Supplement of Geochronology, 5, 229–240, 2023
https://doi.org/10.5194/gchron-5-229-2023-supplement

Supplement of

Ultra-distal tephra deposits and Bayesian modelling constrain a variable marine radiocarbon offset in Placentia Bay, Newfoundland

Alistair J. Monteath et al.

Correspondence to: Alistair J. Monteath (a.j.monteath@soton.ac.uk) and Matthew S. M. Bolton (bolton1@ualberta.ca)

1. Supplementary text: Oxcal code

The complete code for the Placentia Bay age models, Model I and Model II, follows. All models were developed using Oxcal v.4.4.4 (Bronk Ramsey, 2009). The main difference between Model I and II is that Model I includes only a single "Delta_R" calculation for the whole core, while Model II models independent Delta_Rs for each radiocarbon date, and the chronology is constrained by two tephra ages; Mazama Ash, and White River Asheastern lobe. Secondarily, Model II includes a slightly reduced interpolation rate, given its added complexity. Both models produced outputs at 1 mm depth resolution.

1.1 Model I

```
// Delta_R values updated for Marine20
 Options()
 {
  Curve="marine20.14c";
 };
 Plot()
 {
  Delta_R("Whole-core Delta",N(-29,56));
  P_Sequence("Placentia Marine20 Model",1,10,U(-2,2))
  {
   Boundary();
   R_Date("AAR-12117",9521,86)
   {
    z=457.5;
   };
   R_Date("AAR-15768",8905,70)
   {
    z=392.5;
   };
   R_Date("AAR-15767",8072,73)
   {
    z=284.5;
   };
   R_Date("AAR-17062",7199,73)
   {
    z=195.5;
   };
   R_Date("AAR-15766",6730,69)
   {
```

```
 z=174.5;
 };
 R_Date("AAR-17061",5979,70)
 {
 z=146.5;
 };
 R_Date("AAR-15765",4821,67)
 {
 z=116;
 };
 R_Date("AAR-17060",3993,66)
 {
 z=77;
 };
 R_Date("AAR-15764",1306,70)
 {
 z=34.5;
 };
 Date("Core top", Exp("exponential decay", 50 , 1007.7, 2007.7))
 {
 z=0;
 };
 Boundary();
 };
};
```

1.2 Model II

```
// Delta_R values updated for Marine20
Options()
{
 Curve="marine20.14c";
};
Plot()
{
 P_Sequence("Placentia Marine20 Model",1,1,U(-2,2))
 {
 Boundary();
 Delta_R("D1",N(-29,224));
 R_Date("AAR-12117",9521,86)
 {
 z=457.5;
```

```
};
Delta_R("D2",N(-29,224));
R_Date("AAR-15768",8905,70)
{
 z=392.5;
};
Delta_R("D3",N(-29,224));
R_Date("AAR-15767",8072,73)
{
 z=284.5;
};
Delta_R("D4",N(-29,224));
R_Date("AAR-17062",7199,73)
{
 z=195.5;
};
Calculate("Mazama","+")
{
 Date("MazamaAge", N(calBP(7572), 18));
 U("MazamaUncertainty",-53,53);
 z=192.5;
};
Delta_R("D5",N(-29,224));
R_Date("AAR-15766",6730,69)
{
 z=174.5;
};
Delta_R("D6",N(-29,224));
R_Date("AAR-17061",5979,70)
{
 z=146.5;
};
Delta_R("D7",N(-29,224));
R_Date("AAR-15765",4821,67)
{
 z=116;
};
Delta_R("D8",N(-29,224));
R_Date("AAR-17060",3993,66)
{
 z=77;
};
```

```
Delta_R("D9",U(-1000,1000));
R_Date("AAR-15764",1306,70)
{
 z=34.5;
};
Calculate("WRAe","+")
{
 Date("WRAeAge", N(calBP(1098), 1));
 U("WRAeUncertainty",-44,44);
 z=32.5;
};
Date("Core top", Exp("test exp", 50 , 1007.7, 2007.7))
{
 z=0;
};
Boundary();
};
};
```

1.2 Similarity coefficient formula

The similarity coefficient formula (Borchardt et al., 1972) used to compare glass electron microprobe analyses (EPMA) from cryptotephra deposits in Core AI07-10G is detailed below.

$$d_{(A,B)} = \frac{\sum_{i=1}^{n} R_1}{n}$$

$d_{(A,B)}$ = similarity coefficient for comparison between sample *A* and sample *B*.
i = element number
n = number of elements
Ri = X_{iA}/X_{iB}, if $X_{iB} \geq X_{iA}$
Ri = X_{iB}/X_{iA} if $X_{iA} > X_{iB}$
Xi = concentration of element i in sample *A*
Xi = concentration of element i in sample *B*.

