

**Annex S1.** Complete reports of the radiocarbon dating analyses (sample codes and location in Tab. 2 of the main text).

Order of the samples:

- S227\_5-1
- S228\_7-1
- S249-A
- S228\_1ter
- S228\_3 (228/3 in the report)
- SPOT-1 Bulk Organic Sediment
- SPOT-1 Alkali Insoluble Fraction
- C1\_DONIA\_E
- C3\_DONIA\_E
- C7\_DONIA\_W
- C8\_DONIA\_W



## REPORT OF RADIOCARBON DATING ANALYSES

Prof. Paolo Boncio

Report Date: July 31, 2017

Universita G.D Annunzio Chieti Pescara

Material Received: July 24, 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)	
<b>Beta - 470317</b>	<b>S227_5-1</b>	<b>3000 +/- 30 BP</b>	<b>IRMS <math>\delta^{13}C</math>: -24.8 o/oo</b>

Submitter Material: Sediment (Bulk organic fraction)

(89.4%) 1304 - 1126 cal BC (3253 - 3075 cal BP)  
( 6.0%) 1377 - 1348 cal BC (3326 - 3297 cal BP)

Analyzed Material: Organic sediment

Pretreatment: (organic sediment) acid washes

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 68.83 +/- 0.26 pMC

Fraction Modern Carbon: 0.6883 +/- 0.0026

D14C: -311.65 +/- 2.57 o/oo

$\Delta^{14}C$ : -317.21 +/- 2.57 o/oo(1950:2017)

Measured Radiocarbon Age: (without  $\delta^{13}C$  correction): 3000 +/- 30 BP

Calibration: BetaCal3.21: HPD method: INTCAL13

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

Prof. Paolo Boncio

Report Date: July 31, 2017

Universita G.D Annunzio Chieti Pescara

Material Received: July 24, 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)	
<b>Beta - 470318</b>	<b>S228_7-1</b>	<b>104.71 +/- 0.39 pMC</b>	<b>IRMS <math>\delta^{13}C</math>: -26.1 o/oo</b>

Submitter Material: Sediment (Bulk organic fraction)

**(95.4%) post AD 1950**

Analyzed Material: Organic sediment

Pretreatment: (organic sediment) acid washes

Analysis Service: AMS-Standard delivery

Conventional Radiocarbon Age: -370 +/- 30 BP

Fraction Modern Carbon: 1.0471 +/- 0.0039

D14C: 47.14 +/- 3.91 o/oo

$\Delta^{14}C$ : 38.69 +/- 3.91 o/oo(1950:2017)

Raw pMC: (without d13C correction): 104.48 +/- 0.39 pMC

Calibration: BetaCal3.21: HPD method: (none)

COMMENTS: The reported result indicates an age of post 0 BP and has been reported as a % of the modern reference standard, indicating the material was living about the last 60 years or so ("pMC" = percent modern carbon).

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

Prof. Paolo Boncio

Report Date: July 31, 2017

Universita G.D Annunzio Chieti Pescara

Material Received: July 24, 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)	
<b>Beta - 470319</b>	<b>S249-A</b>	<b>38800 +/- 380 BP</b>	IRMS $\delta^{13}\text{C}$ : -23.5 o/oo
Submitter Material: Charcoal fragments		(95.4%) <b>41352 - 40260 cal BC</b>	<b>(43301 - 42209 cal BP)</b>
Analyzed Material: Charred material			
Pretreatment: (charred material) acid/alkali/acid			
Analysis Service: AMS-Standard delivery			
Percent Modern Carbon: 0.80 +/- 0.04 pMC			
Fraction Modern Carbon: 0.0080 +/- 0.0004			
D14C: -992.01 +/- 0.38 o/oo			
$\Delta^{14}\text{C}$ : -992.08 +/- 0.38 o/oo(1950:2017)			
Measured Radiocarbon Age: (without d13C correction): 38780 +/- 380 BP			
Calibration: BetaCal3.21: HPD method: INTCAL13			

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  $^{14}\text{C}$  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.

# Calibration of Radiocarbon Age to Calendar Years

(High Probability Density Range Method (HPD): INTCAL13)

(Variables:  $\delta^{13}\text{C} = -24.8$  o/oo)

**Laboratory number**      **Beta-470317**

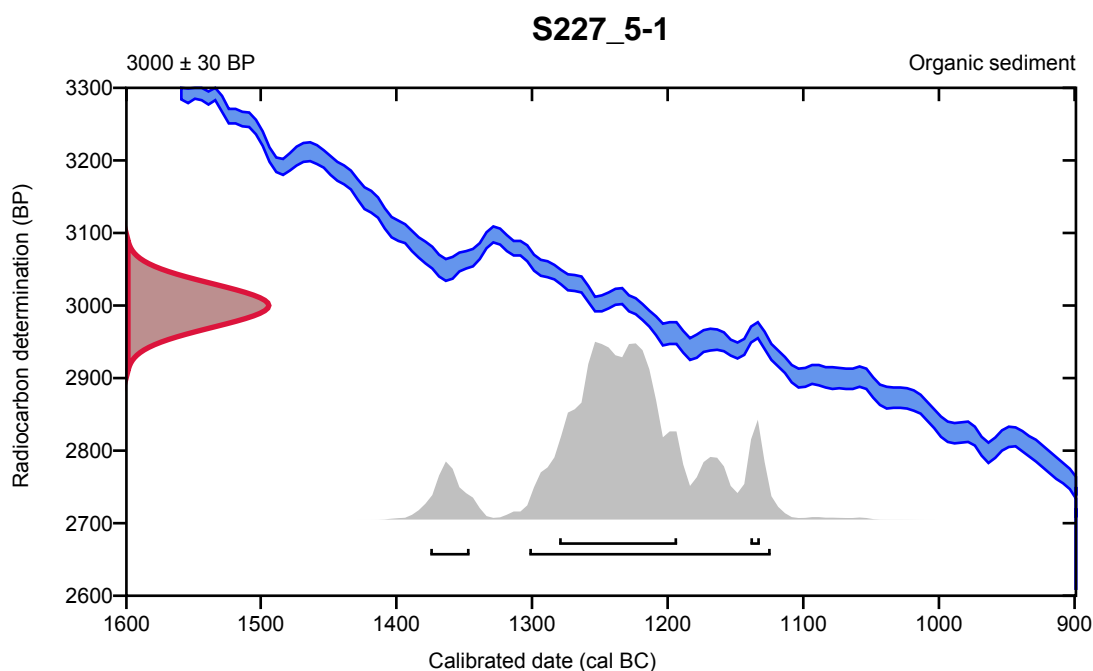
**Conventional radiocarbon age**      **3000  $\pm$  30 BP**

95.4% probability

(89.4%)	1304 - 1126 cal BC	(3253 - 3075 cal BP)
(6%)	1377 - 1348 cal BC	(3326 - 3297 cal BP)

68.2% probability

(64.6%)	1282 - 1195 cal BC	(3231 - 3144 cal BP)
(3.6%)	1141 - 1134 cal BC	(3090 - 3083 cal BP)



**Database used**  
INTCAL13

## References

### References to Probability Method

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

### References to Database INTCAL13

Reimer, et.al., 2013, Radiocarbon55(4).

