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The absolute chronology of the North Cemetery at Ayios Vasileios, Laconia

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ABSTRACT

In mortuary archaeology, it can be particularly difficult to establish a spatiotemporal framework for specific contexts such as commingled or unfurnished burials. This is the case for the Ayios Vasileios North Cemetery, a 2nd millennium BCE site in Greece. Here, the uneven stratigraphic information, the use of tombs for multiple burials, the manipulation of human remains, and the scarcity of ceramic offerings has hampered chronological analysis. In this study, we analysed 56 radiocarbon dates on human remains where we sought to establish an absolute chronology for this Early Mycenaean cemetery. We used Kernel Density Estimation to assess the length of use of the cemetery and compared the results to different ceramic typology-based chronologies of Bronze Age Greece. Our analysis placed many of the burial contexts in different cultural phases when different ceramic chronologies (High or Low Chronology) were used, highlighting the necessity for a higher resolution Aegean chronology. Regardless of the preferred system, the current data indicate that activity at the cemetery extended from at least Middle Helladic III to Late Helladic IIB.

1. Introduction

Ayios Vasileios is an important Mycenaean site located in Laconia, on the southern Greek mainland, named after the post-Byzantine church on the site. Excavations at the site have revealed a monumental palatial complex, with prominent finds such as Linear B tablets (Aravantinos and Vasilogamvrou, 2012; Karadimas, 2016) and demonstrated that the site was the long-sought palatial centre of Mycenaean Laconia (Karadimas et al., 2022).

Ayios Vasileios North Cemetery (AVNC) is located directly north of the palatial complex on the same hill. Its systematic excavation since 2010 has revealed a typical extramural cemetery of the Early Mycenaean period (Voutsaki et al., 2022). It displays characteristic features of this transitional period such as large stone-built cist graves and pits containing both single and multiple burials. The examination of the burials has shown that many of them have undergone secondary treatment. Specifically, the remains have been disarticulated and pushed into heaps or pits, removed within and from the grave, possibly at the occasion of a new burial or other post-burial events (Moutafi and Voutsaki, 2016; Voutsaki et al., 2018).

Establishing the chronology of the cemetery has proven to be challenging, due to the fact that many graves were used for multiple burials, and most of them were unfurnished. Indeed, the observed burial practices were complex, and the relative sequence of burials and graves were not always clear. So far, only a few of the graves could be situated relatively to the ceramic chronology. This was done using the prehistoric Greek mainland (or Helladic) chronology of the 2nd millennium BCE, which is divided into 3 different subperiods called Early Helladic (EH, also Early Bronze Age), Middle Helladic (MH, also Middle Bronze Age) and Late Helladic (LH, also Late Bronze Age or Mycenaean period) based on the changes in pottery typology (Dickinson, 1994). Each of these periods is categorised into phases and subphases, denoted by Roman numerals I, II, III and further divided into IA, IB, and so forth (see Table 1). On the basis of taphonomic and stratigraphic observations, as well as the scarce ceramic offerings, the main period of use of AVNC was placed between MH III and LH IIB (Voutsaki et al., 2020). There is no evidence of use in the MH I–II periods (Hachtmann and Voutsaki, 2022), but there was sporadic use of the cemetery during LH IIIA and LH IIB.

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The ceramic chronology of mainland (Mycenaean) Greece is well documented, and the relative sequence and the correlations with Minoan and Cycladic counterparts are well established (Warren and Hankey, 1989; Dietz, 1991; Manning, 1995, 2012; Mountjoy, 1999; Rutter, 2020). However, the absolute dates for these periods are usually approximations based on comparisons with the historical chronologies of Egypt and Mesopotamia, where timelines are more robustly established (Manning et al., 2006; Hofmayer, 2012; Shelton, 2012). The pinning down of these chronologies in calendar time has been debated not only in the Aegean but in the whole Mediterranean (Bietak, 2000; Bietak, 2003; Bietak and Czerny, 2007). The date of the Minoan eruption of Thera, placed in the Late Minoan IA (LM IA) period in relative chronology, is often proposed to be a major geological event that could synchronise many of the chronologies in the Mediterranean (Warburton, 2009; Manning, 2014, 2022). However, establishing this date has been a challenge. The controversy mainly concerns disagreements between Low and High Chronologies, especially regarding the absolute dates for the period from the end of MH III to LH III. The distinction between the two chronological schemes (Low Chronology i.e. Warren and Hankey, 1989; Shelmerdine, 2008; French, 2013, and High Chronology i.e. Manning, 2012) is noted on Table 1. The difference is as large as c.100 years especially for LH I and LH II A, but in later periods this difference shortens to c.50–20 years.

