Radiocarbon, Vol 65, Nr 2, 2023, p 521–538 DOI:10.1017/RDC.2023.12

FIRST RADIOCARBON DATING OF NEOLITHIC STONE CIST GRAVES FROM THE AOSTA VALLEY (ITALY): INSIGHTS INTO THE CHRONOLOGY AND BURIAL RITES OF THE WESTERN ALPINE REGION

Noah Steuri[1]* • Marco Milella[2] • Francesca Martinet[3] • Luca Raiteri[3] • Sönke Szidat[4] • Sandra Lösch[2] • Albert Hafner[1]

[1]Department of Prehistoric Archaeology, Institute of Archaeological Sciences and Oeschger Center for Climate Change Research (OCCR), University of Bern, Switzerland
[2]Department of Physical Anthropology, Institute of Forensic Medicine, University of Bern, Switzerland
[3]Regione autonoma Valle d'Aosta, Dipartimento Soprintendenza per i beni e le attività culturali, Aosta, Italy
[4]Department of Chemistry, Biochemistry and Pharmaceutical Sciences and Oeschger Center for Climate Change Research (OCCR), University of Bern, Switzerland

ABSTRACT. Previous research on the Neolithic cist graves of the Western Alpine region—also known under the term Chamblandes type graves—mostly focused on sites located in western Switzerland and eastern France. For the adjacent Aosta Valley (Italy), only a little information is available. Within the framework of our research project, it was possible to identify about 120 stone cist graves from 10 sites in the Aosta Valley. Due to the lack of distinctive grave goods and missing absolute dating, however, their chronological position has been unclear until now. Here we present the first extensive series of radiocarbon dates from Neolithic stone cist graves of the Aosta Valley. We analyzed 31 human bone samples from four sites, and most dates indicate an unexpected early chronological position around the first half of the 5th millennium BCE, in particular, the site of Villeneuve, dating to 4800–4550 cal BCE. This identifies these burials from the Aosta Valley as belonging to the oldest known Neolithic cist graves of the Western Alpine region discovered so far. Altogether, our study provides new evidence allowing the first time to clarify the chronology of these sites and trace the evolution of this burial practice in the Western Alps.

KEYWORDS: Aosta Valley, human remains, Neolithic burial, radiocarbon, stone cist grave, Western Alps.

INTRODUCTION

In the Western Alpine region Neolithic cist graves are named after the eponymous site of Pully, Chamblandes (Moinat and Studer 2007) and have a surprisingly long period of use of around 1000 years and date largely between 4800–3800 BCE (see discussion). Jeunesse et al. (2019) placed the emergence of this burial type in the regions of Savoy and Ain (eastern France). Regionally, the study of Chamblandes type graves has been traditionally centered within the surroundings of Lake Geneva and the Upper Rhône Valley, in Switzerland and France respectively (e.g., Gallay 2008; Honegger 2011; Stöckli 2016; Baudais et al. 2017). These two regions describe an area to the north of the main Alpine ridge in the northwestern Alps and in the catchment area of the river Rhône. The adjacent Aosta Valley (Italy) lies south of the main Alpine ridge and drains into the Po River. All these regions are connected by alpine passes, which usually have altitudes of over 2000 m a.s.l.

While the northern areas of Lake Geneva and the Upper Rhône Valley are relatively well studied, only a few analyses have covered the stone cist graves in the Aosta Valley. In particular, there was a complete lack of radiocarbon (^{14}C) data in this region, which made a proper chronological contextualization of the archeological findings challenging. This knowledge gap is particularly unfortunate given the promising scientific potential of this region, as the Aosta Valley is connected via high-Alpine passes and therefore an ideal area for the analysis of transalpine Neolithic exchange networks. The distribution of stone cist

*Corresponding author. Email: noah.steuri@iaw.unibe.ch

grave sites (Figure 1a) shows the broader intra-regional significance of this burial type. They are situated on both sides of the Alpine ridge, in the border areas of larger Neolithic cultural zones in eastern France, northern Italy, and southern Germany. About 120 stone cist graves pertaining to 10 different sites have been identified in the Aosta Valley. These consist of two large cemeteries (Vollein and Villeneuve) and several old discoveries or unexcavated sites (Figure 1b). Neolithic graves of the Chamblandes type usually consist of four lateral stone slabs forming a rectangular box or cist of varying small dimensions. Individuals were placed on the grave floor, generally on their left side and with the lower limbs flexed (Figure 2a). Most stone cist graves include single burials, whereas multiple burials of at least three individuals have been described only sporadically in the unpublished documentation of the Vollein excavation. Chamblandes graves typically include only a few grave goods, for the mentioned sites in the Aosta Valley, these are mainly large *Glycymeris* shell bracelets (one example visible on Figure 2a) and small jet disc beads. This scarcity hampers the typochronological and cultural historical interpretation of these finds (Denaire et al. 2011; Stöckli 2016). Accordingly, serial ^{14}C dating becomes essential, not only for a chronological reconstruction of the contexts, but also for a better understanding of the complex social networks characterizing both sides of the Alps during the periods of emerging farming societies.

MATERIAL AND METHODS

In this study, we consider four recently sampled sites:

- Villeneuve, Champ Rotard (Italy): this necropolis consists of 33 stone cist graves; 25 excavated in 1917 and 8 additional graves discovered in 1987 (Figure 2b; Barocelli 1919; Barocelli 1951; Mezzena 1997). So far, only the human remains excavated in 1917 (T1-T25) were anthropologically analyzed (Corrain 1986).
- Quart, Vollein (Italy): the necropolis includes at least 66 stone cist graves (T1-T66) and stands as the largest in the Aosta Valley. The human remains excavated between 1968 and 1983 (Mezzena 1981, 1997) were stored without anthropological examination. However, in the context of our project, the bones were cleaned and will be analyzed soon.
- La Salle, Derby (Italy): a single stone cist grave from this previously unknown site was discovered in 1952 and the human remains of three individuals have been collected and partially examined (Fumagalli 1955).
- Montjovet, Fiusey (Italy): 5 stone cist graves (Sep. I-Sep. V) with the remains of at least 8 individuals were discovered and excavated without anthropological examination below an Early Medieval cemetery in 1910 (Rizzo 1910).

Selection of Individuals

For each site, we first screened the available archaeological and anthropological documentation. We then proceeded to a re-evaluation of the basic demographic parameters for each individual: We estimated adult age-at-death based on the morphological changes of the pubic symphysis and auricular surface of the ilium (Brooks and Suchey 1990; Buckberry and Chamberlain 2002). For nonadults, we estimated age-at-death based on the development and eruption of deciduous and permanent teeth and the degrees of epiphyseal fusion (Ubelaker 1989; Scheuer and Black 2000; Schaefer et al. 2009). We determined sex only of adult remains following standard methods based on the sexually dimorphic features of the pubic symphysis, coxal bone, cranium, and mandible (Buikstra and Ubelaker 1994). To avoid double sampling, only human remains that could be clearly

