



André E. Lalonde AMS Laboratory

Radiocarbon Sample Preparation
25 Templeton St., ARC rm 447
Ottawa, ON, K1N 6N5, CANADA

www.ams.uottawa.ca
Email to: radiocarbon@uottawa.ca

GENERAL

Submitter Name:	Affiliation:
Principal Investigator:	Street Address:
Date:	City, Province:
Phone Number:	Postal Code:
Email:	Country:

We are a LOW-BACKGROUND LABORATORY, FREE OF ANY ENRICHED 14C MATERIAL

By submitting this form you warrant that your samples are free of any enriched 14C material. If elevated levels of 14C from these samples or the packaging they are sent in result in contamination of equipment or instrumentation requiring cleanup or replacement, significant charges will be incurred.

I have read and understand the [Terms of Service and Conditions](#). My samples do not contain, nor have been in contact with, enriched 14C.

BILLING Address same as above

Name:	Affiliation:
Phone Number:	Street Address:
Email:	City, Province:
Cost Center or PO:	Postal Code:
Price (if known):	Country:
Check if applicable: <input type="checkbox"/> 10% discount (10 samples or more) <input type="checkbox"/> Training Program (5 sample minimum)	
Method of payment: <input type="checkbox"/> Cheque (preferred) <input type="checkbox"/> Credit card <input type="checkbox"/> Wire Transfer (Additional \$10 fee applies)	
Sector <input type="checkbox"/> Academic <input type="checkbox"/> Public <input type="checkbox"/> Private <input type="checkbox"/> Non-profit <input type="checkbox"/> Internal / OCGC	

Should unused material be returned? \$15 minimum fee Check if Yes

Internal Notes:

PROJECT

Project title:
Country:
Site Name:
Collection date:
Approx. age range: <input type="checkbox"/> Present-AD1955 <input type="checkbox"/> AD1955-1700 <input type="checkbox"/> <15,000 yrs <input type="checkbox"/> 15,000-35,000 yrs <input type="checkbox"/> >35,000 yrs

Treatment (preservatives, filtration, etc), and storage:

Sample significance and any other relevant information (eg. potential contamination, ΔR, % Marine):

DATA REPORTING

For radiocarbon dating, please select **one** option for calibration: No calibration cal AD/BC cal BP

For environmental analysis, please select one or both options for reporting: Δ14C D14C

***Please refer to tabs 2-5 for further information**



SAMPLE LIST

Please contact us about our training program!

Shipping Address:
 Radiocarbon Laboratory
 25 Templeton St., ARC rm447
 Ottawa, ON, K1N 6N5, CANADA

	Lab ID	Submitter ID*	Material*	Material Code*	Dry weight	%C or ppmC	Comments
	<i>leave blank</i>	<i>20 characters max.</i>	<i>bone, shell, charcoal, etc</i>	<i>See tab 3</i>	<i>or volume</i>	<i>if known</i>	<i>any information relevant to this sample specifically.</i>
1	<i>leave blank</i>						
2	<i>leave blank</i>						
3	<i>leave blank</i>						
4	<i>leave blank</i>						
5	<i>leave blank</i>						
6	<i>leave blank</i>						
7	<i>leave blank</i>						
8	<i>leave blank</i>						
9	<i>leave blank</i>						
10	<i>leave blank</i>						
11	<i>leave blank</i>						
12	<i>leave blank</i>						

**essential information*

Unless specified otherwise, the entire sample will be used.

Please email radiocarbon@uottawa.ca if you have any questions or are unsure about which media code to use.



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	Lab ID	Submitter ID*	Material*	Material Code*	Dry weight	%C or ppmC	Comments
13	leave blank						
14	leave blank						
15	leave blank						
16	leave blank						
17	leave blank						
18	leave blank						
19	leave blank						
20	leave blank						
21	leave blank						
22	leave blank						
23	leave blank						
24	leave blank						

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	Lab ID	Submitter ID*	Material*	Material Code*	Dry weight	%C or ppmC	Comments
25	<i>leave blank</i>						
26	<i>leave blank</i>						
27	<i>leave blank</i>						
28	<i>leave blank</i>						
29	<i>leave blank</i>						
30	<i>leave blank</i>						
31	<i>leave blank</i>						
32	<i>leave blank</i>						
33	<i>leave blank</i>						
34	<i>leave blank</i>						
35	<i>leave blank</i>						
36	<i>leave blank</i>						