In light of these disagreements and complexity concerning the chronology of the Aegean Bronze Age and of the AVNC, radiocarbon (14C) dating has been called upon to create an absolute chronology. Due to the small amount of grave goods, the cemetery-wide chronology as well as the time periods of the unfurnished graves could be obtained primarily through 14C dating of the human remains. Here, our goal is to utilize 14C dates to establish the absolute timeframe for the cemetery and then compare these dates with the generally accepted absolute dates of the Mycenaean chronology found in the literature.

2. Material and Methods

Our analysis involved multiple steps: First, we sampled human remains from AVNC for 14C dating, and faunal remains for stable isotope analysis (δ15N and δ13C). The results from the herbivores were used to check whether a reservoir effect was present, which would cause the 14C dates on the humans to appear much older than their true age. This complication arises when an individual subsists mainly on resources from freshwater or marine ecosystems. In such cases, a separate 14C calibration process is required (Jull et al., 2013; Philippsen, 2013; Alves et al., 2018). Second, we investigated the distribution of the calibrated 14C dates in terms of the ceramic typology-based chronologies listed on Table 1 in order to situate each 14C date and the relevant grave on Mycenaean chronology. Additionally, we used modelling and Kernel Density Estimation (KDE) analysis to establish the span of use and identify if there are any trends in the activity at the site over time. Our ultimate objective, insofar as the data allowed, was to construct a chronological framework for the AVNC.

2.1. Radiocarbon data from AVNC

All of the burial contexts from the cemetery were sampled, in order to cover the complete length of use of the cemetery. The sampling strategy was to select and date as many individuals as possible from every grave and burial. From these contexts, a total of 74 bone samples were taken for 14C dating. Burial numbers of the samples are given in Table 2. For some multi-burial graves, several options are indicated, since it was not always possible to determine which specific individual the sample came from due to secondary depositions and commingled burials. Thirty-five samples were pretreated and measured at the Centre for Isotope Research (CIO), University of Groningen, 20 at the 14C Chrono Centre at Queen’s University Belfast, and 19 at the Keck Carbon Cycle AMS Facility at the University of California Irvine. The samples collected for 14C measurement consisted of human remains only. Routine collagen extraction procedures were done in each laboratory (see Santos et al., 2007; Beverly et al., 2010; Reimer et al., 2015; Dee et al., 2020). A detailed list of the samples is given in Table 2. The 14C calibration and analysis was done on OxCal version 4.4 using InMCa20 (Bronk Ramsey, 1995, 2009; Reimer et al., 2020).

2.2. Stable isotope data from AVNC

To assess whether the measurements on human remains from AVNC were likely to be affected by reservoir offsets, we compared the δ15N and δ13C values obtained on the collagen extracted from the humans and from local herbivores. The diet of herbivores should consist only of terrestrial plant material. Thus, if the stable isotope values of the humans and herbivores were congruent, or only separated by the expected increment associated with one trophic level shift (DeNiro, 1987), a reservoir effect was unlikely be present and 14C dates would not need to be separately calibrated. Eleven herbivore samples were used for stable isotope analysis, listed in Table 3 (for a more extensive discussion, see Vika et al., forthcoming).

3. Results and Discussion

3.1. Experimental Results

The 14C results from the AVNC burials are given in Table 2. From a total of 74 samples, 56 samples were successfully measured and 18 failed to produce enough collagen to generate a result. The number of successful measurements corresponds to 21 out of 23 burial contexts, which allows us to have a comprehensive understanding of the whole cemetery.

The atomic (C:N) ratio of the human remains (3.15–3.38) and the herbivore faunal material collected for δ13C and δ15N analysis (3.17–3.31) are found to be exceptionally well clustered around the expected range for collagen, implying the pretreatment products were very pure. For herbivores, the δ15N values range from 3.30‰ to 6.00‰, with an average of 4.38 ± 0.75‰ and the δ13C values range from -22.12‰ to -17.36‰, with an average of -20.13 ± 1.18‰. In comparison, the