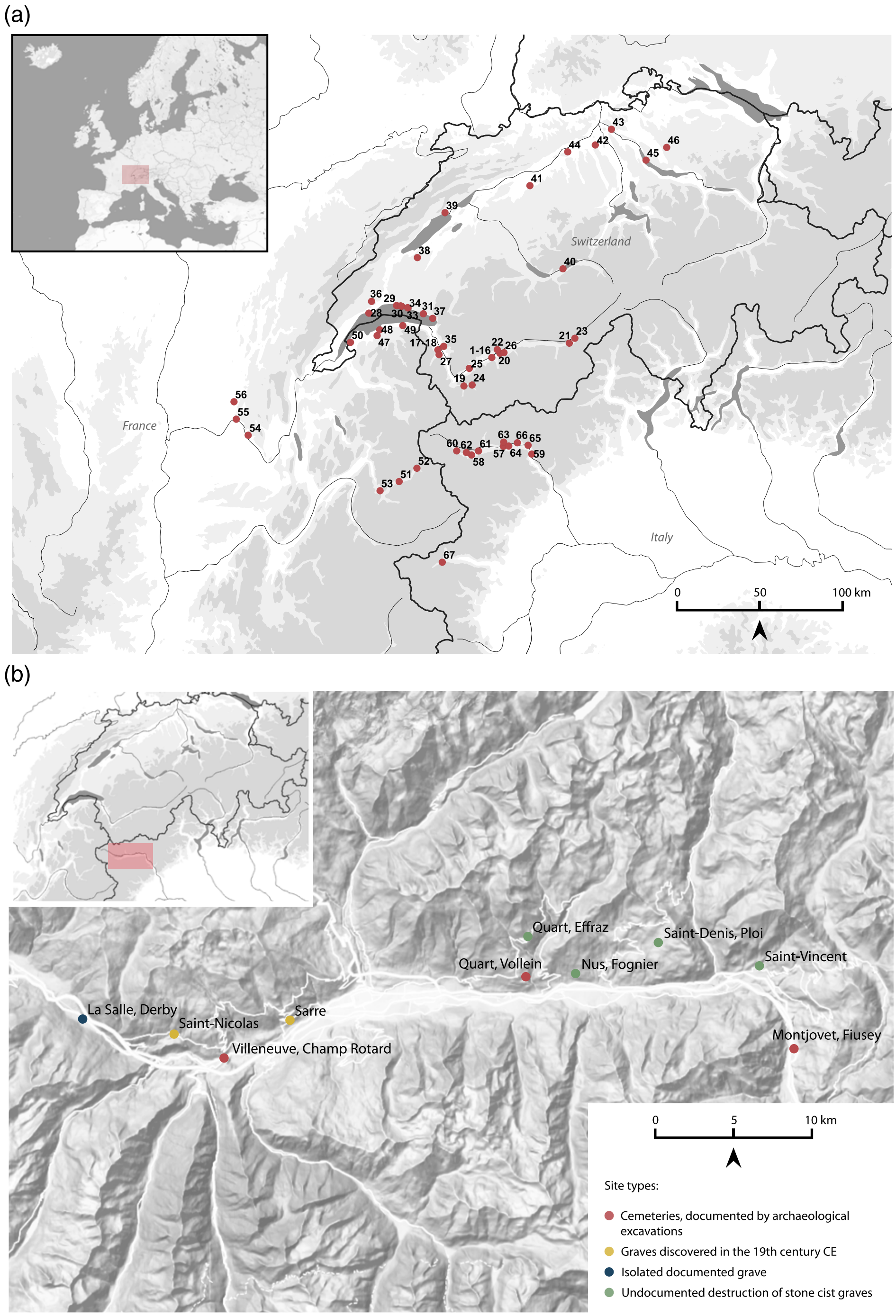

Figure 1 (a) Examined sites of Neolithic cist graves in the Western Alps and (b) sites identified in the Aosta Valley (Italy).

https://doi.org/10.1017/RDC.2023.12 Published online by Cambridge University Press

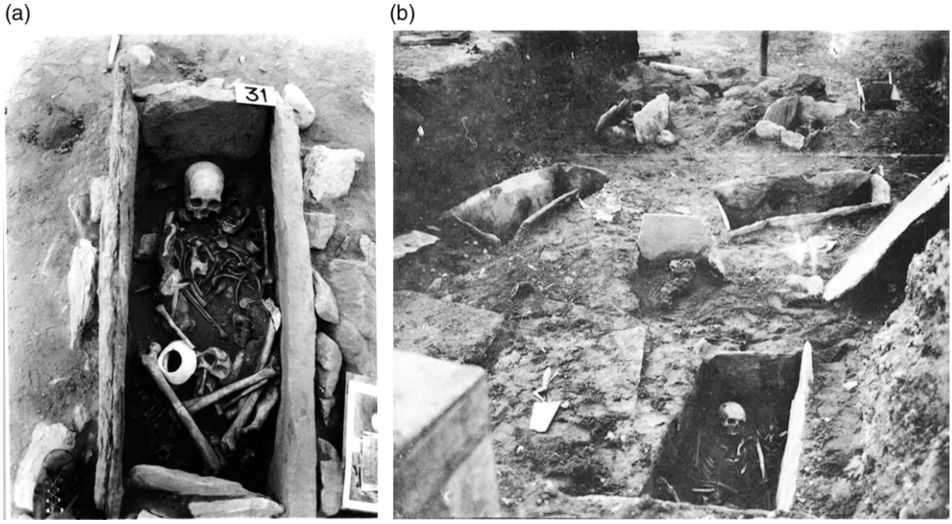

Figure 2 (a) Tomb 31 from the stone cist necropolis of Quart, Vollein (Photo: Soprintendenza di Aosta), (b) excavation of the necropolis in Villeneuve, Champ Rotard in 1917 (Corrain 1986:20).

assigned to a specific individual and grave number were considered for this study. The specimens were selected in such a way to minimize possible age- or sex biases.

Sample Collection

For each selected individual we collected a bone sample of ca. 3 g, taken from the petrous portion of the temporal bone. We targeted this anatomical region since (a) this region presents a good portion of highly mineralized compact bone which makes it ideal for sampling (Lösch et al. 2020), and (b) it allows to minimize the risk of double-sampling. In the few cases where more than one individual was buried in a grave, double sampling was avoided by considering only temporal bone from one side and/or belonging to individuals of obvious different age-at-death (i.e., adults vs. nonadults). These criteria led to the following sample composition collected in September 2019:

- 11 individuals from 10 graves of the Villeneuve necropolis corresponding to approximately a third of all the graves (n=33),
- 12 individuals from 8 different graves of Vollein could be sampled, which corresponds to about 12% of the necropolis,
- Among the rediscovered bones labeled to be from the stone cist grave from Derby, 3 individuals could be distinguished and sampled.

In July/August 2021 the few remaining human bones from the site of Montjovet (stored in the Musei Reali in Torino, Italy) were examined by the laboratory of ancient DNA of the University of Bologna, and 1 g of 4 different petrous bones could be sampled. It was however not possible to assign these bones to specific individuals or graves mentioned in the archaeological documentation. The human remains were heavily disturbed, and 3 of the 5 graves were destroyed during the Second World War (Fumagalli 1955). Further, as a surprise, in April 2022 one complete stone cist grave with the human remains of 1

https://doi.org/10.1017/RDC.2023.12 Published online by Cambridge University Press

individual in original position was rediscovered in the archive of the Musei Reali in Torino and subsequently sampled for this study.

Treatment

The 31 samples were processed in the laboratory of the Department of Physical Anthropology (IRM) of the University of Bern and transferred to the Laboratory for the Analysis of Radiocarbon with AMS (LARA) of the University of Bern for dating. The sample preparation was slightly modified from Szidat et al. (2017) by implementation of an ultrafiltration step. In brief, the bones were cleaned by ultrasonication in ultra-pure water and ground to 0.5–1 mm with a ball mill. The chemical treatment included the following steps: 4% hydrochloric acid (HCl) for 60 hr, 0.1 mol/L sodium hydroxide (NaOH) for 1 hr, 4% HCl for 1 hr, followed by a gelatinization in diluted HCl at pH 3 and 60°C overnight. The warm solution was filtered using precleaned Ezee-Filters, ultrafiltration was performed with Vivaspin™ 15 30 kDa molecular weight cut-offs (MWCO) ultrafilters (Sartorius) and the high-molecular-weight fraction was lyophilized. The extracted collagen was combusted and graphitized with an automated graphitization equipment (AGE). The ^{14}C measurements were performed with the accelerator mass spectrometry (AMS) system MICADAS using ^{14}C-free sodium acetate and the NIST standard Oxalic Acid II (SRM 4990C) for blank subtraction, standard normalization, and correction for isotope fractionations (Szidat et al. 2014).

