morphological evidence from Antelope Cave, northwestern Arizona. *Journal of Field Archaeology* **40**, 310–324 (2015).
48. Wohlgemuth, E. Appendix H: Archaeobotanical Remains. in *Prehistory of the Sacramento River Canyon, Shasta County, California* (eds. Basgall, M. E. & Hildebrandt, W. R.) (Center for Archaeological Research, 1989).
49. Pearsall, D. M. *Paleoethnobotany: A Handbook of Procedures*. (Routledge, 2015).
50. Reimer, P. J. *et al.* The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0-55 cal kBP). *Radiocarbon* **62**, 725–757 (2020).
51. Ramsey, C. B. Bayesian Analysis of Radiocarbon Dates. *Radiocarbon* **51**, 337–360 (2009).

326

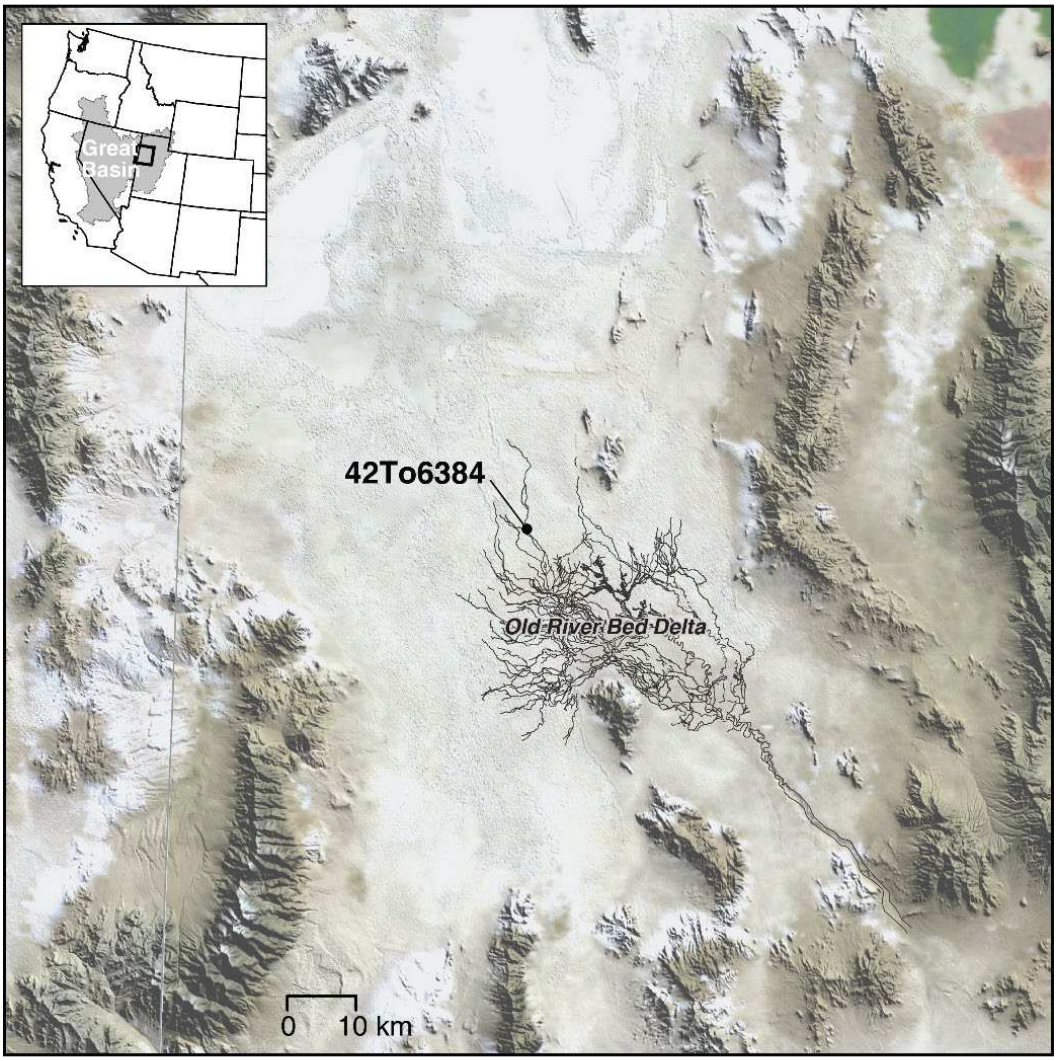


327

328

329 **Fig. 1.** *Nicotiana* seeds and measurements from the Wishbone site. (A) Specimen 1-35-98-1. (B)

