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delivered on time

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Darden Hood
President

Ronald Hatfield
Christopher Patrick
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June 05, 2017

Mrs. Kiersten Medvedich
Gaia
833 S Boulder Road
Louisville, CO 80027
United States

RE: Radiocarbon Dating Results

Dear Mrs. Medvedich,

Enclosed are the radiocarbon dating results for three 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 2013 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 17025:2005 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 17025:2005 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. The reported $\delta^{13}C$ values were measured separately in an IRMS (isotope ratio mass spectrometer). They are NOT the AMS $\delta^{13}C$ 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.

The cost of the analysis was charged to the American Express card provided. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact us.

Sincerely ,



Digital signature on file



REPORT OF RADIOCARBON DATING ANALYSES

Mrs. Kiersten Medvedich

Report Date: June 05, 2017

Gaia

Material Received: May 30, 2017

Sample Information and Data

Sample Code Number

Conventional Radiocarbon Age (BP) or
Percent Modern Carbon (pMC) & Stable Isotopes

Calendar Calibrated Results: 95.4 % Probability
High Probability Density Range Method (HPD)

Beta - 466015

Hazel

3380 +/- 30 BP

IRMS $\delta^{13}C$: -27.7 o/oo

Submitter Material: Tissue

(91.7%) 1695 - 1521 cal BC (3644 - 3470 cal BP)
(3.7%) 1736 - 1716 cal BC (3685 - 3665 cal BP)

Analyzed Material: Tissue

Pretreatment: MATERIAL/PRETREATMENT: (tissue)
acid/alkali/acid

Analysis Service: AMS-TIMEGUIDE delivery

Percent Modern Carbon: 65.65 +/- 0.25 pMC

Fraction Modern Carbon: 0.6565 +/- 0.0025

$\delta^{14}C$: -343.46 +/- 2.45 o/oo

$\Delta^{14}C$: -348.76 +/- 2.45 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 3420 +/- 30 BP

Calibration: BetaCal3.21: HPD method: SHCAL13

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 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 ^{14}C 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. $\delta^{13}C$ values are on the material itself (not the AMS $\delta^{13}C$). $\delta^{13}C$ and $\delta^{15}N$ values are relative to VPDB-1. References for calendar calibrations are cited at the bottom of calibration graph pages.



REPORT OF RADIOCARBON DATING ANALYSES

Mrs. Kiersten Medvedich

Report Date: June 05, 2017

Gaia

Material Received: May 30, 2017

Sample Information and Data

Sample Code Number

Conventional Radiocarbon Age (BP) or
Percent Modern Carbon (pMC) & Stable Isotopes

Calendar Calibrated Results: 95.4 % Probability
High Probability Density Range Method (HPD)

Beta - 466016

Brown

400 +/- 30 BP

IRMS $\delta^{13}C$: -14.6 o/oo

Submitter Material: Tissue

(49.6%) 1536 - 1626 cal AD
(45.8%) 1454 - 1523 cal AD

(414 - 324 cal BP)
(496 - 427 cal BP)

Analyzed Material: Tissue

Pretreatment: MATERIAL/PRETREATMENT: (tissue)
acid/alkali/acid

Analysis Service: AMS-TIMEGUIDE delivery

Percent Modern Carbon: 95.14 +/- 0.36 pMC

Fraction Modern Carbon: 0.9514 +/- 0.0036

$\delta^{14}C$: -48.58 +/- 3.55 o/oo

$\Delta^{14}C$: -56.26 +/- 3.55 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 230 +/- 30 BP

Calibration: BetaCal3.21: HPD method: SHCAL13

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 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 ^{14}C 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. $\delta^{13}C$ values are on the material itself (not the AMS $\delta^{13}C$). $\delta^{13}C$ and $\delta^{15}N$ values are relative to VPDB-1. References for calendar calibrations are cited at the bottom of calibration graph pages.