1.3 Details for compositional principal component analysis

Principal Component Analysis (PCA) for compositional data was conducted according to the approach of Filmoser et al. (2018). First, data were pre-processed using the "impCoda" function from the "robCompositions" package (Templ et al., 2011) to address missing values in the input data (here, zeros). This function initialized the missing values based on K-nearest neighbours (k=5). Then iterative least-trimmed squares regression was used to refine the estimates for the zero values. On this pre-processed result, we used the "pcaCoDa" function from the same package to run principal component analysis on the compositional data, following Filmoser et al. (2009) (but not their robust algorithm as outliers were not a problem in this dataset). The data was first converted into isometric log-ratio coordinates. Then the conventional PCA method was applied. The resulting loadings and scores were then retransformed to centred log-ratio space, allowing the production of a compositional PCA score plot. Loading vectors are not shown in the present work but can be generated from this centred log-ratio method.

2. Supplementary tables

Electron microprobe analyses (EPMA) were made on 08/12/21 and 10/11/2022 with wavelength dispersive spectrometry on a JEOL 8900 Superprobe at the University of Alberta. A 5 µm beam diameter was used with a 15 keV accelerating voltage, and 6 nA beam current, with time-dependent intensity corrections applied to Na to compensate for the smaller beam diameter (e.g., Jensen et al., 2008, 2021). Offline corrections were made to the data because of minor, but consistent offsets on Na_2O (08/12/21) and SiO_2, Al_2O_3 and Na_2O (10/11/2022) using accepted values from reference standard ID3506. This ensures these data are fully comparable to reference data of Mazama and WRAe collected on the same probe, but on different days. Therefore, EPMA from Placentia Bay samples and Old Crow tephra, which is used to track instrumental drift, were correct for these offsets.

Table S1: Major-minor EPMA analyses from cryptotephra deposits 10G_195 and 10G_35 in core AI07-10G, Placentia Bay. UA n. refers to the University of Alberta ascension number.

Sample	UA n.	SiO_2	TiO2	Al_2O_3	FeO_T	MnO	MgO	CaO	Na_2O	K_2O	Cl	Total	H_2O Diff.	Date
10G_35	UA3768	73.52	0.22	14.58	1.52	0.07	0.40	1.83	4.50	3.12	0.31	100	-0.23	08/12/21
10G_35	UA3768	73.54	0.22	14.72	1.43	0.04	0.41	1.87	4.30	3.20	0.36	100	0.51	08/12/21
10G_35	UA3768	73.59	0.19	15.05	1.46	0.03	0.43	1.86	4.16	3.03	0.27	100	0.91	08/12/21
10G_35	UA3768	73.66	0.21	14.64	1.56	0.07	0.35	1.92	4.15	3.16	0.37	100	1.01	08/12/21
10G_35	UA3768	73.90	0.20	14.28	1.42	0.07	0.41	1.90	4.48	3.06	0.37	100	0.18	10/11/22
10G_35	UA3768	73.19	0.17	15.16	1.53	0.08	0.44	1.92	4.11	3.14	0.34	100	1.01	10/11/22
Mean	-	*73.57*	*0.20*	*14.74*	*1.49*	*0.06*	*0.41*	*1.88*	*4.28*	*3.12*	*0.34*	-	*0.57*	-
StDev	-	*0.23*	*0.02*	*0.32*	*0.06*	*0.02*	*0.03*	*0.04*	*0.17*	*0.06*	*0.04*	-	*0.51*	-