Exploratory Check for Freshwater Reservoir Effect

In order to check for possible freshwater reservoir effect on our ^{14}C estimates, we run a preliminary analysis of stable isotopic ratios of carbon (δ^{13}C) and nitrogen (δ^{15}N) on a subset of seven individuals (three each from Villeneuve and Vollein, and one from Derby). Isotope ratios were measured by isotope ratio mass spectrometry (IRMS) at Isolab GmbH, Schweitenkirchen, Germany, using the average of three measurements per sample. Results are reported in δ-notation as units per mill (‰) according to the international standards of Vienna Pee Dee Belemnite (V-PDB) for carbon and Ambient Inhalable Reservoir (AIR) for nitrogen. Moreover, the laboratory internal standards STD R (collagen from cowhide from the EU project TRACE) and STD BRA (collagen from Brazilian cowhide) were used. Internal analytical errors were recorded as ± 0.1‰ for δ^{13}C, ± 0.2‰ for δ^{15}N (standard error of the means calculated from 3 or 4 measurements).

Isotopic ratios were first explored visually and then included in Bayesian models of dietary composition using FRUITS (Fernandes et al. 2014), including as dietary resources C_3 plants, terrestrial animals, and freshwater fish. Previous isotopic research strongly suggest that millets were, in the Italian peninsula, part of human diet only starting from the Early Bronze Age (Varalli et al. 2022). For this reason, we did not include C_4 plants in the model. Faunal and paleobotanical samples are at present not available from the analyzed contexts. The model was therefore run with no priors and using as proxies published isotopic values for C_3 plants and terrestrial herbivores/omnivores (averaging values for bovids, caprinae, pigs, and red deer) from Bronze Age western Switzerland (Varalli et al. 2021), and from Bronze Age Savoy for freshwater fish (pike) (Varalli et al. 2021). Given the location of the sites (the nearest coastline is some 250 km away), we assume that the dietary exploitation of marine resources was quite unlikely for prehistoric times and was therefore not considered.

Calibration and plots of the raw ^{14}C data were conducted with the Oxcal 4.4.4 software (Bronk Ramsey 2009, 2021) using the IntCal20 atmospheric curve (Reimer et al. 2020). The two-sigma probability interval was used discussing the ^{14}C results (as recommended by Millard 2014). Quality control for the data focused on the atomic C/N ratio and the collagen yield (%w/w) (van Klinken 1999; Szidat et al. 2017). Sufficient collagen preservation of bone samples is indicated by a C/N ratio between 3.10 and 3.30 and collagen yields ≥0.5%. In contrast to earlier work (Szidat et al. 2017), we narrowed the range of the C/N ratio conservatively to 3.10–3.30 due to the observation that the distribution of both good and still acceptable bone samples widely falls into these boundaries, whereas C/N ratios above 3.30 may occasionally show biased results. A similar approach was recently applied by Zazzo et al. (2019).

RESULTS

Table 1 shows all the obtained ^{14}C data. Considered valid ^{14}C dates are displayed in Figure 3 as a multi-plot (a) and summarized using overlapping sum and kernel density estimation (KDE) plot (b) with the purpose of showing the most likely use time of the burial sites. While the sum distribution often exhibits sharp drops and rises associated with features from the calibration curve (Bronk Ramsey 2017), the frequentist method KDE can be applied to characterize the overall age range while removing much of the frequency variability of sum distributions (Loftus et al. 2019).

Villeneuve

The LARA was able to generate a valid result for 64%, or 7 out of 11 samples, the remaining 4 did not meet the quality control criteria and were rejected. Thus, a valid ^{14}C date is now available for 21% of the 33 stone cist graves from the Villeneuve necropolis. The raw dates (n=7) are almost identical dating in the period between 4720 and 4550 cal BCE, with the exception of the slightly older individual from T17 (4798–4681 cal BCE).

Vollein

For all samples (n=12) a valid result could be generated. The bones were stored unwashed and untreated right after their excavation, and we assume that these circumstances may explain the good collagen preservation. The data of the bone samples show a larger spread. The oldest dating yielded the individual from grave T31 (4611–4455 cal BCE; Figure 2a). The youngest result is from individual 1 of grave T50 (4442–4265 cal BCE). Based on the age determination of individual 2 from T50 (4445–4332 cal BCE), assumed to have been deposited simultaneously with individual 1, a dating to the 43rd century BCE is rather unlikely. With this exception addressed, the graves date in the period between 4600 and 4350 cal BCE.

Derby

A valid result could be generated for all 3 samples. The dates of individuals 1 and 2 are almost identical, dating in the period between 4700 and 4450 cal BCE (chronologically situated between the dated individuals of Villeneuve and Vollein; Figure 3b). Individual 3 yielded an Early Medieval date, it can be assumed that this third skull fragment does not originate from the Neolithic stone cist (therefore this dating was not considered for the investigation).

Table 1 ^{14}C results of the analyzed bone samples (n=31).

Site	Burial/ individual	Anthro-pological sex estimation	Age at death estimation (in years)	Bone sampled	Lab code	^{14}C age (BP ± 1σ)	Calibrated age (BCE, 2σ range)	Atomic C/N ratio	C content (%w/w) in gelatin	Collagen yield (% w/w)
Derby	1, Ind. 1	Male	35–49	Temporal bone*	BE-14324.1.1	5737 ± 28	4681–4498	3.29	42.6	0.7
Derby	1, Ind. 2	Female	20–34	Temporal bone	BE-14325.1.1	5717 ± 28	4675–4458	3.28	43.6	1.2
Derby	1, Ind. 3	Unknown	Around 3	Temporal bone	BE-14326.1.1	1270 ± 25	668–821 (CE)†	3.21	44.1	3.5
Montjovet	Sep. 1	Unknown	Unknown	Tooth	BE-19220.1.1	—	—	3.34†	40.2	0.2†
Montjovet	351 D	Unknown	Unknown	Temporal bone	BE-17005.1.1	—	—	3.37†	45.7	0.9
Montjovet	352 D	Unknown	Unknown	Temporal bone	BE-17006.1.1	1291 ± 22	666–774 (CE)†	3.25	45.6	3.2
Montjovet	352 S	Unknown	Unknown	Temporal bone	BE-17007.1.1	1366 ± 22	611–759 (CE)†	3.26	45.2	3.3
Montjovet	354 S	Unknown	Unknown	Temporal bone	BE-17008.1.1	1543 ± 22	435–591 (CE)†	3.29	44.7	3.3
Villeneuve	T4	Male	<50	Temporal bone	BE-14327.1.1	—	—	3.23	43.3	0.4†
Villeneuve	T5	Female	<50	Temporal bone	BE-14328.1.1	5789 ± 28	4713–4550	3.20	44.0	0.8
Villeneuve	T7	Female	<50	Temporal bone	BE-14329.1.1	5787 ± 28	4711–4550	3.20	44.0	2.0
Villeneuve	T8	Female	19–34	Temporal bone	BE-14330.1.1	5799 ± 28	4719–4550	3.24	44.2	1.2
Villeneuve	T10	Male	20–34	Temporal bone	BE-14331.1.1	5801 ± 28	4721–4550	3.21	43.8	1.3
Villeneuve	T11	Male	<50	Temporal bone	BE-14332.1.1	—	—	3.29	43.6	0.3†
Villeneuve	T16, Ind. 1	Unknown	Around 10	Temporal bone	BE-14333.1.1	—	—	3.39†	44.5	1.0
Villeneuve	T16, Ind. 2	Male	35–49	Temporal bone	BE-14334.1.1	5804 ± 25	4722–4551	3.24	44.6	3.0
Villeneuve	T17	Female	<50	Temporal bone	BE-14335.1.1	5866 ± 25	4798–4681	3.30	43.4	1.3
Villeneuve	T23	Male	35–49	Occipital bone	BE-14336.1.1	—	—	3.33	39.5	0.1†
Villeneuve	T25	Male	34–41	Temporal bone	BE-14337.1.1	5798 ± 25	4718–4551	3.23	43.5	1.0
Vollein	T1	Female?	<50	Temporal bone	BE-14338.1.1	5633 ± 25	4537–4367	3.21	43.1	1.4
Vollein	T7, Ind. 1	Male	35–49	Temporal bone	BE-14339.1.1	5614 ± 25	4498–4360	3.22	43.7	2.1
Vollein	T7, Ind. 2	Male	<50	Temporal bone	BE-14340.1.1	5605 ± 31	4496–4356	3.21	44.6	2.9
Vollein	T7 (?)	Female	Unknown	Temporal bone	BE-14341.1.1	5590 ± 26	4487–4355	3.24	43.3	1.0

