Refining techniques for radiocarbon dating small archaeological bone samples

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Appendix 1

Pretreatment information, direct AMS radiocarbon dates and references for Fig. 2, Chapter 6. Dates have been rounded to nearest 10 years and calibrated in OxCal 4.3 [1] using the IntCal13 dataset [2]. Multiple dates from the same bone/collagen extract were combined using the R_Combine feature in OxCal [1] when the results were statistically indistinguishable. Under Pretreatment: 'Bulk' denotes unfiltered collagen/gelatin extracts (generally pretreated with protocols based on Longin [3]); 'UF' indicates ultrafiltered [4] gelatinised collagen extracts; 'HYP' indicates individual hydroxyproline amino acids were isolated for compound specific dating[5]; other methods of collagen purification (XAD-2 resin/glass microfiber filter/ion-exchange) are also marked. In general, 1% collagen yield is regarded as the minimum level of preservation suitable for ^{14}C dating. Well-preserved collagen extracts are expected to have C:N ratios In the range of 2.9-3.6 [6] whereas the theoretical C:N ratio of HYP is 5.0 [5]. '-' data not available in source publication.

Sample ID	Species	Country	AMS lab no	Pretreat-ment	Coll yield (%)	C:N	^{14}C age ± 1SD (BP)	1σ calibrated range (cal BP)	2σ calibrated range (cal BP)	Ref
Western Europe										
Goyet Q56-16	*Homo sapiens*	Belgium	GrA-59991	-	-	-	22100 ± 100	26440-26140	26610-26040	[7]
Goyet 2878-21	*Homo sapiens*	Belgium	GrA-62455	-	-	-	22360 ± 110	26860-26420	27060-26270	[7]
Goyet Q376-19	*Homo sapiens*	Belgium	GrA-54026	-	-	-	23260 ± 110	27620-27410	27720-27310	[7]
Goyet Q55-2	*Homo sapiens*	Belgium	GrA-54031	-	-	-	23270 ± 120	27630-27410	27740-27310	[7]
La Rochette	*Homo sapiens*	France	OxA-23413	UF	3.4%	3.1	23400 ± 110	27700-27500	27790-27400	[8]
Arene Candid 1 burial	*Homo sapiens*	Italy	OxA-10700	UF	-	3.2	23440 ± 190	27760-27480	27900-27330	[9]
Ostuni 1 burial	*Homo sapiens*	Italy	MAMS-11449	UF	-	-	23450 ± 110	27730-27530	27820-27430	[10]
Goyet Q53-1	*Homo sapiens*	Belgium	GrA-46169	-	-	-	23920 ± 100	28060-27810	28240-27710	[7]
Eel Point 1	*Homo sapiens*	UK	OxA-14164	UF	7.2%	3.2	24470 ± 110	28680-28390	28790-28220	[11]
Ostuni 2 burial	*Homo sapiens*	Italy	MAMS-11450	UF	-	-	24910 ± 130	29100-28750	29330-28630	[10]
Cussac Cave Locus 1	*Homo sapiens*	France	Beta-156643	-	-	-	25120 ± 120	29340-28980	29500-28830	[12]
Vilhonneur 1	*Homo sapiens*	France	Beta-216141 Beta-216142	Bulk	-	-	26890 ± 140	31110-30890	31210-30780	[13]
Paviland 1 burial	*Homo sapiens*	UK	OxA-16412 OxA-16413	UF	3.4% 2.6%	3.2 3.2	29150 ± 140	33610-33210	33730-32970	[14]
Goyet Q376-3	*Homo sapiens*	Belgium	GrA-60034	-	-	-	29370 ± 180	33800-33430	33950-33150	[7]
La Crouzade VI	*Homo sapiens*	France	Erl-9415	-	-	3.2	30640 ± 640	35200-34020	36020-33650	[15]
Goyet Q116-1	*Homo sapiens*	Belgium	GrA-46175	-	-	-	30880 ± 170	34960-34610	35170-34430	[7]
Spy 430a	Neanderthal	Belgium	GrA-32630	Bulk	7.4%	3.5	33940 ± 220	38720-38240	38950-37810	[16]
Spy 94a	Neanderthal	Belgium	GrA-32623	Bulk	7.8%	3.4	35810 ± 260	40780-40120	41110-39820	[16]
Spy 92b	Neanderthal	Belgium	GrA-32626	Bulk	9%	3.3	36350 ± 310	41360-40670	41620-40300	[16]
Saint-Cesaire SP 28	Neanderthal	France	OxA-18099	UF	0.8%	3.3	36200 ± 750	41550-40110	42150-39340	[17]
Grotte du Renne AR-14	Neanderthal	France	MAMS-25149	UF	3.9%	3.2	36840 ± 660	41980-40840	42430-40180	[18]
Rochers-de-Villeneuve 1	Neanderthal	France	OxA-15257	UF	3.6%	3.3	45200 ± 1100	49670-47640	Out of range	[19]
El Sidron 00/46	Neanderthal	Spain	OxA-21776	UF	3.3%	3.3	48400 ± 3200	Out of range	Out of range	[20]
Central Europe										
Brno 2 burial	*Homo sapiens*	Czech Republic	OxA-8293	Bulk	11%	-	23680 ± 200	27940-27610	28200-27460	[21]
Willendorf I	*Homo sapiens*	Austria	ETH-20690	Bulk	-	-	24250 ± 180	28510-28060	28690-27880	[22]

