



Beta Analytic
RADIOCARBON DATING

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Mr. Darden Hood
President

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

ISO/IEC 2005:17025-Accredited Testing Laboratory

REPORT OF RADIOCARBON DATING ANALYSES

Maren Bender

Report Date: November 12, 2018

Universitaet Bremen

Material Received: October 31, 2018

Laboratory Number

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 - 508371

SB_FMA19

5560 +/- 30 BP

IRMS $\delta^{13}C$: -0.7 o/oo

IRMS $\delta^{18}O$: -7.0 o/oo

(95.4%)

4091 - 3924 cal BC

(6040 - 5873 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 50.05 +/- 0.19 pMC

Fraction Modern Carbon: 0.5005 +/- 0.0019

D14C: -499.50 +/- 1.87 o/oo

$\Delta^{14}C$: -503.60 +/- 1.87 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 5160 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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Beta - 508372

SB_FMA 26

3700 +/- 30 BP

IRMS $\delta^{13}C$: -2.1 o/oo

IRMS $\delta^{18}O$: -5.5 o/oo

(95.4%)

1764 - 1567 cal BC

(3713 - 3516 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 63.09 +/- 0.24 pMC

Fraction Modern Carbon: 0.6309 +/- 0.0024

D14C: -369.10 +/- 2.36 o/oo

$\Delta^{14}C$: -374.27 +/- 2.36 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 3330 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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

Beta - 508373

PS_FMA 2

560 +/- 30 BP

IRMS $\delta^{13}C$: -1.8 o/oo

IRMS $\delta^{18}O$: -5.5 o/oo

(95.4%)

1671 - 1854 cal AD

(279 - 96 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 93.27 +/- 0.35 pMC

Fraction Modern Carbon: 0.9327 +/- 0.0035

$\delta^{14}C$: -67.34 +/- 3.48 o/oo

$\Delta^{14}C$: -74.98 +/- 3.48 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 180 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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

Beta - 508374

PS_FMA 4

500 +/- 30 BP

IRMS $\delta^{13}C$: -2.2 o/oo

IRMS $\delta^{18}O$: -5.6 o/oo

(95.4%)

1714 - Post AD 1950

(236 - Post BP 0)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 93.97 +/- 0.35 pMC

Fraction Modern Carbon: 0.9397 +/- 0.0035

D14C: -60.35 +/- 3.51 o/oo

$\Delta^{14}C$: -68.04 +/- 3.51 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 130 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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Percent Modern Carbon (pMC) & Stable Isotopes

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

Beta - 508375

PT_FMA 6

490 +/- 30 BP

IRMS $\delta^{13}C$: +0.1 o/oo

IRMS $\delta^{18}O$: -5.4 o/oo

(95.4%)

1722 - Post AD 1950

(228 - Post BP 0)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 94.08 +/- 0.35 pMC

Fraction Modern Carbon: 0.9408 +/- 0.0035

D14C: -59.18 +/- 3.51 o/oo

$\Delta^{14}C$: -66.88 +/- 3.51 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 80 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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

Beta - 508376

PT_FMA 7

470 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -1.2 o/oo

IRMS $\delta^{18}\text{O}$: -6.0 o/oo

**(88.1%)
(5.2%)
(2.1%)**

**1800 - Post AD 1950
1754 - 1789 cal AD
1725 - 1740 cal AD**

**(150 - Post BP 0)
(196 - 161 cal BP)
(225 - 210 cal BP)**

Submitter Material: Coral
Pretreatment: (coral) acid etch
Analyzed Material: Coral
Analysis Service: AMS-Standard delivery
Percent Modern Carbon: 94.32 +/- 0.35 pMC
Fraction Modern Carbon: 0.9432 +/- 0.0035
D14C: -56.83 +/- 3.52 o/oo
 $\Delta^{14}\text{C}$: -64.56 +/- 3.52 o/oo(1950:2,018.00)
Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 80 +/- 30 BP
Calibration: BetaCal3.21: HPD method: MARINE13

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



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Calendar Calibrated Results: 95.4 % Probability
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Beta - 508377

