World Data Service for Paleoclimatology standard format for Radiocarbon tables

Last updated: December 8, 2023

This document provides instructions to create a standardized Radiocarbon table for the Chronology section of a WDS-Paleo data contribution. The purpose of this standard is to promote interoperability and reusability. Specifically, standardized nomenclature and consistent formatting ensure datasets are human-understandable and machine-readable (i.e., capable of being read by computer code for reprocessing, etc.). All new contributions to the WDS-Paleo will adhere to this standard, and datasets already archived by the WDS-Paleo will be converted to the standard format as resources permit.

Within a formatted Radiocarbon chronology block (**Figure 1**), there are two subsections. First is a series of standardized fields for important chronology-related metadata (e.g., Chronology_Methods, Missing_Values, etc.), as defined in **Appendix A**. Second is the tab-delimited Radiocarbon table (Chronology_Table) that uses standardized column heading names listed in **Appendix B**.

```
#----------------------------------------
# Chronology_Information
#   Chronology: Radiocarbon
#   Chronology_Download_Resource: https://www.ncei.noaa.gov/pub/data/paleo/templates/noaa-wds-paleo-14c-terms.csv
#     Chronology_Download_Description: Radiocarbon terms and definitions.
#   Chronology_Notes:
#   Rejection_Rationale:
#   Reservoir_Method:
#   Calibration_Method:
#   Age_Model_Method:
#   Missing_Values: NaN
#   Chronology_Table:
# lab_code→material_dated→depth_cm→frac_mod→frac_mod_err→d13C_PDB→age_14C_BP1950→age_14C_1s_yr→
age_calib_neg2s_BP1950→age_calib_pos2s_BP1950→calib_curve
# 14WLL2A1→aquatic moss→5.5→0.9078→0.0019→-22.01→775→15→677→726→→IntCal
```

Figure 1. Snippet of a WDS-Paleo text dataset file, showing a standardized Radiocarbon chronology block. Dashes demarcate the beginning and end of a chronology block. Every new line must start with #. Only standard column headings listed in Appendix B of this document may be used for the Chronology_Table (i.e., samp_id, depth_mm, etc).

In addition to radiocarbon dates, the standard format can accommodate other sorts of dates that are commonly reported with radiocarbon dates. These include stratigraphic tie points, tephras, core top ages, 137Cs, and 210Pb. These dates are reported in the same table with radiocarbon dates, using the “date_type” column (**Appendix B**) to label them.

Appendix A. Standardized metadata tags and their uses

Above the Chronology_Table that contains the radiocarbon data, there are six fields for free-text metadata information. Providing information for these fields is not required, but is recommended for proper interpretation and reuse of data. The metadata tag names should not be altered, but there is no restriction on the format of the text that follows the colon of each tag.

Metadata tag	**Use**
Chronology_Notes	Provide general information about the chronology section.
Rejection_Rationale	Explain why certain dates were not used in the age model (e.g., out of stratigraphic alignment). If dates were rejected, also include the “date_used” column in Chronology_Table to mark these dates as “no” (date not used). See Appendix B.
Reservoir_Method	Provide information about any reservoir corrections used and justification (e.g., applied a local reservoir correction of 50 years based on the marine reservoir correction database of Reimer and Reimer 2001). If local reservoir corrections are applied, the Chronology_Table should contain a “delta_R_yr” column (for marine sediments) or a “res_age_yr” column (for lake sediments). See Appendix B.
Calibration_Method	Explain how radiocarbon dates were calibrated (e.g., used Calib version 8). The recommended calibration curve (e.g., SHCal, IntCal, Marine) should be included as a column in Chronology_Table. See Appendix B.
Age_Model_Method	Provide information about how the age model was constructed from the Chronology_Table (e.g., rbacon, linear interpolation).
Missing_Values	Define how missing values are denoted in Chronology_Table (e.g., NA).