**essential information*

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MATERIAL CODES

Code		Sample Size		Cost	
		Min	Ideal	Canadian Non-profit	Other
Refined material					
G	Graphite <i>Please contact us first</i>	-	-	\$ 120.00	\$ 170.00
C	CO ₂ known pCO ₂ , purified, 15 cm long x 6 mm OD pyrex	0.5 mgC	1 mgC	\$ 180.00	\$ 250.00
CX	Gas sample <i>requires purification, please contact us</i>	-	-	\$ 210.00	\$ 290.00
D	Direct combustion <i>see materials below for sample size</i>	-	-	\$ 240.00	\$ 330.00
Q	Swipe test ¹ <i>analyzed by liquid scintillation counter</i>	-	-	\$ 50.00	\$ 100.00
Charcoal, wood, peat, organics					
A	Acid wash only (bulk sediment)	300 mg	1-2 g	\$ 300.00	\$ 410.00
AAA	Acid, Alkali, Acid (wood, charcoal, most organics)	10 mg	100 mg	\$ 300.00	\$ 410.00
HA	Humic acid extraction	100 mg	500 mg	\$ 380.00	\$ 530.00
H	Humin fraction	100 mg	500 mg	\$ 380.00	\$ 530.00
HH	Humic/humin on same sample	100 mg	500 mg	\$ 560.00	\$ 710.00
Bone, tooth, antler, ivory					
B	AAA, collagen extraction	500 mg	3-5 g	\$ 425.00	\$ 585.00
BU	AAA, collagen extraction, ultrafiltration ²	500 mg	3-5 g	\$ 450.00	\$ 630.00
CN	δ13C, δ15N ³			\$ 15.00	\$ 20.00
Shells, carbonates					
S	Standard, pre-etch with acid prior to digestion	20 mg	50 mg	\$ 265.00	\$ 370.00
SN	NO pre-etch <i>Recommended for small samples (eg. forams)</i>	10 mg	20 mg	\$ 265.00	\$ 370.00
Water (Freshwater only, 0.45 μm pre-filtered)⁴					
DIC	Dissolved inorganic carbon	500 ml	1000 ml	\$ 300.00	\$ 410.00
DOC	Dissolved organic carbon	500 ml	1000 ml	\$ 380.00	\$ 525.00
DIOC	Both DIC/DOC extraction from same sample	500 ml	1000 ml	\$ 600.00	\$ 835.00
POC	Particulate organic carbon (sent on quartz filters)			\$ 255.00	\$ 350.00
Skin, parchment, leather, hide, textiles, other					
X	Typically AAA, but likely will require consultation	30 mg	200 mg	\$ 300.00	\$ 410.00

Please contact us about our training program!

¹ Please contact us if you are considering sending a **swipe test**.

² **Ultrafiltration** is used to concentrate longer protein molecules and can be used to remove shorter chain proteins more likely to originate from contaminants (e.g. Brown et al., 1988; Bronk Ramsey et al 2004). Please contact us for a consultation prior to selecting ultrafiltration.

³ **GG Hatch stable isotope laboratory**. ONLY for samples submitted for radiocarbon dating.

⁴ **Additional fee applies if concentration determination or filtration is required** (see website for sampling guidelines).

Extraction premium may apply for low concentration samples, please contact us first if your sample has <1ppmC.

If **carbon content** is known from a previous analysis, please include with sample list. This is especially valuable information for material such as bulk sediment, which can have a wide range of carbon content.

We offer a **10% discount** on quantities greater than or equal to 10 for non-profit samples.

References

Brown, T.A., Nelson, D.E., Vogel, J.S., Southon, J.R., 1988. Improved collagen extraction by modified Longin method. *Radiocarbon*, 30, 171-177.
Bronk Ramsey, C., Higham, T., Bowles, A., Hedges, R., 2004. Improvements to the pre-treatment of bone at Oxford. *Radiocarbon*, 46, 155-163.