# Calibration of Radiocarbon Age to Calendar Years

(High Probability Density Range Method (HPD): INTCAL13)

(Variables:  $\delta^{13}\text{C} = -23.5$  o/oo)

**Laboratory number**      **Beta-470319**

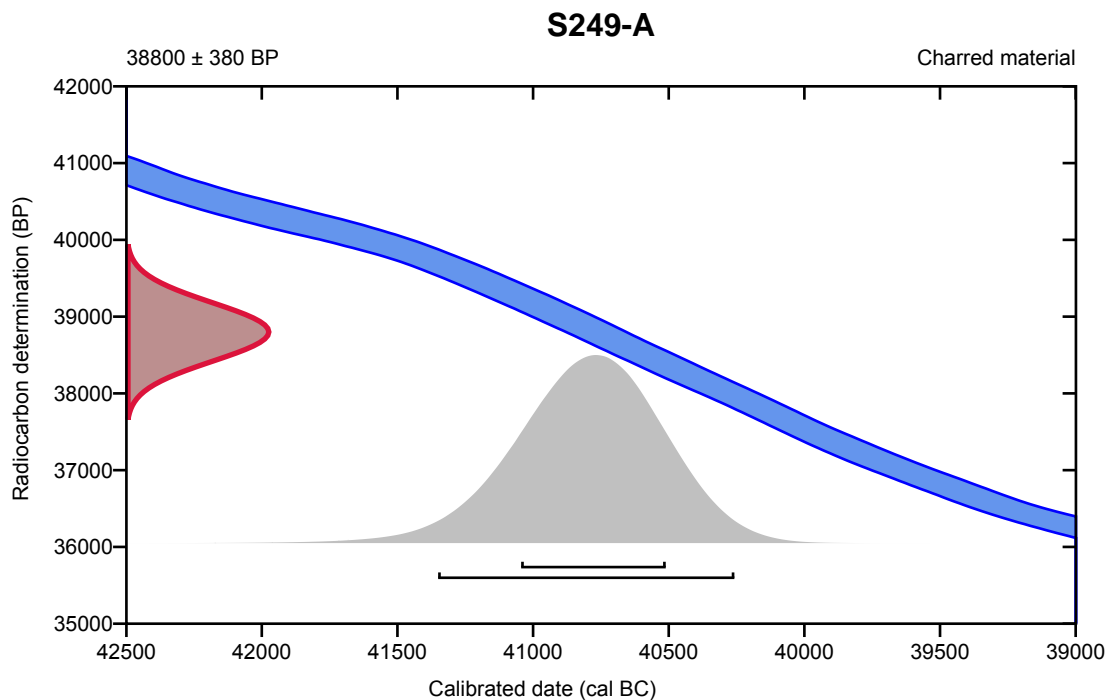
**Conventional radiocarbon age**      **38800  $\pm$  380 BP**

95.4% probability

(95.4%)    41352 - 40260 cal BC      (43301 - 42209 cal BP)

68.2% probability

(68.2%)    41046 - 40513 cal BC      (42995 - 42462 cal BP)



**Database used**  
INTCAL13

## References

### References to Probability Method

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

### References to Database INTCAL13

Reimer, et.al., 2013, Radiocarbon55(4).



Radiocarbon Dating

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Deputy Directors

*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:** July 31, 2017  
**Submitter:** Prof. Paolo Boncio

### QA MEASUREMENTS

#### Reference 1

Expected Value: 129.41 +/- 0.06 pMC

Measured Value: 129.20 +/- 0.37 pMC

Agreement: Accepted

#### Reference 2

Expected Value: 96.69 +/- 0.50 pMC

Measured Value: 96.56 +/- 0.29 pMC

Agreement: Accepted

#### Reference 3

Expected Value: 0.44 +/- 0.10 pMC

Measured Value: 0.46 +/- 0.04 pMC

Agreement: Accepted

**COMMENT:** All measurements passed acceptance tests.

Validation:

Date: July 31, 2017



**Beta Analytic Inc.**  
DR. M.A. TAMERS and MR. D.G. HOOD

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## REPORT OF RADIOCARBON DATING ANALYSES

Prof. Paolo Boncio

Report Date: 8/29/2016

Universita G.D Annunzio Chieti Pescara

Material Received: 8/9/2016

Sample Data	Measured Radiocarbon Age	Isotopes Results o/oo	Conventional Radiocarbon Age(*)
Beta - 443310 SAMPLE: S228_1TER ANALYSIS: AMS-Standard delivery MATERIAL/PRETREATMENT: (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1445 to 1530 (Cal BP 505 to 420) and Cal AD 1545 to 1635 (Cal BP 405 to 315) Cal AD 1545 to 1635 (Cal BP 405 to 315)	380 +/- 30 BP	d13C= -25.6	370 +/- 30 BP

Results are ISO-17025 accredited. AMS measurements were made on one of 4 in-house NEC SSAMS accelerator mass spectrometers. The reported age is the "Conventional Radiocarbon Age", corrected for isotopic fraction using the d13C. Age is reported as RCYBP (radiocarbon years before present, abbreviated as BP, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C signature of NBS SRM-4990C (oxalic acid) and calculated using the Libby 14C half life (5568 years). Quoted error on the BP date is 1 sigma (1 relative standard deviation with 68% probability) of counting error (only) on the combined measurements of sample, background and modern reference standards. Total error at Beta (counting + laboratory) is known to be well within +/- 2 sigma. d13C values are reported in parts per thousand (per mil) relative to PDB-1 measured on a Thermo Delta Plus IRMS. Typical d13C error is +/- 0.3 o/oo. Percent modern carbon (pMC) and Delta 14C (D14C) are not absolute. They equate to the Conventional Radiocarbon Age. Calendar calibrated results were calculated the material appropriate 2013 database (INTCAL13, MARINE13 or SHCAL13). See graph report for references.



# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12 = -25.6 o/oo : lab. mult = 1)

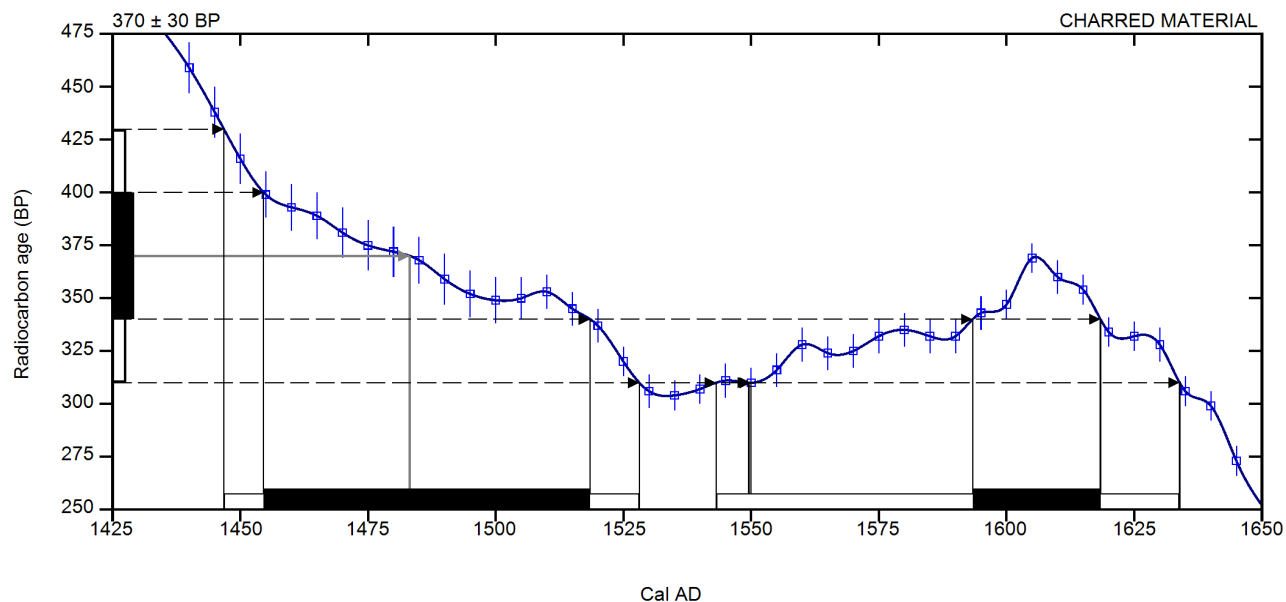
Laboratory number      **Beta-443310 : S228\_1TER**

Conventional radiocarbon age      **370 ± 30 BP**

Calibrated Result (95% Probability)      **Cal AD 1445 to 1530 (Cal BP 505 to 420)**  
Cal AD 1545 to 1635 (Cal BP 405 to 315)

Intercept of radiocarbon age with calibration curve      Cal AD 1485 (Cal BP 465)

Calibrated Result (68% Probability)      Cal AD 1455 to 1520 (Cal BP 495 to 430)  
Cal AD 1595 to 1620 (Cal BP 355 to 330)



Database used  
INTCAL13

## References

### Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates, Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

### References to INTCAL13 database

Reimer PJ et al. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887., 2013.

## Beta Analytic Radiocarbon Dating Laboratory

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**Prof. Paolo Boncio**  
**Università degli Studi di Chieti**

**Lecce, 23 Dicembre 2015**

**Rif.CEDAD: 2015 0305**

**OGGETTO:** *Risultati delle datazioni con il radiocarbonio.*

Il campione indicato in Tabella 1 è stato sottoposto a datazione con il metodo del radiocarbonio mediante la tecnica della spettrometria di massa ad alta risoluzione (AMS), presso il Centro di Datazione e Diagnostica (CEDAD) dell'Università del Salento.

<b>Codice</b>	<b>Codice CeDaD</b>	<b>Provenienza</b>
S228/3	<b>LTL15135A</b>	

*TABELLA 1. ELENCO DEL MATERIALE ANALIZZATO E RELATIVO CODICE IDENTIFICATIVO.*

I macrocontaminanti presenti nel campione, sono stati individuati mediante osservazione al microscopio ottico e rimossi meccanicamente. Il trattamento chimico di rimozione delle contaminazioni dal campione è stato effettuato sottoponendo il materiale selezionato ad attacchi chimici alternati acido-alcalino-acido.

Il materiale estratto è stato successivamente convertito in anidride carbonica mediante combustione a 900°C in ambiente ossidante, e quindi in grafite mediante



riduzione. Si è utilizzato  $H_2$  come elemento riducente e polvere di ferro come catalizzatore.

La quantità di grafite estratta dal campione è risultata sufficiente per una accurata determinazione sperimentale dell'età.

La concentrazione di radiocarbonio è stata determinata confrontando i valori misurati delle correnti di  $^{12}C$  e  $^{13}C$ , e i conteggi di  $^{14}C$  con i valori ottenuti da campioni standard di Saccarosio C6 forniti dalla IAEA.

La datazione convenzionale al radiocarbonio è stata corretta per gli effetti di frazionamento isotopico sia mediante la misura del termine  $\delta^{13}C$  effettuata direttamente con l'acceleratore, sia per il fondo della misura.

Campioni di concentrazione nota di Acido Ossalico forniti dalla NIST (National Institute of Standard and Technology) sono stati utilizzati come controllo della qualità dei risultati.

Per la determinazione dell'errore sperimentale nella data al radiocarbonio è stato tenuto conto sia dello scattering dei dati intorno al valore medio, sia dell'errore statistico derivante dal conteggio del  $^{14}C$ .

La Tabella 2 riporta la datazione al radiocarbonio (non calibrata) per il campione con l'indicazione dell'errore assoluto della misura.

<b>Campione</b>	<b>Radiocarbon Age (BP)(*)</b>	<b><math>\delta^{13}C</math> (‰)(**)</b>	<b>Note</b>
<b>LTL15135A</b>	<b>7561 <math>\pm</math> 60</b>	<b>-26.7 <math>\pm</math> 0.3</b>	

(\*\*) Il valore riportato del termine di frazionamento isotopico degli isotopi stabili del carbonio ( $\delta^{13}C$ ) si riferisce a quello misurato con il sistema AMS. Tale valore, pertanto, può differire dal termine di frazionamento naturale e da quello misurato mediante IRMS.

