

# Package: ananke (via r-universe)

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**Title** Quantitative Chronology in Archaeology

**Version** 0.3.0.9000

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**Description** Simple radiocarbon calibration and chronological analysis.

This package allows the calibration of radiocarbon ages and modern carbon fraction values using multiple calibration curves. It allows the calculation of highest density region intervals and credible intervals. The package also provides tools for visualising results and estimating statistical summaries.

**License** GPL (>= 3)

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<https://packages.tesselle.org/ananke/>,  
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 'c14\_spd.R' 'c14\_uncalibrate.R' 'c14\_validate.R' 'coerce.R'  
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|               |                               |
|---------------|-------------------------------|
| as.data.frame | <i>Coerce to a Data Frame</i> |
|---------------|-------------------------------|

---

## Description

Coerce to a Data Frame

## Usage

```
## S4 method for signature 'CalibratedAges'
as.data.frame(x, ..., level = 0.954, calendar = get_calendar())

## S4 method for signature 'CalibratedIntervals'
as.data.frame(x, ..., calendar = get_calendar())

## S4 method for signature 'RECE'
as.data.frame(x, ..., calendar = get_calendar())

## S4 method for signature 'ProxyRecord'
as.data.frame(x, ..., calendar = get_calendar())
```

## Arguments

|          |                                                                                                                                                             |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x        | An R object.                                                                                                                                                |
| ...      | Currently not used.                                                                                                                                         |
| level    | A length-one <a href="#">numeric</a> vector giving the confidence level (see <a href="#">interval_hdr()</a> ).                                              |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ).<br>If NULL, <i>rata die</i> are returned. |

## Value

A [data.frame](#).

## Author(s)

N. Frerebeau

## See Also

Other coercion methods: [as.list\(\)](#)

## Examples

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
```

```

    names = c("X", "Y")
  )

  as.data.frame(cal)

  as.data.frame(cal, calendar = BP())

```

as.list

*Coerce to a List***Description**

Coerce to a List

**Usage**

```

## S4 method for signature 'CalibratedIntervals'
as.list(x, ..., calendar = get_calendar())

```

**Arguments**

|          |                                                                                                                                                          |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| x        | An R object.                                                                                                                                             |
| ...      | Currently not used.                                                                                                                                      |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). If NULL, <i>rata die</i> are returned. |

**Value**A [list](#).**Author(s)**

N. Frerebeau

**See Also**Other coercion methods: [as.data.frame](#)**Examples**

```

## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

as.data.frame(cal)

as.data.frame(cal, calendar = BP())

```

c14\_calibrate

*14C Calibration***Description**

Calibrates radiocarbon ages.

**Usage**

```
c14_calibrate(values, errors, ...)

## S4 method for signature 'numeric,numeric'
c14_calibrate(
  values,
  errors,
  curves = "intcal20",
  names = NULL,
  positions = NULL,
  reservoir_offsets = 0,
  reservoir_errors = 0,
  from = 55000,
  to = 0,
  resolution = 1,
  normalize = TRUE,
  F14C = FALSE,
  method = c("student", "normal"),
  df = 100,
  drop = TRUE,
  eps = 1e-06,
  verbose = getOption("ananke.verbose")
)
```

**Arguments**

|                   |                                                                                                                      |
|-------------------|----------------------------------------------------------------------------------------------------------------------|
| values            | A <b>numeric</b> vector giving the BP ages or F14C values to be calibrated (conventional ages).                      |
| errors            | A <b>numeric</b> vector giving the errors associated to the values to be calibrated.                                 |
| ...               | Currently not used.                                                                                                  |
| curves            | A <b>character</b> vector specifying the calibration curve to be used. Different curves can be specified per sample. |
| names             | A <b>character</b> vector specifying the names of the samples (e.g. laboratory codes).                               |
| positions         | A <b>numeric</b> vector giving the position values (e.g. depths) for each age.                                       |
| reservoir_offsets | A <b>numeric</b> vector giving the offset values for any marine reservoir effect (defaults to 0; i.e. no offset).    |

|                  |                                                                                                                                                                              |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| reservoir_errors | A <b>numeric</b> vector giving the offset value errors for any marine reservoir effect (defaults to 0; i.e. no offset).                                                      |
| from             | length-one <b>numeric</b> vector specifying the earliest data to calibrate for, in cal. BP years.                                                                            |
| to               | A length-one <b>numeric</b> vector specifying the latest data to calibrate for, in cal. BP years.                                                                            |
| resolution       | A length-one <b>numeric</b> vector specifying the temporal resolution (in years) of the calibration.                                                                         |
| normalize        | A <b>logical</b> scalar: should the calibration be normalized?                                                                                                               |
| F14C             | A <b>logical</b> scalar: should the calibration be carried out in F14C space? If TRUE, values must be expressed as F14C.                                                     |
| method           | A <b>character</b> string specifying the distribution assumed for the 14C ages. It must be one of "student" (the default) or "normal". Only used if F14C is FALSE.           |
| df               | A <b>character</b> vector giving the degrees-of-freedom values for the student t-distribution associated with the calibration calculation. Only used if method is "student". |
| drop             | A <b>logical</b> scalar: should years with zero probability be discarded? If TRUE (the default), results in a narrower time range.                                           |
| eps              | A length-one <b>numeric</b> value giving the cutoff below which calibration values will be removed.                                                                          |
| verbose          | A <b>logical</b> scalar: should extra information be reported (e.g. warning message for dates out of calibration range)?                                                     |

**Value**

A **CalibratedAges** object.

**Note**

Adapted from **Bchron** BchronCalibrate() by Andrew Parnell and **rcarbon** calibrate() by Andrew Bevan and Enrico Crema.

**Author(s)**

N. Frerebeau

**References**

Bronk Ramsey, C. (2008). Radiocarbon Dating: Revolutions in Understanding. *Archaeometry*, 50:249-275. doi:10.1111/j.14754754.2008.00394.x.

**See Also**

Other radiocarbon tools: F14C, c14\_combine(), c14\_count(), c14\_curve(), c14\_plot, c14\_sample(), c14\_spd(), c14\_uncalibrate(), rec\_plot, ridgelines()

## Examples

```
## Calibrate a single date
cal <- c14_calibrate(300, 20)
plot(cal, panel.first = graphics::grid())

## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)
plot(cal)

## Calibrate F14C
cal <- c14_calibrate(
  values = 0.0062,
  errors = 0.0006,
  F14C = TRUE
)
plot(cal)

## Out of 14C range?
out <- c14_calibrate(130, 20)
plot(out)
```

---

c14\_combine

*Combine 14C*


---

## Description

Combines radiocarbon dates.

## Usage

```
c14_combine(values, errors, ...)