(Continued)

Table 1 (*Continued*)

Site	Burial/ individual	Anthro- pological sex estimation	Age at death estimation (in years)	Bone sampled	Lab code	^{14}C age (BP ± 1σ)	Calibrated age (BCE, 2σ range)	Atomic C/N ratio	C content (%w/w) in gelatin	Collagen yield (% w/w)
Vollein	T15, Ind. 1	Unknown	Unknown	Temporal bone	BE-14342.1.1	5573 ± 25	4451–4352	3.23	43.7	2.1
Vollein	T15, Ind. 2	Unknown	Unknown	Temporal bone	BE-14343.1.1	5576 ± 27	4454–4351	3.21	44.3	1.6
Vollein	T25	Unknown	Around 10	Temporal bone	BE-14344.1.1	5594 ± 25	4489–4356	3.19	44.1	2.0
Vollein	T30	Male	35–49	Temporal bone	BE-14345.1.1	5566 ± 25	4449–4352	3.22	44.1	0.7
Vollein	T31	Female	<50	Temporal bone	BE-14346.1.1	5704 ± 25	4611–4455	3.18	44.2	2.3
Vollein	T50, Ind. 1 E	Unknown	Unknown	Temporal bone	BE-14347.1.1	5499 ± 25	4442–4265	3.27	43.7	0.8
Vollein	T50, Ind. 2 W	Female	20–24	Temporal bone	BE-14348.1.1	5517 ± 25	4445–4331	3.26	43.7	1.0
Vollein	T55	Male?	20–34	Temporal bone	BE-14349.1.1	5529 ± 25	4446–4337	3.23	44.1	1.1

*All temporal bone samples were taken from the petrous portion.

†Invalid data, indicating where it does not meet the quality control criteria.

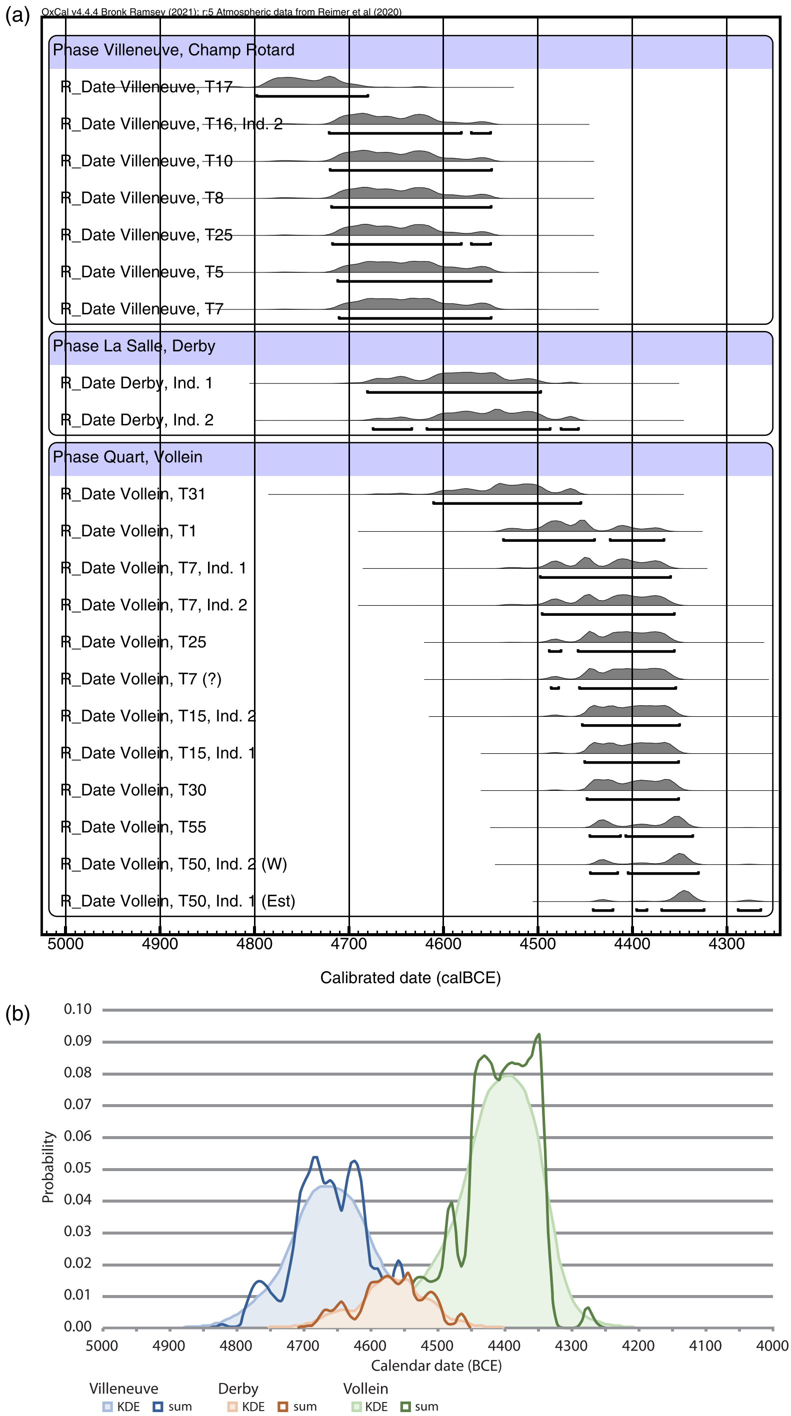

Figure 3 Calendar ages of the considered valid ^{14}C dates (n=21) displayed as (a) multi-plot and (b) overlapping sum and KDE plots using the software OxCal 4.4.4 with default settings (Bronk Ramsey 2017) based on the data from Table 1.

https://doi.org/10.1017/RDC.2023.12 Published online by Cambridge University Press

Table 2 Stable isotope ratios of carbon and nitrogen from bone collagen of the 7 analyzed individuals.

Individual	Age (yr)	Sex	δ13C [‰]V-PDB	δ15N [‰]AIR	%C	%N	molar C/N
Villeneuve T4	≥ 50	M	–19.99	9.72	36.70	13.30	3.22
Villeneuve T7	≥ 50	F	–19.84	9.38	40.80	14.90	3.19
Villeneuve T16.2	35–49	M	–19.65	9.17	39.90	14.50	3.21
Vollein T7.2	≥ 50	M	–19.43	10.64	39.60	14.20	3.25
Vollein T25	10 ± 2.5	NA	–19.63	9.57	39.70	14.30	3.24
Vollein T31	≥ 50	F	–19.5	9.9	39.60	14.40	3.21
Derby Ind. 2	20–34	F	–19.79	9.84	35.10	12.60	3.25
N			7	7			
Mean			–19.69	9.75			
SD			0.15	0.47			

Montjovet

Three of the five analyzed samples yielded a valid ^{14}C result. However, with dating ranges between 435–775 cal CE these were not considered for the investigation. Based on the archaeological record, Late Antique or Early Medieval dating for these graves seems highly unlikely and a mix up with bones from the overlying cemetery during the long and disturbed storage of these human remains is most likely.

Stable Isotopes of Carbon and Nitrogen: Preliminary Results and Explorative Analysis

Table 2 shows the isotopic values of the 7 human samples. All samples fit the quality criteria. Stable carbon and nitrogen isotopic ratios range respectively from –19.43 to –19.99 (average: –19.69 ± 0.15) and from 9.17 to 10.64 (average: 9.75 ± 0.47). Figure 4 illustrates the results of the Bayesian modeling of dietary composition. These are consistent with a mixed diet including C_3 plant products (64.9%). Conversely, the exploitation of terrestrial animals and freshwater food resources seems quite low (respectively 15.5% and 19.5%).

