

The search for pre-clovis in the ice-free corridor: archaeological geophysics at Wally's Beach

William T.D. Wadsworth ^{1*}, Gabriel Yanicki ²

1 Institute of Prairie and Indigenous Archaeology, Department of Anthropology, University of Alberta, Edmonton, Alberta, Canada

2 Canadian Museum of History, Gatineau, Quebec, Canada

* Corresponding author: E-mail: wwadswor@ualberta.ca

Abstract

Wally's Beach is an important archaeological/paleontological locality in southern Alberta where pre-Clovis dates have been reported from butchered faunal remains, but associated cultural materials are poorly known. Significant challenges exist for research at the site, including poor access, limited stratigraphy, and the extreme size of the site (>2km²). Ground penetrating radar and drone imagery were conducted to identify higher-potential areas, which discovered a possible paleochannel. This discovery aids future research efforts at Wally's Beach to better understand the earliest human occupation of the ice-free corridor.

Keywords

Alberta; GPR; ice-free corridor; paleochannel; UAV

Introduction

The ice-free corridor (IFC) was a habitable zone that emerged between the retreating Cordilleran and Laurentide ice sheets during the terminal Pleistocene in what is now western Canada. The IFC holds great significances an early route from Beringia in the first peopling of the Americas, or as a path of back-migration (Potter et al. 2018; Ives et al. 2019). Wally's Beach (DhPg-8) is an archaeological and paleontological locality located in the southern funnel of the IFC where the butchered remains of late Pleistocene megafauna have been found and radiocarbon dated to more than 13,300 calendar years ago (Waters et al. 2015). The cultural affiliation of the people who hunted these animals several centuries before the attested range of the widely known Clovis culture (ca. 13,050–12,750 cal. yr. BP, Waters et al. 2020) remains unknown.

Background

Creation of southern Alberta's St. Mary Reservoir in the early 1950s resulted in the inundation of prairie surfaces

that are now intermittently exposed, at times of low water, to aeolian and lacustrine erosion. As sediments stripped away, the footprints of Pleistocene megafauna are exposed, along with scattered faunal remains. Bones of extinct horse and camel species—some with cut marks attributed to stone tools—have yielded the earliest known dates for human presence in the IFC. Cultural materials from the late Pleistocene through to the modern era are also left scattered on the surface. The actively eroding contexts of the faunal and cultural finds makes their association uncertain; a goal of this project is to identify parts of the site area where late Pleistocene-aged deposits may be found still buried, prior to their exposure by wind and waves.

Preliminary remote sensing was conducted in 2019 to assess subsurface topography through the central portion of the site, where intact capping strata indicate erosion has not yet reached Pleistocene-aged deposits. Ground penetrating radar (GPR) survey identified a suspected paleochannel of the St. Mary River that has subsequently infilled. Principal faunal exposures are associated with the west bank of this former channel, while newly discovered