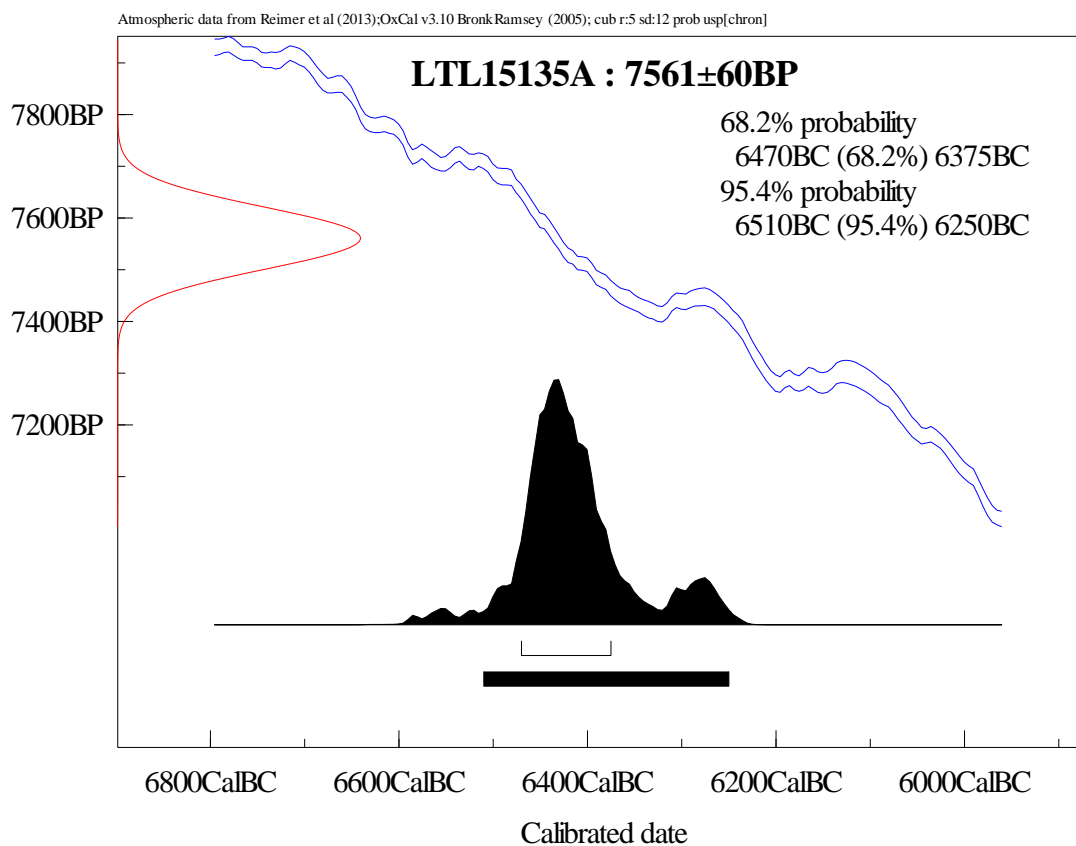
TABELLA 2. VALORE MISURATO DELLA RADIOCARBON AGE.

(\*) Con BP si intende qui una datazione convenzionale al radiocarbonio non calibrata il cui calcolo implica (cfr. M. Stuiver, H.A. Polach, Radiocarbon, Vol. 19, No.3, 1977, 355-363):



- L'uso del tempo di dimezzamento di Libby (5568 anni) rispetto al valore corretto di 5730 anni;
- L'anno 1950 come anno di riferimento.
- L'utilizzo diretto o indiretto dell'acido ossalico come standard di riferimento.

La datazione al radiocarbonio per i campioni è stata quindi calibrata in età di calendario utilizzando il software OxCal Ver. 3.10 basato sui dati atmosferici [Reimer PJ, et al. 2009 *Radiocarbon*]. Il risultato della calibrazione è riportato nei grafici e nelle Tabelle seguenti.



**Figura 1. Calibrazione della data convenzionale al radiocarbonio del campione LTL15135A**



<b>Campione</b>	<b><i>Datazione calibrata e relativa probabilità (Livello di confidenza 2 deviazioni standard)</i></b>
S228/3	6510BC (95.4%) 6250BC

*TABELLA 3. RIEPILOGO DELLA DATA AL RADIOCARBONIO CALIBRATA PER IL CAMPIONE LTL15135A*

Cordiali Saluti,

Prof. Lucio Calcagnile

Direttore, Centro di Datazione e Diagnostica dell'Università del Salento



## REPORT OF RADIOCARBON DATING ANALYSES

Paolo Boncio

Report Date: October 26, 2021

Universita G.D Annunzio Chieti Pescara

Material Received: October 06, 2021

Laboratory Number	Sample Code Number	Conventional Radiocarbon Age (BP) or Percent Modern Carbon (pMC) & Stable Isotopes
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**Beta - 605091**

**SPOT-1 Bulk Organic Sediment**

**6320 +/- 30 BP**

**IRMS  $\delta^{13}C$ : -24.4 o/oo**

**(50.0%)**

**5278 - 5216 cal BC**

**(7227 - 7165 cal BP)**

**(45.4%)**

**5363 - 5283 cal BC**

**(7312 - 7232 cal BP)**

Submitter Material: Organic Sediment/Gyttja

Pretreatment: (organic sediment) acid washes

Analyzed Material: Organic sediment

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 45.53 +/- 0.17 pMC

Fraction Modern Carbon: 0.4553 +/- 0.0017

D14C: -544.68 +/- 1.70 o/oo

$\Delta^{14}C$ : -548.58 +/- 1.70 o/oo (1950:2021)

Measured Radiocarbon Age: (without d13C correction): 6310 +/- 30 BP

Calibration: BetaCal4.20: HPD method: INTCAL20

Results are ISO/IEC-17025:2017 accredited. No sub-contracting or student labor was used in the analyses. All work was done at Beta in 4 in-house NEC accelerator mass spectrometers and 4 Thermo IRMSs. The "Conventional Radiocarbon Age" was calculated using the Libby half-life (5568 years), is corrected for total isotopic fraction and was used for calendar calibration where applicable. The Age is rounded to the nearest 10 years and is reported as radiocarbon years before present (BP), "present" = AD 1950. Results greater than the modern reference are reported as percent modern carbon (pMC). The modern reference standard was 95% the  $^{14}C$  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. References for calendar calibrations are cited at the bottom of calibration graph pages.