## S4 method for signature 'numeric,numeric'
c14_combine(values, errors, groups = NULL)
```

## Arguments

|        |                                                                                                                                                                                                                  |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| values | A <a href="#">numeric</a> vector giving the BP ages to be calibrated.                                                                                                                                            |
| errors | A <a href="#">numeric</a> vector giving the standard deviation of the ages to be calibrated.                                                                                                                     |
| ...    | Currently not used.                                                                                                                                                                                              |
| groups | A <a href="#">factor</a> in the sense that <code>as.factor(groups)</code> defines the groups to combine with. If <code>NULL</code> (the default), all dates are combined. NAs will be treated as isolated dates. |

Value

A `data.frame` with the following columns:

|        |                                  |
|--------|----------------------------------|
| groups | Group names                      |
| ages   | Combined 14C ages                |
| errors | Combined 14C standard deviations |
| chi2   | Chi-squared test statistic       |
| p      | Chi-squared test p-value         |

Author(s)

N. Frerebeau

References

Ward, G. K. and Wilson, S. R. (1978). Procedures for Comparing and Combining Radiocarbon Age Determinations: A Critique. *Archaeometry* 20(1): 19-31. doi:10.1111/j.14754754.1978.tb00208.x.

See Also

Other radiocarbon tools: `F14C`, `c14_calibrate()`, `c14_count()`, `c14_curve()`, `c14_plot`, `c14_sample()`, `c14_spd()`, `c14_uncalibrate()`, `rec_plot`, `ridgelines()`

Examples

```
## Replicate Ward and Wilson (1978), p. 28
polach1972 <- data.frame(
  samples = c("ANU-7", "ANU-7", "ANU-7", "W-1571", "ANU-5",
              "C-800", "L-698D", "FSU-3", "Tx-44"),
  ages = c(14550, 15000, 13700, 14650, 11700, 10860, 11840, 11245, 10700),
  errors = c(270, 600, 300, 500, 260, 410, 100, 450, 210)
)

c14_combine(
  values = polach1972$ages,
  errors = polach1972$errors,
  groups = polach1972$samples
)
```

---

|           |                                |
|-----------|--------------------------------|
| c14_count | <i>Radiocarbon Event Count</i> |
|-----------|--------------------------------|

---

Description

Radiocarbon Event Count

**Usage**

```
c14_count(object, ...)

## S4 method for signature 'CalibratedAges'
c14_count(
  object,
  from = NULL,
  to = NULL,
  by = 10,
  n = 100,
  calendar = BP(),
  progress = getOption("ananke.progress")
)
```

**Arguments**

|          |                                                                                                                                                                                                   |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| object   | A <a href="#">CalibratedAges</a> object.                                                                                                                                                          |
| ...      | Currently not used.                                                                                                                                                                               |
| from     | length-one <a href="#">numeric</a> vector specifying the earliest data to calibrate for (in cal BP years).                                                                                        |
| to       | A length-one <a href="#">numeric</a> vector specifying the latest data to calibrate for (in cal BP years).                                                                                        |
| by       | A length-one <a href="#">numeric</a> vector specifying the temporal resolution (in years) of the calibration.                                                                                     |
| n        | An <a href="#">integer</a> specifying the number of item to choose randomly.                                                                                                                      |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). Defaults to <a href="#">aion::CE()</a> . If NULL, <i>rata die</i> are returned. |
| progress | A <a href="#">logical</a> scalar: should a progress bar be displayed?                                                                                                                             |

**Value**

An [RECE](#) object.

**Note**

This function is currently *experimental*.

**Author(s)**

N. Frerebeau

**References**

Carleton, W. C. (2021). Evaluating Bayesian Radiocarbon-dated Event Count (REC) Models for the Study of Long-term Human and Environmental Processes. *Journal of Quaternary Science*, 36(1): 110-23. doi:[10.1002/jqs.3256](https://doi.org/10.1002/jqs.3256).

**See Also**

Other radiocarbon tools: [F14C](#), [c14\\_calibrate\(\)](#), [c14\\_combine\(\)](#), [c14\\_curve\(\)](#), [c14\\_plot](#), [c14\\_sample\(\)](#), [c14\\_spd\(\)](#), [c14\\_uncalibrate\(\)](#), [rec\\_plot](#), [ridgelines\(\)](#)

**Examples**

```
## Radiocarbon data from Bosch et al. 2015
data("ksarakil")

## Calibrate
cal <- c14_calibrate(
  values = ksarakil$date,
  errors = ksarakil$error,
  names = ksarakil$code,
  curves = "marine13",
  reservoir_offsets = 53,
  reservoir_errors = 43,
  from = 50000, to = 0
)

## RECE
tmp <- c14_count(cal, n = 500)
plot(tmp, col = grDevices::hcl.colors(12, "Viridis", rev = TRUE))
```

c14\_curve

*14C Calibration Curve***Description**

14C Calibration Curve

**Usage**

```
c14_curve(name, ...)
```

## S4 method for signature 'character'

```
c14_curve(name)
```

## S4 method for signature 'CalibratedAges'

