Beta Analytic, Inc.
4985 SW 74th Court
Miami, FL 33155 USA
Tel: 305-667-5167
Fax: 305-663-0964
info@betalabservices.com

ISO/IEC 17025:2017-Accredited Testing Laboratory

February 01, 2022

Dr. Alex Steely
Washington Geological Survey
1111 Washington St SE
Olympia, WA 98504
United States

RE: Radiocarbon Dating Results

Dear Dr. Steely,

Enclosed are the radiocarbon dating results for two samples recently sent to us. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable. The Conventional Radiocarbon Ages have all been corrected for total fractionation effects and where applicable, calibration was performed using 2020 calibration databases (cited on the graph pages).

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

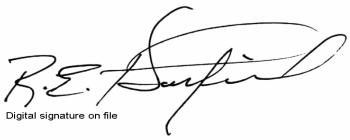
Reported results are accredited to ISO/IEC 17025:2017 Testing Accreditation PJLA #59423 standards and all chemistry was performed here in our laboratory and counted in our own accelerators here. Since Beta is not a teaching laboratory, only graduates trained to strict protocols of the ISO/IEC 17025:2017 Testing Accreditation PJLA #59423 program participated in the analyses.

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 unless otherwise requested. The reported d13C values were measured separately in an IRMS (isotope ratio mass spectrometer). They are NOT the AMS d13C which would include fractionation effects from natural, chemistry and AMS induced sources.

When interpreting the results, please consider any communications you may have had with us regarding the samples.

Thank you for prepaying the analyses. As always, if you have any questions or would like to discuss the results, don't hesitate to contact us.

Sincerely,



Ronald E. Hatfield President

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REPORT OF RADIOCARBON DATING ANALYSES

Alex Steely

Washington Geological Survey

Report Date: February 01, 2022

Material Received: January 12, 2022

Laboratory Number	Sample Code Number	Conventional Radiocarbon Age (BP) or Percent Modern Carbon (pMC) & Stable Isotopes	
Beta - 615854	**6SEP21-4**	**7160 +/- 30 BP**	IRMS δ13C: -22.6 o/oo

(95.4%) 6073 - 5985 cal BC (8022 - 7934 cal BP)

Submitter Material: Charcoal
Pretreatment: (charred material) acid/alkali/acid
Analyzed Material: Charred material
Analysis Service: AMS-Standard delivery
Percent Modern Carbon: 41.01 +/- 0.15 pMC
Fraction Modern Carbon: 0.4101 +/- 0.0015
D14C: -589.89 +/- 1.53 o/oo
Δ14C: -593.45 +/- 1.53 o/oo (1950:2022)
Measured Radiocarbon Age: (without d13C correction): 7120 +/- 30 BP
Calibration: BetaCal4.20: HPD method: INTCAL20

Results are ISO/IEC-17025:2017 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 IRMSs. The "Conventional Radiocarbon Age" was calculated using the Libby half-life (5568 years), is corrected for total isotopic fraction and was used for calendar calibration where applicable. The Age is rounded 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 95% the 14C signature of NIST SRM-4990C (oxalic acid). Quoted errors are 1 sigma counting statistics. Calculated sigmas less than 30 BP on the Conventional Radiocarbon Age are conservatively rounded up to 30. d13C values are on the material itself (not the AMS d13C). d13C and d15N values are relative to VPDB. References for calendar calibrations are cited at the bottom of calibration graph pages.

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REPORT OF RADIOCARBON DATING ANALYSES

Alex Steely

Washington Geological Survey

Report Date: February 01, 2022

Material Received: January 12, 2022

Laboratory Number	Sample Code Number	Conventional Radiocarbon Age (BP) or Percent Modern Carbon (pMC) & Stable Isotopes	
Beta - 615855	**23SEP21-1**	**9140 +/- 30 BP**	IRMS δ13C: -22.6 o/oo

(95.4%) 8457 - 8281 cal BC (10406 - 10230 cal BP)