# Calibration of Radiocarbon Age to Calendar Years

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

(Variables:  $\delta^{13}\text{C} = -24.4$  o/oo)

**Laboratory number**      **Beta-605091**

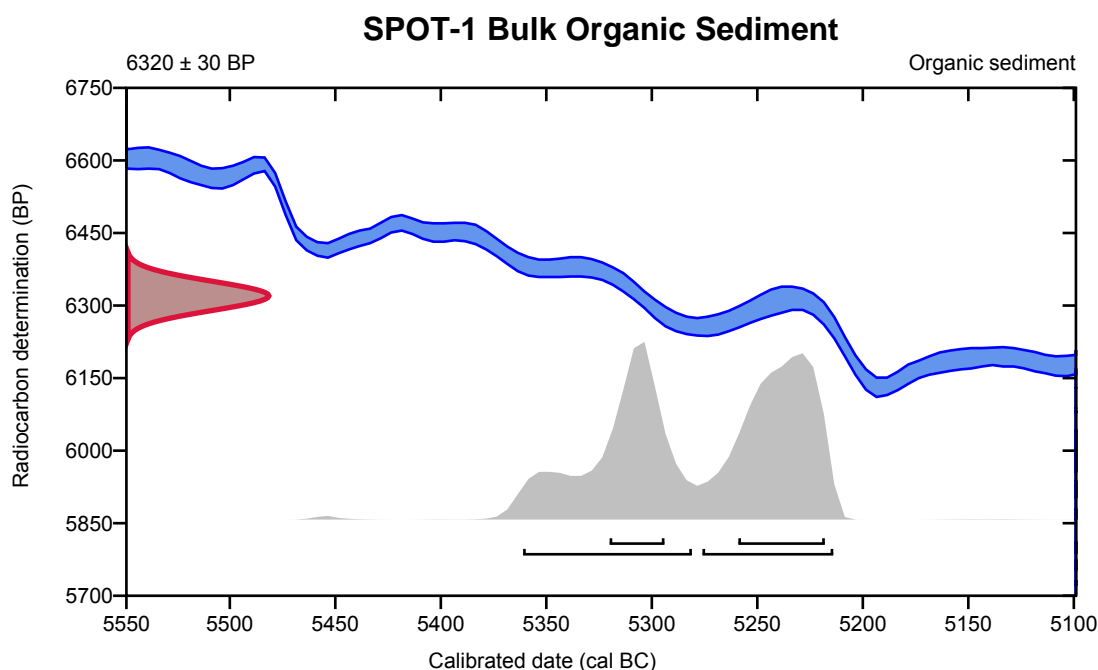
**Conventional radiocarbon age**      **6320  $\pm$  30 BP**

95.4% probability

(50%)	5278 - 5216 cal BC	(7227 - 7165 cal BP)
(45.4%)	5363 - 5283 cal BC	(7312 - 7232 cal BP)

68.2% probability

(42.3%)	5261 - 5220 cal BC	(7210 - 7169 cal BP)
(25.9%)	5322 - 5296 cal BC	(7271 - 7245 cal BP)



**Database used**  
INTCAL20

## References

### References to Probability Method

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

### References to Database INTCAL20

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



**Beta Analytic**  
TESTING LABORATORY

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ISO/IEC 17025:2017-Accredited Testing Laboratory

## Quality Assurance Report

This report provides the results of reference materials used to validate radiocarbon analyses prior to reporting. Known-value reference materials were analyzed quasi-simultaneously with the unknowns. Results are reported as expected values vs measured values. Reported values are calculated relative to NISTSRM-1990C and corrected for isotopic fractionation. Results are reported using the direct analytical measure percent modern carbon (pMC) with one relative standard deviation. Agreement between expected and measured values is taken as being within 2 sigma agreement (error x 2) to account for total laboratory error.

**Report Date:** October 26, 2021  
**Submitter:** Prof. Paolo Boncio

### QA MEASUREMENTS

#### Reference 1

Expected Value: 0.44 +/- 0.10 pMC

Measured Value: 0.45 +/- 0.03 pMC

Agreement: Accepted

#### Reference 2

Expected Value: 129.41 +/- 0.06 pMC

Measured Value: 129.45 +/- 0.35 pMC

Agreement: Accepted

#### Reference 3

Expected Value: 96.69 +/- 0.50 pMC

Measured Value: 96.82 +/- 0.28 pMC

Agreement: Accepted

**COMMENT:** All measurements passed acceptance tests.

**Validation:**

  
Digital signature on file

**Date:** October 26, 2021





## REPORT OF RADIOCARBON DATING ANALYSES

Paolo Boncio

Report Date: October 29, 2021

Universita G.D Annunzio Chieti Pescara

Material Received: October 06, 2021

Laboratory Number	Sample Code Number	Conventional Radiocarbon Age (BP) or Percent Modern Carbon (pMC) & Stable Isotopes
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**Beta - 605092**

**SPOT-1 Alkali Insoluble Fraction**

**10140 +/- 30 BP**

**IRMS  $\delta^{13}C$ : -25.5 o/oo**

(82.2%)	<b>9936 - 9738 cal BC</b>	<b>(11885 - 11687 cal BP)</b>
( 9.6%)	<b>9724 - 9669 cal BC</b>	<b>(11673 - 11618 cal BP)</b>
( 3.2%)	<b>9983 - 9954 cal BC</b>	<b>(11932 - 11903 cal BP)</b>
( 0.5%)	<b>9570 - 9563 cal BC</b>	<b>(11519 - 11512 cal BP)</b>

Submitter Material: Alkali insoluble organics

Pretreatment: (alkali insoluble organics) acid/alkali/acid

Analyzed Material: Alkali insoluble organics

Analysis Service: AMS-Standard delivery

Percent Modern Carbon: 28.30 +/- 0.11 pMC

Fraction Modern Carbon: 0.2830 +/- 0.0011

D14C: -717.00 +/- 1.06 o/oo

$\Delta^{14}C$ : -719.42 +/- 1.06 o/oo (1950:2021)

Measured Radiocarbon Age: (without  $\delta^{13}C$  correction): 10150 +/- 30 BP

Calibration: BetaCal4.20: HPD method: INTCAL20

Results are ISO/IEC-17025:2017 accredited. No sub-contracting or student labor was used in the analyses. All work was done at Beta in 4 in-house NEC accelerator mass spectrometers and 4 Thermo IRMSs. The "Conventional Radiocarbon Age" was calculated using the Libby half-life (5568 years), is corrected for total isotopic fraction and was used for calendar calibration where applicable. The Age is rounded to the nearest 10 years and is reported as radiocarbon years before present (BP), "present" = AD 1950. Results greater than the modern reference are reported as percent modern carbon (pMC). The modern reference standard was 95% the  $^{14}C$  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. References for calendar calibrations are cited at the bottom of calibration graph pages.