```
c14_curve(name)
```

**Arguments**

|      |                                                                             |
|------|-----------------------------------------------------------------------------|
| name | A <a href="#">character</a> vector naming calibration curves (see details). |
| ...  | Currently not used.                                                         |

## Details

The following calibration curves are available:

| Curve    | Reference            |
|----------|----------------------|
| intcal04 | Reimer et al. 2004   |
| intcal09 | Reimer et al. 2009   |
| intcal13 | Reimer et al. 2013   |
| intcal20 | Reimer et al. 2020   |
| marine04 | Hughen et al. 2004   |
| marine09 | Reimer et al. 2009   |
| marine13 | Reimer et al. 2013   |
| marine20 | Heaton et al. 2020   |
| shcal04  | McCormac et al. 2004 |
| shcal13  | Hogg et al. 2013     |
| shcal20  | Hogg et al. 2020     |

## Value

A list of three-column [data.frame](#):

|       |                              |
|-------|------------------------------|
| CALBP | Calibrated age BP            |
| AGE   | Uncalibrated radiocarbon age |
| ERROR | Standard deviation           |

## Author(s)

N. Frerebeau

## References

- Heaton, Timothy J, Peter Köhler, Martin Butzin, Edouard Bard, Ron W Reimer, William E N Austin, Christopher Bronk Ramsey, et al. (2020). Marine20 The Marine Radiocarbon Age Calibration Curve (0-55,000 Cal BP). *Radiocarbon*, 62(4): 779-820. doi:10.1017/RDC.2020.68.
- Hogg, Alan G, Timothy J Heaton, Quan Hua, Jonathan G Palmer, Chris SM Turney, John Southon, Alex Bayliss, et al. (2020). SHCal20 Southern Hemisphere Calibration, 0-55,000 Years Cal BP. *Radiocarbon*, 62(4): 759-78. doi:10.1017/RDC.2020.59.
- Hogg, Alan G, Quan Hua, Paul G Blackwell, Mu Niu, Caitlin E Buck, Thomas P Guilderson, Timothy J Heaton, et al. (2013). SHCal13 Southern Hemisphere Calibration, 0-50,000 Years Cal BP. *Radiocarbon*, 55(4): 1889-1903. doi:10.2458/azu\_js\_rc.55.16783.
- Hua, Quan, and Mike Barbetti (2004). Review of Tropospheric Bomb 14C Data for Carbon Cycle Modeling and Age Calibration Purposes. *Radiocarbon*, 46(3): 1273-1298. doi:10.1017/S0033822200033142.
- Hua, Quan, Mike Barbetti, and Andrzej Z Rakowski (2013). Atmospheric Radiocarbon for the Period 1950-2010. *Radiocarbon*, 55(4): 2059-2072. doi:10.2458/azu\_js\_rc.v55i2.16177.
- Hua, Quan, Jocelyn C Turnbull, Guaciara M Santos, Andrzej Z Rakowski, Santiago Ancapichún, Ricardo De Pol-Holz, Samuel Hammer, et al. (2022). Atmospheric Radiocarbon for the Period 1950-2019. *Radiocarbon*, 64(4): 723-745. doi:10.1017/RDC.2021.95.

- Hughen, K., S. Lehman, J. Southon, J. Overpeck, O. Marchal, C. Herring, and J. Turnbull (2004). 14C Activity and Global Carbon Cycle Changes over the Past 50,000 Years. *Science*, 303(5655): 202-207. doi:[10.1126/science.1090300](https://doi.org/10.1126/science.1090300).
- Hughen, Konrad A, Mike G L Baillie, Edouard Bard, J Warren Beck, Chanda J H Bertrand, Paul G Blackwell, Caitlin E Buck, et al. (2004). Marine04 Marine Radiocarbon Age Calibration, 0-26 cal kyr BP. *Radiocarbon*, 46(3): 1059-1086. doi:[10.1017/S0033822200033002](https://doi.org/10.1017/S0033822200033002).
- Kueppers, Lara M., John Southon, Paul Baer, and John Harte (2004). Dead Wood Biomass and Turnover Time, Measured by Radiocarbon, along a Subalpine Elevation Gradient. *Oecologia*, 141(4): 641-651. doi:[10.1007/s004420041689x](https://doi.org/10.1007/s004420041689x).
- McCormac, F G, A G Hogg, P G Blackwell, C E Buck, T F G Higham, and P J Reimer (2004). Shcal04 Southern Hemisphere Calibration, 0-11.0 cal kyr BP. *Radiocarbon*, 46(3): 1087-1092. doi:[10.1017/S0033822200033014](https://doi.org/10.1017/S0033822200033014).
- Reimer, P J, M G L Baillie, E Bard, A Bayliss, J W Beck, P G Blackwell, C Bronk Ramsey, et al. (2009). IntCal09 and Marine09 Radiocarbon Age Calibration Curves, 0-50,000 Years cal BP. *Radiocarbon*, 51(4): 1111-1150. doi:[10.1017/S0033822200034202](https://doi.org/10.1017/S0033822200034202).
- Reimer, Paula J, William E N Austin, Edouard Bard, Alex Bayliss, Paul G Blackwell, Christopher Bronk Ramsey, Martin Butzin, et al. (2020). The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0-55 cal kBP). *Radiocarbon*, 62(4): 725-757. doi:[10.1017/RDC.2020.41](https://doi.org/10.1017/RDC.2020.41).
- Reimer, Paula J, Mike G L Baillie, Edouard Bard, Alex Bayliss, J Warren Beck, Chanda J H Bertrand, Paul G Blackwell, et al. (2004). Intcal04 Terrestrial Radiocarbon Age Calibration, 0-26 cal kyr BP. *Radiocarbon*, 46(3): 1029-1058. doi:[10.1017/S0033822200032999](https://doi.org/10.1017/S0033822200032999).
- Reimer, Paula J, Edouard Bard, Alex Bayliss, J Warren Beck, Paul G Blackwell, Christopher Bronk Ramsey, Caitlin E Buck, et al. (2013). IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years cal BP. *Radiocarbon*, 55(4): 1869-1887. doi:[10.2458/azu\\_js\\_rc.55.16947](https://doi.org/10.2458/azu_js_rc.55.16947).
- Stuiver, Minze, Paula J. Reimer, Edouard Bard, J. Warren Beck, G. S. Burr, Konrad A. Hughen, Bernd Kromer, Gerry McCormac, Johannes van der Plicht, and Marco Spurk (1998). INTCAL98 Radiocarbon Age Calibration, 24,000-0 cal BP. *Radiocarbon*, 40(3): 1041-1083. doi:[10.1017/S0033822200019123](https://doi.org/10.1017/S0033822200019123).
- Stuiver, Minze, Paula J. Reimer, and Thomas F. Braziunas. (1998). High-Precision Radiocarbon Age Calibration for Terrestrial and Marine Samples. *Radiocarbon*, 40(3): 1127-1151. doi:[10.1017/S0033822200019172](https://doi.org/10.1017/S0033822200019172).

## See Also

Other radiocarbon tools: [F14C](#), [c14\\_calibrate\(\)](#), [c14\\_combine\(\)](#), [c14\\_count\(\)](#), [c14\\_plot](#), [c14\\_sample\(\)](#), [c14\\_spd\(\)](#), [c14\\_uncalibrate\(\)](#), [rec\\_plot](#), [ridgelines\(\)](#)

## Examples

```
## IntCal20
intcal20 <- c14_curve("intcal20")
head(intcal20[[1]])

## IntCal
intcal <- c14_curve(c("intcal09", "intcal13", "intcal20"))
lapply(X = intcal, FUN = head)
```

c14\_plot

*Plot Calibrated Radiocarbon Ages***Description**

Plot Calibrated Radiocarbon Ages

**Usage**

```
## S4 method for signature 'CalibratedAges,missing'
plot(
  x,
  calendar = get_calendar(),
  interval = c("hdr", "credible"),
  level = 0.954,
  sort = TRUE,
  decreasing = FALSE,
  col = "grey",
  main = NULL,
  sub = NULL,
  ann = graphics::par("ann"),
  axes = TRUE,
  frame.plot = TRUE,
  panel.first = NULL,
  panel.last = NULL,
  ...
)

## S4 method for signature 'CalibratedSPD,missing'
plot(
  x,
  calendar = get_calendar(),
  main = NULL,
  sub = NULL,
  ann = graphics::par("ann"),
  axes = TRUE,
  frame.plot = TRUE,
  panel.first = NULL,
  panel.last = NULL,
  ...
)
```

**Arguments**

|          |                                                                                                                                                             |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x        | A <a href="#">CalibratedAges</a> or <a href="#">CalibratedSPD</a> object.                                                                                   |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ).<br>If NULL, <i>rata die</i> are returned. |

|             |                                                                                                                                                                       |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| interval    | A <a href="#">character</a> string specifying the intervals to be drawn. It must be one of "hrd" (the default) or "credible". Any unambiguous substring can be given. |
| level       | A length-one <a href="#">numeric</a> vector giving the confidence level. Only used if interval is TRUE.                                                               |
| sort        | A <a href="#">logical</a> scalar: should ages be arranged in chronological order?                                                                                     |
| decreasing  | A <a href="#">logical</a> scalar: should the sort order be decreasing?                                                                                                |
| col         | A specification for the plotting colors.                                                                                                                              |
| main        | A <a href="#">character</a> string giving a main title for the plot.                                                                                                  |
| sub         | A <a href="#">character</a> string giving a subtitle for the plot.                                                                                                    |
| ann         | A <a href="#">logical</a> scalar: should the default annotation (title and x and y labels) appear on the plot?                                                        |
| axes        | A <a href="#">logical</a> scalar: should axes be drawn on the plot?                                                                                                   |
| frame.plot  | A <a href="#">logical</a> scalar: should a box be drawn around the plot?                                                                                              |
| panel.first | An expression to be evaluated after the plot axes are set up but before any plotting takes place. This can be useful for drawing background grids.                    |
| panel.last  | An expression to be evaluated after plotting has taken place but before the axes, title and box are added.                                                            |
| ...         | Further parameters to be passed to <a href="#">aion::plot()</a> .                                                                                                     |

### Value

`plot()` is called it for its side-effects: it results in a graphic being displayed. Invisibly returns `x`.

### Author(s)

N. Frerebeau

### See Also

Other radiocarbon tools: [F14C](#), [c14\\_calibrate\(\)](#), [c14\\_combine\(\)](#), [c14\\_count\(\)](#), [c14\\_curve\(\)](#), [c14\\_sample\(\)](#), [c14\\_spd\(\)](#), [c14\\_uncalibrate\(\)](#), [rec\\_plot](#), [ridgelines\(\)](#)

### Examples

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Specify calendar
plot(cal, calendar = b2k(), flip = TRUE)

## HDR intervals (default)
plot(cal, interval = "hdr", level = 0.95)
```

```
## Credible intervals
plot(cal, interval = "credible", level = 0.95)

## No intervals
plot(cal, level = 0)
```

---

|            |                               |
|------------|-------------------------------|
| c14_sample | <i>Sample Calibrated Ages</i> |
|------------|-------------------------------|

---

## Description

Sample Calibrated Ages

## Usage

```
c14_sample(object, ...)
```

## S4 method for signature 'CalibratedAges'

```
c14_sample(object, n = 100, calendar = get_calendar())
```

## Arguments

|          |                                                                                                                                                                                                   |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| object   | A <a href="#">CalibratedAges</a> object.                                                                                                                                                          |
| ...      | Currently not used.                                                                                                                                                                               |
| n        | An <a href="#">integer</a> specifying the number of random samples.                                                                                                                               |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). Defaults to <a href="#">aion::CE()</a> . If NULL, <i>rata die</i> are returned. |

## Value

An numeric matrix.