REPORT OF RADIOCARBON DATING ANALYSES

Mrs. Kiersten Medvedich

Report Date: June 05, 2017

Gaia

Material Received: May 30, 2017

Sample Information and Data

Sample Code Number

Conventional Radiocarbon Age (BP) or
Percent Modern Carbon (pMC) & Stable Isotopes

Calendar Calibrated Results: 95.4 % Probability
High Probability Density Range Method (HPD)

Beta - 466017

Violet

1110 +/- 30 BP

IRMS $\delta^{13}C$: -11.8 o/oo

Submitter Material: Tissue

(73.3%) 956 - 1026 cal AD
(22.1%) 894 - 936 cal AD

(994 - 924 cal BP)
(1056 - 1014 cal BP)

Analyzed Material: Tissue

Pretreatment: MATERIAL/PRETREATMENT: (tissue)
acid/alkali/acid

Analysis Service: AMS-TIMEGUIDE delivery

Percent Modern Carbon: 87.09 +/- 0.33 pMC

Fraction Modern Carbon: 0.8709 +/- 0.0033

$\delta^{14}C$: -129.06 +/- 3.25 o/oo

$\Delta^{14}C$: -136.09 +/- 3.25 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 890 +/- 30 BP

Calibration: BetaCal3.21: HPD method: SHCAL13

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 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 ^{14}C 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. $\delta^{13}C$ values are on the material itself (not the AMS $\delta^{13}C$). $\delta^{13}C$ and $\delta^{15}N$ values are relative to VPDB-1. 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): SHCAL13)

(Variables: $\delta^{13}\text{C} = -27.7$ o/oo)

Laboratory number **Beta-466015**

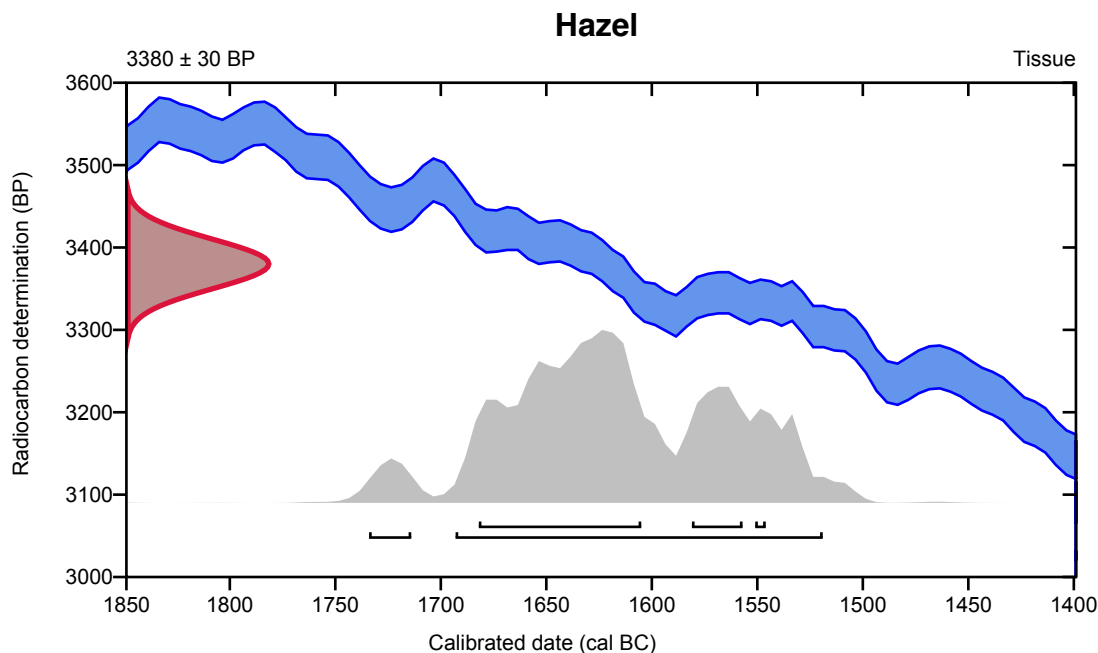
Conventional radiocarbon age **3380 \pm 30 BP**