PT_FMA 9

420 +/- 30 BP

IRMS $\delta^{13}C$: -1.4 o/oo

IRMS $\delta^{18}O$: -6.1 o/oo

(95.4%)

1834 - Post AD 1950

(116 - Post BP 0)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 94.91 +/- 0.35 pMC

Fraction Modern Carbon: 0.9491 +/- 0.0035

D14C: -50.94 +/- 3.54 o/oo

$\Delta^{14}C$: -58.72 +/- 3.54 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 40 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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

Beta - 508378

BB_FMA 13

3750 +/- 30 BP

IRMS $\delta^{13}C$: +2.1 o/oo

IRMS $\delta^{18}O$: -3.1 o/oo

(95.4%)

1851 - 1636 cal BC

(3800 - 3585 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 62.70 +/- 0.23 pMC

Fraction Modern Carbon: 0.6270 +/- 0.0023

D14C: -373.01 +/- 2.34 o/oo

$\Delta^{14}C$: -378.15 +/- 2.34 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 3310 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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Beta - 508379

KK_FMA 15

5500 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -0.7 o/oo

IRMS $\delta^{18}\text{O}$: -5.7 o/oo

(95.4%)

4018 - 3821 cal BC

(5967 - 5770 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 50.43 +/- 0.19 pMC

Fraction Modern Carbon: 0.5043 +/- 0.0019

D14C: -495.75 +/- 1.88 o/oo

$\Delta^{14}\text{C}$: -499.88 +/- 1.88 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 5100 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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Beta - 508380

KK_FMA 17

5160 +/- 30 BP

IRMS $\delta^{13}C$: +0.1 o/oo

IRMS $\delta^{18}O$: -5.0 o/oo

(95.4%)

3636 - 3505 cal BC

(5585 - 5454 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 52.61 +/- 0.20 pMC

Fraction Modern Carbon: 0.5261 +/- 0.0020

D14C: -473.95 +/- 1.96 o/oo

$\Delta^{14}C$: -478.26 +/- 1.96 o/oo(1950:2,018.00)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 4750 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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Report Date: March 06, 2018
Material Received: February 13, 2018

Laboratory Number

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 - 487545

BB_FMA11

4630 +/- 30 BP

IRMS $\delta^{13}C$: -0.3 o/oo

IRMS $\delta^{18}O$: -4.5 o/oo

(95.4%) 2995 - 2845 cal BC (4944 - 4794 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 56.19 +/- 0.21 pMC

Fraction Modern Carbon: 0.5619 +/- 0.0021

D14C: -438.07 +/- 2.10 o/oo

$\Delta^{14}C$: -442.61 +/- 2.10 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 4230 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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Deputy Directors

ISO/IEC 2005:17025-Accredited Testing Laboratory

REPORT OF RADIOCARBON DATING ANALYSES

Maren Bender
Universitaet Bremen

Report Date: March 06, 2018
Material Received: February 13, 2018

Laboratory Number

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 - 487546

BB_FMA12

4910 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -1.1 o/oo

IRMS $\delta^{18}\text{O}$: -5.7 o/oo

(93.1%) 3365 - 3161 cal BC (5314 - 5110 cal BP)
(2.3%) 3151 - 3129 cal BC (5100 - 5078 cal BP)

Submitter Material: Coral
Pretreatment: (coral) acid etch
Analyzed Material: Coral
Analysis Service: AMS-Standard delivery
Percent Modern Carbon: 54.27 +/- 0.20 pMC
Fraction Modern Carbon: 0.5427 +/- 0.0020
D14C: -457.32 +/- 2.03 o/oo
 $\Delta^{14}\text{C}$: -461.70 +/- 2.03 o/oo(1950:2017)
Measured Radiocarbon Age: (without d13C correction): 4520 +/- 30 BP
Calibration: BetaCal3.21: HPD method: MARINE13

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



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High Probability Density Range Method (HPD)

Beta - 487547

SB_FMA18

4730 +/- 30 BP

IRMS $\delta^{13}C$: -1.9 o/oo

IRMS $\delta^{18}O$: -6.7 o/oo

(95.4%) 3115 - 2896 cal BC (5064 - 4845 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 55.50 +/- 0.21 pMC