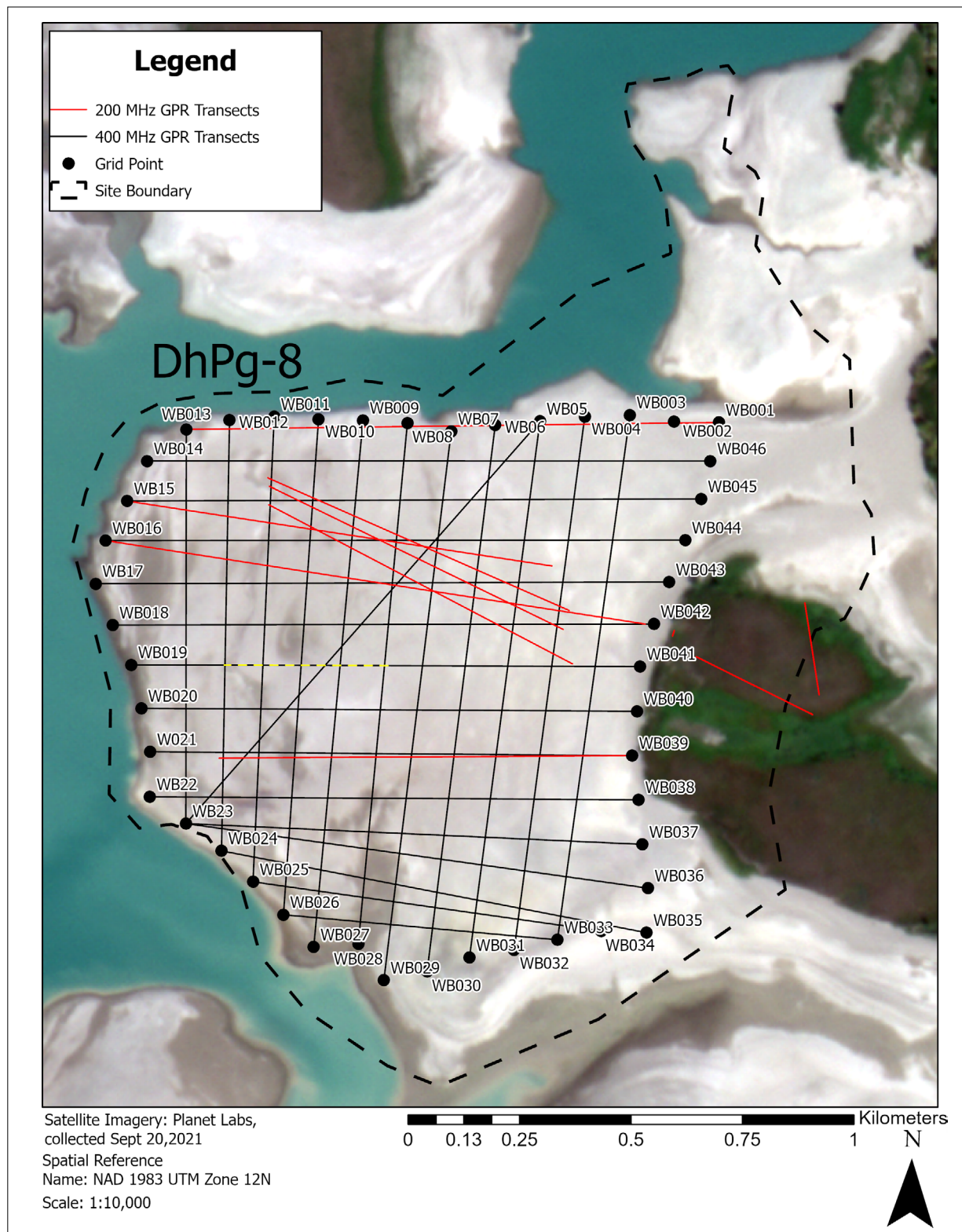


Fig. 1: Satellite photo of exposed St. Mary Reservoir bed showing Wally's Beach (dashed black line) with GIS-plotted survey grid waypoints (black circles with labels), 400 MHz GPR transects (black lines), 200 MHz GPR transects (red lines). Yellow dashed line shows profile section in Fig. 2 .