330 Specimen 1-40-98-2. (C) Specimen 1-40-98-1. (D) Specimen 2-40-98-1.



331

332 **Fig. 2.** Location of 42TO6384 and important physiographic features. The ORBD channels are

333 based on GIS mapping of extant landforms using aerial imagery (courtesy U.S. Army Dugway

334 Proving Ground).

335
336

337 **Fig. 3**. Position of hearth (circled) relative to selected artifacts at the Wishbone site. (A) Haskett

338 fragment, FS 247, refits with FS 59. (B) Haskett fragment, FS 59, refits with FS 247. (C)

339 Anatidae humerus, FS 230. (D) Haskett, FS 220. (E) incised mammal bone, FS 761. (F) Anatidae

340 furculum, FS 230.

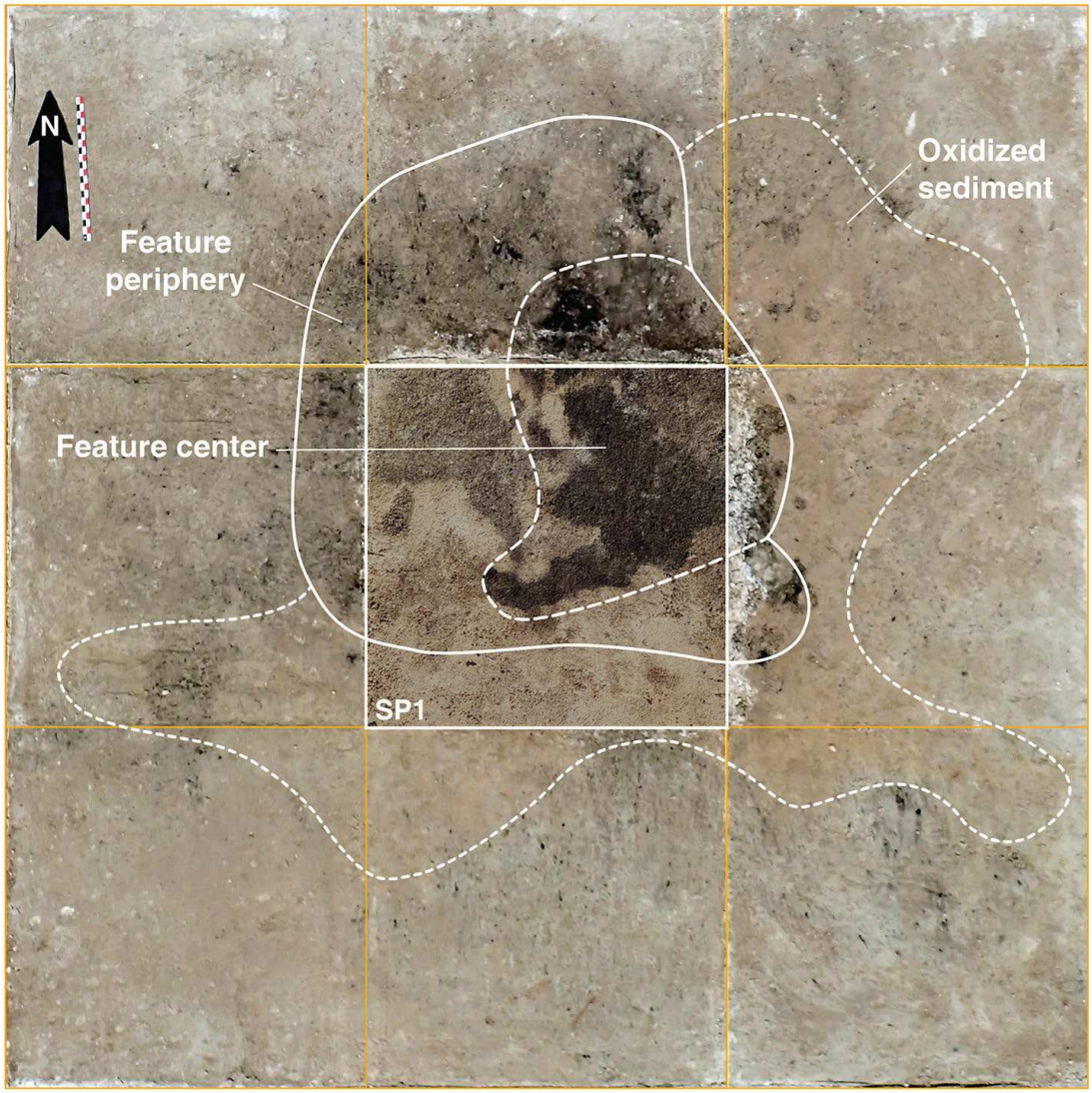


Fig. 4. Hearth (Feature 1) plan view. View is at 2 cm below the ground surface (162 cm below datum). Central square represents the 0.5-x-0.5-m shovel probe (SP1) excavated and photographed in 2015. The *Nicotiana* seeds were found in the flotation-processed feature center fill from SP1. Remaining area excavated to the same level and photographed in 2016. Charcoal flecks outside the defined hearth boundary likely represent windblown pieces from the time of use.

Methods

Macrobotanical specimens were identified in the laboratory from sediment fill collected during site excavations (Extended Data Table 1). The hearth extended approximately two centimeters down from the ground surface. All excavated sediment within a 3-x-3-m gridded area inclusive of and surrounding the hearth was bagged by 0.5-x-0.5-m subunit for comprehensive analysis in the laboratory. Artifacts were piece plotted when encountered to document their spatial association with the hearth.

