Amino Acid Racemization Geochronology Results from the Wendover Core in the Salduro Quadrangle, Utah

by

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DISCLAIMER

INTRODUCTION

This Open-File Report makes available raw analytical data from laboratory procedures completed to estimate the age of sediment samples collected during geologic investigations funded or partially supported by the Utah Geological Survey (UGS). Table 1 provides the approximate location for the Wendover core and table 2 provides sample numbers and depths. The references listed in table 1 generally provide additional information such as geologic setting and the significance or interpretation of the core material in the context of the area where it was collected. Figure 1 in the appendix provides preliminary amino acid racemization (AAR)-based age estimates for the Wendover core sediments by correlating ostracode AAR values to those from the Burmester core (Oviatt and others, 1999). This report was prepared by the Northern Arizona University Amino Acid Geochronology Laboratory under contract to the UGS. For more details on this geochronologic technique (AAR), see Miller and others (2013). These data are highly technical in nature and proper interpretation requires considerable training in the applicable laboratory and geochronologic techniques.

In conjunction with ongoing geologic mapping by the UGS and other research near the Bonneville Salt Flats, Oviatt suggested this project and advised Clark on the collection of sediment samples containing ostracodes from several depths in the Wendover core. The core was collected by A.J. Eardley (University of Utah) in 1960 and is archived at the Utah Core Research Center in Salt Lake City. A detailed log of the core has not been published. Eight samples were submitted in 2021 to the Northern Arizona University Amino Acid Geochronology Laboratory, operated by Bright, from approximate depths (feet and inches) in the core indicated in table 2. The sample depths are considered approximate because the sediment core is now dried out and broken, and core segments have been handled by several individuals at the core repository. After lab preparation work, Bright determined that six samples of ostracode valves were appropriate for AAR analysis. Sample WC#7 was omitted from AAR analysis because it did not contain any ostracodes other than very small, rare valve fragments (see below). Ooids were analyzed from sample WC#5 in order to compare ooid calcite to ostracode calcite. Lab analyses were completed in 2021.

Table 1. *Wendover core location.*

Core ID	7.5' quadrangle	UTM83-12 E	UTM83-12 N	References
WC	Salduro	257501	4513544	Shuey (1971); Williams (1994); Clark and others (2020a); Clark and others (in prep); Oviatt and others (2020)
		Latitude WGS84 (°N)	**Longitude WGS84 (°W)**	
		40.73712	113.87185	as above

Notes:

The Wendover core location is approximate. Shuey (1971) and Williams (1994) gave the location of the Wendover core to the nearest quarter section (SE1/4, Sec. 15, T. 1 S., R. 18 W.). For this report, we have assumed that the Wendover core was taken at the center of the 1/4 section, and we have estimated the coordinates of that spot. However, to be consistent with Oviatt and others (2020) we assume higher precision. It should be noted, however, that the precise location of the core, more than 60 years after it was taken, is not known.

Table 2. *Wendover core samples.*

UGS Sample ID	Approximate Depth ft. in.	Lab ID (UAL)
WC#1	10' 1"	21620
WC#2	11' 0"	21621
WC#3	59' 0"	21622
WC#4	102' 3"	21623
WC#5	102' 8"	21624
WC#6	170' 6"	21625
WC#7	170' 6"	--
WC#8	220' 0"	21626

Notes:

Sample WC#7 did not contain any ostracodes other than very small, rare valve fragments.

RESULTS

The analytical data can be accessed electronically as an Excel document attached to the PDF file of this report and available at https://ugspub.nr.utah.gov/publications/open_file_reports/ofr-741/ofr-741.xlsx.

A discussion of the results and plot of D/L Asp values from the Wendover and Burmester cores and their geochronologic context (figure 1) are presented in the appendix. The results from the Wendover core are similar to those from other sediment cores in the vicinity of Great Salt Lake and the Great Salt Lake Desert, including Burmester, S-28, Saltair, and Knolls (see Oviatt and others, 1999, 2020; Clark and others, 2020a, 2020b). AAR results from the latter three cores have not yet been published.