Fraction Modern Carbon: 0.5550 +/- 0.0021

$\delta^{14}C$: -445.02 +/- 2.07 o/oo

$\Delta^{14}C$: -449.50 +/- 2.07 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 4350 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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

Beta - 487548

SB_FMA20

5140 +/- 30 BP

IRMS $\delta^{13}\text{C}$: +0.1 o/oo

IRMS $\delta^{18}\text{O}$: -5.3 o/oo

(95.4%) 3627 - 3494 cal BC (5576 - 5443 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 52.74 +/- 0.20 pMC

Fraction Modern Carbon: 0.5274 +/- 0.0020

D14C: -472.64 +/- 1.97 o/oo

$\Delta^{14}\text{C}$: -476.89 +/- 1.97 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 4730 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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



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

Beta - 487549

SB_FMA21

5570 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -0.2 o/oo

IRMS $\delta^{18}\text{O}$: -5.5 o/oo

(95.4%) 4110 - 3932 cal BC (6059 - 5881 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 49.99 +/- 0.19 pMC

Fraction Modern Carbon: 0.4999 +/- 0.0019

D14C: -500.12 +/- 1.87 o/oo

$\Delta^{14}\text{C}$: -504.16 +/- 1.87 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 5170 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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



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High Probability Density Range Method (HPD)

Beta - 487550

SB_FMA22

5200 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -1.6 o/oo

IRMS $\delta^{18}\text{O}$: -6.5 o/oo

(95.4%) 3679 - 3524 cal BC (5628 - 5473 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 52.34 +/- 0.20 pMC

Fraction Modern Carbon: 0.5234 +/- 0.0020

D14C: -476.56 +/- 1.95 o/oo

$\Delta^{14}\text{C}$: -480.79 +/- 1.95 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 4820 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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



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High Probability Density Range Method (HPD)

Beta - 487551

SB_FMA23

4550 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -0.5 o/oo

IRMS $\delta^{18}\text{O}$: -5.2 o/oo

(95.4%) 2886 - 2697 cal BC (4835 - 4646 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 56.76 +/- 0.21 pMC

Fraction Modern Carbon: 0.5676 +/- 0.0021

D14C: -432.45 +/- 2.12 o/oo

$\Delta^{14}\text{C}$: -437.03 +/- 2.12 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 4150 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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



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

Beta - 487552

SB_FMA24

4350 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -1.8 o/oo

IRMS $\delta^{18}\text{O}$: -6.3 o/oo

(95.4%) 2631 - 2448 cal BC (4580 - 4397 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 58.19 +/- 0.22 pMC

Fraction Modern Carbon: 0.5819 +/- 0.0022

D14C: -418.14 +/- 2.17 o/oo

$\Delta^{14}\text{C}$: -422.83 +/- 2.17 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 3970 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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



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High Probability Density Range Method (HPD)

Beta - 487553

SB_FMA25

4320 +/- 30 BP

IRMS $\delta^{13}\text{C}$: +0.8 o/oo

IRMS $\delta^{18}\text{O}$: -4.8 o/oo

(95.4%) 2597 - 2412 cal BC (4546 - 4361 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 58.40 +/- 0.22 pMC

Fraction Modern Carbon: 0.5840 +/- 0.0022

D14C: -415.96 +/- 2.18 o/oo

$\Delta^{14}\text{C}$: -420.67 +/- 2.18 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 3900 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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



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Beta - 487554

PS_FMA1

490 +/- 30 BP

IRMS $\delta^{13}C$: -0.6 o/oo

IRMS $\delta^{18}O$: -6.1 o/oo

(95.4%) 1722 - Post AD 1950 (228 - Post BP 0)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 94.08 +/- 0.35 pMC

Fraction Modern Carbon: 0.9408 +/- 0.0035

D14C: -59.18 +/- 3.51 o/oo

$\Delta^{14}C$: -66.77 +/- 3.51 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 90 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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Beta - 487555

PS_FMA3

620 +/- 30 BP

IRMS $\delta^{13}C$: -0.4 o/oo

IRMS $\delta^{18}O$: -6.0 o/oo

(95.4%) 1617 - 1810 cal AD (333 - 140 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 92.57 +/- 0.35 pMC

Fraction Modern Carbon: 0.9257 +/- 0.0035

D14C: -74.28 +/- 3.46 o/oo

$\Delta^{14}C$: -81.75 +/- 3.46 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 220 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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.