Paleoenvironmental control samples from seven geo-localities in the vicinity (<3 km) of the site were collected for comparison to the hearth contents. These are of similar age to the site and intended to represent the macrobotanically identifiable plant profile of the ORBD wetlands at the Pleistocene-Holocene transition. The sediments, often referred to as "black mats," are extant shallow-marsh, organic-rich sediment layers that retain a black-to-gray color. While bulk organic sediments can only represent an average of time, their deposition on the ORBD tended to occur in short-lived oscillations of wetland waterways. They have proven useful in radiocarbon dating of the ORBD system[24,25] (Duke 2011; Madsen et al. 2015), and their age resolution is sufficient for current purposes.

The sediment samples were flotation-processed using a manual technique utilized for thousands of soil samples throughout the Great Basin and California[48,49] (Wohlgemuth 1989; Pearsall 2015). Three iterations of filling, skimming, and decanting from the slurry in a washtub ensured thorough recovery collection of charred plant remains in the buoyant light fraction collected using 0.4-mm screen. The approximately 1.0-mm tobacco seeds and other small plant specimens would be caught in this mesh. The non-buoyant heavy fraction was washed through 3-mm and 0.7-mm mesh to retrieve other fine-grained site constituents as well as the rare non-

buoyant plant remains. Thorough washing of all equipment, prior to and upon completion of flotation, ensured that no inter-sample contamination occurred. Light fraction was size-sorted using 2-mm, 1-mm, 0.7-mm, and 0.5-mm mesh. Sorting of light fractions for charred seeds and other recognizable plant material was then completed. Each size grade, including the 0.4-mm residue, was examined under a microscope at 10-30x magnifications. Soil volume (L) and weight (kg) were recorded for each flotation sample.