Submitter Material:	Charcoal
Pretreatment:	(charred material) acid/alkali/acid
Analyzed Material:	Charred material
Analysis Service:	AMS-Standard delivery
Percent Modern Carbon:	32.05 +/- 0.12 pMC
Fraction Modern Carbon:	0.3205 +/- 0.0012
D14C:	-679.48 +/- 1.20 o/oo
Δ14C:	-682.26 +/- 1.20 o/oo (1950:2022)
Measured Radiocarbon Age:	(without d13C correction): 9100 +/- 30 BP
Calibration:	BetaCal4.20: HPD method: INTCAL20

Results are ISO/IEC-17025:2017 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 IRMSs. The "Conventional Radiocarbon Age" was calculated using the Libby half-life (5568 years), is corrected for total isotopic fraction and was used for calendar calibration where applicable. The Age is rounded 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 95% the 14C signature of NIST SRM-4990C (oxalic acid). Quoted errors are 1 sigma counting statistics. Calculated sigmas less than 30 BP on the Conventional Radiocarbon Age are conservatively rounded up to 30. d13C values are on the material itself (not the AMS d13C). d13C and d15N values are relative to VPDB. References for calendar calibrations are cited at the bottom of calibration graph pages.

Calibration of Radiocarbon Age to Calendar Years

(High Probability Density Range Method (HPD): INTCAL20)

(Variables: d13C = -22.6 o/oo)

Laboratory number **Beta-615854**

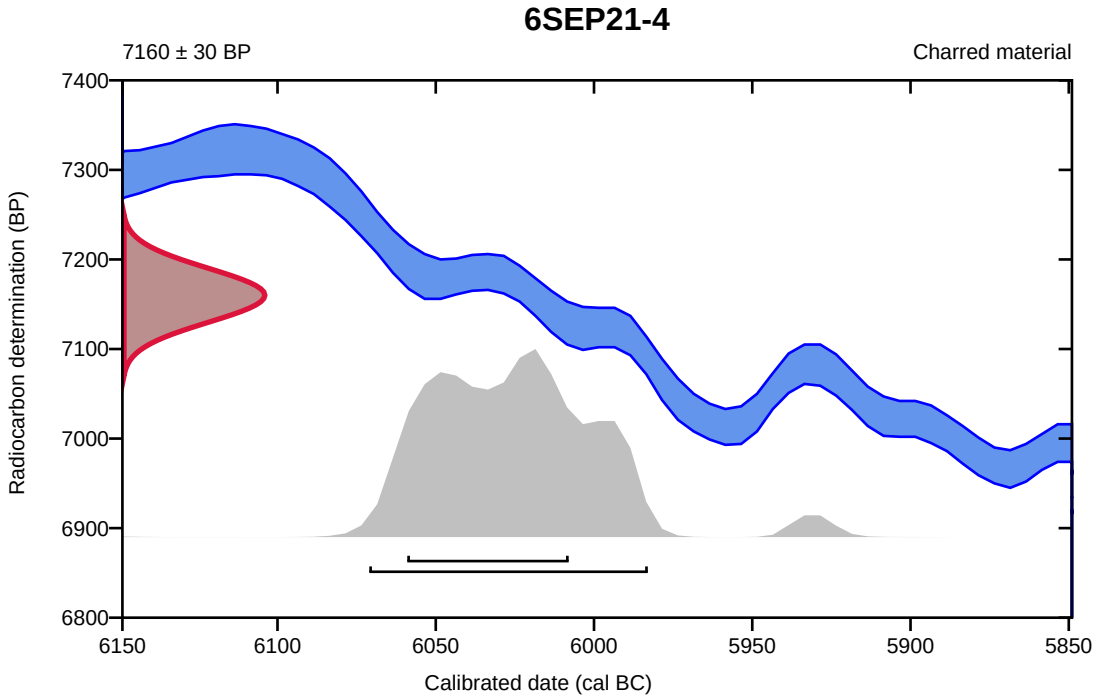
Conventional radiocarbon age **7160 ± 30 BP**

95.4% probability

(95.4%) 6073 - 5985 cal BC (8022 - 7934 cal BP)

68.2% probability

(68.2%) 6061 - 6010 cal BC (8010 - 7959 cal BP)



Database used

INTCAL20

References

References to Probability Method

Bronk Ramsey, C. (2009). Bayesian analysis of radiocarbon dates. Radiocarbon, 51(1), 337-360.