95.4% probability

(91.7%)	1695 - 1521 cal BC	(3644 - 3470 cal BP)
(3.7%)	1736 - 1716 cal BC	(3685 - 3665 cal BP)

68.2% probability

(53.1%)	1684 - 1607 cal BC	(3633 - 3556 cal BP)
(13%)	1583 - 1559 cal BC	(3532 - 3508 cal BP)
(2.1%)	1553 - 1548 cal BC	(3502 - 3497 cal BP)



Database used
SHCAL13

References

References to Probability Method

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

References to Database SHCAL13

Hogg, et.al., 2013, Radiocarbon 55(4).

Calibration of Radiocarbon Age to Calendar Years

(High Probability Density Range Method (HPD): SHCAL13)

(Variables: $\delta^{13}\text{C} = -14.6$ o/oo)

Laboratory number **Beta-466016**

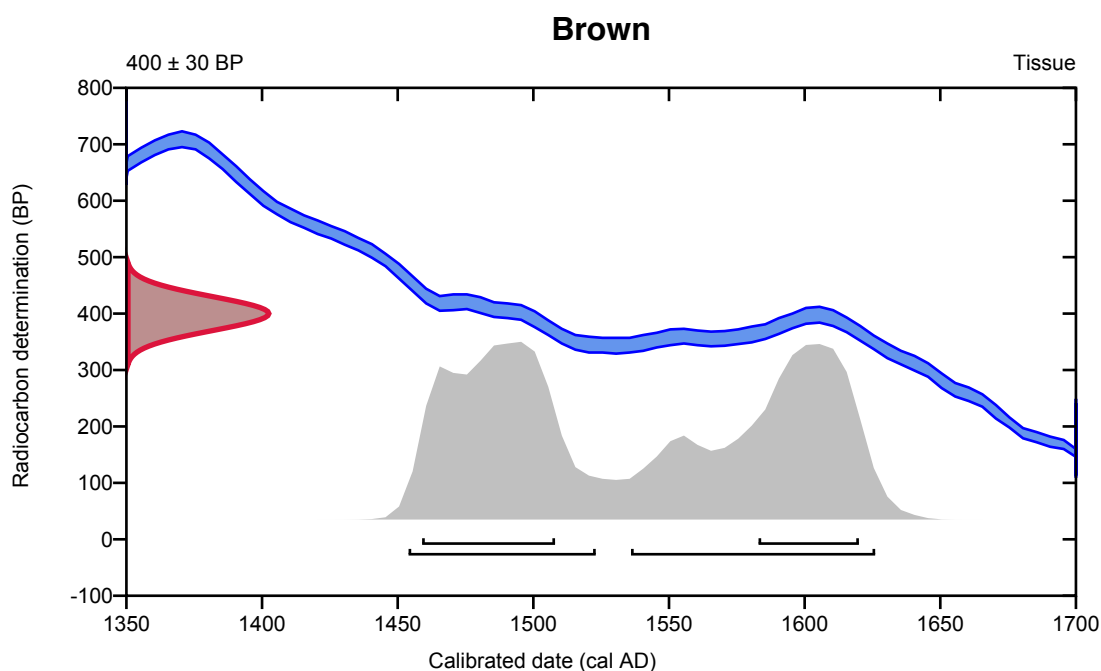
Conventional radiocarbon age **400 \pm 30 BP**

95.4% probability

(49.6%)	1536 - 1626 cal AD	(414 - 324 cal BP)
(45.8%)	1454 - 1523 cal AD	(496 - 427 cal BP)

68.2% probability

(39.3%)	1459 - 1508 cal AD	(491 - 442 cal BP)
(28.9%)	1583 - 1620 cal AD	(367 - 330 cal BP)



Database used
SHCAL13

References

References to Probability Method

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

References to Database SHCAL13

Hogg, et.al., 2013, Radiocarbon 55(4).