10G_195	UA3769	72.05	0.44	14.32	1.95	0.04	0.48	1.59	5.76	2.97	0.50	100	10.75	08/12/21
10G_195	UA3769	72.37	0.38	14.95	1.93	0.04	0.43	1.59	5.33	2.80	0.22	100	4.20	08/12/21
10G_195	UA3769	72.38	0.43	14.73	1.88	0.06	0.43	1.51	5.71	2.73	0.18	100	0.78	08/12/21
10G_195	UA3769	72.50	0.45	15.01	1.85	0.06	0.46	1.61	4.89	2.90	0.34	100	10.62	08/12/21
10G_195	UA3769	72.55	0.42	14.65	1.88	0.02	0.50	1.56	5.34	2.94	0.18	100	1.78	08/12/21
10G_195	UA3769	72.64	0.44	14.57	1.90	0.05	0.48	1.61	5.33	2.85	0.18	100	0.81	08/12/21
10G_195	UA3769	72.84	0.43	14.67	1.90	0.03	0.44	1.55	5.14	2.88	0.15	100	-0.12	08/12/21
10G_195	UA3769	72.86	0.44	14.79	1.74	0.06	0.45	1.56	5.23	2.74	0.19	100	2.39	08/12/21
10G_195	UA3769	72.88	0.43	14.56	1.93	0.03	0.50	1.55	5.21	2.78	0.17	100	0.14	08/12/21
10G_195	UA3769	72.95	0.48	14.81	1.90	0.07	0.48	1.60	4.67	2.85	0.25	100	5.15	08/12/21
10G_195	UA3769	72.98	0.45	14.55	1.84	0.06	0.51	1.65	5.10	2.71	0.17	100	0.70	08/12/21
10G_195	UA3769	73.02	0.42	14.52	1.89	0.08	0.46	1.56	5.09	2.84	0.17	100	0.59	08/12/21
10G_195	UA3769	73.10	0.40	14.62	1.80	0.01	0.44	1.55	5.14	2.77	0.21	100	2.03	08/12/21
Mean	-	*72.70*	*0.43*	*14.67*	*1.88*	*0.05*	*0.47*	*1.58*	*5.23*	*2.83*	*0.22*	-	*3.06*	-
StDev	-	*0.31*	*0.02*	*0.19*	*0.06*	*0.02*	*0.03*	*0.04*	*0.29*	*0.08*	*0.10*	-	*3.72*	-

Table S2: Major-minor EPMA analyses from INTAV secondary standards; Lipari ID3506 and Old Crow tephra (Kuehn et al., 2011).

Sample	SiO_2	TiO2	Al_2O_3	FeO_T	MnO	MgO	CaO	Na_2O	K_2O	Cl	Total	H_2O Diff.	Date
ID3506	74.70	0.11	13.37	1.48	0.04	0.04	0.69	4.04	5.30	0.31	100	0.24	08/12/2021
ID3506	74.38	0.05	13.29	1.59	0.06	0.06	0.73	4.32	5.29	0.31	100	-1.15	08/12/2021
ID3506	74.34	0.04	13.39	1.54	0.07	0.04	0.73	4.24	5.37	0.30	100	-0.03	08/12/2021
ID3506	74.69	0.04	13.13	1.56	0.07	0.02	0.75	4.32	5.19	0.30	100	0.27	08/12/2021
Mean	*74.53*	*0.06*	*13.30*	*1.54*	*0.06*	*0.04*	*0.73*	*4.23*	*5.28*	*0.31*	-	*-0.17*	-
StDev	*0.19*	*0.04*	*0.12*	*0.05*	*0.01*	*0.02*	*0.02*	*0.13*	*0.07*	*0.01*	-	*0.67*	-
Old Crow	75.24	0.27	13.01	1.70	0.08	0.29	1.53	4.15	3.55	0.24	100	4.28	08/12/2021
Old Crow	75.44	0.32	12.95	1.62	0.03	0.33	1.45	3.77	3.85	0.28	100	4.22	08/12/2021
Old Crow	74.80	0.33	13.19	1.74	0.04	0.29	1.50	3.98	3.96	0.23	100	4.69	08/12/2021
Old Crow	75.43	0.29	13.42	1.72	0.08	0.26	1.46	3.56	3.57	0.26	100	5.4	08/12/2021
Mean	*75.23*	*0.30*	*13.14*	*1.70*	*0.06*	*0.29*	*1.49*	*3.87*	*3.73*	*0.25*	-	*4.64*	-
StDev	*0.30*	*0.03*	*0.21*	*0.05*	*0.02*	*0.03*	*0.04*	*0.26*	*0.20*	*0.02*	-	*0.54*	-
ID3506	74.83	0.07	13.25	1.56	0.07	0.04	0.72	4.08	5.15	0.29	100	0.37	08/12/2021
ID3506	75.09	0.02	13.06	1.55	0.09	0.06	0.74	3.93	5.21	0.34	100	0.9	08/12/2021
ID3506	74.78	0.09	13.25	1.58	0.04	0.06	0.74	3.88	5.32	0.33	100	0.54	08/12/2021
ID3506	74.71	0.10	13.33	1.54	0.07	0.02	0.73	4.06	5.16	0.35	100	0.92	08/12/2021
ID3506	74.46	0.10	13.25	1.59	0.06	0.03	0.72	4.31	5.25	0.31	100	0.34	08/12/2021
ID3506	74.60	0.03	13.30	1.60	0.08	0.03	0.77	4.07	5.24	0.34	100	1.07	08/12/2021
Mean	*74.74*	*0.07*	*13.24*	*1.57*	*0.07*	*0.04*	*0.74*	*4.06*	*5.22*	*0.33*	-	*0.69*	-
StDev	*0.21*	*0.04*	*0.09*	*0.02*	*0.02*	*0.02*	*0.02*	*0.15*	*0.06*	*0.02*	-	*0.31*	-
Old Crow	75.39	0.28	13.18	1.66	0.06	0.29	1.46	3.80	3.68	0.27	100	5.45	08/12/2021