Pavlov 1	*Homo sapiens*	Czech Republic	Aix-12026	UF	9.3%	3.4	25490 ± 90	29720-29410	29910-29260	[23]
Dolní Věstonice II DV15 burial	*Homo sapiens*	Czech Republic	Aix-12029	UF	8.%	3.2	26730 ± 100	31020-30820	31110-30720	[23]
Dolní Věstonice II DV14 burial	*Homo sapiens*	Czech Republic	Aix-12028	UF	9.5%	3.5	26760 ± 100	31040-30830	31120-30730	[23]
Dolní Věstonice II DV13 burial	*Homo sapiens*	Czech Republic	Aix-12027	UF	13.5%	3.2	27040 ± 100	31170-30980	31250-30880	[23]
Dolní Věstonice II DV43	*Homo sapiens*	Czech Republic	Aix-12032	UF	10.2%	3.3	27070 ± 110	31190-30990	31270-30890	[23]
Dolní Věstonice II DV42	*Homo sapiens*	Czech Republic	Aix-12031	UF	9%	3.4	26880 ± 110	31100-30900	31180-30790	[23]
Dolní Věstonice II DV16 burial	*Homo sapiens*	Czech Republic	Aix-12030	UF	13.9%	3.3	27220 ± 110	31250-31060	31350-30970	[23]
Oblazowa Cave OBC6 P.5546	*Homo sapiens*	Poland	OxA-4586	Ion exchange	3.8%	-	31000 ± 550	35510-34430	36110-34010	[24]
Mladeč 8	*Homo sapiens*	Czech Republic	VERA-3075	Bulk	8.3%	2.7	30680 +380/-360	34960-34250	35410-33960	[25]
Mladeč 1	*Homo sapiens*	Czech Republic	VERA-3073	Bulk	-	-	31190 +400/-390	35510-34710	36010-34380	[25]
Mladeč 2	*Homo sapiens*	Czech Republic	VERA-3074	Bulk	-	-	31320 +410/-390	35640-34810	36130-34510	[25]
Mladeč 9a	*Homo sapiens*	Czech Republic	VERA-3076A	Bulk	-	-	31500 +420/-400	35820-34950	36280-34640	[25]
Kleine Feldhofer Grotte NN1	Neanderthal	Germany	ETH-19660	Bulk	-	-	39240 ± 670	43610-42540	44350-42190	[26]
Kleine Feldhofer Grotte Nean 1	Neanderthal	Germany	ETH-20981	Bulk	-	-	39900 ± 620	44130-43040	44750-42660	[26]
Kleine Feldhofer Grotte NN4	Neanderthal	Germany	ETH-19661	Bulk	-	-	40360 ± 760	44620-43280	45370-42810	[26]
Eastern Europe										
Peştera Cioclovina 1	*Homo sapiens*	Romania	OxA-15527	UF	5.9%	3.4	28510 ± 170	32860-32170	33090-31780	[27]
Peştera Muierii 2	*Homo sapiens*	Romania	OxA-16252	UF	11.2%	3.3	29110 ± 190	33590-33100	33760-32840	[28]
Peştera Muierii 1	*Homo sapiens*	Romania	LuA-5229 OxA-15529	- UF	- 13.3%	- 3.4	29940 ± 170	34170-33850	34370-33710	[28]
Bacho Kiro Cave BK 1653	*Homo sapiens*	Bulgaria	ETH-86768 AIX-12024	UF	11.8%	3.2	30570 ± 120	34690-34380	34820-34210	[29]
Bacho Kiro Cave F6-597	*Homo sapiens*	Bulgaria	ETH-86773 AIX-12025	UF	4.2%	3.2	31660 ± 140	35750-35340	35970-35140	[29]
Buran-Kaya III parietal	*Homo sapiens*	Ukraine	GrA-37938	Bulk	-	3.3	31900 ± 230	36090-35550	36300-35260	[30]
Peştera cu Oase 1	*Homo sapiens*	Romania	GrA-22810 OxA-11711	Bulk UF	4% 0.4%	2.6 3.3	34950 + 990/-890	40040-37610	41070-36470	[31]
Bacho Kiro Cave AA7-738	*Homo sapiens*	Bulgaria	ETH-86769	UF	12.3%	3.1	39750 ± 380	43760-43050	44210-42810	[29]
Bacho Kiro Cave CC7-2289	*Homo sapiens*	Bulgaria	ETH-86771	UF	4.2%	3.1	40600 ± 420	44580-43720	44980-43340	[29]
Bacho Kiro Cave BB7-240	*Homo sapiens*	Bulgaria	ETH-86770	UF	9%	3.1	41850 ± 480	45660-44800	46130-44400	[29]
Bacho Kiro Cave CC7-335	*Homo sapiens*	Bulgaria	ETH-86772	UF	11.9%	3.1	42450 ± 510	46190-45250	46790-44830	[29]
Vindija Vi-208	Neanderthal	Croatia	Ox-X-2689-09	HYP	5.6%	5.6	42700 ± 1600	47830-44690	49690-43890	[32]
Vindija Vi-207	Neanderthal	Croatia	Ox-X-2689-10	HYP	6%	5.6	43900 ± 2000	49010-45770	Out of range	[32]
Vindija Vi-33.19	Neanderthal	Croatia	Ox-X-2717-11	HYP	-	4.9	44300 ± 1200	48860-46430	49950-45850	[32]
Vindija Vi-2291-18	Neanderthal	Croatia	Ox-V-2291-18	UF	-	3.3	44450 ± 550	48430-47010	49210-46450	[33]
Vindija Vi-*28	Neanderthal	Croatia	Ox-X-2687-57	HYP	5.4%	5.0	46200 ± 1500	Out of range	Out of range	[32]
Western Russia										
Kostenki 8	*Homo sapiens*	Russia	OxA-7109	-	-	-	23020 ± 320	27630-27050	27800-26580	[34]

