GPC-Radiocarbon-Labor
Physikalisches Institut, Universität Bern
Sidlerstrasse 5, CH-3012 Bern
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www.climate.unibe.ch/c14

Please complete one form for each sample
Please leave this section blank

B- ..... $\delta^{13}C$ ……..‰
Date of receipt: ..... .....y BP ± .....
Analysis number: .....

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Please fill out, circle as appropriate

Sender: ..... Phone: .....
Organisation: ..... Email: .....
Address: .....
.....
National fund proposal: ..... Principal investigator: .....

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Material, e.g. wood (type of wood, if known), peat, charcoal: .....
.....
Weight: ..... grams
Does more material of the same sample exist?
Find spot: ..... m ASL (above sea level)
District: ..... County/Country: .....
Longitude and latitude (or CH coordinates): .....
Type of excavation: ..... Director of excavation: .....
Date of removal: ..... Your sample code: .....

Type of find spot: Cave, moor, grave, hearth, terrace, valley bottom, hilltop, slope, settlement, pit, rampart, trench .....

Add profile sketch with the following specifics:
Plant growth over find spot: meadow, field, forest .....
Depth of sample below surface: .....cm/m
Do roots extend into the sample stratum? yes / no
Type of sediments where the sample originated:
loose rocks, rocky loam, loam, gravel, sand, clay, loess, peat.....
Type of sediments above the find spot:
loose rocks, rocky loam, loam, gravel, sand, clay, loess, peat.....

Can it be assumed with certainty that the sample contains no asphalt, bituminous coal, or similar substances and that the sample was not chemically treated after being unearthed? yes / no

Previous treatments as applicable (e.g. sorted, sifted, dried): .....

Presumed age of the sample: .....
Previous $^{14}C$ analyses related to the sample (laboratory, number) .....
$^{14}C$ age: ..... (younger, older, or same age as the submitted sample?)
Problem this $^{14}C$ dating is expected to solve: .....
.....
Results to be published in: .....

Date: .....Signature: .....

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## Storing Sample Materials

Micro-organisms can decompose or chemically alter sample materials. As micro-organisms are ubiquitous, samples should be stored and packaged in a dry state whenever possible. This prevents distortions of the $^{14}C$ results.

Samples collected under water don't require drying. They should, however, be hermetically sealed to prevent exposure to oxygen.

Wrapped in aluminium foil and enclosed in sealable plastic bags, samples stay protected for many years.

## Minimum sample size (dry weight)

| | |
|---|---|
| Wood, roots: | Ideally more than 10 grams (the size of a finger)<br>Samples of less than 1-2 gram cannot be measured by our proportional counters. |
| Peat: | Ideally 20 grams or more (at least 2 grams) |
| Charcoal: | Ideally 6 grams or more (at least 1 grams, i.e. approximately 2 $cm^3$) |

## Time requirements

The results are available after 2-3 months. Our gas proportional counting tubes are able to determine a maximum age of 57,000 years.

## Traceability

Sample materials may become relevant again after 20 or more years due to new findings. For this reason we keep a sample archive. However, this archive is only useful if every sample we receive is accompanied by a comprehensive sample description (previous page).

## Conditions

| | |
|---|---|
| Express orders (result available after approx. 5 weeks*) | CHF 800.00 per sample + VAT |
| Regular orders (result available after approx. 2-4 months*) | CHF 600.00 per sample + VAT |

(more than 10 samples: 10% discount)

The expenditure of work is approx. 3 working days per sample.

* The counting gas for measuring the radioactivity derived from the sample is stored for 4 weeks in order to allow any radon (which could potentially distort the results) to decay before the actual measurement takes place.

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**Carbon Dating Using the $^{14}C$ Method**

Samples such as wood, charcoal, peat, leaves etc. are first pre-treated in order to remove as much foreign matter as possible and are then oxygenated under hermetically sealed conditions in an $O_2$ stream where they convert to $CO_2$.
Some 15 cm³ STP of the resulting $CO_2$ is extracted and analyzed in a mass spectrometer to determine its percentage of $^{13}C$. The measured $\delta^{13}C$ value indicates the degree of natural and/or laboratory induced shift of isotopic carbon composition, i. e. fractionation. This $^{13}C$ value is representative for the counting gas and does not necessarily indicate the isotopic composition of the original sample.
By adding $H_2$, the bulk of the $CO_2$ into which the sample was converted is catalytically reduced to $CH_4$, which then becomes the filling gas of the proportional counter that determines the $^{14}C$ activity of the sample. The $^{14}C$ activity measured by the counter is compared to the activity of the calibration gas. The depletion of $^{14}C$ in the sample compared to this standard is called **$D^{14}C$** and is expressed in parts per thousand (i. e. per mill). By calculating $D^{14}C$ and normalizing to $\delta^{13}C$ = -25‰, possible fractionations are taken into account.
Based on the $^{14}C$ content of the sample and assuming certain conditions described by Stuiver and Polach in the magazine RADIOCARBON, Vol. 19, No. 3, 1977, pp. 355-363 (a constant $^{14}C$ concentration in the atmosphere, among others), the **conventional radiocarbon age or $^{14}C$ age** of the sample can be calculated. The conventional radiocarbon age is calculated using the **Libby half-life** (5568 years) and is expressed as a rounded number in years before 1950 (years BP (before present)).
As the above mentioned assumptions are only justified under certain conditions, the radiocarbon age is not necessarily identical with the true ("calendar") age of the sample. Using **calibration curves** based on highly precise measurements of tree rings and other absolutely dated samples, it is possible to convert the radiocarbon age into a **calendar age**. However, ambiguities do sometimes occur during this conversion process.
For a discussion of calibration curves please refer to RADIOCARBON, Vol. 35, No. 1, 1993, pp. 215-230, RADIOCARBON, Vol. 46, No. 3, 2004, pp. 1029-1058 (INTCAL04 RADIOCARBON AGE CALIBRATION, 26,000-0 cal BP) and RADIOCARBON, Vol. 51, No. 4, 2009, pp. 1111-1150 and Vol. 55, No. 4, 2013 pp. 1869-1887 (INTCAL09, INTCAL13 Calibration Curves, 0-50'000 Years cal BP). The calibration program is available online or as a download:
www.calib.org or **Oxcal 4.2** https://c14.arch.ox.ac.uk/oxcal.html

Corollary for publishing results:

As the calculation of the true age (calibration) may be further optimized in the future, the conventional age should always be included in published results.

Also required is the laboratory sample number (B-…. for the GPC radiocarbon lab or BE-….. for the AMS lab LARA at the University of Bern). According to an international agreement, each laboratory was assigned a unique identifier. Our identifiers (B or BE numbers) should always be included in publications. They are the link to the original samples in our archives and the complete sample data (coordinates of the find spot etc.)