Radiocarbon dating by Accelerator Mass Spectrometry (AMS) was conducted on charred woody material from the hearth contents, retrieved during manual flotation, and on six of the seven the paleoenvironmental control localities (Extended Data Table 2). The *Nicotiana* seeds were judged too small (<0.1 mg) and fragile for direct dating by current methods. The charred wood samples were submitted to the Paleoscapes Archaeobotanical Services Team for plant identification before submission to Beta Analytic for AMS dating. Age calibrations are based on the IntCal20 curve[50] (Reimer et al. 2020) via OxCal 4.4[51] (Ramsey 2009). The calibrated median probability age for the site was generated using the OxCal combining tool.

References (Methods)

Included in above References section

Site			**42TO6384**	**42TO6384**	**42TO6384**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Geo-locality			**To64-1**	**n/a**	**n/a**	**To27-1**	**To35-1, -2, -3, -4, -5**	**To65-1**	**To66-1**	**To81-4**	**To85-8**	**To114-1**
Sediment Context			**Within hearth (fill)**	**Beneath hearth**	**Outside hearth**	**Organic sediment**	**Organic sediment**	**Organic sediment**	**Organic sediment**	**Organic sediment**	**Organic sediment**	**Organic sediment**
Volume (l)			**12.1**	**23.3**	**327.9**	**2.3**	**35.2**	**0.15**	**0.5**	**1.8**	**19.5**	**2.5**
Scientific name	**Common name**											
Calandrinia spp.	Red maids	ct	1	-	-	-	-	-	-	-	-	-
Chenopodium berlandieri	Pitseed goosefoot	ct	5	-	-	-	-	-	-	-	-	-
Chenopodium spp.	Goosefoot	ct	-	-	-	-	11	-	-	-	-	-
Deschampsia spp.	Hairgrass	ct	3	-	-	-	-	-	-	-	2	-
Juncus spp.	Rush	ct	4	1	-	-	-	-	-	-	1	-
Nicotiana spp.	Tobacco	ct	4	-	-	-	-	-	-	-	-	-
Potamogeton spp.	Pondweed	ct	44	-	20	-	3	-	-	-	-	-
Rumex spp.	Dock	ct	-	-	-	1	-	-	-	-	1	-
Schoenoplectus spp.	Tule	ct	75	6	67	99	94	2	4	2	133	57
Typha spp.	Cattail	ct	-	-	1	4	-	-	-	-	23	-
Chenopodiaceae	Goosefoot family	ct	1	-	3	1	-	-	-	8	66	9
Poaceae fragments	Grass family	ct	11	1	4	2	1	-	2	-	-	1
Unidentifiable seeds		ct	33	9	60	5	21	5	4	3	16	2
Total identified to genus		ct	136	7	88	104	108	2	4	160	104	57
Total identified to family		ct	149	8	95	107	109	2	6	226	107	67
Salix sp. wood charcoal		mg	830.8	-	-	-	-	-	-	-	-	-
Unidentified wood charcoal		mg	247.2	0.6	-	2.3	5.7	-	-	-	275.0	-

388 **Extended Data Table 1.** Charred plant materials from the Wishbone site (42TO6384) and paleoenvironmental control samples.

Site	Geo-Locality	Lab Number	Material	13C/12C Ratio	Conventional Radiocarbon Age (BP)	Median Probability (cal BP)	Age Range (cal BP)	Comments
42TO6384	To64-1	Beta-428728	Charcoal - *Salix* (twig)	-26	10,370 ± 30	12,250	12,480-12,000	-
42TO6384	To64-1	Beta-428729	Charcoal - *Salix* (bark)	-26.9	10,430 ± 40	12,320	12,610-12,090	-
42TO6384	To64-1	Beta-428730	Charcoal - *Salix* (bark)	-27.3	10,370 ± 40	12,240	12,480-12,000	-
42TO6384	To64-1	-	-	-	10,390 ± 20	12,270	12,480-12,060	Above three dates combined
-	To27-1	Beta-479064	Organic sediment	-26.4	10,820 ± 30	12,750	12,830-12,720	-
-	To35-2	Beta-479058	Organic sediment	-20.2	10,720 ± 30	12,720	12,750-12,680	-
-	To35-2	Beta-479059	Organic sediment	-19.4	10.660 ± 30	12,700	12,740-12,620	Representative for To35-1, -3, -4, -5
-	To65-1	Beta-428734	Organic sediment	-25.8	9590 ± 30	10,930	11,150-10,760	-
-	To66-1	Beta-432288	Organic sediment	-18	10,350 ± 30	12,190	12,470-11,970	-
-	To81-4	Beta-479056	Organic sediment	-22.3	10,270 ± 30	11,970	12,430-11,820	-
-	To85-8	Beta-479061	Organic sediment	-26.8	10,710 ± 30	12,720	12,750-12,680	-
-	To85-8	Beta-479071	Charcoal specimen	-23.5	10,580 ± 40	12,630	12,710-12,480	Individual piece from To85-8 sediment