## Author(s)

N. Frerebeau

## See Also

Other radiocarbon tools: [F14C](#), [c14\\_calibrate\(\)](#), [c14\\_combine\(\)](#), [c14\\_count\(\)](#), [c14\\_curve\(\)](#), [c14\\_plot](#), [c14\\_spd\(\)](#), [c14\\_uncalibrate\(\)](#), [rec\\_plot](#), [ridgelines\(\)](#)

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Sample
spl <- c14_sample(cal, n = 100)
```

c14\_spd

*Summed Probability Distributions***Description**

Computes summed probability distributions (SPD) of radiocarbon dates.

**Usage**

```
c14_spd(object, ...)

## S4 method for signature 'CalibratedAges'
c14_spd(object, normalize_date = FALSE, normalize_spd = FALSE)
```

**Arguments**

|                |                                                                                                                                                               |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| object         | A <a href="#">CalibratedAges</a> object.                                                                                                                      |
| ...            | Currently not used.                                                                                                                                           |
| normalize_date | A <a href="#">logical</a> scalar: should the total probability mass of the calibrated dates be normalised (to sum to unity within the time-span of analysis)? |
| normalize_spd  | A <a href="#">logical</a> scalar: should the total probability mass of the SPD be normalised (to sum to unity)?                                               |

**Details**

Summed probability distributions (SPD) are not statistically valid estimators of the calendar age of a potential future sample. They should not be used in any dates-as-data approach to provide a population proxy.

**Value**

A [CalibratedSPD](#) object.

**Author(s)**

N. Frerebeau

**See Also**

Other radiocarbon tools: `F14C`, `c14_calibrate()`, `c14_combine()`, `c14_count()`, `c14_curve()`, `c14_plot`, `c14_sample()`, `c14_uncalibrate()`, `rec_plot`, `ridgelines()`

**Examples**

```
## Radiocarbon data from Bosch et al. 2015
data("ksarakil")

## Calibrate
cal <- c14_calibrate(
  values = ksarakil$date,
  errors = ksarakil$error,
  names = ksarakil$code,
  curves = "marine13",
  reservoir_offsets = 53,
  reservoir_errors = 43,
  from = 50000, to = 0
)
plot(cal, level = 0.68)

## SPD
s <- c14_spd(cal)
plot(s)
```

---

|                 |                                       |
|-----------------|---------------------------------------|
| c14_uncalibrate | <i>Uncalibrate a Radiocarbon Date</i> |
|-----------------|---------------------------------------|

---

**Description**

Uncalibrate a Radiocarbon Date

**Usage**

```
c14_uncalibrate(object, ...)
```

## S4 method for signature 'numeric'

```
c14_uncalibrate(object, curves = "intcal20")
```

## S4 method for signature 'CalibratedAges'

```
c14_uncalibrate(object, n = 10000, rounding = getOption("ananke.round"), ...)
```

**Arguments**

|        |                                                                                                                    |
|--------|--------------------------------------------------------------------------------------------------------------------|
| object | A <a href="#">CalibratedAges</a> object or a <a href="#">numeric</a> vector of calibrated ages (in years BP).      |
| ...    | Currently not used.                                                                                                |
| curves | A <a href="#">character</a> vector specifying the calibration curve to be used. Different curves can be specified. |

**n** An [integer](#) specifying the number of random samples.

**rounding** A [character](#) string specifying the rounding convention. It can be one of "none" (the default, no rounding) or "stuiver". Any unambiguous substring can be given.

### Author(s)

N. Frerebeau

### See Also

Other radiocarbon tools: [F14C](#), [c14\\_calibrate\(\)](#), [c14\\_combine\(\)](#), [c14\\_count\(\)](#), [c14\\_curve\(\)](#), [c14\\_plot](#), [c14\\_sample\(\)](#), [c14\\_spd\(\)](#), [rec\\_plot](#), [ridgelines\(\)](#)

### Examples

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Uncalibrate
c14_uncalibrate(cal, rounding = "stuiver")
```

---

describe

*Data Description*

---

### Description

Data Description

### Usage

```
## S4 method for signature 'CalibratedAges'
describe(x, calendar = get_calendar(), level = 0.954, ...)
```

### Arguments

**x** A [CalibratedAges](#) object.

**calendar** An [aion::TimeScale](#) object specifying the target calendar (see [aion::calendar\(\)](#)).

**level** A length-one [numeric](#) vector giving the confidence level.

**...** Further parameters to be passed to [cat\(\)](#).

**Value**

`describe()` is called for its side-effects. Invisibly returns `x`.

**Author(s)**

N. Frerebeau

**References**

Millard, A. R. (2014). Conventions for Reporting Radiocarbon Determinations. *Radiocarbon*, 56(2): 555-559. doi:10.2458/56.17455.

**See Also**

Other summary: [summary\(\)](#)

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Full text description
describe(cal)
```

---

F14C

---

*F14C*


---

**Description**

Converts F14C values to 14C ages.

**Usage**

```
c14_f14c(values, errors, ...)

f14c_c14(values, errors, ...)

## S4 method for signature 'numeric,numeric'
c14_f14c(values, errors, tau = 8033)

## S4 method for signature 'numeric,numeric'
f14c_c14(
  values,
  errors,
```

```

    tau = 8033,
    asymmetric = FALSE,
    rounding = getOption("ananke.round")
)

```

### Arguments

|            |                                                                                                                                                                        |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| values     | A <b>numeric</b> vector giving the radiocarbon ages or the F14C values.                                                                                                |
| errors     | A <b>numeric</b> vector giving the standard deviations.                                                                                                                |
| ...        | Currently not used.                                                                                                                                                    |
| tau        | A length-one <b>numeric</b> vector specifying the mean-life of radiocarbon (defaults to 14C half-life value as introduced by Libby 1952).                              |
| asymmetric | A <b>logical</b> scalar: should asymmetric 14C errors be returned (van der Plicht & Hogg, 2006)?                                                                       |
| rounding   | A <b>character</b> string specifying the rounding convention. It can be one of "none" (the default, no rounding) or "stuiver". Any unambiguous substring can be given. |

### Details

`f14c_c14()` calculates the conventional radiocarbon age:

$$t = -\frac{1}{\lambda} \ln F^{14}C = -\tau \ln F^{14}C$$

`c14_f14c()` calculates the inverse:

$$F^{14}C = e^{-\lambda t} = e^{-\frac{t}{\tau}}$$

### Value

A **data.frame**.

### Author(s)

N. Frerebeau

### References

- Bronk Ramsey, C. (2008). Radiocarbon Dating: Revolutions in Understanding. *Archaeometry*, 50:249-275. doi:[10.1111/j.14754754.2008.00394.x](https://doi.org/10.1111/j.14754754.2008.00394.x).
- Stuiver, M., Polach, H. A. (1977). Discussion Reporting of 14C Data. *Radiocarbon*, 19(3): 355-363. doi:[10.1017/S0033822200003672](https://doi.org/10.1017/S0033822200003672).
- van der Plicht, J., Hogg, A. (2006). A Note on Reporting Radiocarbon. *Quaternary Geochronology*, 1(4): 237-240. doi:[10.1016/j.quageo.2006.07.001](https://doi.org/10.1016/j.quageo.2006.07.001).

### See Also

Other radiocarbon tools: `c14_calibrate()`, `c14_combine()`, `c14_count()`, `c14_curve()`, `c14_plot`, `c14_sample()`, `c14_spd()`, `c14_uncalibrate()`, `rec_plot`, `ridgelines()`

## Examples