TERMS OF SERVICE

1. We are a LOW-BACKGROUND LABORATORY, free of any ENRICHED 14C MATERIAL. By submitting this form you warrant that your samples are free of any enriched 14C material. If elevated levels of 14C from these samples or the packaging they are sent in result in contamination of equipment or instrumentation requiring cleanup or replacement, **significant charges will be incurred.**

2. Submission: Please fill out the Cover Sheet (Tab 1) and Sample List (Tab 2) to the best of your ability. Send an electronic copy of this submission form to radiocarbon@uottawa.ca **prior to shipping your samples.** Please also include a hard copy of the submission form with your samples. For more information on sample submission and shipping, please see our website:

<http://ams.uottawa.ca/Radiocarbon/SampleSubmission.html>

3. Liability: The University of Ottawa specifically disclaims liability for any and all direct, indirect, special, consequential, exemplary or punitive damages, including but not limited to any interruption of business or lost profits arising out of or inability to use any product or service provided by the University of Ottawa. The University of Ottawa makes no warranties, express or implied, with respect to the product or service, including but not limited to any warranty or merchantability or fitness for any particular purpose or against infringement.

4. Ownership: Samples are not the property of the University of Ottawa and we assume no responsibility for any loss or damage to the samples. Unless specified that the samples are to be returned to the client, samples will be held for a period of six (6) months, after which time they will be discarded. A minimum fee of \$15 will be applied to return shipment; larger return shipments will be the responsibility of the client.

5. Pricing, invoicing, and terms of payment: The pricing schedule (Canadian non-profit or Other) is assigned based on the billing address listed on the cover sheet of this submission form and the pricing posted on our website at the time of submission. "Canadian Non-profit" is defined as Canadian academic institution, Canadian Government agency, Registered Canadian non-profit organization, or Canadian Indigenous Group. For non-profit users, an invoice is issued upon delivery of the the results, and payment is required withing 30 days. For Other users (Canadian commercial users, and non-Canadian users), payment is required prior to releasing results. A purchase order is required for for submissions over \$5,000.

6. Results: Upon successful completing of the analysis, we will provide the client with the results using the email address provided in this submission form. Results will not be released to any third party not listed on the submission form unless permission is granted by the original submitter.

7. Unforeseen Events/Force Majeure: We will not be liable or responsible for any failure to perform, or delay in performance, caused by events outside reasonable control.

8. Discounts: A 10% discount will be applied to a single submission of 10 samples or more, or a cumulative project of 10 samples or more where all 10 samples are processed at the same time (same accelerator run, or "wheel"). For fully trained outside users processing samples at the AEL-AMS laboratory, a 20% discount will be applied at the discretion of AEL-AMS staff.

DATA REPORTING

1. Sample Processing

Sample pretreatment techniques and definitions of media codes can be found in Crann et al. (2017). For more information about the equipment used for sample preparation, please see St-Jean et al. (2017). Both manuscripts can be found at www.ams.uottawa.ca/Research

2. Radiocarbon Analysis. Radiocarbon analyses are performed on a 3MV accelerator mass spectrometer (AMS) built by High Voltage Engineering. ^{12}C , ^{13}C , $^{14}\text{C}+^3\text{He}$ ions are measured at 2.5 MV terminal voltage with Ar stripping. The fraction modern carbon, $F_{14\text{C}}$, is calculated according to Reimer et al. (2004) as the ratio of the sample $^{14}\text{C}/^{12}\text{C}$ to the standard $^{14}\text{C}/^{12}\text{C}$ (Ox-II) measured in the same data block. Both $^{14}\text{C}/^{12}\text{C}$ ratios are background-corrected and the result is corrected for spectrometer and preparation fractionation using the AMS measured $^{13}\text{C}/^{12}\text{C}$ ratio and is normalized to $\delta^{13}\text{C}$ (PDB). Radiocarbon ages are calculated as $-8033\ln(F_{14\text{C}})$ and reported in ^{14}C yr BP (BP=AD 1950) as described by Stuiver and Polach (1977). Errors on ^{14}C ages (1σ) are based on counting statistics and $^{14}\text{C}/^{12}\text{C}$ and $^{13}\text{C}/^{12}\text{C}$ variation between data blocks. $\Delta^{14}\text{C}$ (defined as per mil Depletion or Enrichment Relative to Standard Normalized for Isotope Fractionation) is calculated as $(F_{14\text{C}} - 1) \cdot 1000$. $\Delta^{14}\text{C}$ (defined as age corrected $\Delta^{14}\text{C}$) is calculated as $(F_{14\text{C}} \cdot e^{(1950-y)/8267} - 1) \cdot 1000$, where y = year of measurement.