DISCUSSION

Our ^{14}C dates are the first available for Chamblandes type burials in the Aosta Valley. They significantly expand our knowledge of the chronological timespan for the use of this type of grave. Previous hypotheses placed the stone cist graves from this region in the Late Neolithic, or even the Bronze Age (Mezzena 1997). Our data, especially those from Villeneuve, allow to substantially revise these estimates, rather pointing to an earlier chronology. The Bayesian results based on an overlapping phase model (Figure 5; $A_{model} = 84.2$, $A_{overall} = 80.5$), frame the burial activity within the Villeneuve necropolis to 4737–4606 cal BCE (68.4%)/4785–4555 cal BCE (95.4%) and within the Vollein site to 4502–4320 cal BCE (68.4%)/4555–4305 cal BCE (95.4%). This result is of special interest since it places the finds from the Aosta Valley among the oldest Chamblandes type graves ever discovered.

Regarding the burial activity, contemporaneity is statistically unlikely for all available dates of the two necropolises; modeled in one phase they span 331–387 (68.4%)/286–426 (95.4%) years. Regarding the sites themselves, the span of dates from Villeneuve is 0–63 (68.4%)/0–131

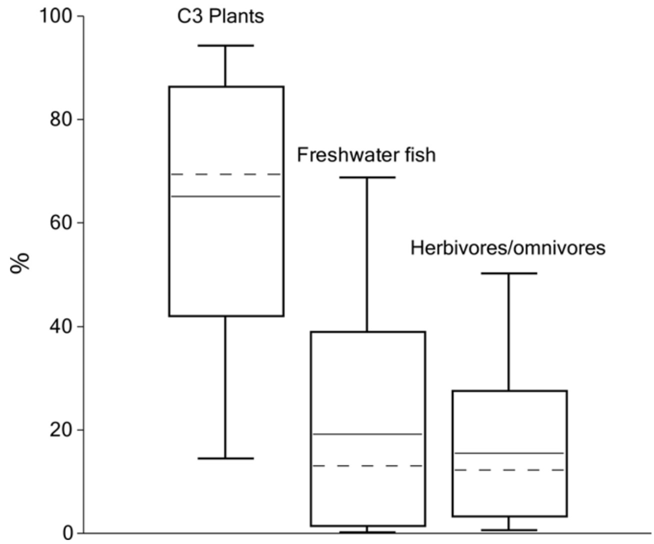

Figure 4 Estimates of dietary composition based on the average $\delta^{13}C$ and $\delta^{15}N$ values from human bone collagen. Horizontal continuous and dashed lines show the mean and median values respectively.

(95.4%) years and as it includes zero, they could be isochronous. In contrast, the dates from the site of Vollein span 36–151 (68.4%)/18–177 (95.4%) years. However, excluding the oldest sample (T31), the span of dates from Vollein is 6–72 (68.4%)/0–109 (95.4%) years and contemporaneity is statistically possible. This indicates that the data from Vollein should be divided into an older, and a younger main phase. Finally, the combination of the Villeneuve-dates with sample T31 from Vollein, results in a span of 0–112 (68.4%)/0–194 (95.4%) years. This indicates that the oldest date from Vollein could statistically be isochronous to the burials from Villeneuve. Taken together, the sample T31 is difficult to contextualize—both within Vollein and compared to Villeneuve—and further ^{14}C dates would be required to dismiss or confirm the older phase from Vollein.

Table 3 lists the most important Neolithic stone cist sites in the Western Alpine region featuring multiple ^{14}C data. The considered ^{14}C dates (n=112) were modeled in independent bounded phases ($A_{model} = 99$, $A_{overall} = 89.7$). Figure 6 shows the KDE plots ordered by their respective median to visualize the likely period of use for these necropolises. From this overview it appears that the only context presenting a ^{14}C age as old as those from Villeneuve is the vast necropolis of Thonon-les-Bains, Genevray (Haute-Savoie, France). In addition, a single date each from the two sites of Bourg-Saint-Maurice, Le Châtelard (Haute-Savoie, France) and Sion, Sous-le-Scex (Valais, Switzerland) indicate burials starting in the 48th century BCE. However, only few data are so far available from Bourg-Saint-Maurice, Le Châtelard (Rey et al. 2018) and the current ^{14}C data from Sion, Sous-le-Scex exhibit relatively high uncertainties of ± 65 yr (Honegger 2011), resulting in a modeled median date of 4510 cal BCE (see Figure 6). Taken together, the comparison of these data suggests the intriguing hypothesis of an almost contemporaneous emergence of the use of stone cist burials in the southern shore of Lake Geneva (Thonon-les-Bains, Genevray) and several inner-Alpine Valleys (mainly Aosta, but most probably also the Tarentaise and Upper Rhône Valley).

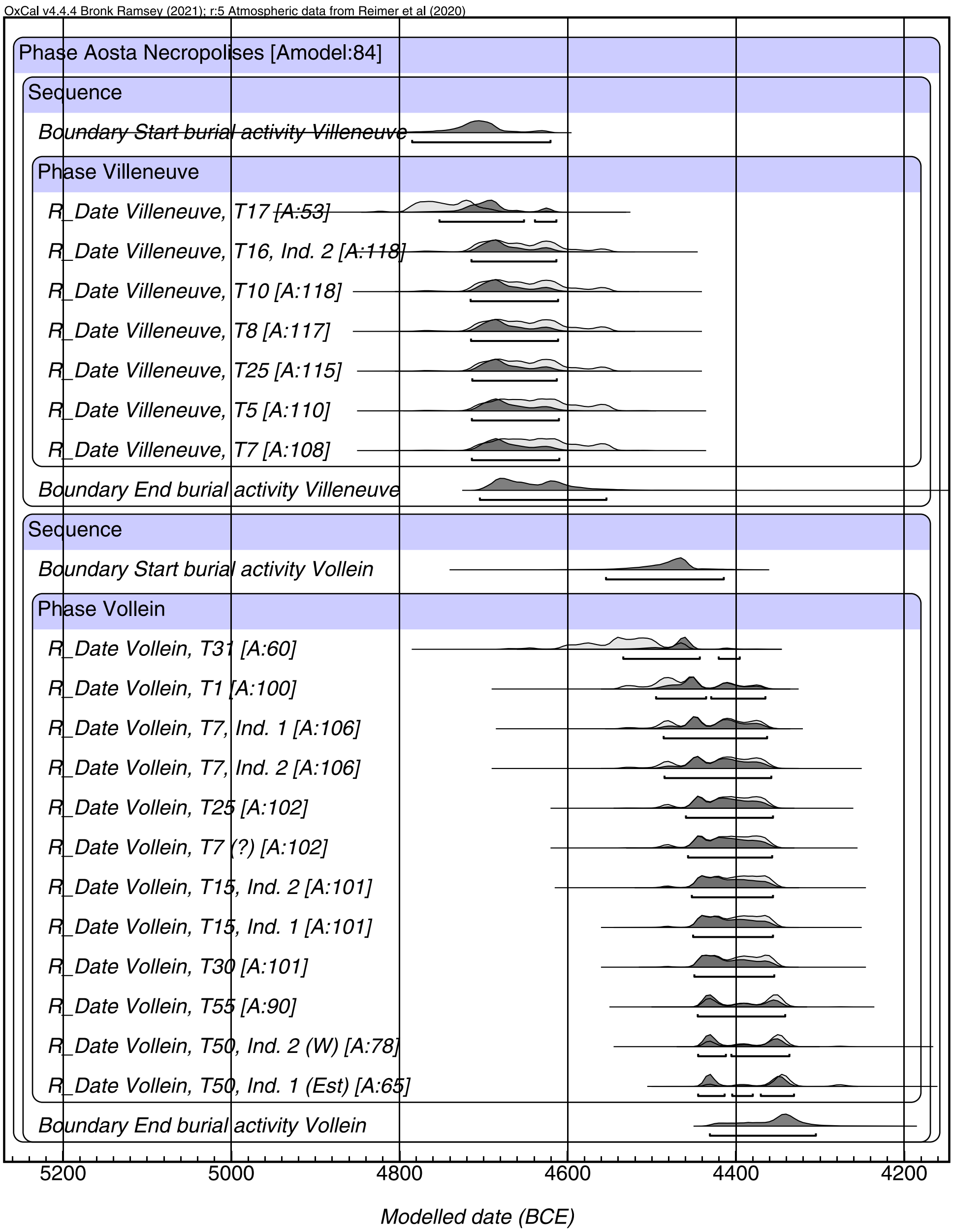

Figure 5 Independent bounded phase model of ^{14}C dates from the necropolises of Villeneuve and Vollein using OxCal 4.4.4 software (Bronk Ramsey 2009).