# Calibration of Radiocarbon Age to Calendar Years

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

(Variables:  $\delta^{13}\text{C} = -25.5$  o/oo)

Laboratory number      **Beta-605092**

Conventional radiocarbon age      **10140  $\pm$  30 BP**

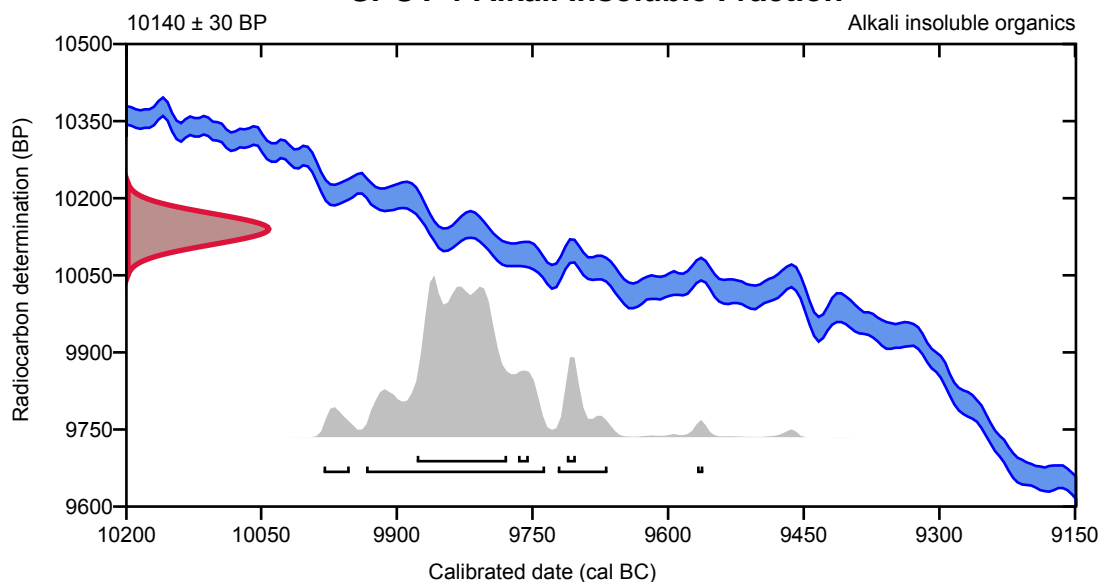
95.4% probability

(82.2%)	9936 - 9738 cal BC	(11885 - 11687 cal BP)
(9.6%)	9724 - 9669 cal BC	(11673 - 11618 cal BP)
(3.2%)	9983 - 9954 cal BC	(11932 - 11903 cal BP)
(0.5%)	9570 - 9563 cal BC	(11519 - 11512 cal BP)

68.2% probability

(61%)	9880 - 9780 cal BC	(11829 - 11729 cal BP)
(3.6%)	9768 - 9756 cal BC	(11717 - 11705 cal BP)
(3.6%)	9714 - 9704 cal BC	(11663 - 11653 cal BP)

## SPOT-1 Alkali Insoluble Fraction



Database used  
INTCAL20

## References

### References to Probability Method

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

### References to Database INTCAL20

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



**Beta Analytic**  
TESTING LABORATORY

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ISO/IEC 17025:2017-Accredited Testing Laboratory

## Quality Assurance Report

This report provides the results of reference materials used to validate radiocarbon analyses prior to reporting. Known-value reference materials were analyzed quasi-simultaneously with the unknowns. Results are reported as expected values vs measured values. Reported values are calculated relative to NISTSRM-1990C and corrected for isotopic fractionation. Results are reported using the direct analytical measure percent modern carbon (pMC) with one relative standard deviation. Agreement between expected and measured values is taken as being within 2 sigma agreement (error x 2) to account for total laboratory error.

**Report Date:** October 29, 2021  
**Submitter:** Prof. Paolo Boncio

### QA MEASUREMENTS

#### Reference 1

Expected Value: 0.42 +/- 0.04 pMC

Measured Value: 0.42 +/- 0.03 pMC

Agreement: Accepted

#### Reference 2

Expected Value: 129.41 +/- 0.06 pMC

Measured Value: 129.43 +/- 0.34 pMC

Agreement: Accepted

#### Reference 3

Expected Value: 96.69 +/- 0.50 pMC

Measured Value: 96.84 +/- 0.26 pMC

Agreement: Accepted

**COMMENT:** All measurements passed acceptance tests.

**Validation:**

  
Digital signature on file

**Date:** October 29, 2021



## REPORT OF RADIOCARBON DATING ANALYSES

Prof. Paolo Boncio

Report Date: 2/29/2016

Universita G.D Annunzio Chieti Pescara

Material Received: 2/10/2016

Sample Data	Measured Radiocarbon Age	d13C	Conventional Radiocarbon Age(*)
Beta - 431374 SAMPLE : C1_DONIA_E ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal AD 660 to 770 (Cal BP 1290 to 1180)	1260 +/- 30 BP	-23.2 o/oo	1290 +/- 30 BP
Beta - 431375 SAMPLE : C3_DONIA_E ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal AD 1270 to 1305 (Cal BP 680 to 645) and Cal AD 1365 to 1385 (Cal BP 585 to 565)	680 +/- 30 BP	-24.2 o/oo	690 +/- 30 BP
Beta - 431376 SAMPLE : C3_PITEO ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal BC 8795 to 8565 (Cal BP 10745 to 10515)	9400 +/- 50 BP <div>Not in this paper</div>	-24.4 o/oo	9410 +/- 50 BP
Beta - 431377 SAMPLE : C7_DONIA_W ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal AD 1275 to 1315 (Cal BP 675 to 635) and Cal AD 1355 to 1390 (Cal BP 595 to 560)	660 +/- 30 BP	-24.3 o/oo	670 +/- 30 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the  $^{14}\text{C}$  activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby  $^{14}\text{C}$  half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured  $^{13}\text{C}/^{12}\text{C}$  ratios (delta  $^{13}\text{C}$ ) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta  $^{13}\text{C}$ . On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta  $^{13}\text{C}$ , the ratio and the Conventional Radiocarbon Age will be followed by "\*\*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12 = -23.2 o/oo : lab. mult = 1)