References to Database INTCAL20

Reimer, et al., 2020, Radiocarbon 62(4):725-757.

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BetaCal 4.20

Calibration of Radiocarbon Age to Calendar Years

(High Probability Density Range Method (HPD): INTCAL20)

(Variables: d13C = -22.6 o/oo)

Laboratory number **Beta-615855**

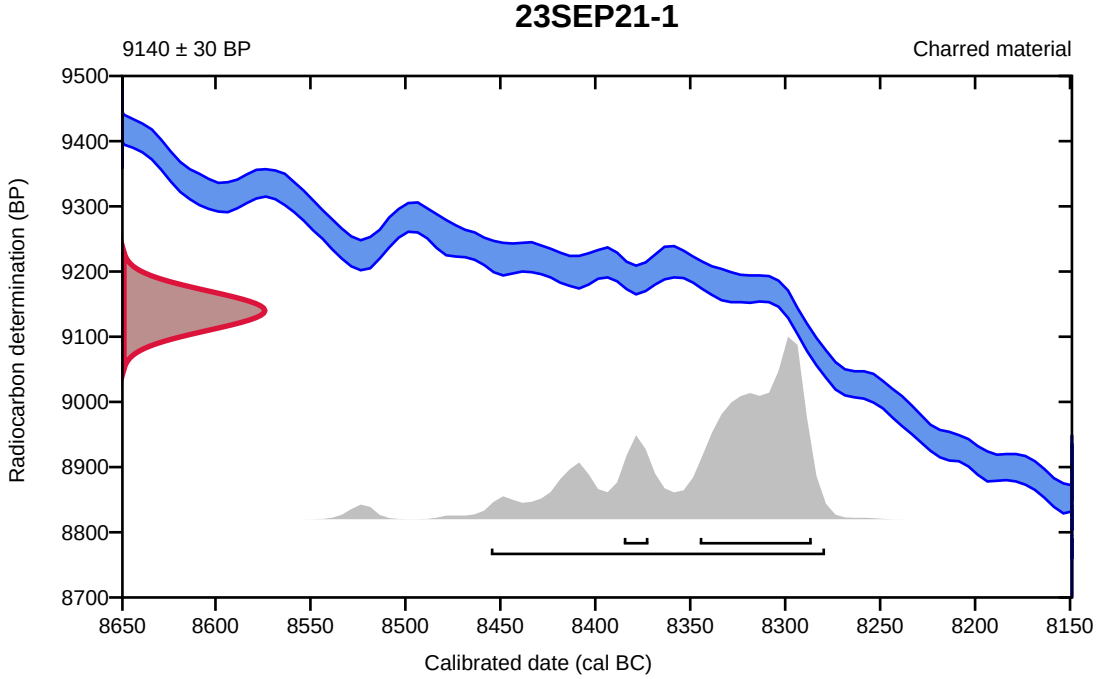
Conventional radiocarbon age **9140 ± 30 BP**

95.4% probability

(95.4%) 8457 - 8281 cal BC (10406 - 10230 cal BP)

68.2% probability

(60.6%) 8347 - 8288 cal BC (10296 - 10237 cal BP)
(7.6%) 8387 - 8374 cal BC (10336 - 10323 cal BP)



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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 NISTSRM-1990C 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: February 01, 2022
Submitter: Dr. Alex Steely

QA MEASUREMENTS

Reference 1

Expected Value:	0.42 +/- 0.04 pMC
Measured Value:	0.46 +/- 0.03 pMC
Agreement:	Accepted

Reference 2

Expected Value:	129.41 +/- 0.06 pMC
Measured Value:	129.29 +/- 0.37 pMC
Agreement:	Accepted

Reference 3

Expected Value:	96.69 +/- 0.50 pMC
Measured Value:	96.10 +/- 0.29 pMC
Agreement:	Accepted

COMMENT: All measurements passed acceptance tests.

Validation: 

Date: February 01, 2022