Appendix B. Standardized column headings, definitions, and units

Column headings for the Chronology_Table must be selected from standard terms listed below. It is not required to use all of the column headings listed below. However, there are several required columns:

- depth (e.g., depth_cm, depth_mm)
- age (e.g., age_14C_BP1950, age_calib_BP1950)
- corresponding age uncertainty (e.g., age_14C_1s_yr, age_calib_2s_yr)
- reservoir age correction (if a local correction is applied, e.g., delta_R_yr, res_age_yr)
- calib_curve
- date_type (if including dates other than radiocarbon dates)
- date_used (if some dates were not used in the final age model)

There is no particular order in which the columns need to be arranged. The term lists below are grouped into categories for organizational purposes.

Terms for sample metadata

Column heading	Definition	Units
core_id	Name of core	N/A
samp_id	Sample identification	N/A
lab_name	Name of laboratory producing 14C measurement	N/A
lab_code	Sample name assigned by 14C laboratory	N/A
depth_raw_mm	Mid-depth of sample from top of core, before compositing and not for use in age model	millimeters
depth_raw_cm	Mid-depth of sample from top of core, before compositing and not for use in age model	centimeters
depth_raw_m	Mid-depth of sample from top of core, before compositing and not for use in age model	meters
depth_start_raw_mm	Depth of sample at the start (oldest part) of sample interval, before compositing and not for use in age model	millimeters
depth_end_raw_mm	Depth of sample at the end (youngest part) of sample interval, before compositing and not for use in age model	millimeters
depth_start_raw_cm	Depth of sample at the start (oldest part) of	centimeters

	sample interval, before compositing and not for use in age model	
depth_end_raw_cm	Depth of sample at the end (youngest part) of sample interval, before compositing and not for use in age model	centimeters
depth_start_raw_m	Depth of sample at the start (oldest part) of sample interval, before compositing and not for use in age model	meters
depth_end_raw_m	Depth of sample at the end (youngest part) of sample interval, before compositing and not for use in age model	meters
depth_mm	Mid-depth of sample from top of core, after compositing or corrections and for use in age model	millimeters
depth_cm	Mid-depth of sample from top of core, after compositing or corrections and for use in age model	centimeters
depth_m	Mid-depth of sample from top of core, after compositing or corrections and for use in age model	meters
depth_start_mm	Depth of sample at the start (oldest part) of sample interval, after compositing or corrections and for use in age model	millimeters
depth_end_mm	Depth of sample at the end (youngest part) of sample interval, after compositing or corrections and for use in age model	millimeters
depth_start_cm	Depth of sample at the start (oldest part) of sample interval, after compositing or corrections and for use in age model	centimeters
depth_end_cm	Depth of sample at the end (youngest part) of sample interval, after compositing or corrections and for use in age model	centimeters
depth_start_m	Depth of sample at the start (oldest part) of sample interval, after compositing or corrections and for use in age model	meters
depth_end_m	Depth of sample at the end (youngest part) of sample interval, after compositing or corrections and for use in age model	meters

thick_mm	Thickness of sample	millimeters
thick_cm	Thickness of sample	centimeters
thick_m	Thickness of sample	meters
material_dated	Type of material dated (e.g. bulk organic, macrofossil)	N/A
date_type	Measurement method, valid entries are: “14C conv”, “14C AMS”, “tie point”, “tephra”, “core top”, “210Pb”, “137Cs”, “other marker”	N/A
weight_ug	Weight of sample	micrograms
weight_mg	Weight of sample	milligrams
weight_g	Weight of sample	grams
date_used	Indicates whether date was used in age model, valid entries are: “yes” or “no”	N/A
IGSN	International Geo Sample Number	N/A
notes	Any additional sample information	N/A
calib_curve	Calibration curve to use for converting radiocarbon years to calendar years, valid entries are: ● “None” (for a date that should not be calibrated) ● “BombNHZ1”, “BombNHZ2”, “BombNHZ3”, “BombSHZ12”, “BombSHZ3” (the dataset year may also be included, e.g., “Bomb13NHZ1”) ● “IntCal” (the dataset year may also be included, e.g., “IntCal13”) ● “SHCal” (the dataset year may also be included, e.g., “SHCal13”) ● “Marine” (the dataset year may also be included, e.g., “Marine13”)	N/A