Extended Data Table 2. Radiocarbon age estimates from Feature 1 at the Wishbone site (42TO6384) and paleoenvironmental controls. Calibrations using OxCal 4.4, 2σ SD. Ages rounded to the nearest 10 years.

Acknowledgements

We thank the United States Air Force for support of this work, especially Jaynie Hirschi, Anya Kitterman, and Michael Shane. We also appreciate the assistance and field support of U.S. Army Dugway Proving Ground archaeologists Jennifer DeGraffenried and Nate Nelson. Mark Slaughter, Bureau of Reclamation, and Leilani Lucas, College of Southern Nevada, provided valued feedback. Numerous others deserve more credit than space will allow for their devoted fieldwork, insightful thoughts, and generous assistance. We thank you. The work was funded through a Research Subaward Agreement (PG16-24878-01) to Far Western Anthropological Research Group by the Center for Integrated Research on the Environment, University of Montana, under Contract No. W9128F-14-2-0002 TO 12 with the United States Army Corps of Engineers, Omaha District. The Air Force publication authorization case number for the current study is 75ABW-2019-0014. The *Nicotiana* specimens collected in this study are currently being stored at Far Western Anthropological Research Group's laboratory in Henderson, Nevada, and will be curated at the Natural History Museum of Utah.

Author Contributions

Author Contributions: D.D. directed the project and wrote the main text with assistance from E.W., K.R.A., and S.K.R. E.W. supervised the archaeobotanical laboratory and assisted D.D. with the Methods section. K.R.A. provided specialized knowledge of *Nicotiana* morphology and human use. A.A-I. initially identified and photographed the *Nicotiana* seeds in the laboratory. D.D and S.K.R. directed excavations. D.C.Y. conducted geomorphological investigations and directed paleoenvironmental control sampling with D.D.

Data Availability Statement

The data analysed during this study are not currently publicly available but are available upon reasonable request from the corresponding author. They are being processed for curation under accession number UMNH.A.2016.18 at the Natural History Museum of Utah, Salt Lake City, which serves as the repository for archaeological artifacts and related field notes, files, databases, and reporting from military lands managed by Hill Air Force Base.