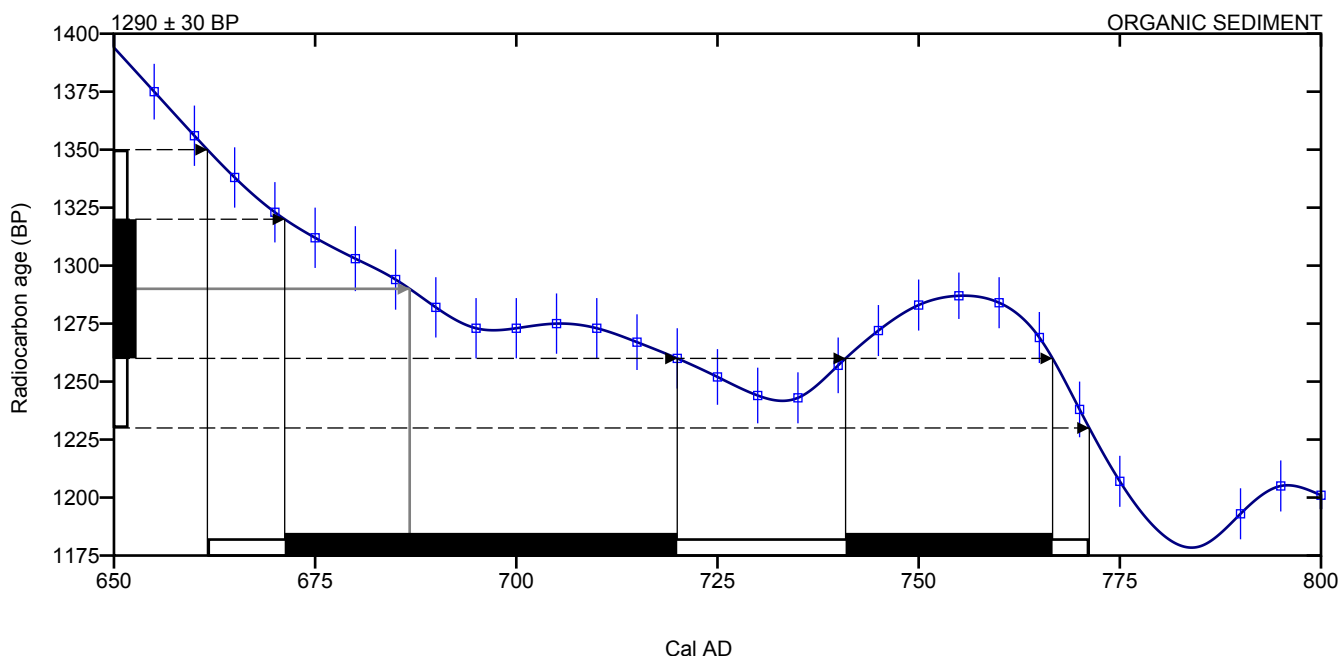
Laboratory number      **Beta-431374 : C1\_DONIA\_E**

Conventional radiocarbon age      **1290 ± 30 BP**

Calibrated Result (95% Probability)      **Cal AD 660 to 770 (Cal BP 1290 to 1180)**

Intercept of radiocarbon age with calibration curve      Cal AD 685 (Cal BP 1265)

Calibrated Result (68% Probability)      Cal AD 670 to 720 (Cal BP 1280 to 1230)  
Cal AD 740 to 765 (Cal BP 1210 to 1185)



Database used  
INTCAL13

## References

### Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates, Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

### References to INTCAL13 database

Reimer PJ et al. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887., 2013.

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# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12 = -24.2 o/oo : lab. mult = 1)

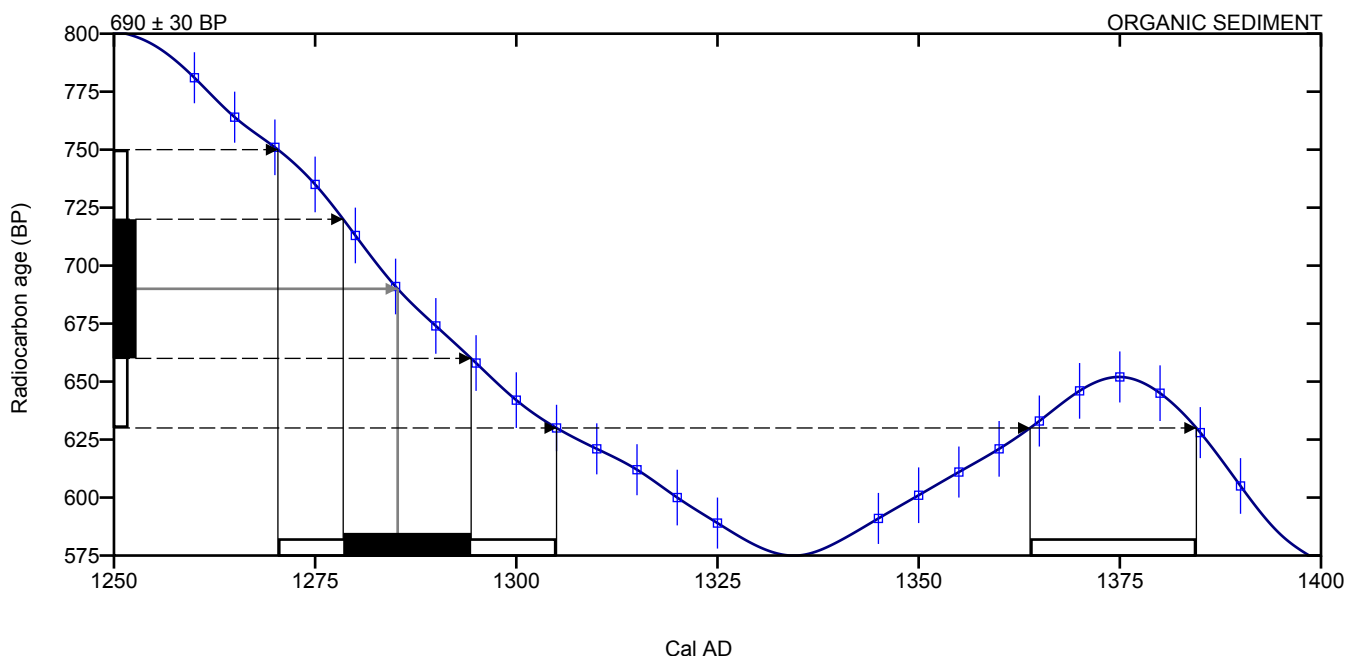
Laboratory number      **Beta-431375 : C3\_DONIA\_E**

Conventional radiocarbon age      **690 ± 30 BP**

Calibrated Result (95% Probability)      **Cal AD 1270 to 1305 (Cal BP 680 to 645)  
Cal AD 1365 to 1385 (Cal BP 585 to 565)**

Intercept of radiocarbon age with calibration curve      **Cal AD 1285 (Cal BP 665)**

Calibrated Result (68% Probability)      **Cal AD 1280 to 1295 (Cal BP 670 to 655)**



Database used  
**INTCAL13**

## References

### Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates, Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

### References to INTCAL13 database

Reimer PJ et al. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887., 2013.