```
## Asymmetric 14C errors (van der Plicht and Hogg 2006)
f14c_c14(0.0052, 0.0006, asym = TRUE)

## Symmetric 14C errors (Bronk Ramsey 2008)
f14c_c14(0.0052, 0.0006, asym = FALSE)
```

---

|                   |                                   |
|-------------------|-----------------------------------|
| interval_credible | <i>Bayesian Credible Interval</i> |
|-------------------|-----------------------------------|

---

## Description

Bayesian Credible Interval

## Usage

```
## S4 method for signature 'CalibratedAges'
interval_credible(x, level = 0.954, n = 100, ...)
```

## Arguments

|       |                                                                          |
|-------|--------------------------------------------------------------------------|
| x     | A <a href="#">CalibratedAges</a> object.                                 |
| level | A length-one <a href="#">numeric</a> vector giving the confidence level. |
| n     | An <a href="#">integer</a> specifying the number of random samples.      |
| ...   | Currently not used.                                                      |

## Value

A [CalibratedIntervals](#) object.

## Author(s)

N. Frerebeau

## See Also

[arkhe::interval\\_credible\(\)](#)

Other statistics: [interval\\_hdr](#), [mean\(\)](#), [median\(\)](#), [quantile\(\)](#), [radialplot\(\)](#)

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Credible intervals
crd68 <- interval_credible(cal, level = 0.683)
crd95 <- interval_credible(cal, level = 0.954)
crd99 <- interval_credible(cal, level = 0.997)

## Coerce to data.frame
as.data.frame(crd95, calendar = BC())

## Plot
plot(cal, interval = "credible")
```

---

|              |                                |
|--------------|--------------------------------|
| interval_hdr | <i>Highest Density Regions</i> |
|--------------|--------------------------------|

---

**Description**

Highest Density Regions

**Usage**

```
## S4 method for signature 'CalibratedAges,missing'
interval_hdr(x, level = 0.954, ...)
```

**Arguments**

|       |                                                                          |
|-------|--------------------------------------------------------------------------|
| x     | A <a href="#">CalibratedAges</a> object.                                 |
| level | A length-one <a href="#">numeric</a> vector giving the confidence level. |
| ...   | Currently not used.                                                      |

**Value**

A [CalibratedIntervals](#) object.

**Author(s)**

N. Frerebeau

**References**

Hyndman, R. J. (1996). Computing and graphing highest density regions. *American Statistician*, 50: 120-126. doi:[10.2307/2684423](https://doi.org/10.2307/2684423).

**See Also**

`stats::density()`, `arkhe::interval_hdr()`

Other statistics: `interval_credible`, `mean()`, `median()`, `quantile()`, `radialplot()`

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## HDR
hdr68 <- interval_hdr(cal, level = 0.683)
hdr95 <- interval_hdr(cal, level = 0.954)
hdr99 <- interval_hdr(cal, level = 0.997)

## Coerce to a data.frame
as.data.frame(hdr95, calendar = BC())
## Coerce to a list
as.list(hdr95)

## Plot
plot(hdr95, lwd = 3)
```

---

ksarakil

*Ksâr 'Akil Radiocarbon Dates*


---

**Description**

Ksâr 'Akil Radiocarbon Dates

**Usage**

ksarakil

**Format**

A `data.frame` with 16 rows and 5 variables:

**code** Laboratory code.

**date** Radiocarbon date (year BP).

**error** Radiocarbon error (year).

**layer** Stratigraphic layer.

**phase** Chronological phase.

**Source**

Bosch, M. D., Mannino, M. A., Prendergast, A. L., O’Connell, T. C., Demarchi, B., Taylor, S. M., Niven, L., van der Plicht, J. and Hublin, J.-J. (2015). New Chronology for Ksâr ’Akil (Lebanon) Supports Levantine Route of Modern Human Dispersal into Europe. *Proceedings of the National Academy of Sciences* 112(25): 7683-8. doi:[10.1073/pnas.1501529112](https://doi.org/10.1073/pnas.1501529112).

---

labels

*Find Labels from Object*

---

**Description**

Find a suitable set of labels from an object for use in printing or plotting, for example.

**Usage**

```
## S4 method for signature 'CalibratedAges'  
labels(object, ...)
```

**Arguments**

|        |                                      |
|--------|--------------------------------------|
| object | An object from which to find labels. |
| ...    | Currently not used.                  |

**Value**

A [character](#) vector.

**Author(s)**

N. Frerebeau

**See Also**

Other mutators: [mutators](#)

---

mean

*Mean*


---

## Description

Mean

## Usage

```
## S4 method for signature 'CalibratedAges'
mean(x, na.rm = FALSE, ..., calendar = get_calendar())

## S4 method for signature 'ProxyRecord'
mean(x, na.rm = FALSE, ...)
```

## Arguments

|          |                                                                                                                                                          |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| x        | A <a href="#">CalibratedAges</a> object.                                                                                                                 |
| na.rm    | A <a href="#">logical</a> scalar: should NA values be stripped before the computation proceeds?                                                          |
| ...      | Currently not used.                                                                                                                                      |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). If NULL, <i>rata die</i> are returned. |

## Value

A [numeric](#) vector.

## Author(s)

N. Frerebeau

## See Also

Other statistics: [interval\\_credible](#), [interval\\_hdr](#), [median\(\)](#), [quantile\(\)](#), [radialplot\(\)](#)

## Examples

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Statistics
quantile(cal)
median(cal)
```

```

mean(cal)

## Plot
plot(cal, calendar = CE())

## Need to set 'calendar'
abline(v = median(cal, calendar = CE()), lty = 2, col = "blue")
abline(v = mean(cal, calendar = CE()), lty = 2, col = "red")

```

---

|        |               |
|--------|---------------|
| median | <i>Median</i> |
|--------|---------------|

---

## Description

Median

## Usage

```

## S4 method for signature 'CalibratedAges'
median(x, na.rm = FALSE, ..., calendar = get_calendar())

```

## Arguments

|                       |                                                                                                                                                          |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>x</code>        | A <a href="#">CalibratedAges</a> object.                                                                                                                 |
| <code>na.rm</code>    | A <a href="#">logical</a> scalar: should NA values be stripped before the computation proceeds?                                                          |
| <code>...</code>      | Currently not used.                                                                                                                                      |
| <code>calendar</code> | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). If NULL, <i>rata die</i> are returned. |

## Value

A [numeric](#) vector.