<table>
<thead>
<tr>
<th>Pottery Phases</th>
<th>High Chronology</th>
<th>Low Chronology</th>
</tr>
</thead>
<tbody>
<tr>
<td>MH I</td>
<td>2100/2050 –</td>
<td>2090/2050 onwards</td>
</tr>
<tr>
<td>MH II</td>
<td></td>
<td>1900 – 1700</td>
</tr>
<tr>
<td>MH III</td>
<td></td>
<td>1700 – 1590</td>
</tr>
<tr>
<td>LH I</td>
<td>1700/1675 – 1635/00</td>
<td>1600 – 1510/1500</td>
</tr>
<tr>
<td>LH II A</td>
<td>1635/00 – 1480/70</td>
<td>1510/1500 – 1440</td>
</tr>
<tr>
<td></td>
<td>1390 – 1340/1330</td>
<td></td>
</tr>
<tr>
<td>LH III C</td>
<td>1200/1190 – 1075/50</td>
<td>1185/1180 – 1065</td>
</tr>
</tbody>
</table>
δ15N values from the human samples range from 7.46 % to 11.2 %, with an average of 9.05 ± 0.83 %. The δ13C range from -23.01 % to -17.64 %, with an average of -19.83 ± 0.81 %. Two measurements, GrM-15106 and GrM-14676, which returned the uppermost and lowermost values of the δ13C range, showed δ15N values that were in agreement with the rest of the dataset. In general, the values from the herbivore samples and the humans are commensurate with the expected trophic shift between them, and inconsistent with notable marine or freshwater food input; therefore, we observe no compelling evidence for any reservoir effect, and do not believe it is necessary to apply specialist calibration procedures to the δ13C dates from AVNC. For details of the isotope and diet analysis of the complete faunal data for Ayios Vasileios, the reader is referred to Vika et al. (forthcoming).

Grave 17 has two skeletons that were buried in a tightly embracing, interlocked position. Initially 3 samples were taken for δ13C dating (GrM-14031 from 17.2, UBA-41525 from 17.2 and UBA-41524 from 17.1). Due to their positioning, the two burials are assumed to have died and been interred at the same time. However, the two measurements from 17.2 date to c.16th BCE, while the result for 17.1 is much older (c.19th–18th BCE). Neither the C:N ratio nor the stable isotope values indicate any problems with the measurement UBA-41524 on 17.1. Individual 17.1 was therefore sampled again for an additional δ13C

Table 2
The list of all 14C measurements from Ayios Vasileios North Cemetery. Measurements with the same burial number are not duplicates, as different bone elements were utilized for each. It was not possible to obtain stable isotope results for GrM-31017 and UCI-238650. UBA-41524 (in red) was found to be an outlier upon further investigation (see main text).

<table>
<thead>
<tr>
<th>Laboratory ID</th>
<th>Grave No</th>
<th>Burial No</th>
<th>14C Age (cal BP)</th>
<th>Error</th>
<th>Calibrated Date (BCE, 95.4%)</th>
<th>δ13C(‰)</th>
<th>δ15N(‰)</th>
<th>C:N</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM-13988</td>
<td>Grave 1</td>
<td>Individual 1.1</td>
<td>3356 16 1736 1543</td>
<td>-20.24 8.85</td>
<td>3.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UCI-232755</td>
<td>Grave 3</td>
<td>Individual 3.1</td>
<td>3375 16 1736 1618</td>
<td>-19.50 9.40</td>
<td>3.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UCI-232981</td>
<td>Grave 4</td>
<td>Individual 4.3 or 4.4 (secondary burial)</td>
<td>3430 15 1871 1642</td>
<td>-19.70 9.80</td>
<td>3.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM-14015</td>
<td>Grave 5</td>
<td>Individual 5.1</td>
<td>3255 15 1540 1455</td>
<td>-20.20 7.91</td>
<td>3.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UCI-232756</td>
<td>Grave 6</td>
<td>Individual 6.1</td>
<td>3415 15 1862 1630</td>
<td>-19.50 9.60</td>
<td>3.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UCI-232978</td>
<td>Grave 7</td>
<td>Individual 7.2</td>
<td>3450 15 1876 1691</td>
<td>-19.30 10.00</td>
<td>3.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM-14016</td>
<td>Grave 7</td>
<td>Individual 7.1 or 7.2 (secondary burial)</td>
<td>3354 16 1735 1543</td>
<td>-19.66 8.71</td>
<td>3.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM-14019</td>
<td>Grave 10</td>
<td>Individual 10.5 or 10.6 (secondary burial)</td>
<td>3307 16 1617 1520</td>
<td>-20.80 8.33</td>
<td>3.31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM-14020</td>
<td>Grave 10</td>
<td>Individual 10.1–10.4 (secondary burial)</td>
<td>3388 16 1740 1622</td>
<td>-20.28 8.50</td>
<td>3.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UBA-41509</td>
<td>Grave 10</td>
<td>Individual 10.3</td>
<td>3399 16 1735 1544</td>
<td>-20.60 8.70</td>
<td>3.20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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measurement (GrM-31017). The date of this new sample matched with the measurements on 17.2, implying that the two burials do indeed date to the same period. UBA-41524 was ostensibly an outlier and was thus removed from the rest of the analysis. While the specific reason remains unclear, outliers may occur due to various factors, ranging from errors in sample handling to contamination during laboratory pretreatment.