Kostenki 18 burial	*Homo sapiens*	Russia	OxA-X-2666-53	HYP	-	5.4	23230 ± 150	27630-27370	27740-27240	[35]
Sungir 1 burial	*Homo sapiens*	Russia	OxA-X-2464-12	HYP	-	5.0	28650 ± 400	33300-32110	33640-31600	[36]
Sungir 4 burial	*Homo sapiens*	Russia	OxA-X-2462-52	HYP	-	5.1	29670 ± 290	34070-33590	34390-33270	[36]
Sungir 2 burial	*Homo sapiens*	Russia	OxA-X-2395-6	HYP	-	5.0	30100 ± 550	34660-33740	35290-33180	[5]
Sungir 3 burial	*Homo sapiens*	Russia	OxA-X-2395-7	HYP	-	5.0	30000 ± 550	34600-33660	35160-33030	[5]
Kostenki 1	*Homo sapiens*	Russia	OxA-15055	UF	9.6%	3.2	32070 ± 190	36200-35760	36380-35520	[37]
Kostenki 14	*Homo sapiens*	Russia	OxA-X-2395-15	HYP	-	5.1	33250 ± 500	38220-36810	38690-36260	[5]
Mezmaiskaya Cave Mez 2	Neanderthal	Russia	OxA-21839	UF	14.6%	3.2	39700 ± 1100	44430-42640	45630-42030	[38]
Siberia and Mongolia										
Mal'ta MA-1	*Homo sapiens*	Russia (Siberia)	UCIAMS-79666	XAD_2 resin	18.7%	-	20240 ± 60	24430-24200	24520-24090	[39]
Pokrovka 2	*Homo sapiens*	Russia (Siberia)	OxA-19850	UF	6.7%	3.3	27740 ± 150	31600-31300	31830-31180	[40]
Salkhit skullcap	*Homo sapiens*	Mongolia	OxA-X-2717-25	HYP	-	5.0	30430 ± 300	34680-34140	34940-33900	[41]
Okladnikov Cave OK1	Neanderthal	Russia (Siberia)	OxA-15481	UF	5%	3.3	37800 ± 450	42430-41800	42750-41480	[42]
Ust'-Ishim 1	*Homo sapiens*	Russia (Siberia)	OxA-25516 OxA-30190	UF	7.7% 10%	3.2 3.3	41400 ± 950	45750-44010	46840-43210	[43]
Eastern Asia										
Shiraho-Saonetabaru Cave (No. 2)	*Homo sapiens*	Japan	MTC-12820	Glass microfiber filter	0.9%	3.1	20420 ± 110	24760-24340	25000-24210	[44]
Tianyuan Cave (1)	*Homo sapiens*	China	BA-03222	-	-	-	34430 ± 510	39560-38450	40260-37760	[45]

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