Figures

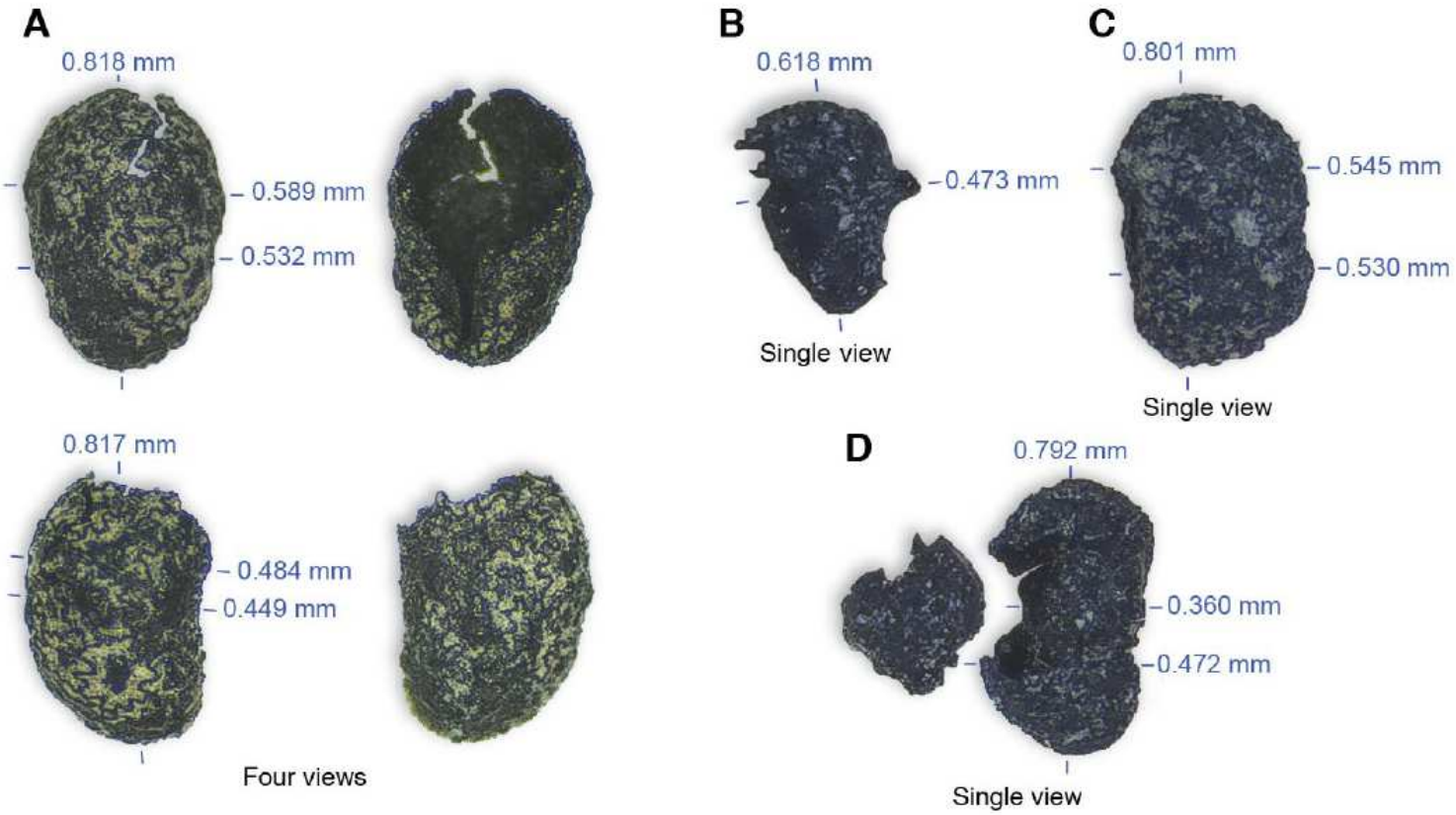


Figure 1

Nicotiana seeds and measurements from the Wishbone site. (A) Specimen 1-35-98-1. (B) Specimen 1-40-98-2. (C) Specimen 1-40-98-1. (D) Specimen 2-40-98-1.