Calibration of Radiocarbon Age to Calendar Years

(High Probability Density Range Method (HPD): SHCAL13)

(Variables: $\delta^{13}\text{C} = -11.8$ o/oo)

Laboratory number **Beta-466017**

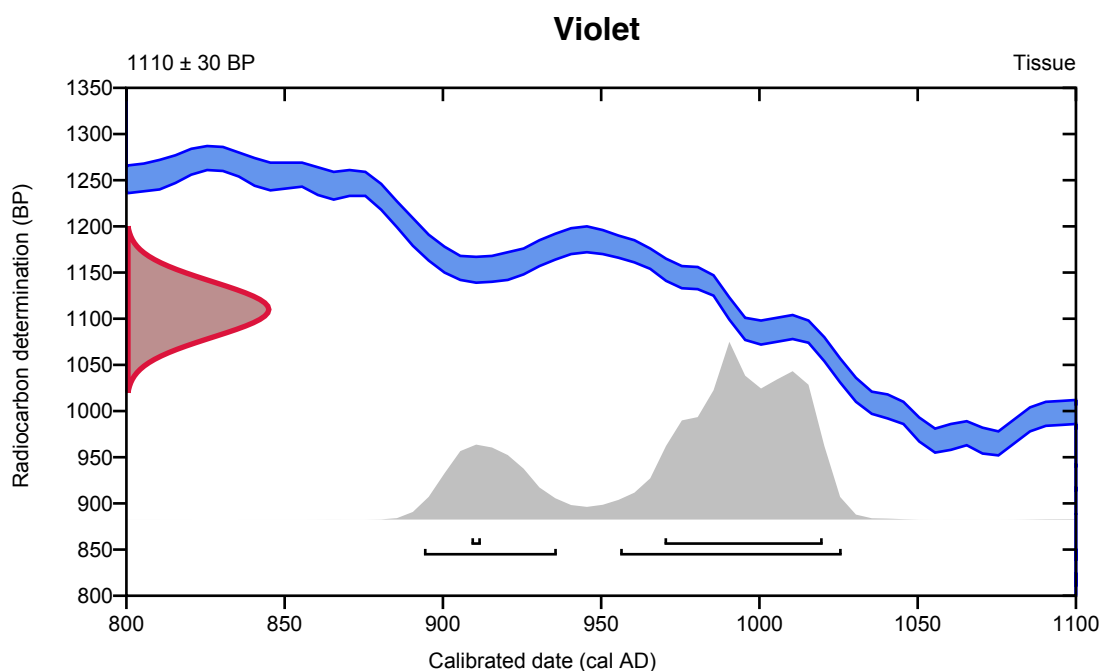
Conventional radiocarbon age **1110 \pm 30 BP**

95.4% probability

(73.3%)	956 - 1026 cal AD	(994 - 924 cal BP)
(22.1%)	894 - 936 cal AD	(1056 - 1014 cal BP)

68.2% probability

(65.9%)	970 - 1020 cal AD	(980 - 930 cal BP)
(2.3%)	909 - 912 cal AD	(1041 - 1038 cal BP)



Database used
SHCAL13

References

References to Probability Method

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

References to Database SHCAL13

Hogg, et.al., 2013, Radiocarbon 55(4).



Radiocarbon Dating

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The Radiocarbon Laboratory Accredited to ISO/IEC 17025:2005 Testing Accreditation PJLA #59423

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 02, 2017
Submitter: Mrs. Kiersten Medvedich

QA MEASUREMENTS

Reference 1

Expected Value: 0.44 +/- 0.10 pMC

Measured Value: 0.39 +/- 0.03 pMC

Agreement: Accepted

Reference 2

Expected Value: 129.41 +/- 0.06 pMC

Measured Value: 129.52 +/- 0.39 pMC

Agreement: Accepted

Reference 3

Expected Value: 129.41 +/- 0.06 pMC

Measured Value: 129.35 +/- 0.39 pMC

Agreement: Accepted

COMMENT: All measurements passed acceptance tests.

Validation:

Date: June 02, 2017