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# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12 = -24.3 o/oo : lab. mult = 1)

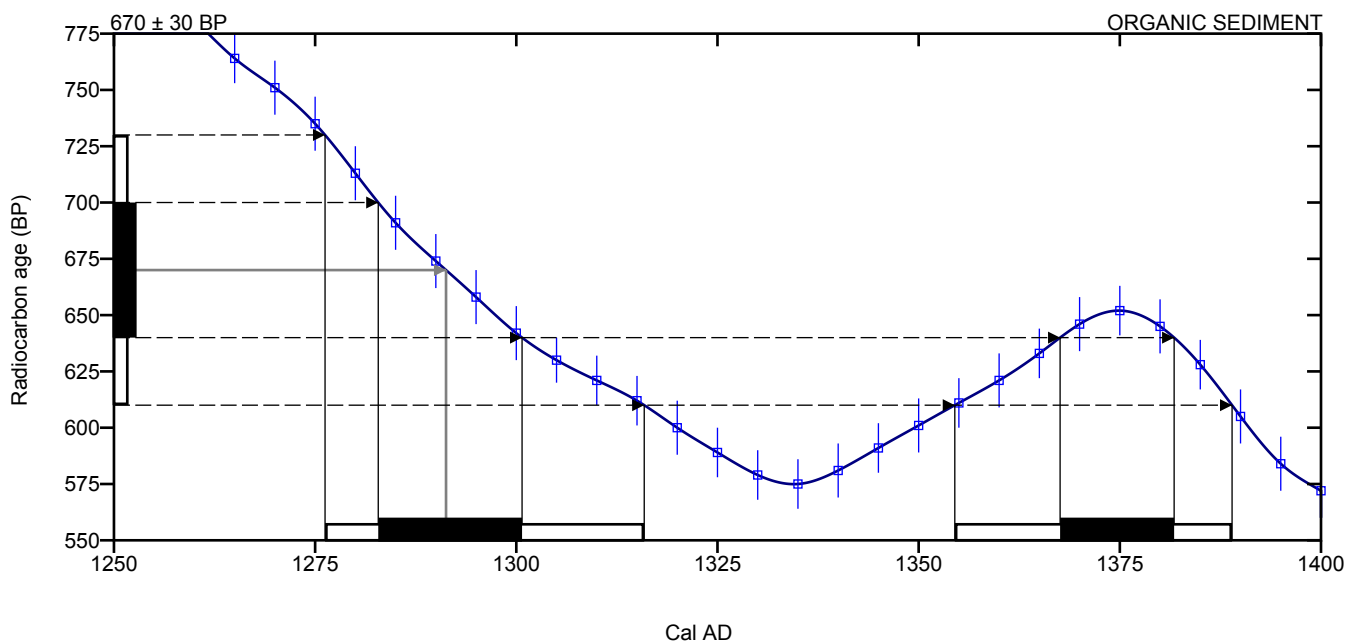
Laboratory number      Beta-431377 : C7\_DONIA\_W

Conventional radiocarbon age      670 ± 30 BP

Calibrated Result (95% Probability)      Cal AD 1275 to 1315 (Cal BP 675 to 635)  
Cal AD 1355 to 1390 (Cal BP 595 to 560)

Intercept of radiocarbon age with calibration curve      Cal AD 1290 (Cal BP 660)

Calibrated Result (68% Probability)      Cal AD 1285 to 1300 (Cal BP 665 to 650)  
Cal AD 1370 to 1380 (Cal BP 580 to 570)



Database used  
INTCAL13

## References

### Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates, Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

### References to INTCAL13 database

Reimer PJ et al. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887., 2013.

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## REPORT OF RADIOCARBON DATING ANALYSES

Prof. Paolo Boncio

Report Date: 7/27/2016

Università G.D Annunzio Chieti Pescara

Material Received: 7/7/2016

Sample Data	Measured Radiocarbon Age	Isotopes Results o/oo	Conventional Radiocarbon Age(*)
Beta - 441080 SAMPLE: C8_Donia_W ANALYSIS: AMS-Standard delivery MATERIAL/PRETREATMENT: (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal BC 905 to 805 (Cal BP 2855 to 2755)	2680 +/- 30 BP	d13C= -23.9	2700 +/- 30 BP



# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12 = -23.9 o/oo : lab. mult = 1)

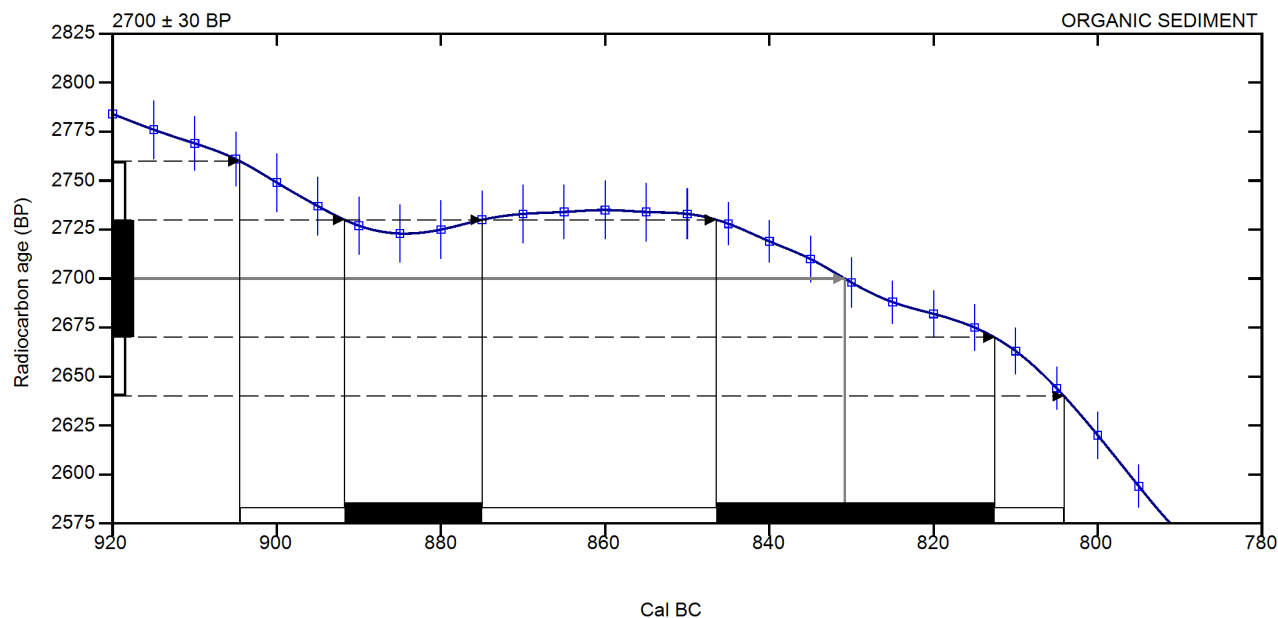
Laboratory number      Beta-441080 : C8\_DONIA\_W

Conventional radiocarbon age      2700 ± 30 BP

Calibrated Result (95% Probability)      Cal BC 905 to 805 (Cal BP 2855 to 2755)

Intercept of radiocarbon age with calibration curve      Cal BC 830 (Cal BP 2780)

Calibrated Result (68% Probability)      Cal BC 890 to 875 (Cal BP 2840 to 2825)  
Cal BC 845 to 815 (Cal BP 2795 to 2765)



Database used  
INTCAL13

## References

Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates, Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

References to INTCAL13 database

Reimer PJ et al. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887., 2013.

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