Old Crow	74.87	0.31	13.21	1.75	0.05	0.29	1.50	3.99	3.82	0.27	100	5.5	08/12/2021
Old Crow	75.00	0.30	13.19	1.79	0.05	0.33	1.52	3.78	3.82	0.27	100	4.65	08/12/2021
Old Crow	74.98	0.30	13.32	1.66	0.03	0.29	1.46	4.02	3.74	0.28	100	4.7	08/12/2021
Old Crow	75.13	0.24	13.29	1.72	0.05	0.23	1.43	4.00	3.67	0.30	100	4.3	08/12/2021
Old Crow	75.15	0.30	13.03	1.64	0.09	0.28	1.50	4.22	3.60	0.24	100	4.4	08/12/2021
Mean	*75.09*	*0.29*	*13.20*	*1.70*	*0.06*	*0.29*	*1.48*	*3.97*	*3.72*	*0.27*	-	*4.83*	-
StDev	*0.18*	*0.02*	*0.10*	*0.06*	*0.02*	*0.03*	*0.03*	*0.16*	*0.09*	*0.02*	-	*0.52*	-
ID3506	74.52	0.09	13.52	1.61	0.09	0.03	0.70	4.03	5.14	0.35	100	0.74	10/11/2021
ID3506	74.35	0.03	13.39	1.61	0.06	0.01	0.76	4.31	5.23	0.29	100	0.04	10/11/2021
ID3506	74.53	0.13	13.20	1.70	0.06	0.06	0.76	4.15	5.13	0.37	100	0.59	10/11/2021
ID3506	74.83	0.04	13.01	1.66	0.10	0.06	0.73	4.17	5.11	0.36	100	1.24	10/11/2021
ID3506	74.72	0.04	13.33	1.54	0.03	0.05	0.78	4.16	5.10	0.33	100	0.68	10/11/2021
Mean	*74.59*	*0.07*	*13.29*	*1.62*	*0.07*	*0.04*	*0.75*	*4.17*	*5.15*	*0.34*	-	*0.66*	-
StDev	*0.19*	*0.04*	*0.19*	*0.06*	*0.03*	*0.02*	*0.03*	*0.10*	*0.05*	*0.03*	-	*0.43*	-
Old Crow	74.89	0.31	13.52	1.67	0.07	0.31	1.50	3.79	3.72	0.28	100	5.21	10/11/2021
Old Crow	75.01	0.33	13.32	1.65	0.08	0.28	1.44	3.96	3.74	0.24	100	4.15	10/11/2021
Old Crow	74.67	0.32	13.43	1.73	0.00	0.32	1.53	3.93	3.85	0.29	100	4.10	10/11/2021
Old Crow	75.11	0.32	13.44	1.70	0.05	0.27	1.50	3.80	3.60	0.28	100	6.01	10/11/2021
Old Crow	74.66	0.35	13.37	1.67	0.03	0.30	1.41	4.35	3.62	0.29	100	4.61	10/11/2021
Old Crow	74.88	0.31	13.08	1.67	0.05	0.29	1.51	4.26	3.71	0.31	100	3.40	10/11/2021
Mean	*74.87*	*0.32*	*13.36*	*1.68*	*0.05*	*0.30*	*1.48*	*4.02*	*3.71*	*0.28*	-	*4.58*	-
StDev	*0.18*	*0.02*	*0.15*	*0.03*	*0.03*	*0.02*	*0.05*	*0.24*	*0.09*	*0.02*	-	*0.92*	-
ID3506	74.59	0.08	13.31	1.55	0.11	0.04	0.75	4.10	5.21	0.35	100	0.47	10/11/2021
ID3506	74.55	0.07	13.17	1.70	0.04	0.06	0.79	4.19	5.17	0.34	100	0.90	10/11/2021