## Author(s)

N. Frerebeau

## See Also

Other statistics: [interval\\_credible](#), [interval\\_hdr](#), [mean\(\)](#), [quantile\(\)](#), [radialplot\(\)](#)

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Statistics
quantile(cal)
median(cal)
mean(cal)

## Plot
plot(cal, calendar = CE())

## Need to set 'calendar'
abline(v = median(cal, calendar = CE()), lty = 2, col = "blue")
abline(v = mean(cal, calendar = CE()), lty = 2, col = "red")
```

---

mutators

*Get or Set Parts of an Object*

---

**Description**

Getters and setters to extract or replace parts of an object.

**Arguments**

|       |                                                |
|-------|------------------------------------------------|
| x     | An object from which to get or set element(s). |
| value | A possible value for the element(s) of x.      |

**Value**

An object of the same sort as x with the new values assigned.

**Author(s)**

N. Frerebeau

**See Also**

Other mutators: [labels\(\)](#)

---

pb\_age

*Geological Model Age from Lead Isotope Analysis*


---

**Description**

Compute geological model age (T) and U/Pb ( $\mu$ ) and Th/U ( $\kappa$ ) ratios from lead isotopic measurements.

**Usage**

```
pb_age(x, y, z, ...)
```

```
## S4 method for signature 'numeric,numeric,numeric'
```

```
pb_age(
  x,
  y,
  z,
  t0 = 3.8,
  x_star = 18.75,
  y_star = 15.63,
  z_star = 38.86,
  mu = 9.66,
  kappa = 3.9,
  th232 = 0.049475,
  u238 = 0.155125,
  u235 = 0.98485,
  u238_235 = 137.79,
  tolerance = sqrt(.Machine$double.eps),
  stop = 100
)
```

```
## S4 method for signature 'list,missing,missing'
```

```
pb_age(
  x,
  t0 = 3.8,
  x_star = 18.75,
  y_star = 15.63,
  z_star = 38.86,
  mu = 9.66,
  kappa = 3.9,
  th232 = 0.049475,
  u238 = 0.155125,
  u235 = 0.98485,
  u238_235 = 137.79,
  tolerance = sqrt(.Machine$double.eps),
  stop = 100
)
```

**Arguments**

|           |                                                                                                                                                                      |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x         | A <b>numeric</b> vector of 206Pb/204Pb ratios. If y and z are missing, must be a <b>list</b> (or a <b>data.frame</b> ) with numeric components (columns) x, y and z. |
| y         | A <b>numeric</b> vector of 207Pb/204Pb ratios. If missing, an attempt is made to interpret x in a suitable way.                                                      |
| z         | A <b>numeric</b> vector of 208Pb/204Pb ratios. If missing, an attempt is made to interpret x in a suitable way.                                                      |
| ...       | Currently not used.                                                                                                                                                  |
| t0        | A <b>numeric</b> value giving the time of the second stage of the reference model.                                                                                   |
| x_star    | A <b>numeric</b> value giving the 206Pb/204Pb ratio at $t = 0$ .                                                                                                     |
| y_star    | A <b>numeric</b> value giving the 207Pb/204Pb ratio at $t = 0$ .                                                                                                     |
| z_star    | A <b>numeric</b> value giving the 208Pb/204Pb ratio at $t = 0$ .                                                                                                     |
| mu        | A <b>numeric</b> value giving the 238U/204Pb ratio of the reference model.                                                                                           |
| kappa     | A <b>numeric</b> value giving the 232Th/238U ratio of the reference model.                                                                                           |
| th232     | A <b>numeric</b> value giving the decay constants of 232Th.                                                                                                          |
| u238      | A <b>numeric</b> value giving the decay constants of 238U.                                                                                                           |
| u235      | A <b>numeric</b> value giving the decay constants of 235U.                                                                                                           |
| u238_235  | A <b>numeric</b> value giving the actual 238U/235U ratio.                                                                                                            |
| tolerance | A <b>numeric</b> value specifying the tolerance (stopping criteria for the Newton–Raphson method).                                                                   |
| stop      | An <b>integer</b> giving the stopping rule (i.e. maximum number of iterations) to avoid infinite loop.                                                               |

**Value**

A four columns **data.frame**:

age Geological model age (in Ma).

mu 238U/204Pb ratio.

kappa 232Th/238U ratio.

residual Newton loop residual.

**Note**

Reference values from Albarede & Juteau (1984).

**Author(s)**

N. Frerebeau, F. Albarede (original Matlab code)

## References

- Albarède, F., Desaulty, A.-M. & Blichert-Toft, J. (2012). A Geological Perspective on the Use of Pb Isotopes in Archaeometry. *Archaeometry*, 54: 853-867. doi:10.1111/j.14754754.2011.00653.x.
- Albarède, F. & Juteau, M. (1984). Unscrambling the Lead Model Ages. *Geochimica et Cosmochimica Acta*, 48(1): 207-12. doi:10.1016/00167037(84)903648.
- Allègre, C. (2005). *Géologie isotopique*. Belin sup. Paris: Belin.

## Examples

```
Pb <- data.frame(
  x = c(18.23247, 18.22936, 18.23102), # Pb206/Pb204
  y = c(15.65199, 15.65216, 15.65097), # Pb207/Pb204
  z = c(38.5167, 38.51516, 38.51601) # Pb208/Pb204
)

## Default reference values from Albarede & Juteau (1984)
pb_age(
  Pb,
  t0 = 3.8,
  x_star = 18.75, y_star = 15.63, z_star = 38.86,
  mu = 9.66, kappa = 3.90, th232 = 0.049475,
  u238 = 0.155125, u235 = 0.98485, u238_235 = 137.79
)

## Reference values from Albarede et al. (2012)
pb_age(
  Pb,
  t0 = 4.43,
  x_star = 18.75, y_star = 15.63, z_star = 38.83,
  mu = 9.66, kappa = 3.90, th232 = 0.049475,
  u238 = 0.155125, u235 = 0.98485, u238_235 = 137.79
)
```

---

proxy\_ensemble

*Layer-Counted Proxy Records Uncertainties*

---

## Description

Represents layer-counted proxy records as sequences of probability distributions on absolute, error-free time axes.

## Usage

```
proxy_ensemble(positions, ...)

## S4 method for signature 'numeric'
proxy_ensemble(
  positions,
```

```

    proxy_values,
    proxy_errors,
    proxy_step,
    time_values,
    time_errors,
    calendar,
    from = NULL,
    to = NULL,
    by = NULL,
    n = 30,
    progress = getOption("ananke.progress"),
    verbose = getOption("ananke.verbose")
)

```

### Arguments

|              |                                                                                                                                                                                                                                                                                              |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| positions    | A positive <a href="#">numeric</a> vector giving the positions (e.g. depths) at which proxy values and calendar ages were measured. In the case of layers of non-zero thickness, this should be the middle value of the slice. It must be in decreasing order (i.e. in chronological order). |
| ...          | Currently not used.                                                                                                                                                                                                                                                                          |
| proxy_values | A <a href="#">numeric</a> vector giving the proxy values.                                                                                                                                                                                                                                    |
| proxy_errors | A <a href="#">numeric</a> vector giving the proxy uncertainties.                                                                                                                                                                                                                             |
| proxy_step   | A length-one <a href="#">numeric</a> vector specifying the step size (in units of proxy_values) at which proxy records densities are to be estimated.                                                                                                                                        |
| time_values  | A <a href="#">numeric</a> vector giving the calendar ages (in years).                                                                                                                                                                                                                        |
| time_errors  | A <a href="#">numeric</a> vector giving the calendar age uncertainties (in years).                                                                                                                                                                                                           |
| calendar     | An <a href="#">aion::TimeScale</a> object specifying the calendar of time (see <a href="#">aion::calendar()</a> ).                                                                                                                                                                           |
| from         | A length-one <a href="#">numeric</a> vector specifying the starting value of the temporal sequence at which densities are to be estimated (in years).                                                                                                                                        |
| to           | A length-one <a href="#">numeric</a> vector specifying the end value of the temporal sequence at which densities are to be estimated (in cal BP years).                                                                                                                                      |
| by           | A length-one <a href="#">numeric</a> vector specifying the increment of the temporal sequence at which densities are to be estimated (in years).                                                                                                                                             |
| n            | An <a href="#">integer</a> specifying the number of item to choose randomly.                                                                                                                                                                                                                 |
| progress     | A <a href="#">logical</a> scalar: should a progress bar be displayed?                                                                                                                                                                                                                        |
| verbose      | A <a href="#">logical</a> scalar: should extra information be reported?                                                                                                                                                                                                                      |

### Value

A [ProxyRecord](#) object.

### Note

This function is currently *experimental*.

**Author(s)**

N. Frerebeau

**References**

Boers, N., Goswami, B. & Ghil, M. (2017). A Complete Representation of Uncertainties in Layer-Counted Paleoclimatic Archives. *Climate of the Past*, 13(9): 1169-1180. doi:10.5194/cp131169-2017.

**See Also**

Other proxy tools: [proxy\\_plot](#)

**Examples**