Further, we observe the wider inter-regional spread of stone cist graves occurring after 4500 BCE, mainly to the north (Swiss northern shore of Lake Geneva), northeast (Swiss Plateau) and west (Ain, France). Moreover, our new data show that the use of stone cist graves for burials in the Aosta Valley ceased around 4300 BCE. This is earlier than in neighboring areas, where the demise of this funerary custom can be placed around 4000/3800 BCE.

https://doi.org/10.1017/RDC.2023.12 Published online by Cambridge University Press

https://doi.org/10.1017/RDC.2023.12 Published online by Cambridge University Press

Table 3 Selection of the most important sites of Neolithic cist graves in the northwestern Alpine region. Published ^{14}C dates were recalibrated with the Oxcal 4.4.4 software (Bronk Ramsey 2009) using the IntCal20 atmospheric curve (Reimer et al. 2020), data with uncertainties over ± 65 yr were not considered.

Region	Area	Site	Nr of located graves	Summarized ^{14}C age (BCE)	Nr of dated bone samples	Nr on map (Figure 1a)	Reference
Aosta (Italy)	Aosta Valley	Villeneuve, Champ Rotard	33	4800–4550	7	58	This work
Aosta (Italy)	Aosta Valley	Quart, Vollein	66	4600–4350	12	57	This work
Savoie (France)	Tarentaise Valley	Aime, Le Replat	9 (30)	4600–4250	6	51	Gély 2005; Gély et al. 1991
Savoie (France)	Tarentaise Valley	Bourg-Saint-Maurice, Le Châtelard	6	4750–4350	3	52	Rey et al. 2018
Ain (France)	Bugey	Montagnieu, Grotte-du-Souhait	8	4450–4000	10	54	Gatto 2012; Banque Nationale de Données Radiocarbone (BANADORA)
Haute-Savoie (France)	Lake Geneva (southern shore)	Thonon-les-Bains, Genevray	<220	4800–4000 (pit graves starting ca. 4900, isolated younger burials)	37	47	Baudais et al. 2017
Vaud (Switzerland)	Lake Geneva (northern shore)	Pully, Chamblandes	<71	4350–4000	4	30	Moinat/Studer 2007
Vaud (Switzerland)	Lake Geneva (northern shore)	Lausanne, Vidy	<126	4500–3800 (isolated younger burials)	16	29	Moinat/Studer 2007
Valais (Switzerland)	Upper Rhône Valley	Sion, Remparts	12	4500–3750	7	1–16	Mariéthoz 2007
Valais (Switzerland)	Upper Rhône Valley	Sion, Sous-le-Scex	16 (24)	4700–3800/3650	6	1–16	Honegger 2011
Aargau (Switzerland)	Swiss Plateau	Lenzburg, Goffersberg	16	4450–4000	4	42	De Capitani 2007

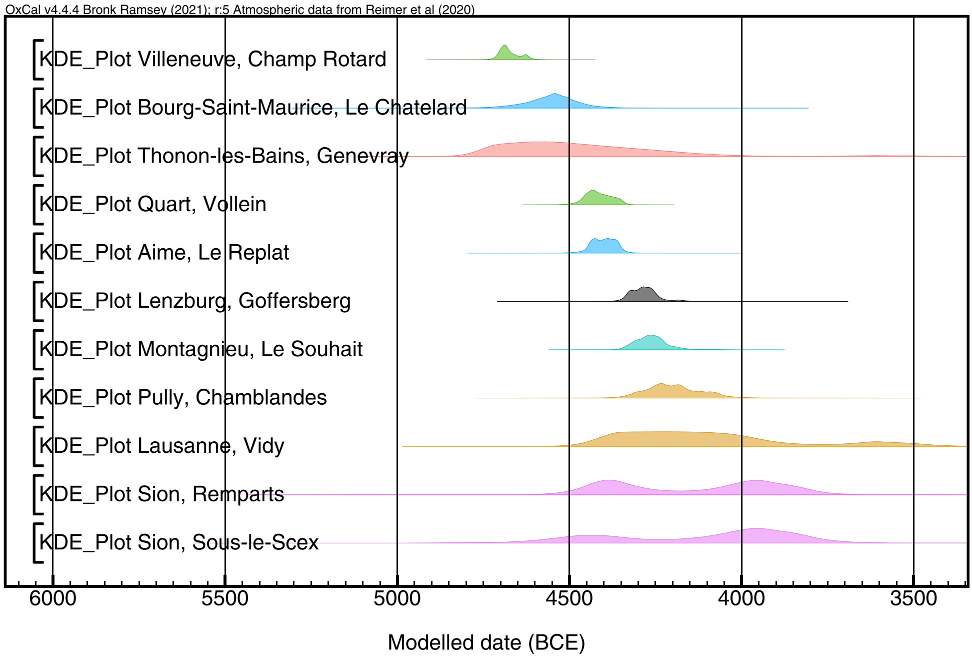

Figure 6 KDE plots derived from independent bounded phase model of ^{14}C dates (n=112) from the sites listed in Table 3 using OxCal 4.4.4 software (Bronk Ramsey 2009). The colors refer to the geographical area (green: Aosta Valley, blue: Tarentaise Valley, purple: Upper Rhône Valley, red: Lake Geneva South, orange: Lake Geneva North, gray: Swiss Plateau, teal: Bugey).

Isolated burials from the late 4th or 3rd millennium BCE (identified within the sites of Thonon-les-Bains, Genevray and Lausanne, Vidy) indicate the sporadic reuse of stone cist graves in younger periods, an interesting phenomenon which deserves further investigations.

This assessment of the chronology and emergence of Neolithic cist graves in the Western Alpine region is supported by the fact that the earliest pile dwelling sites on the southern foothills of the Alps were found at Lake Varese (Lombardy, Italy), where the beginning of farming activities was dated around ca. 5000–4850 cal BCE (Antolín et al. 2022), whereas the earliest settlement of this type north of the Alps was found in Egolzwil (Lucerne, Switzerland) dating to 4300 cal BCE (Stöckli et al. 2013). Therefore, it was suggested that parts of the Neolithic community from Lake Varese could have migrated to north of the Alps, possibly across the Upper Rhône Valley (Antolín et al. 2022). In that sense, ^{14}C data of Neolithic settlement layers in the region of Sion (Valais, Switzerland) date to after 4750 cal BCE and increase in the second halve of the 5th millennium BCE (Piguet 2011). In addition, evidence for high Alpine mobility between the Upper Rhône Valley and the Swiss Plateau during this period was found on top of the Schnidejoch mountain pass in the western Bernese Alps (Bern, Switzerland) at 2750 m a.s.l, where 5 wood samples of arrow shafts date to 4800–4500 cal BCE (Hafner 2015). Therefore, these finds are even older than the famous Iceman from the more eastern Italian Alps, who dates to 3370–3100 cal BCE (Kutschera and Rom 2000). In this context, also the few available grave goods found within stone cist graves in the Aosta Valley indicate far reaching exchange networks of these inner Alpine societies, as the mentioned Glycymeris shell bracelets originate from the

https://doi.org/10.1017/RDC.2023.12 Published online by Cambridge University Press

Mediterranean Sea (Borrello et al. 2009), whereas the raw material of the disc jet beads probably came from southern Germany (Rochna 1962; Baudais et al. 2017).