3.2. Heat map analysis of the radiocarbon dates

In this section, we analyse the \(^{14}\)C dates from AVNC and compare them with the absolute dates for ceramic typology-based chronologies for mainland Greece, in order to situate the unfurnished graves in relative time. The absolute start and end dates for MH I through LH IIIC were obtained from the references listed on Table 1.

We calibrated all \(^{14}\)C dates from AVNC with a calendrical resolution set to one in OxCal and extracted the resultant numerical probability for each year (BCE). The total probability that lay within each ceramic period was then summed up and converted into a percentage. To avoid misinterpretation, each result was ultimately rounded to the nearest 10%. This process allowed us to categorise the calibrated probability ranges of our \(^{14}\)C dates into a ceramic sequence. It is important to note that only an approximate temporal distribution of the burials is obtained with this method. Nonetheless, the output is visually represented below in heat maps (Fig. 1). Whilst this approach is certainly an oversimplification, no other strategy was obviously superior.

The distribution of the \(^{14}\)C dates is different in each heat map and preferred chronology. Most of the burials cluster around MH and LH IIA when we use the chronology by Shelmerdine (2008), French (2013) and Warren and Hankey (1989) as seen on Fig. 1 a, c and d. However, this distribution gets stretched out until LH IIB, when we use the chronology...
by Manning (2012) on Fig. 1b. Indeed, the limited ceramic evidence obtained from two graves (2 and 21) at AVNC suggests that the cemetery was in use during LH IIB. Although the chronology by Shelmerdine (2008) categorises a few graves to MH II with a high probability, as mentioned earlier, neither the AVNC nor the settlement seems to have been in use between MH I–II (Hachtmann and Voutsaki, 2022; Wiersma et al., 2022). Therefore, upon this initial analysis, the evidence at AVNC mostly closely concurs with the chronology described by Manning (2012). Our results align with the general pattern similar to other \(^{14}\)C studies from Mycenaean sites (i.e. Iklaina, Aegina Kolonna), favouring a stronger correlation with the High Chronology (Wild et al., 2010; Cosmosopoulos et al., 2019). The results of this chronological comparison will be integrated with the stratigraphic, taphonomic, ceramic and geoarchaeological data in Voutsaki et al. (forthcoming).

### 3.3. Duration of use

The calibrated dates of all 55 \(^{14}\)C results are plotted on the IntCal calibration curve in Fig. 2. Many of the dates are clustered together, forming a group over the mid-1700s to 1500 BCE. The beginning and the end of this cluster is visibly separate since these dates are situated in relatively steep sections of the curve. There are 3 \(^{14}\)C dates that are distinctly younger than the rest of the cluster (GrM-14017 Grave 9.1, UCI-232908 Grave 24.1, and GrM-14662 Grave 24.2).

The span of use of the cemetery was investigated using a KDE model in OxCal. This analysis allows us to summarise \(^{14}\)C dates, in which the distribution of large groups of dates becomes less influenced by the shape of the calibration curve (Bronk Ramsey, 2017). The output probability of the KDE model for all 55 \(^{14}\)C dates (Fig. 2a) shows that there is a sharp drop in use of the cemetery around the late 16th century BCE, although some probability extends until the mid-14\textsuperscript{th} century BCE. This slight shoulder on the KDE plot on Fig. 2b. is caused by the aforementioned youngest 3 \(^{14}\)C dates which are visibly different from the main cluster of \(^{14}\)C dates on Fig. 2a.

Upon further investigation, it is observed that the measurements come from two graves (9 and 24) which share common features: simple stone-lined pits containing infant burials. Indeed, these graves follow a local Laconian tradition of burying infants in the area of abandoned burial grounds throughout LH III, evidence of which is found in the neighbouring site of Ayios Stephanos (Taylour and Janko, 2008). This feature disappears on the graph when we plot a KDE model that excludes the dates from these 3 infant burials (Fig. 2c), which would be the best representation of the duration of use of AVNC. This model suggests that the cemetery was in use for about 300 years and that there was a single continuous phase of burial activity at AVNC over this time period.