```
## Get NGRIP records
data("ngrip2010", package = "folio")
ngrip2010 <- subset(ngrip2010, !is.na(MCE))
ngrip2010 <- ngrip2010[nrow(ngrip2010):1, ] # Sort in chronological order

## Replicate fig. 3d from Boers et al. (2017)
## !\ This may take a while... /\
ngrip_record <- proxy_ensemble(
  positions = ngrip2010$depth,
  proxy_values = ngrip2010$delta,
  proxy_errors = 0.01,
  proxy_step = 0.01,
  time_values = ngrip2010$age,
  time_errors = ngrip2010$MCE,
  calendar = b2k(), # !\
  by = 20,
  n = 30
)

plot(ngrip_record)
```

---

proxy\_plot

*Plot Layer-Counted Proxy Records Uncertainties*

---

**Description**

Plot Layer-Counted Proxy Records Uncertainties

**Usage**

```
## S4 method for signature 'ProxyRecord,missing'
plot(
  x,
  calendar = get_calendar(),
  iqr = TRUE,
  xlab = NULL,
  ylab = NULL,
  col = grDevices::hcl.colors(12, "YlOrRd", rev = TRUE),
  col.mean = "black",
  col.iqr = col.mean,
  lty.mean = 1,
  lty.iqr = 3,
  lwd.mean = 2,
  lwd.iqr = lwd.mean,
  ...
)
```

**Arguments**

|                   |                                                                                                                                                          |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| x                 | A <a href="#">ProxyRecord</a> object.                                                                                                                    |
| calendar          | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). If NULL, <i>rata die</i> are returned. |
| iqr               | A <a href="#">logical</a> scalar: should the mean and IQR be displayed?                                                                                  |
| xlab, ylab        | A <a href="#">character</a> string giving a label for the x and y axis.                                                                                  |
| col               | A list of colors such as that generated by <a href="#">grDevices::hcl.colors()</a> .                                                                     |
| col.mean, col.iqr | A specification for the line colors. Only used if iqr is TRUE.                                                                                           |
| lty.mean, lty.iqr | A specification for the line types. Only used if iqr is TRUE.                                                                                            |
| lwd.mean, lwd.iqr | A specification for the line widths. Only used if iqr is TRUE.                                                                                           |
| ...               | Further parameters to be passed to <a href="#">graphics::image()</a> .                                                                                   |

**Value**

`plot()` is called it for its side-effects: it results in a graphic being displayed. Invisibly returns x.

**Author(s)**

N. Frerebeau

**See Also**

Other proxy tools: [proxy\\_ensemble\(\)](#)

## Examples

```
## Get NGRIP records
data("ngrip2010", package = "folio")
ngrip2010 <- subset(ngrip2010, !is.na(MCE))
ngrip2010 <- ngrip2010[nrow(ngrip2010):1, ] # Sort in chronological order

## Replicate fig. 3d from Boers et al. (2017)
## /\ This may take a while... /\
ngrip_record <- proxy_ensemble(
  positions = ngrip2010$depth,
  proxy_values = ngrip2010$delta,
  proxy_errors = 0.01,
  proxy_step = 0.01,
  time_values = ngrip2010$age,
  time_errors = ngrip2010$MCE,
  calendar = b2k(), # /\
  by = 20,
  n = 30
)

plot(ngrip_record)
```

---

quantile

*Quantiles of a Density Estimate*


---

## Description

Quantiles of a Density Estimate

## Usage

```
## S4 method for signature 'CalibratedAges'
quantile(
  x,
  probs = seq(0, 1, 0.25),
  na.rm = FALSE,
  ...,
  calendar = get_calendar()
)

## S4 method for signature 'ProxyRecord'
quantile(x, probs = seq(0, 1, 0.25), na.rm = FALSE, ...)
```

## Arguments

|       |                                                                             |
|-------|-----------------------------------------------------------------------------|
| x     | A <a href="#">CalibratedAges</a> object.                                    |
| probs | A <a href="#">numeric</a> vector of probabilities with values in $[0, 1]$ . |

|          |                                                                                                                                                          |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| na.rm    | A <a href="#">logical</a> scalar: should NA values be stripped before the computation proceeds?                                                          |
| ...      | Currently not used.                                                                                                                                      |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). If NULL, <i>rata die</i> are returned. |

**Value**

A numeric [matrix](#) containing the quantiles.

**Author(s)**

N. Frerebeau

**See Also**

Other statistics: [interval\\_credible](#), [interval\\_hdr](#), [mean\(\)](#), [median\(\)](#), [radialplot\(\)](#)

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Statistics
quantile(cal)
median(cal)
mean(cal)

## Plot
plot(cal, calendar = CE())

## Need to set 'calendar'
abline(v = median(cal, calendar = CE()), lty = 2, col = "blue")
abline(v = mean(cal, calendar = CE()), lty = 2, col = "red")
```

---

radialplot

*Radial Plot*


---

**Description**

Radial Plot

**Usage**

```
radialplot(values, errors, ...)

## S4 method for signature 'numeric,numeric'
radialplot(
  values,
  errors,
  log = TRUE,
  centrality = c("weighted.mean", "mean", "median"),
  bar = FALSE,
  grid = TRUE,
  main = NULL,
  sub = NULL,
  ann = graphics::par("ann"),
  ...
)

## S4 method for signature 'CalibratedAges,missing'
radialplot(
  values,
  log = TRUE,
  centrality = c("weighted.mean", "mean", "median"),
  bar = FALSE,
  grid = TRUE,
  main = NULL,
  sub = NULL,
  ann = graphics::par("ann"),
  ...
)
```

**Arguments**

|            |                                                                                                                                                                                                                  |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| values     | A <a href="#">numeric</a> vector giving the BP ages or F14C values to be calibrated (conventional ages) or a <a href="#">CalibratedAges</a> object.                                                              |
| errors     | A <a href="#">numeric</a> vector giving the errors associated to the values to be calibrated.                                                                                                                    |
| ...        | Further graphical parameters to be passed to <a href="#">graphics::points()</a> .                                                                                                                                |
| log        | A <a href="#">logical</a> scalar: should the z-axis be displayed in logarithmic scale?                                                                                                                           |
| centrality | A <a href="#">character</a> string specifying a measure of centrality, used for centering the plot. It must be one of "weighted.mean" (the default), "mean" or "median". Any unambiguous substring can be given. |
| bar        | A <a href="#">logical</a> scalar: should a bar showing the 2-sigma range around the central value be displayed?                                                                                                  |
| grid       | A <a href="#">logical</a> scalar: should a grid (originating at [0,0] and stretching to the z-scale) be displayed?                                                                                               |
| main       | A <a href="#">character</a> string giving a main title for the plot.                                                                                                                                             |
| sub        | A <a href="#">character</a> string giving a subtitle for the plot.                                                                                                                                               |

ann                    A [logical](#) scalar: should the default annotation (title and x and y labels) appear on the plot?