3. Reporting of Data. In the analysis report, we have followed the conventions recommended by Millard (2014). An analysis report will include the $F_{14\text{C}}$, and uncalibrated age in the units of yr BP ("years before present", present = AD1950). We do not report $\delta^{13}\text{C}$ because it is not measured by Isotope Ratio Mass Spectrometry (IRMS). A $\delta^{13}\text{C}$ measured by an accelerator mass spectrometer (AMS) includes both natural and machine fractionation and is used as a fractionation correction of a radiocarbon age (see Section 2), and therefore should not be used for dietary or environmental inference. We report $\Delta^{14}\text{C}$ and $\Delta^{14}\text{C}$ only when requested by the submitter.

4. Calibration. Calibration is performed using OxCal v4.2.4 (Bronk Ramsey, 2009). Calibrated results are given as a range (or ranges) with an associated probability, as point estimates (mean, median) cannot represent the uncertainties involved (Millard, 2014). We acknowledge that point estimates are often desired and are thus included on the calibration plots in the Appendix, but we recommend that data tables used in publication maintain calibrated age ranges. Where the **$F_{14\text{C}}$ is less than 1 (older than AD1955)**, the IntCal13 calibration curve is used for Northern Hemisphere samples (Reimer et al., 2013) and ShCal13 for Southern Hemisphere samples (Hogg et al., 2013). For samples with an **$F_{14\text{C}}$ greater than 1 (younger than AD1955)**, the post-bomb atmospheric curve is used with an appropriate geographic zone selected (Hua et al., 2013). Post-bomb samples have two age ranges due to calibration on both sides of the bomb pulse. Samples that calibrate **between the 1700's and early 1950's** will always result in a calibrated age range covering the majority of this period. This is due to the "Seuss Effect", which is a flat portion of the calibration curve caused by the burning of fossil fuels and a Maunder Minimum. For **marine samples**, the Marine13 calibration curve is used with the appropriate marine reservoir correction (Reimer et al., 2013). A marine reservoir correction is applied following coordinates provided by the client in the submission file. ΔR values (regional difference from the average global marine reservoir correction) are provided by the client, or determined using 14CHRONO Queen's University Belfast marine reservoir correction database (<http://radiocarbon.pa.qub.ac.uk/marine>), and incorporated into the calibrated dates. Marine samples with Radiocarbon ages minus ΔR that is less than 460 ^{14}C yr BP should not be calibrated due to high atmospheric ^{14}C levels from nuclear weapons testing (Reimer et al. 2004).

5. References. Bronk Ramsey C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51: 337–360. Crann CA, Murseli S, St-Jean G, Zhao X, Clark ID, Kieser WE. 2017. First status report on radiocarbon sample preparation at the A.E. Lalonde AMS Laboratory (Ottawa, Canada). *Radiocarbon* 59(3): 695–704. <http://doi.org/10.1017/RDC.2016.55> Hogg A, Hua Q, Blackwell PG, Niu M, Buck CE, Guilderson TP, Heaton TJ, Palmer JG, Reimer PJ, Reimer RW, Turney CS, Zimmerman SRH. 2013. SHCal13 Southern Hemisphere Calibration, 0–50,000 Years cal BP. *Radiocarbon* 55(4): 1889–1903. Hua Q, Barbetti M, Rakowski AZ. 2013. Atmospheric radiocarbon for the period 1950–2010. *Radiocarbon* 55(4): 2059–2072. Millard A. 2014. Conventions for reporting radiocarbon determinations. *Radiocarbon* 56(2): 555–559. Reimer PJ, Bard E, Bayliss A, Beck JW, Blackwell PG, Bronk Ramsey C, Buck CE, Cheng H, Edwards RL, Friedrich M, Grootes PM, Guilderson TP, Hafliadason H, Hajdas I, Hatté C, Heaton TJ, Hogg AG, Hughen KA, Kaiser KF, Kromer B, Manning SW, Niu M, Reimer RW, Richards DA, Scott EM, Southon JR, Turney CSM, van der Plicht J. 2013. IntCal13 and MARINE13 radiocarbon age calibration curves 0–50000 years calBP. *Radiocarbon* 55(4): 1869–1887. St-Jean G, Kieser WE, Crann CA, Murseli S. 2017. Semi-automated equipment for CO₂ purification and graphitization at the A.E. Lalonde AMS Laboratory (Canada). *Radiocarbon* 59(3): 941–956. <https://doi.org/10.1017/RDC.2016.57> Stuiver M, Polach HA. 1977. Discussion: reporting of ^{14}C data. *Radiocarbon* 19(3):355–63.