It should be noted that the two uppermost samples from the Wendover core (from depths 10' 1", and 11'), gave D/L Asp ratios similar to those in the sample of Lake Bonneville age in the Burmester core (figure 1). In our interpretation, this indicates that the sediments near the top of the Wendover core are approximately of Lake Bonneville age, but the AAR technique is likely not sensitive enough to distinguish Lake Bonneville-aged sediments from sediments slightly older or slightly younger. Age estimates derived from AAR likely have uncertainties on the order of ± 20 percent. Ostracode-based amino acid geochronology readily distinguishes Lake Bonneville sediments (~30 ka to 13 ka) from Little Valley lake sediments (~ 150 ka) (Oviatt and others, 1999), however, ostracode AAR values from Lake Bonneville sediments overlap with values from the Cutler Dam lake cycle (~60 ka) (Kaufman and others, 2001). In our interpretation, the uppermost Wendover core samples have to be slightly older than Lake Bonneville because, based on field and stratigraphic relationships in the Bonneville Salt Flats area, no Lake Bonneville sediments are present (Clark and others, 2020a, in preparation).

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APPENDIX

Discussion of AAR Results for the Wendover Core

by Jordon Bright and Darrell Kaufman

(The following text has been updated and modified from an email from J. Bright to D.L. Clark on February 8, 2021.)

Attached are the amino acid racemization results for ostracodes that I recovered from the Wendover core samples that you forwarded. The "AAR Results" tab shows all of the data with some summary graphs. The ILC data are the Inter-Lab Comparison standards (Wehmiller, 1984), which all amino acid geochronology labs analyze for inter-comparison of their results (Powell and others, 2013). The "AAR Summary" tab shows averaged D/L values and concentration data in stratigraphic order, as well as two graphs showing D/L values and amino acid concentrations plotted by core depth.

Analytically, the samples ran well. Each subsample comprised plenty of material, but the ostracode valves were thin, so I decided to err on the side of caution and used larger subsamples than usual. All but one of the AAR samples was comprised exclusively of *Limnocythere staplini* valves. Sample UAL 21624 (~ 102' 8") comprises rod-shaped ooids.

The results from one run are highlighted in red because they exceeded one of our primary criteria for identifying aberrant results following Kosnik and Kaufman (2008). Serine is easily decomposed and should not be present in large quantities in fossils. Conversely, aspartic acid is more stable through time and often makes up a large portion of the aminos present. Runs with a peak area ratio for L-Ser/L-Asp ≥ 0.8 likely contain some modern contamination and are therefore excluded from the mean and standard deviation calculations.

The two runs highlighted in blue were excluded because their D/L values deviated from other subsamples from the same horizon (Kosnik and Kaufman, 2008). This is shown at the far right of the Results sheet in the cross-plot of D/L Asp vs. D/L Glu values for each sample. These two runs can be visually (albeit somewhat subjectively) excluded as they fall off the trend of the remaining subsamples in the group.

Of the 42 subsamples analyzed, only three (7%) met one of the two exclusion criteria. That is about half of the typical rejection rate for microfossils in our lab, which is usually closer to 15%.

I also ran ooids from the 102' 8" sample. I was curious how they compared to ostracode calcite, primarily to see if they could be useful in future Bonneville AAR studies. They plot well off of the ostracode data trend (see graphs at bottom of Results tab). This is indicative of their different protein composition, possibly related to an abundance of bacteria. Thus, the ooid AAR values are not plotted on figure 1, but they are plotted for comparison in the supplementary analytical data file.

On the Summary tab, the D/L and concentration data are summarized as means, standard deviation (stdev), and coefficients of variation (CV) based on the multiple subsamples analyzed for each sample. As expected, the D/L values increase with depth (i.e., time) and the amino acid concentrations decrease with depth. One exception is the D/L Asp values from 170' 6", which are lower than the sample that is stratigraphically above it. The other amino acid D/L values progressively increase with depth. All of the amino acid concentration values for that sample are also abnormally low compared to the other samples.