Since it is not possible to plot date ranges on KDE models, we used a simple Sequence model in OxCal in order to obtain an estimate for the start and end dates for the period of use. 52 \(^{14}\)C dates, excluding the youngest 3 \(^{14}\)C dates, were grouped under a single Phase with Boundary functions that were placed at the beginning and at the end. The resulting probabilities for these start and end boundaries are plotted on Fig. 3. The outputs generated agree with the KDE models. The use of the cemetery is estimated to have begun between 1766 and 1701 BCE (95.4\% probability) and concluded between 1500 and 1447 BCE (95.4\% probability). Compared to the dates on Table 1, this places the cemetery between MH to LH IIB in High Chronology and between MH to LH IIA in Low Chronology.

Considering that there is so far no evidence of activity between MH I–II (Hachtmann and Voutsaki, 2022), we can conclude that the start of use of the cemetery began at least as early as MH III. \(^{14}\)C dates are consistent with the initial chronological analysis done at AVNC (Voutsaki et al., 2020; Hachtmann and Voutsaki, 2022).

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**Fig. 2.** a. All 55 calibrated \(^{14}\)C dates from AVNC plotted over the calibration curve. b. KDE model of all \(^{14}\)C dates from AVNC. c. KDE model excluding the 3 youngest dates from the cemetery.

**Fig. 3.** The probability plots for a. the start Boundary b. the end Boundary of 52 \(^{14}\)C dates from AVNC. The youngest 3 \(^{14}\)C dates from the cemetery are excluded in these models (see main text).
We then superimposed the different chronological options for ceramic phases from Table 1 onto the KDE plot (Fig. 4). Similar to the heat map analysis from the previous section, the distribution of calibrated dates under pottery phases is different in each chronological option. The peak activity corresponds to MH using the Low Chronology whereas it is categorised under LH in the High Chronology. However, as stated above, neither the ceramic offerings nor the observations on the mortuary practices, which are very characteristic of the Early Mycenaean period, support a MH date. There is a sharp decrease in the use of the cemetery in LH II on all 4 scenarios. The continuous phase of burial activity ends by c.1400 BCE which falls under LH IIB. This is also supported by the few ceramic offerings found in Grave 2 and 21.

3.4. Analysis of the ordering of burials at the AVNC

To construct a chronological framework for the AVNC, we also attempted to establish a chronological sequence for the graves and investigate the burial order within the commingled graves with the eventual goal of identifying any temporal trends. To achieve this, we tried employing the Order function in OxCal, which assigns a numerical probability to the chronological order between pairs of results. However, the majority of the measurements from the cemetery cluster around the same time period, which made it challenging to distinguish conclusively the sequence of the dates. Therefore, the Order function could not be effectively utilised. Indeed, this function is more suited for comparisons between large groups of $^{14}$C dates (or OxCal functions such as Phase, Boundary) rather than individual $^{14}$C dates (see Dee et al., 2014).

While the results of the Order analysis may not have been definite, an interesting pattern can be observed. Consistent with the results of the KDE graphs presented in the previous section, Order did confirm that most of the infant burials represent the youngest dates within the cemetery. In most of the graves containing multiple individuals, the $^{14}$C dates from children and infants are distinctively younger than those of other individuals within the same grave, as well as the whole cemetery. Despite the overall uncertainty of the results from Order function, we could effectively differentiate the sub-adult group through this analysis, as most of the sub-adults were included into the cemetery at a later chronological stage than adults. However, this suggestion can only be confirmed once all data, also from non-sampled burials, are taken into account (see Voutsaki et al., forthcoming).

4. Conclusions

In this study, we attempted to establish the absolute and relative chronology of the burials at Ayios Vasileios North Cemetery. In cases like this, where ceramic offerings data are few and their attribution to the burials is problematic, we have demonstrated that it is still possible to use statistical methods to extract valuable dating information from the $^{14}$C results. By only using $^{14}$C measurements, we have been able to define the most likely phases associated with each burial by using the approximate calendar dates for these periods in the published literature. The initial results shown here are most compatible with the High Chronology; however, the dataset is not decisive enough to draw a definitive conclusion. Nevertheless, our results indicate that the burial site was used at least from MH III to LH IIB, with occasional use for infant burials also during LH IIIA–B.

CRediT authorship contribution statement

Pınar Erdil: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Validation,