Furthermore, a large-scale comparison with the new data shows that the Western Alpine cist graves are largely contemporaneous with settlements and graves of the Upper Rhine area (southern Germany/eastern France). Here, the oldest Neolithic settlements of the region with Linear Pottery (LBK) are followed by a phase of related ceramic styles—Hinkelstein, Grossgartach, Rössen, Bischheim occidental du Rhin supérieur (BORS)—dating to 4800–4000 cal BCE (Denaire et. al 2017). Further connections to the Upper Rhine area exist through the discovery of a typical shoulder cup in one of the stone cist graves at the site of Däniken, Studenweid (Solothurn, Switzerland), number 44 on Figure 1a (Steuri and Hafner 2022).

Based on our preliminary analysis of stable carbon and nitrogen isotopic ratios a freshwater reservoir effect seems unlikely in the present specimen. Naturally, these estimates need in any case to consider three important caveats: (a) the small size of the analyzed sample (n=7, i.e., 23% of the sampled individuals), (b) the lack of faunal samples from the analyzed sites, which strongly limits our interpretation, and (c) freshwater food webs vary greatly in stable carbon and nitrogen isotope ratios depending on the species and additionally the species values show large standard deviations (e.g., Bösl et al. 2006). These three reasons combined make it difficult to estimate a potential freshwater reservoir effect. However, given the long distance of the sites to the nearest coastline, we assume the dietary exploitation of marine resources as quite unlikely.

It should additionally be noted that we investigated almost exclusively petrous bones for ^{14}C dating in this work, whereas the earlier studies (listed in Table 3) applied different bone material such as other skull parts or long bones. All of these bones were selected for the sake of collagen preservation, although none of these allows the determination of the time of death directly due to a slow carbon turnover, which typically results in ^{14}C ages of the bones that are a few decades older than the date of the death (Meadows et al. 2020; Indra et al. 2022). As the petrous bone is already formed in early childhood (Jørkov et al. 2009; Meadows et al. 2020), this offset may even be a few decades larger than for both other skull parts or long bones, which should be taken into account for the comparison of the results from the Aosta Valley from this work with results from earlier studies. As the modeled age ranges span about a century (Figure 5), however, we regard this possible difference of a few decades as negligible.

CONCLUSION

This study provides new evidence about the emergence of a specific burial practice of 5th millennium BCE Neolithic cist graves of the Western Alpine region, and new data about the development of social and cultural transalpine networks. It should be noted that anthropological remains from cist graves of Aosta Valley are typically few and badly preserved. As such, the data presented in this contribution might represent some of the only absolute dating potentially available from the stone cist graves of this region. Our project includes more than 120 new ^{14}C dates from cist graves in the Aosta Valley and neighboring alpine regions and preliminary data does not show major deviations from the chronology provided in this study.

ACKNOWLEDGMENTS

We thank the Swiss National Science Foundation (SNSF) for funding the project of N. Steuri (project number P0BEP1_188130), including the ^{14}C dating. We are grateful to the Soprintendenza, Patrimonio archeologico of the Aosta region for providing access to the material and allowing sample extraction, as well as Gabriele Arenz (Institute of Forensic Medicine, University of Bern) for supporting the initial sample preparation, and Edith Vogel (LARA Bern), who prepared the bone samples for ^{14}C measurement. Further, we thank Andrea Bieri (Institute of Archaeological Sciences, University of Bern) for the support creating the figures, Martin Hinz (Institute of Archaeological Sciences, University of Bern), and Marcel Keller (Institute of Forensic Medicine, University of Bern) for the support creating the chronological models. We also would like to thank Beatrice Demarchi, Rosa Boano, and Alessia Monticone (University of Torino), Elisa Panero (Musei Reali Torino), and Elisabetta Cilli (University of Bologna) for examining and sampling the bones from the Montjovet site.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2023.12

REFERENCES

Antolín F, Martínez-Grau H, Steiner BL, Follmann F, Soteras R, Häberle S, Prats G, Schäfer M, Mainberger M, Hajdas I, Banchieri DG. 2022. Neolithic occupations (c. 5200–3400 cal BC) at Isolino Virginia (Lake Varese, Italy) and the onset of the pile-dwelling phenomenon around the Alps. Journal of Archaeological Science: Reports 42:103375. doi: 10.1016/j.jasrep.2022.103375.

Banque Nationale de Données Radiocarbone (BANADORA). Available at https://www.arar.mom.fr/banadora/ (accessed 12 April 2022).

Barocelli P. 1919. Villeneuve: necropoli neolitica. Notizie degli scavi di antichità comunicate alla R. Accademia dei Lincei per ordine di s.e. il Ministro della pubb. Istruzione 10:253–257.

Barocelli P. 1951. La Préhistoire en Vallée d'Aoste. Augusta Praetoria IV(3,4):143–155, 198–215.

Baudais D, Gatto E, Jallet F. 2017. La nécropole néolithique moyen. Thonon-les-Bains, Haute-Savoie, Rhône-Alpes. Genevray. Volume 1 - textes et illustrations: 74–172.

Borrello MA, Mottes E, Schlichtherle H. 2009. Traverser les Alpes au Néolithique. Le Globe. Revue genevoise de géographie 149:29–60.

Bösl C, Grupe G, Peters J. 2006. A Late Neolithic vertebrate food web based on stable isotope analyses. International Journal of Osteoarchaeology 16:296–315.

Bronk Ramsey C. 2009. Bayesian analysis of radiocarbon dates. Radiocarbon 51(1):337–360. doi: 10.1017/S0033822200033865.

Bronk Ramsey C. 2017. Methods for summarizing radiocarbon dates. Radiocarbon 59(6):1809–1833. doi: 10.1017/RDC.2017.108.

Brooks S, Suchey JM. 1990. Skeletal age determination based on the os pubis: a comparison of the Acsádi-Nemeskéri and Suchey-Brooks methods. Human Evolution 5(3):227–238. doi: 10.1007/BF02437238.

Buckberry JL, Chamberlain AT. 2002. Age estimation from the auricular surface of the ilium: a revised method. American Journal of Physical Anthropology 119(3):231–239. doi: 10.1002/ajpa.10130.

Buikstra JE, Ubelaker DH. 1994. Standards for data collection from human skeletal remains. Arkansas Archaeological Survey Research Series 44. Fayetteville (AR).

Corrain C. 1986. I resti scheletrici della necropoli eneolitica di Villeneuve (Aosta). Memorie del Museo Archeologico di Aosta I. Aosta, Italy.

De Capitani A. 2007. Lenzburg Goffersberg (Argovie) ou les «Chamblandes» de la partie orientale du Plateau Suisse. Les cistes de Chamblandes et la place des coffres dans les pratiques funéraires du Néolithique moyen occidental. Cahiers d'archéologie romande 110:221–232.

Denaire A, Doppler T, Nicod PY, van Willingen S. 2011. Espaces culturels, frontières et interactions au 5ème millénaire entre la plaine du Rhin supérieur et les rivages de la Méditerranée. Jahrbuch Archäologie Schweiz 94:21–59.

Denaire A, Lefranc P, Wahl J, Bronk Ramsey C, Dunbar E, Goslar T, Bayliss A, Beavan N, Bickle P, Whittle A. 2017. The Cultural Project: Formal Chronological Modelling of the Early and Middle Neolithic Sequence in Lower Alsace.