Terms for raw radiocarbon measurements

Column heading	Definition	Units
frac_mod	Fraction of 14C/12C activity compared to modern (defined as 1950 CE)	dimensionless

frac_mod_1s	One standard deviation uncertainty of fraction of 14C/12C activity vs. modern	dimensionless
frac_mod_2s	Two standard deviations uncertainty of fraction of 14C/12C activity vs. modern	dimensionless
frac_mod_err	Unspecified uncertainty of fraction of 14C/12C activity vs. modern	dimensionless
age_14C_BP1950	Radiocarbon age	radiocarbon years before 1950 Common Era
age_14C_1s_yr	One standard deviation uncertainty of the radiocarbon age	radiocarbon years
age_14C_2s_yr	Two standard deviations uncertainty of the radiocarbon age	radiocarbon years
age_14C_err_yr	Unspecified uncertainty of the radiocarbon age	radiocarbon years
Delta_14C_permil	Ratio of the 14C/12C activity in a sample (corrected for year of collection and delta 13C) to that of absolute international standard with base year 1950 CE, i.e., ((14C/12C activity sample)/(14C/12C activity standard) - 1) x 1000	per mil
Delta_14C_1s_permil	One standard deviation uncertainty of Delta_14C	per mil
Delta_14C_2s_permil	Two standard deviations uncertainty of Delta_14C	per mil
Delta_14C_err_permil	Unspecified uncertainty of Delta_14C	per mil

Terms for carbon stable isotope measurements

Column heading	Definition	Units
d13C_PDB	Ratio of 13C/12C in a sample to that of the Pee Dee Belemnite standard, i.e., ((13C/12C sample)/(13C/12C standard) - 1) x 1000	per mil PDB
d13C_1s_PDB	Positive and negative one standard deviation uncertainty for delta 13C	per mil PDB

Terms for calibrated radiocarbon measurements

Column heading	Definition	Units
age_calib_BP1950	Calibrated age mid-point (either mean or median)	calendar years before 1950 Common Era
age_calib_1s_yr	Positive and negative one standard deviation uncertainty for calibrated age mid-point (either mean or median)	calendar years
age_calib_2s_yr	Positive and negative two standard deviations uncertainty for calibrated age mid-point (either mean or median)	calendar years
age_calib_err_yr	Positive and negative uncertainty (unspecified) for calibrated age mid-point (either mean or median)	calendar years
age_calib_neg1s_BP1950	Calibrated age at one standard deviation lower (youngest) confidence bound	calendar years before 1950 Common Era
age_calib_pos1s_BP1950	Calibrated age at one standard deviation upper (oldest) confidence bound	calendar years before 1950 Common Era
age_calib_neg2s_BP1950	Calibrated age at two standard deviations lower (youngest) confidence bound	calendar years before 1950 Common Era
age_calib_pos2s_BP1950	Calibrated age at two standard deviations upper (oldest) confidence bound	calendar years before 1950 Common Era
age_calib_range1s_BP1950	One standard deviation range of calibrated age solutions. This is a free-text field. If a range contains non-continuous time blocks, these can be separated by commas. Probabilities can be enclosed in parentheses.	calendar years before 1950 Common Era
age_calib_range2s_BP1950	Two standard deviations range of calibrated age solutions. This is a free-text field. If a range contains non-continuous time blocks, these can be separated by commas. Probabilities can be enclosed in parentheses.	calendar years before 1950 Common Era
age_calib_CE	Calibrated age mid-point (either mean	years Common