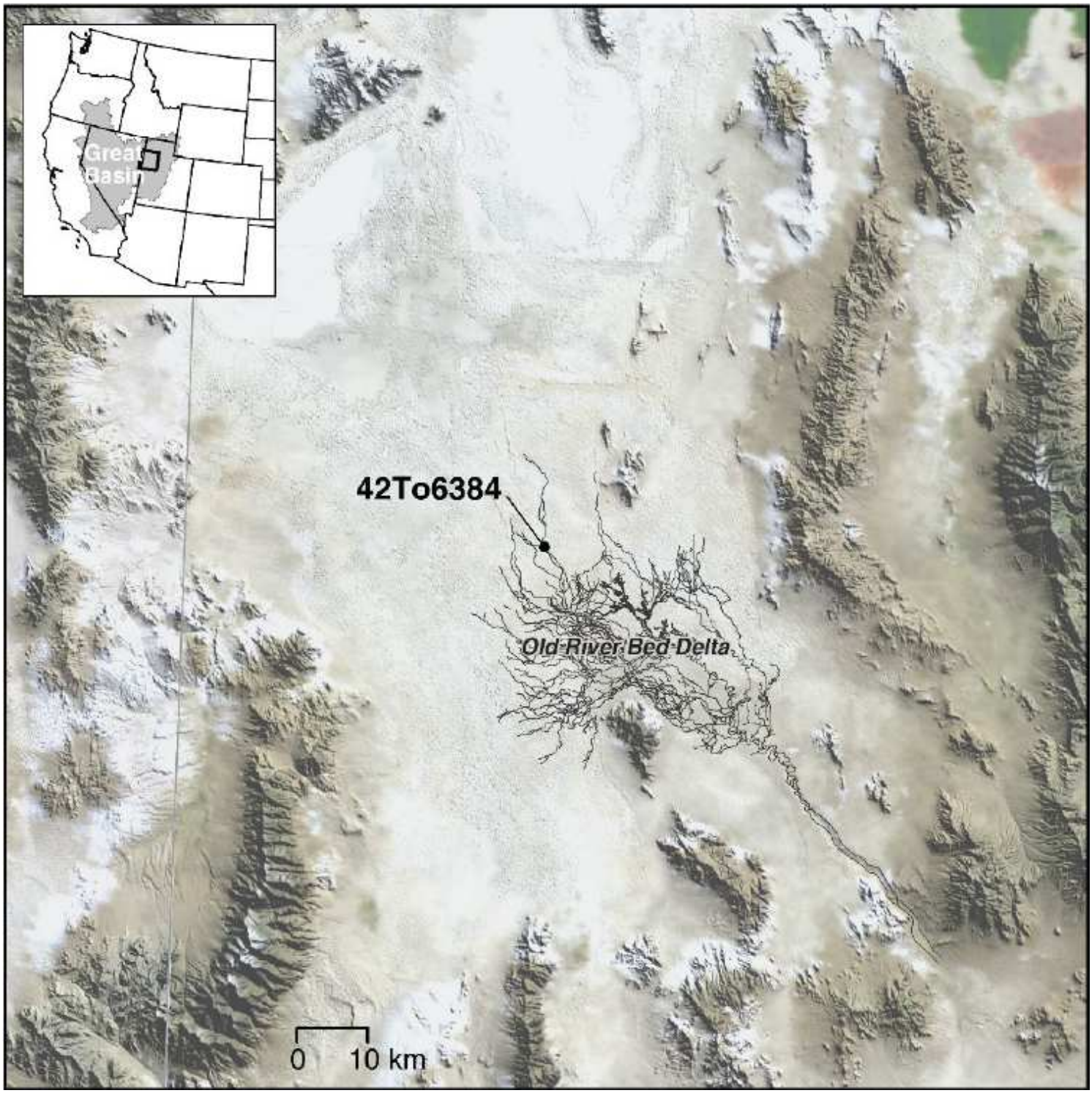


Figure 2

Location of 42TO6384 and important physiographic features. The ORBD channels are based on GIS mapping of extant landforms using aerial imagery (courtesy U.S. Army Dugway Proving Ground).

Figure 3

Position of hearth (circled) relative to selected artifacts at the Wishbone site. (A) Haskett fragment, FS 247, refits with FS 59. (B) Haskett fragment, FS 59, refits with FS 247. (C) Anatidae humerus, FS 230. (D) Haskett, FS 220. (E) incised mammal bone, FS 761. (F) Anatidae furculum, FS 230.