### Value

radialplot() is called it for its side-effects: it results in a graphic being displayed.

### Author(s)

N. Frerebeau

### References

- Galbraith, Rex F. (1988). Graphical Display of Estimates Having Differing Standard Errors. *Technometrics*, 30(3): 271-281. doi:[10.1080/00401706.1988.10488400](#).
- Galbraith, Rex F. (1990). The Radial Plot: Graphical Assessment of Spread in Ages. *International Journal of Radiation Applications and Instrumentation. Part D. Nuclear Tracks and Radiation Measurements*, 17(3): 207-214. doi:[10.1016/13590189\(90\)90036W](#).
- Galbraith, Rex F. (1994). Some Applications of Radial Plots. *Journal of the American Statistical Association*, 89(428): 1232-1242. doi:[10.1080/01621459.1994.10476864](#).

### See Also

Other statistics: [interval\\_credible](#), [interval\\_hdr](#), [mean\(\)](#), [median\(\)](#), [quantile\(\)](#)

### Examples

```
## Data from Bosch et al. 2015
data("ksarakil")

## Radialplot
radialplot(ksarakil$date, ksarakil$error, pch = 16)

## Linear z-scale
radialplot(ksarakil$date, ksarakil$error, log = FALSE, pch = 16)
```

---

rec\_plot

*Plot a Radiocarbon Event Count Ensemble*

---

### Description

Plot a Radiocarbon Event Count Ensemble

### Usage

```
## S4 method for signature 'RECE,missing'
plot(x, calendar = get_calendar(), ...)
```

## Arguments

|          |                                                                                                                                                          |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| x        | An <a href="#">RECE</a> object.                                                                                                                          |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). If NULL, <i>rata die</i> are returned. |
| ...      | Further parameters to be passed to <a href="#">graphics::image()</a> .                                                                                   |

## Value

`plot()` is called it for its side-effects: it results in a graphic being displayed (invisibly returns x).

## Author(s)

N. Frerebeau

## References

Carleton, W. C. (2021). Evaluating Bayesian Radiocarbon-dated Event Count (REC) Models for the Study of Long-term Human and Environmental Processes. *Journal of Quaternary Science*, 36(1): 110-23. doi:[10.1002/jqs.3256](#).

## See Also

Other radiocarbon tools: [F14C](#), [c14\\_calibrate\(\)](#), [c14\\_combine\(\)](#), [c14\\_count\(\)](#), [c14\\_curve\(\)](#), [c14\\_plot](#), [c14\\_sample\(\)](#), [c14\\_spd\(\)](#), [c14\\_uncalibrate\(\)](#), [ridgelines\(\)](#)

## Examples

```
## Radiocarbon data from Bosch et al. 2015
data("ksarakil")

## Calibrate
cal <- c14_calibrate(
  values = ksarakil$date,
  errors = ksarakil$error,
  names = ksarakil$code,
  curves = "marine13",
  reservoir_offsets = 53,
  reservoir_errors = 43,
  from = 50000, to = 0
)

## RECE
tmp <- c14_count(cal, n = 500)
plot(tmp, col = grDevices::hcl.colors(12, "Viridis", rev = TRUE))
```

ridgelines

*Ridgeline Plot of Calibrated Radiocarbon Ages***Description**

Ridgeline Plot of Calibrated Radiocarbon Ages

**Usage**

```
ridgelines(x, ...)

## S4 method for signature 'CalibratedAges'
ridgelines(
  x,
  calendar = get_calendar(),
  interval = c("hdr", "credible"),
  level = 0.954,
  fixed = TRUE,
  decreasing = FALSE,
  col = "grey",
  ...
)
```

**Arguments**

|                         |                                                                                                                                                                                                                                                 |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>x</code>          | A <a href="#">CalibratedAges</a> or <a href="#">CalibratedSPD</a> object.                                                                                                                                                                       |
| <code>...</code>        | Further parameters to be passed to <a href="#">aion::plot()</a> .                                                                                                                                                                               |
| <code>calendar</code>   | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ). If NULL, <i>rata die</i> are returned.                                                                                        |
| <code>interval</code>   | A <a href="#">character</a> string specifying the intervals to be drawn. It must be one of "hrd" (the default) or "credible". Any unambiguous substring can be given.                                                                           |
| <code>level</code>      | A length-one <a href="#">numeric</a> vector giving the confidence level. Only used if <code>interval</code> is TRUE.                                                                                                                            |
| <code>fixed</code>      | A <a href="#">logical</a> scalar: should a fixed y scale be used? If TRUE (the default), ages are equally spaced along the y axis and arranged in chronological order. If FALSE, age positions are used (see <a href="#">c14_calibrate()</a> ). |
| <code>decreasing</code> | A <a href="#">logical</a> scalar: should the sort order be decreasing?                                                                                                                                                                          |
| <code>col</code>        | A specification for the plotting colors.                                                                                                                                                                                                        |

**Value**

`ridgelines()` is called it for its side-effects: it results in a graphic being displayed (invisibly returns `x`).

**Author(s)**

N. Frerebeau

**See Also**

Other radiocarbon tools: [F14C](#), [c14\\_calibrate\(\)](#), [c14\\_combine\(\)](#), [c14\\_count\(\)](#), [c14\\_curve\(\)](#), [c14\\_plot](#), [c14\\_sample\(\)](#), [c14\\_spd\(\)](#), [c14\\_uncalibrate\(\)](#), [rec\\_plot](#)

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Ridgelines plot
ridgelines(cal, panel.first = graphics::grid())

## Change colors
ridgelines(cal, col = c("red", "blue"))
```

subset

*Extract or Replace Parts of an Object***Description**

Operators acting on objects to extract or replace parts.

**Usage**

```
## S4 method for signature 'CalibratedAges'
x[i, j, k, drop = FALSE]
```

**Arguments**

|         |                                                                                                                                                                    |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x       | An object from which to extract element(s) or in which to replace element(s).                                                                                      |
| i, j, k | Indices specifying elements to extract or replace.                                                                                                                 |
| drop    | A <a href="#">logical</a> scalar: should the result be coerced to the lowest possible dimension? This only works for extracting elements, not for the replacement. |

**Value**

A subsetted object.

**Author(s)**

N. Frerebeau

---

summary

---

*Object Summaries***Description**

Object Summaries

**Usage**

```
## S4 method for signature 'CalibratedAges'
summary(object, ..., digits = NULL, calendar = get_calendar())
```

**Arguments**

|          |                                                                                                                                                             |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| object   | A <a href="#">CalibratedAges</a> object.                                                                                                                    |
| ...      | Currently not used.                                                                                                                                         |
| digits   | An <a href="#">integer</a> (or NULL) used for number formatting (see <a href="#">base::format()</a> ).                                                      |
| calendar | An <a href="#">aion::TimeScale</a> object specifying the target calendar (see <a href="#">aion::calendar()</a> ).<br>If NULL, <i>rata die</i> are returned. |

**Value**

An object of class [table](#).

**Author(s)**

N. Frerebeau

**See Also**

Other summary: [describe](#)

**Examples**

```
## Calibrate multiple dates
cal <- c14_calibrate(
  values = c(5000, 4500),
  errors = c(45, 35),
  names = c("X", "Y")
)

## Summary
summary(cal, calendar = CE())
```

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