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Beta - 487556

KK_FMA14

4970 +/- 30 BP

IRMS $\delta^{13}C$: +0.9 o/oo

IRMS $\delta^{18}O$: -3.9 o/oo

(95.4%) 3481 - 3306 cal BC (5430 - 5255 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 53.86 +/- 0.20 pMC

Fraction Modern Carbon: 0.5386 +/- 0.0020

D14C: -461.36 +/- 2.01 o/oo

$\Delta^{14}C$: -465.71 +/- 2.01 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}C$ correction): 4550 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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

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

Beta - 487557

KK_FMA16

5160 +/- 30 BP

IRMS $\delta^{13}\text{C}$: +0.1 o/oo

IRMS $\delta^{18}\text{O}$: -5.6 o/oo

(95.4%) 3636 - 3505 cal BC (5585 - 5454 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 52.61 +/- 0.20 pMC

Fraction Modern Carbon: 0.5261 +/- 0.0020

D14C: -473.95 +/- 1.96 o/oo

$\Delta^{14}\text{C}$: -478.19 +/- 1.96 o/oo(1950:2017)

Measured Radiocarbon Age: (without $\delta^{13}\text{C}$ correction): 4750 +/- 30 BP

Calibration: BetaCal3.21: HPD method: MARINE13

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



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Mr. Darden Hood
President

Mr. Ronald Hatfield
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ISO/IEC 2005:17025-Accredited Testing Laboratory

REPORT OF RADIOCARBON DATING ANALYSES

Maren Bender
Universitaet Bremen

Report Date: March 06, 2018
Material Received: February 13, 2018

Laboratory Number

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 - 487558

PT_FMA5

460 +/- 30 BP

IRMS $\delta^{13}\text{C}$: -1.0 o/oo

IRMS $\delta^{18}\text{O}$: -5.6 o/oo

(92.5%) 1802 - Post AD 1950 (148 - Post BP 0)
(2.9%) 1760 - 1787 cal AD (190 - 163 cal BP)

Submitter Material: Coral
Pretreatment: (coral) acid etch
Analyzed Material: Coral
Analysis Service: AMS-Standard delivery
Percent Modern Carbon: 94.43 +/- 0.35 pMC
Fraction Modern Carbon: 0.9443 +/- 0.0035
D14C: -55.66 +/- 3.53 o/oo
 $\Delta^{14}\text{C}$: -63.28 +/- 3.53 o/oo(1950:2017)
Measured Radiocarbon Age: (without d13C correction): 70 +/- 30 BP
Calibration: BetaCal3.21: HPD method: MARINE13

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



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Maren Bender

Report Date: March 06, 2018

Universitaet Bremen

Material Received: February 13, 2018

Laboratory Number

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 - 487559

PT_FMA8

106.55 +/- 0.40 pMC

IRMS $\delta^{13}\text{C}$: -2.6 o/oo

IRMS $\delta^{18}\text{O}$: -5.7 o/oo

(95.4%) 1902 - 1925 cal AD (48 - 25 cal BP)

Submitter Material: Coral

Pretreatment: (coral) acid etch

Analyzed Material: Coral

Analysis Service: AMS-Standard delivery

Conventional Radiocarbon Age: -510 +/- 30 BP

Fraction Modern Carbon: 1.0655 +/- 0.0040

D14C: 65.55 +/- 3.98 o/oo

$\Delta^{14}\text{C}$: 56.95 +/- 3.98 o/oo(1950:2017)

Raw pMC: (without $\delta^{13}\text{C}$ correction): 111.51 +/- 0.40 pMC

Calibration: BetaCal3.21: HPD method: MARINE13

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