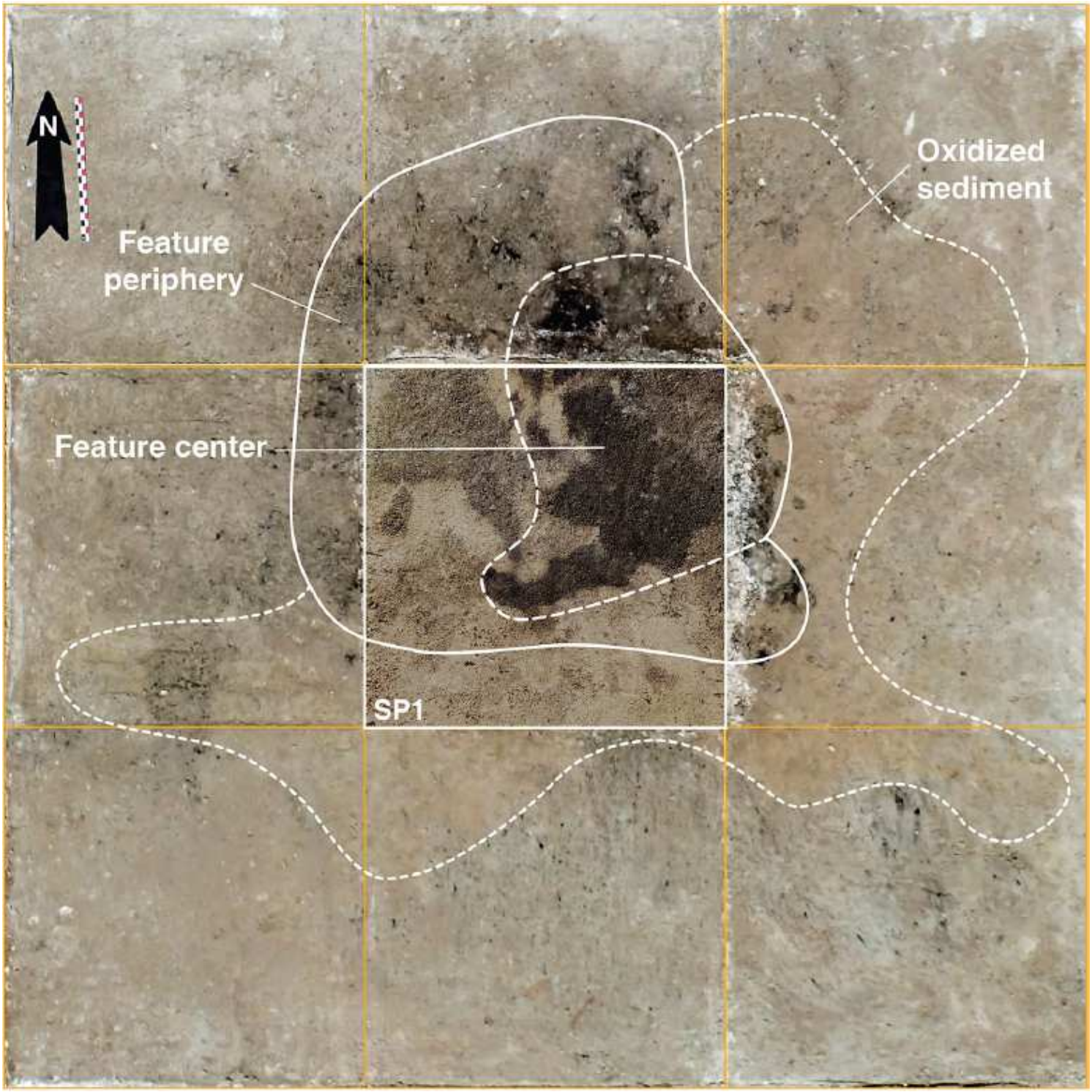


Figure 4

Hearth (Feature 1) plan view. View is at 2 cm below the ground surface (162 cm below datum). Central square represents the 0.5-x-0.5-m shovel probe (SP1) excavated and photographed in 2015. The Nicotiana seeds were found in the flotation-processed feature center fill from SP1. Remaining area excavated to the same level and photographed in 2016. Charcoal flecks outside the defined hearth boundary likely represent windblown pieces from the time of use.