Journal of Archaeological Method and Theory 24:1072–1149. doi: 10.1007/s10816-016-9307-x.
Fernandes R, Millard A, Brabec M, Nadeau M-J, Grootes P. 2014. Food Reconstruction Using Isotopic Transferred Signals (FRUITS): A Bayesian Model for Diet Reconstruction. PLoS ONE 9(2):e87436. doi: 10.1371/journal.pone.0087436.
Fumagalli S. 1955. Crani neolitici di Villeneuve nella Valle d'Aosta. Atti della Società italiana di Scienze naturali e del Museo Civico di Storia naturale in Milano Volume XCIV(2):105–144.
Gallay A. 2008. Des Alpes au Léman. Images de la préhistoire. Gollion.
Gatto E. 2012. Les sépultures de la grotte de Souhait (Montagnieu-Ain). Découvertes par MM. Parriat et Perraud à la lumière des méthodes d'étude actuelles et d'une mise en context. Actes de la première rencontre d'archéologie régionale: (Briord, 29 mai 2010):59–68.
Gély B. 2005. Aime. Le Replat. Bilan scientifique de la région Rhône-Alpes 13:186.
Gély B, Ougier-Simonin P, Porte JL. 1991. Fouilles de sauvetage d'une nécropole néolithique à Aime (Savoie). Bulletin d'études préhistoriques et archéologiques alpines 2:41–55.
Hafner A. 2015. Schnidejoch und Lötschenpass: Datierung und Fundverteilung. Schnidejoch und Lötschenpass Band 1:224–246.
Honegger M. 2011. Sion, Sous-le-Scex (VS) II. Habitats et nécropoles du néolithique et de l'âge du bronze. Cahiers d'archéologie romande 125. Lausanne.
Indra L, Hamann C, Szidat S, Kanz F, Lösch S, Lehn C. 2022. Radiocarbon dating of forensic human bone to estimate the postmortem interval (PMI). 24th Radiocarbon Conference and 10th ^{14}C & Archaeology Conference. 11–16 September 2022. Zürich. Book of Abstracts. p. 202.
Jeunesse C, van Willigen S, Denaire A. 2019. Les sépultures de type Chamblandes et la géographie des systèmes funéraires en Europe centrale et occidentale au 5ème millénaire avant J.-C. Trent'anni di tutela e ricerca preistorica in Emilia occidentale. Atti del Convegno di Studi in onore di Maria Bernabò Brea, Museo Civico Archeologico di Travo - Parco Archeologico Villaggio Neolitico di Travo, Piacenza. p. 65–80.
Jørkov MLS, Heinemeier J, Lynnerup N. 2009. The petrous bone—A new sampling site for identifying early dietary patterns in stable isotopic studies. American Journal of Physical Anthropology 138(2):199–209. doi: 10.1002/ajpa.20919.
Kutschera W, Rom W. 2000. Ötzi, the prehistoric Iceman. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms. 164-165:12–22. doi: 10.1016/S0168-583X(99)01196-9.
Loftus E, Mitchell P, Bronk Ramsey C. 2019. An archaeological radiocarbon database for southern Africa. Antiquity 93(370):870–885. doi: 10.15184/aqy.2019.75.
Lösch S, Siebke I, Furtwängler A, Steuri N, Hafner A, Szidat S, Krause J. 2020. Bioarchäologische Untersuchungen der Knochen aus dem Dolmen von Oberbipp, Steingasse. Archäologie Bern 2020. p. 202–230.
Mariéthoz F. 2007. Chronique des découvertes archéologiques dans le canton du Valais en 2006. Vallesia LXII:404–408.
Meadows J, Rinne C, Immel A, Fuchs K, Krause-Kyora B, Drummer C. 2020. High-precision Bayesian chronological modeling on a calibration plateau: the Niedertiefenbach gallery grave. Radiocarbon 62(5):1261–1284. doi: 10.1017/RDC.2020.76.
Mezzena F. 1981. La Vallée d'Aoste dans la préhistoire et la protohistoire. Archéologie en vallée d'Aoste. Du néolithique à la chute de l'empire Romain 3500 av. J.-C. - Vème siècle apr. J.-C. Catalogue de l'exposition à Saint-Pierre Château Sarriod de la Tour. p. 14–60.
Mezzena F. 1997. La valle d'Aosta nel Neolitico e nell'Eneolitico. La valle d'Aosta nel quadro della preistoria e protostoria dell'arco alpino centro-occidentale. Courmayeur, 2–5 Giugno 1994. Atti della riunione scientifica XXXI. p. 17–138.
Millard A. 2014. Conventions for reporting radiocarbon determinations. Radiocarbon 56(2):555–559. doi: 10.2458/56.17455.
Moinat P, Studer J. 2007. Cistes en pierre et coffres en bois, inhumations simples et dépôts complexes : un bilan des pratiques funéraires à Vidy (Lausanne, Vaud) et à Chamblandes (Pully, Vaud). Les cistes de Chamblandes et la place des coffres dans les pratiques funéraires du Néolithique moyen occidental. Cahiers d'archéologie romande 110:195–220.
Piguet M. 2011. La chronologie absolue du Néolithique moyen valaisan. Le site du Petit-Chasseur (Sion, Valais) 10:107–123.
Reimer P, Austin W, Bard E, Bayliss A, Blackwell P, Bronk Ramsey C, Butzin M, Hai C, Edwards R, Friedrich M, Grootes P, Guilderson T, Hajdas I, Heaton T, Hogg A, Hughen K, Kromer B, Manning S, Muscheler R, Palmer J, Pearson C, van der Plicht J, Reimer R, Richards D, Scott E, Southon J, Turney C, Wacker L, Adolphi F, Büntgen U, Capano M, Fahrni S, Fogtmann-Schulz A, Friedrich R, Köhler P, Kudsk S, Miyake F, Olsen J, Reinig F, Sakamoto M, Sookdeo A, Talamo S. 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). Radiocarbon 62(4):725–757. doi: 10.1017/RDC.2020.41.
Rey PJ, Treffort JM, De Larminat S. 2018. Le Châtelard de Bourg-Saint-Maurice (Savoie) du Néolithique à l'Âge du Fer. Un cas de site perché à fonctions multiples en vallée de Tarentaise. Les Dossiers du Musée Savoisien 4:1–12.

Rizzo G. 1910. Sepolcri neolitici di Montjovet. Atti dell'Accademia delle Scienze di Torino Vol. XLV:830–842.

Rochna O. 1962. Hallstattzeitlicher Lignit- und Gagat-Schmuck. Zur Verbreitung, Zeitstellung und Herkunft. Fundberichte aus Schwaben 16:44–83.

Schaefer M, Black SM, Scheuer L. 2009. Juvenile osteology. San Diego (CA): Academic Press.

Scheuer L, Black S. 2000. Developmental juvenile osteology. London: Academic Press.

Steuri N, Hafner A. 2022. Die neolithischen Steinkistengräber von Däniken/Studenweid. Archäologie und Denkmalpflege im Kanton Solothurn ADSO 27:11–30.

Stöckli W. 2016. Urgeschichte der Schweiz im Überblick (15 000 v. Chr.-Christi Geburt). Die Konstruktion einer Urgeschichte. Antiqua 54. Basel.

Stöckli W, Seifert M, Sormaz T. 2013. Die absolute Datierung von Egolzwil 3. Egolzwil 3. Die Keramik der neolithischen Seeufersiedlung. Archäologische Schriften Luzern 15:127–143.

Szidat S, Salazar G, Vogel E, Battaglia M, Wacker L, Synal H-A, Türler A. 2014. ^{14}C analysis and sample preparation at the new Bern Laboratory for the analysis of radiocarbon with AMS (LARA). Radiocarbon 56(2):561–566. doi: 10.2458/56.17457.

Szidat S, Vogel E, Gubler R, Lösch S. 2017: Radiocarbon dating of bones at the LARA Laboratory in Bern, Switzerland. Radiocarbon 59(3):831–842. doi: 10.1017/RDC.2016.90.

Ubelaker DH. 1989. Human skeletal remains: excavation, analysis, interpretation. taraxacum. Washington DC.

van Klinken GJ. 1999. Bone collagen quality indicators for palaeodietary and radiocarbon measurements. Journal of Archaeological Science 26(6):687–695. doi: 10.1006/jasc.1998.0385.

Varalli A, Desideri J, David-Elbiali M, Goude G, Honegger M, Besse M. 2021. Bronze Age innovations and impact on human diet: a multi-isotopic and multi-proxy study of western Switzerland. PloS One 16(1):e0245726. doi: 10.1371/journal.pone.0245726.

Varalli A, Moggi-Cecchi J, Goude G. 2022. A multi-proxy bioarchaeological approach reveals new trends in Bronze Age diet in Italy. Scientific Reports 12(1):12203. doi: 10.1038/s41598-022-15581-0.

Zazzo A, Lepetz S, Magail J, Gantula J-O. 2019. High-precision dating of ceremonial activity around a large ritual complex in Late Bronze Age Mongolia. Antiquity 93(367):80–98. doi: 10.15184/aqy.2018.175.