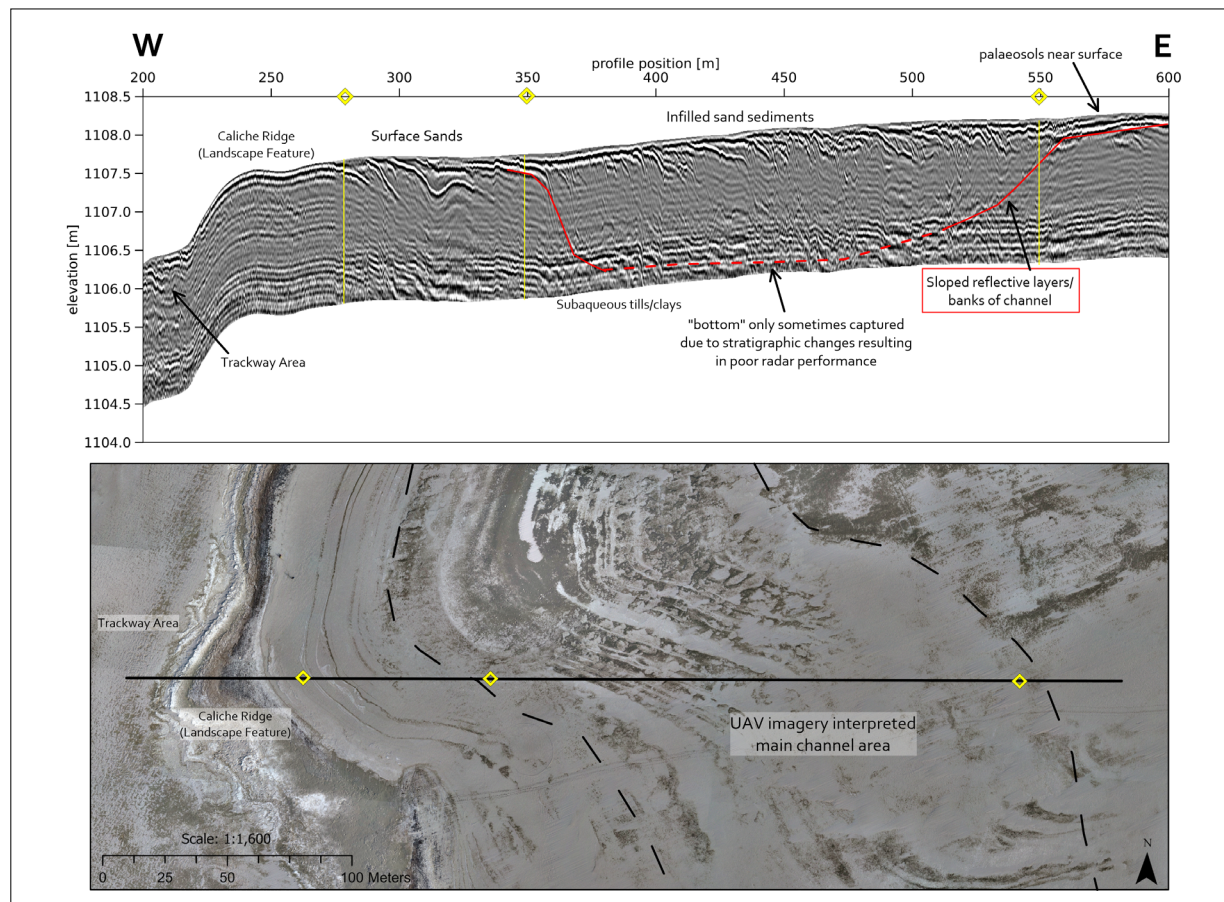


Fig. 2: Annotated 400 MHz GPR profile (transect section from WB19 to WB41) with yellow distance marks (top) and annotated drone imagery showing GPR profile section with corresponding marks (bottom). Both highlight key features and interpretive process (see reference 5 for added description).

terminal Pleistocene materials have been found on the paleochannel’s east bank (Yanicki et al. 2022). Additional GPR data, coupled with unmanned aerial vehicle (UAV) orthoimagery, were collected in October 2021 to better characterize the paleochannel feature.

Methods

Prior to fieldwork in 2021, a systematic survey grid was created in ArcGIS Pro (Fig. 1). Perimeter waypoints were plotted every 100 m and staked in the field using a handheld GPS. Fifteen east-west and twelve north-south GPR transects were walked with a GSSI SIR-3000 using a 400 MHz antenna mounted on a 3-wheel cart. Additionally, 200 MHz data was collected at various intervals to test replicability. During transects, surfaces were examined for exposed artifacts and their location coordinates were recorded.

Drone photography was conducted with a DJI Phantom 4 Pro using Drone Deploy. The UAV was flown at a constant height of 80 m above ground level, yielding a spatial resolution of ~2.4 cm/pixel; over 1400 images were collected. Drone data were processed in ArcGIS Pro to generate a digital elevation model (DEM) and orthomosaics. Imagery from multiple years was also processed in AgisoftMetashape to produce point clouds and assess erosional changes using Cloud Compare (2022).