	or median)	Era
age_calib_neg1s_CE	Calibrated age at one standard deviation lower (youngest) confidence bound	years Common Era
age_calib_pos1s_CE	Calibrated age at one standard deviation upper (oldest) confidence bound	years Common Era
age_calib_neg2s_CE	Calibrated age at two standard deviations lower (youngest) confidence bound	years Common Era
age_calib_pos2s_CE	Calibrated age at two standard deviations upper (oldest) confidence bound	years Common Era
age_calib_range1s_CE	One standard deviation range of calibrated age solutions. This is a free-text field. If a range contains non-continuous time blocks, these can be separated by commas. Probabilities can be enclosed in parentheses.	years Common Era
age_calib_range2s_CE	Two standard deviations range of calibrated age solutions. This is a free-text field. If a range contains non-continuous time blocks, these can be separated by commas. Probabilities can be enclosed in parentheses.	years Common Era
prob_area_1s	Relative area under the probability distribution of calibrated values that is captured by the reported one standard deviation age range	dimensionless with values from 0 to 1
prob_area_2s	Relative area under the probability distribution of calibrated values that is captured by the reported two standard deviations age range	dimensionless with values from 0 to 1

Terms for reservoir age corrections

Column heading	Definition	Units
res_age_yr	Reservoir correction for use with	years

	non-marine calibration curves	
res_age_negerr_yr	Inferred or estimated negative uncertainty in reservoir correction	years
res_age_poserr_yr	Inferred or estimated positive uncertainty in reservoir correction	years
res_age_err_yr	Inferred or estimated positive and negative uncertainty in reservoir correction	years
delta_R_yr	Deviation from global mean reservoir correction, for use with Marine calibration curves	years
delta_R_negerr_yr	Inferred or estimated negative uncertainty in delta_R	years
delta_R_poserr_yr	Inferred or estimated positive uncertainty in delta_R	years
delta_R_err_yr	Inferred or estimated positive and negative uncertainty in delta_R	years

Terms for modeled ages

Column heading	Definition	Units
age_model_BP1950	Age inferred from an age-depth model	calendar years before 1950 Common Era
age_model_neg1s_yr	Negative one standard deviation uncertainty of age inferred from an age-depth model	calendar years
age_model_pos1s_yr	Positive one standard deviation uncertainty of age inferred from an age-depth model	calendar years
age_model_neg2s_yr	Negative two standard deviations uncertainty of age inferred from an age-depth model	calendar years
age_model_pos2s_yr	Positive two standard deviations uncertainty of age inferred from an age-depth model	calendar years

age_model_1s_yr	Positive and negative one standard deviation uncertainty for age inferred from an age-depth model	calendar years
age_model_2s_yr	Positive and negative two standard deviations uncertainty for age inferred from an age-depth model	calendar years
age_model_neg1s_BP1950	Age inferred from an age-depth model at one standard deviation lower (youngest) confidence bound	calendar years before 1950 Common Era
age_model_pos1s_BP1950	Age inferred from an age-depth model at one standard deviation upper (oldest) confidence bound	calendar years before 1950 Common Era
age_model_neg2s_BP1950	Age inferred from an age-depth model at two standard deviations lower (youngest) confidence bound	calendar years before 1950 Common Era
age_model_pos2s_BP1950	Age inferred from an age-depth model at two standard deviations upper (oldest) confidence bound	calendar years before 1950 Common Era
age_model_range1s_BP1950	One standard deviation range of modeled calibrated age solutions. This is a free-text field. If a range contains non-continuous time blocks, these can be separated by commas. Probabilities can be enclosed in parentheses.	calendar years before 1950 Common Era
age_model_range2s_BP1950	Two standard deviations range of modeled calibrated age solutions. This is a free-text field. If a range contains non-continuous time blocks, these can be separated by commas. Probabilities can be enclosed in parentheses.	calendar years before 1950 Common Era