All but two of the core samples contained a monospecific assemblage of *L. staplini* valves. Core sample WC#5 (102' 8") contained only rare monospecific fragments of juvenile *L. staplini* valves, in association with abundant ooids. Overall, the *L. staplin*i valves are smooth, similar to what has been reported for the Cutler Dam lake cycle (Oviatt and others, 1987). The monospecific *L. staplini* assemblages suggest shallow, saline lake conditions that did not exceed Stansbury-type (1380 m) lake levels (Oviatt and others, 1987; Oviatt, 2017). This interpretation assumes that the hydrochemistry of pre-Bonneville lake cycles evolved similarly to Lake Bonneville, which seems reasonable (Balch and others, 2005). The ostracode assemblage in core sample WC#6 (170' 6") is distinct from the other samples. In addition to *L. staplini*, the ostracode assemblage includes juveniles of *Cyprideis* and *Heterocypris*, and *Candona rawsoni* type valves, and there are several fragments of gastropod shells. Based on previous work (e.g., Balch and others, 2005), the *Cyprideis* and *Heterocypris* represent a wetland/marsh environment rather than a lake. Neither ostracode persists during large-scale lake level fluctuations that eliminate lake marginal wetlands/marshes (Balch and others, 2005; Oviatt, 2017). None of the Wendover core samples contained an ostracode fauna indicative of deeper lakes (e.g., Oviatt, 2017), although only a limited number of core samples were provided and a detailed paleoenvironmental analysis was not the purpose of this study. Core sample WC#7 (197' 0") did not contain any ostracodes other than a few very small and unidentifiable valve fragments.

And then lastly, I plotted the Wendover D/L Asp values against published data for the Burmester core (Oviatt and others, 1999). The plot is solely based on D/L Asp values and sample depth. It shows that the Wendover D/L Asp values line up well with D/L Asp values from the Bonneville, Little Valley, and Lava Creek lake cycles from the Burmester core.

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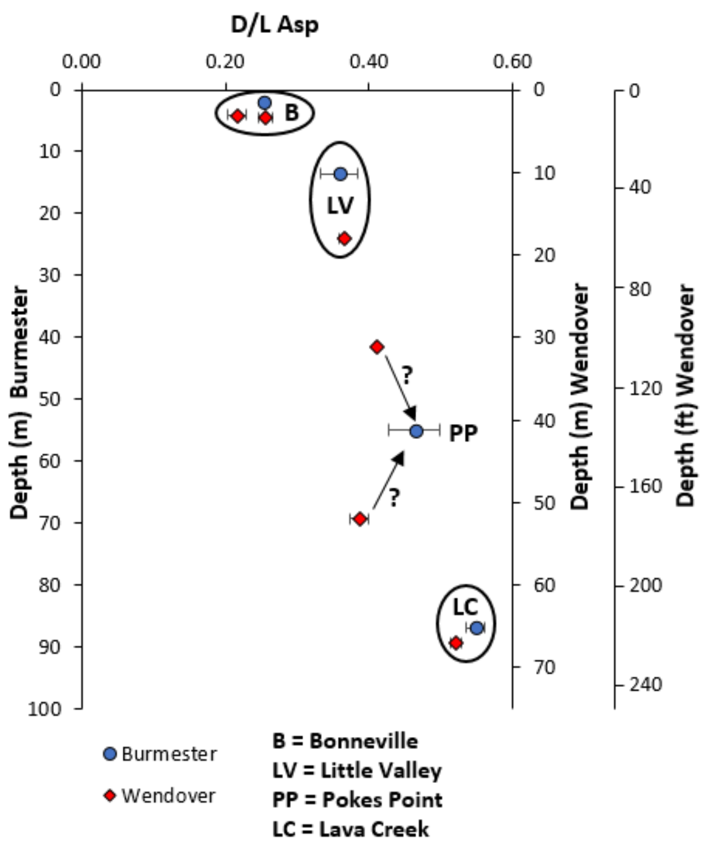

Figure 1. *Plot of average D/L Asp values (± 1σ) from ostracode valves versus depth from the Wendover and Burmester sediment cores. Refer to Oviatt and others (1999) for data on the Burmester core. The four major Pleistocene lake cycles (in stratigraphic order) are indicated at the bottom. Lake chronology is as follows: Lake Bonneville 30 to 13 ka, Little Valley Lake ~150 ka, Pokes Point Lake ~430 ka, and Lava Creek Lake ~630 ka (Oviatt and others, 1999).*