GPR data processing was undertaken using GPRPy, an open-source python-based software program (Plattner 2020). Python scripts were written and adapted to perform basic GPR processing including time-zero, dewow, AGC gain, velocity analysis, trace averaging, and mean background removal corrections. GPR profiles were topographically corrected from the drone-derived DEM. Profiles were interpreted and manual picks were taken to identify a horizontal reflector underlying the infilled sediments of

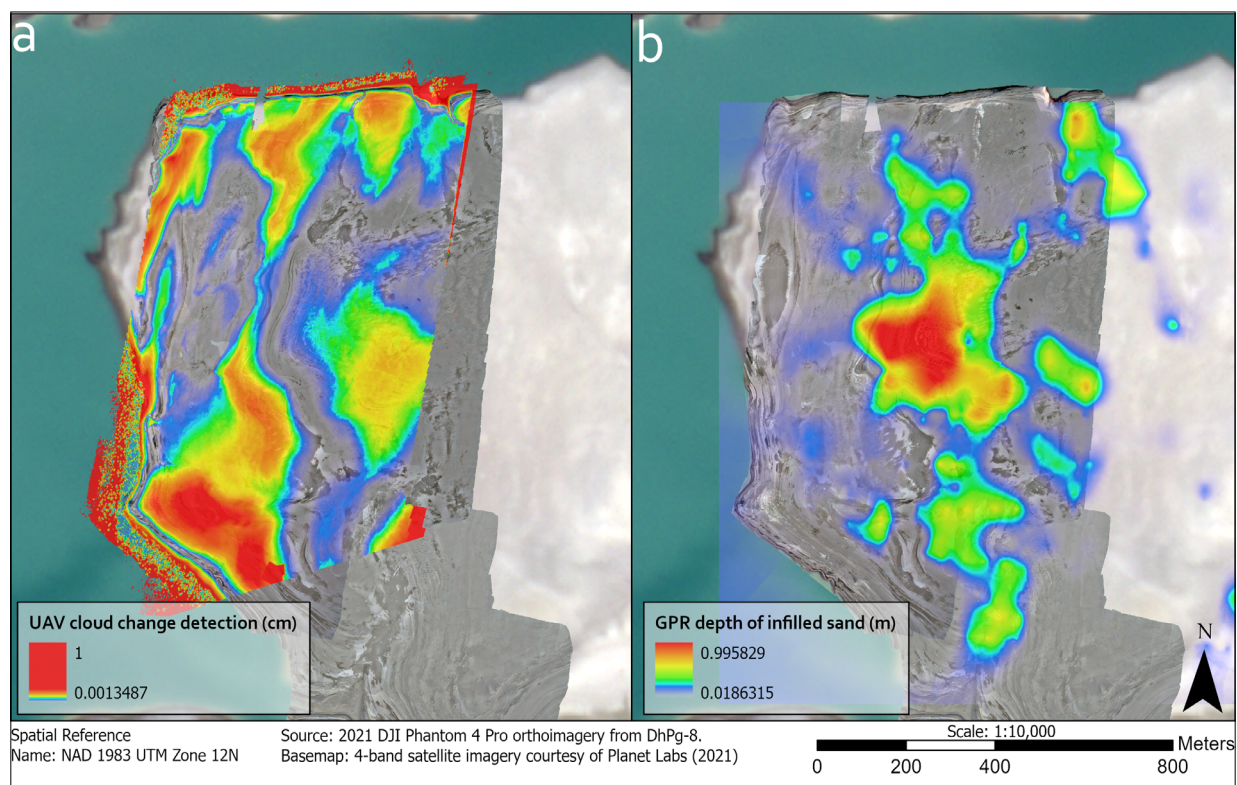


Fig. 3: Comparison of year-to-year cloud change detection results. a) and isopach map showing depth of infilled paleochannel feature, interpolated from 2021 GPR picks b), overlain on UAV orthomosaic.

the paleochannel feature. These picks were then interpolated (inverse distance weighted) in ArcGIS Pro.