ID3506	74.88	0.05	13.15	1.59	0.04	0.05	0.74	4.14	5.08	0.35	100	0.70	10/11/2021
ID3506	75.01	0.08	13.21	1.56	0.10	0.04	0.71	3.79	5.22	0.35	100	1.81	10/11/2021
ID3506	74.83	0.04	13.01	1.66	0.10	0.06	0.73	4.17	5.11	0.36	100	1.24	10/11/2021
ID3506	74.72	0.04	13.33	1.54	0.03	0.05	0.78	4.16	5.10	0.33	100	0.68	10/11/2021
Mean	*74.76*	*0.06*	*13.20*	*1.60*	*0.07*	*0.05*	*0.75*	*4.09*	*5.15*	*0.35*	-	*0.96*	-
StDev	*0.18*	*0.02*	*0.12*	*0.06*	*0.04*	*0.01*	*0.03*	*0.15*	*0.06*	*0.01*	-	*0.49*	-
Old Crow	74.89	0.31	13.52	1.67	0.07	0.31	1.50	3.79	3.72	0.28	100	5.21	10/11/2021
Old Crow	75.01	0.33	13.32	1.65	0.08	0.28	1.44	3.96	3.74	0.24	100	4.15	10/11/2021
Old Crow	74.67	0.32	13.43	1.73	0.00	0.32	1.53	3.93	3.85	0.29	100	4.10	10/11/2021
Old Crow	75.11	0.32	13.44	1.70	0.05	0.27	1.50	3.80	3.60	0.28	100	6.01	10/11/2021
Old Crow	74.66	0.35	13.37	1.67	0.03	0.30	1.41	4.35	3.62	0.29	100	4.61	10/11/2021
Old Crow	74.88	0.31	13.08	1.67	0.05	0.29	1.51	4.26	3.71	0.31	100	3.40	10/11/2021
Mean	*74.87*	*0.32*	*13.36*	*1.68*	*0.05*	*0.30*	*1.48*	*4.02*	*3.71*	*0.28*	-	*4.58*	-
StDev	*0.18*	*0.02*	*0.15*	*0.03*	*0.03*	*0.02*	*0.05*	*0.24*	*0.09*	*0.02*	-	*0.92*	-

Table S3: The 20 points nearest to Placentia Bay, NL study site, collated from CALIB marine reservoir correction database, with regard to Marine20 calibration curve (Reimer and Reimer, 2001). Weighted Mean ΔR= -29. Uncertainty= 56.

Map n.	Latitude	Longitude	ΔR	σ
749	46.00	-56.00	22	30
33	45.00	-55.00	-39	24
743	46.53	-51.53	-3	50
753	45.50	-50.50	-113	40
908	51.37	-55.58	-49	30
890	52.00	-56.07	76	50
847	51.46	-57.24	-9	20
836	51.47	-57.25	-144	50
839	51.47	-57.25	-154	80
747	46.13	-60.62	-43	40
898	53.80	-56.43	-88	40
892	53.77	-56.92	12	40
893	53.77	-56.92	-48	40
894	53.77	-56.92	-98	40
895	53.77	-56.92	72	40
909	53.77	-56.92	-48	40
912	53.77	-56.92	-28	40
841	50.28	-61.16	77	60
852	48.25	-62.00	66	50
907	54.45	-57.22	-98	40

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