



## 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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High Probability Density Range Method (HPD)

**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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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

D14C: -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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**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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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 d13C 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.  $d^{13}C$  values are on the material itself (not the AMS  $d^{13}C$ ).  $d^{13}C$  and  $d^{15}N$  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)	

<b>Beta - 508376</b>	<b>PT_FMA 7</b>	<b>470 +/- 30 BP</b>	IRMS δ13C: -1.2 o/oo IRMS δ18O: -6.0 o/oo
(88.1%)	<b>1800 - Post AD 1950</b>	<b>(150 - Post BP 0)</b>	
( 5.2%)	<b>1754 - 1789 cal AD</b>	<b>(196 - 161 cal BP)</b>	
( 2.1%)	<b>1725 - 1740 cal AD</b>	<b>(225 - 210 cal BP)</b>	

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  
 Δ14C: -64.56 +/- 3.52 o/oo(1950:2,018.00)  
 Measured Radiocarbon Age: (without d13C 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 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-1. References for calendar calibrations are cited at the bottom of calibration graph pages.



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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 d13C 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.  $d^{13}C$  values are on the material itself (not the AMS  $d^{13}C$ ).  $d^{13}C$  and  $d^{15}N$  values are relative to VPDB-1. References for calendar calibrations are cited at the bottom of calibration graph pages.



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

IRMS  $\delta^{18}O$ : -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

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

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



## REPORT OF RADIOCARBON DATING ANALYSES

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 - 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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**Beta - 487546**

**BB\_FMA12**

**4910 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

$\Delta^{14}C$ : -461.70 +/- 2.03 o/oo(1950:2017)

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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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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

D14C: -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.



## REPORT OF RADIOCARBON DATING ANALYSES

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 - 487548**

**SB\_FMA20**

**5140 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

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

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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 - 487549**

**SB\_FMA21**

**5570 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

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

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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 - 487550**

**SB\_FMA22**

**5200 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

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

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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 - 487551**

**SB\_FMA23**

**4550 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

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

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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 - 487552**

**SB\_FMA24**

**4350 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

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

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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 - 487553**

**SB\_FMA25**

**4320 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

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

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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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Conventional Radiocarbon Age (BP) or  
Percent Modern Carbon (pMC) & Stable Isotopes

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

**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 d13C 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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Conventional Radiocarbon Age (BP) or  
Percent Modern Carbon (pMC) & Stable Isotopes

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

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

**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

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 - 487557**

**KK\_FMA16**

**5160 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

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

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

**Beta - 487558**

**PT\_FMA5**

**460 +/- 30 BP**

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

IRMS  $\delta^{18}O$ : -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

$\Delta^{14}C$ : -63.28 +/- 3.53 o/oo(1950:2017)

Measured Radiocarbon Age: (without  $\delta^{13}C$  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.  $\delta^{13}C$  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 - 487559**

**PT\_FMA8**

**106.55 +/- 0.40 pMC**

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

**IRMS  $\delta^{18}O$ : -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

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

Raw pMC: (without d13C 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.  $d^{13}C$  values are on the material itself (not the AMS  $d^{13}C$ ).  $d^{13}C$  and  $d^{15}N$  values are relative to VPDB-1. References for calendar calibrations are cited at the bottom of calibration graph pages.