Results

The 2021 GPR survey successfully reproduced the 2019 findings. The same buried horizontal reflector overlain by sand deposits was identified (Fig. 2). Where Pleistocene materials are found at the surface, this prominent reflective feature is not present in the GPR data and has likely already eroded away. When it is observed, it appears as a broad, shallow, dipping channel across the site area, usually only 0.5–1 m deep, but in places > 200 m wide, overlain by recently redeposited silts and sands. Like 2019, this buried feature was lower amplitude than the reflective surface sands and, in some areas (especially with stratigraphic changes), its presence varied.


Combining GPR and UAV data, surface sediments, topographic features, and potential subsurface features were interpreted (Fig. 2 & 3). Year-to-year comparison of point clouds from UAV orthoimagery supports both the inter-

pretation of paleochannel infilling and erosion of the remaining areas. While many exposed topographic features are actively eroding (Fig. 3a, yellow and red), some parts of the site appear relatively stable (Fig. 3a, no colour). The stable areas correspond well with the GPR-identified paleochannel (Fig. 3b).

Discussion

Expanded GPR surveys at Wally’s Beach, coupled with change detection results from UAV imagery, are refining our understanding of this internationally significant site. A paleochannel once not only bifurcated the site, but in the past would have influenced site utilization by ancient peoples and game. Channel-adjacent areas can be pinpointed and may still contain intact early cultural and faunal deposits, potentially dating to the earliest periods of human occupation in the IFC. Areas at imminent risk of further erosion are also highlighted.

While the most eroded parts of the site have been the focus of past study, the areas east of the paleochannel

identified here have yet to be investigated in detail. As future field work at Wally's Beach is planned, the highest-potential and highest-risk areas will be especially targeted in the search for intact late Pleistocene deposits. 

References

- CloudCompare. Version 2.12.4 beta [GPL software]. 2022. Available from: <http://www.cloudcompare.org/>
- Ives JA, Yanicki G, Supernant K, Lakevold C. Confluences: Fluted points in the Ice-Free Corridor. *PaleoAmerica*. 2019;5(2):143-156. doi: [10.1080/20555563.2019.1600136](https://doi.org/10.1080/20555563.2019.1600136)
- Potter BA, Baichtal JF, Beaudoin AB, Fehren-Schmitz L, Haynes CV, Holliday VT et al. Current evidence allows multiple models for the peopling of the Americas. *Science Advances*. 2018;4(8):eaat5473. doi: [10.1126/sciadv.aat5473](https://doi.org/10.1126/sciadv.aat5473)
- Waters M, Stafford T, Kooyman B, Hills LV. Late Pleistocene horse and camel hunting at the southern margin of the ice-free corridor: Reassessing the age of Wally's Beach, Canada. *P Natl Acad Sci Usa*. 2015;112(14):4263-4267. doi: [10.1073/pnas.1420650112](https://doi.org/10.1073/pnas.1420650112)
- Waters M, Stafford T, Carlson DL. The age of Clovis—13,050 to 12,750 cal yr B.P. *Science Advances*. 2020;6(43):eaaz0455. doi: [10.1126/sciadv.aaz0455](https://doi.org/10.1126/sciadv.aaz0455)
- Yanicki G, Wadsworth WTD, Jass CN, Barron-Ortiz C. Prospects for Wally's Beach: Findings from the 2018-2019 Field Seasons. In: Kooyman B, Ewald T, editors. *Tracks and Traces: Archaeology and Paleontology at Wally's Beach, Alberta*. Calgary: Archaeological Society of Alberta; 2022. p. 283-313.
- Plattner AM. GPRPy: Open-source ground-penetrating radar processing and visualization software. *The Leading Edge*. 2020;39(5):332-7. doi: [10.1190/tle39050332.1](https://doi.org/10.1190/tle39050332.1)

Open Access

This paper is published under the Creative Commons Attribution 4.0 International license (<https://creativecommons.org/licenses/by/4.0/deed.en>). Please note that individual, appropriately marked parts of the paper may be excluded from the license mentioned or may be subject to other copyright conditions. If such third party material is not under the Creative Commons license, any copying, editing or public reproduction is only permitted with the prior consent of the respective copyright owner or on the basis of relevant legal authorization regulations.