

DATA PAPER

An Aegean History and Archaeology Written through Radiocarbon Dates

Markos Katsianis¹, Andrew Bevan², Giorgos Styliaras¹ and Yannis Maniatis³

¹ Department of History and Archaeology, University of Patras, GR

² Institute of Archaeology, University College London, UK

³ Laboratory of Archaeometry, NCSR Demokritos, GR

Corresponding author: Markos Katsianis (mkatsianis@upatras.gr)

This dataset is the outcome of an INSTAP-funded project “An Aegean Prehistory Written in Radiocarbon Dates”. It includes 3159 14C dates from 353 sites in Greece and reflects an attempt to exhaustively collect and cross-check all published radiocarbon dates from existing databases, original publications and preliminary reports using both international and Greek sources (376 sources in total). Although originally targeting prehistoric dates, all dates coming from archaeological or environmental sampling were integrated in the final dataset regardless of chronological period. Sites have been identified and positioned as accurately as possible, while additional information on sampling procedures, sample material and stratigraphic context have been recorded.

Keywords: environment; archaeology; radiocarbon dating; Greece; Holocene

Funding statement: The Institute for Aegean Prehistory (INSTAP) provided the core funding for the “An Aegean Prehistory Written in Radiocarbon Dates” project which ran between 2016–2017. Previous support by INSTAP to Yannis Maniatis for the radiocarbon dating of Early Neolithic settlements in Greece in NCSR Demokritos Radiocarbon Laboratory allowed for several dates to be processed and included in the present work. Work related to data cleaning and terminology mapping was implemented as part of the dataset preparation process to be ingested in the ARIADNEplus portal. ARIADNEplus (Advanced Research Infrastructure for Archaeological Database Networking in Europe) is a project funded by the European Commission under the H2020 Programme, contract no. H2020-INFRAIA-2018-1-823914. The views and opinions expressed in this publication are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission.

(1) Overview

Context

The Aegean area has so far lagged behind several other parts of Europe and the Mediterranean in not offering any major listing of its considerable radiocarbon record, despite decades of radiocarbon sampling at major sites and worldwide radiocarbon-led debates, such as over the dating of the Santorini eruption (e.g. [1–8]). The dataset provided here is the outcome of a project “An Aegean Prehistory Written in Radiocarbon Dates” and it offers the most complete list so far of published radiocarbon dates from Greece. Some 3159 14C dates from 353 sites located in Greece have been discovered or cross-checked via a combination of harmonizing records from several existing radiocarbon databases, searching original publications and checking preliminary reports from both international and Greek sources.

The project was designed to complement/enhance wider research agendas considering the interplay between

human population, land use and long-term environmental processes, especially a Leverhulme Trust funded project known as “Changing the Face of the Mediterranean” (RPG-2015-031, PI Neil Roberts) to which the current radiocarbon data were used as part of regional case study paper ([9], for the special issue, see [10]). In a variety of contexts worldwide, the assessment of radiocarbon date-lists as aggregate times series, often via summed probability distributions, has become popular for modelling human population change (e.g. [11]). Their collation with additional archaeological records, such as pollen cores and site data, has offered further opportunities to detect regional differences in the long-term socio-ecological development.

Although the original aim of the project was to retrieve as exhaustive a list of published radiocarbon dates in the Aegean area from only the Mesolithic to Iron Age (ca.12–2 kya), it became evident that the number of published dates covering the area of modern Greece was far lower

than expected. Four main reasons are identified for this issue:

- There is a small core of radiocarbon dates especially for Aegean prehistory originally published in English and re-used extensively in subsequent attempts by researchers to better define individual chronological subperiod boundaries, period outlets (e.g. the beginning of Neolithic) or important events (e.g. the Santorini eruption).
- A substantial number of measurements (ca. 17%) come from purely or partially non-anthropogenic contexts as part of investigation strategies involving boreholes towards the reconstruction of environmental or geomorphological conditions in the past.
- In the Greek literature, there has been a marked tendency for archaeologists to report calibrated dates without clear reference to conventional (pre-calibration) radiocarbon ages or supplementary data (e.g. context details).
- Later periods (after about ~2500 BP) are under-represented (far fewer dates) due to the lack of an academic tradition in collecting radiocarbon dates for Classical, Medieval and more recent periods of archaeology.

In this respect, the final dataset includes all dates encountered in the literature regardless of research context (archaeological, environmental or material conservation studies) or chronological period. Contextual information regarding the sampling procedure has also been recorded and sites have been identified and located as accurately as possible. A lot of effort has been directed towards cleaning data and refining terminology, with a view to data ingest into the ARIADNEplus portal.¹ As a result, we hope that in terms of both data structure and content, the current date-list aggregate will form an important radiocarbon data reference for Greece and continue to grow through further input and re-use.

Spatial coverage

Description: The dataset covers the area of modern Greece.

Figure 1 shows the study area and the distribution of sites with archaeological and environmental samples. The coordinates of the minimum-bounding box defined by site coordinates are given in WGS84 decimal degrees.

Northern boundary: 41.3871 (Promachonas-Topolnitsa, Central Macedonia)

Southern boundary: 34.8462 (Gavdos, Crete)

Eastern boundary: 28.1757 (Kallithies A, Rhodes, South Aegean)

Western boundary: 19.6981 (Sidari, Corfu, Ionian Islands)

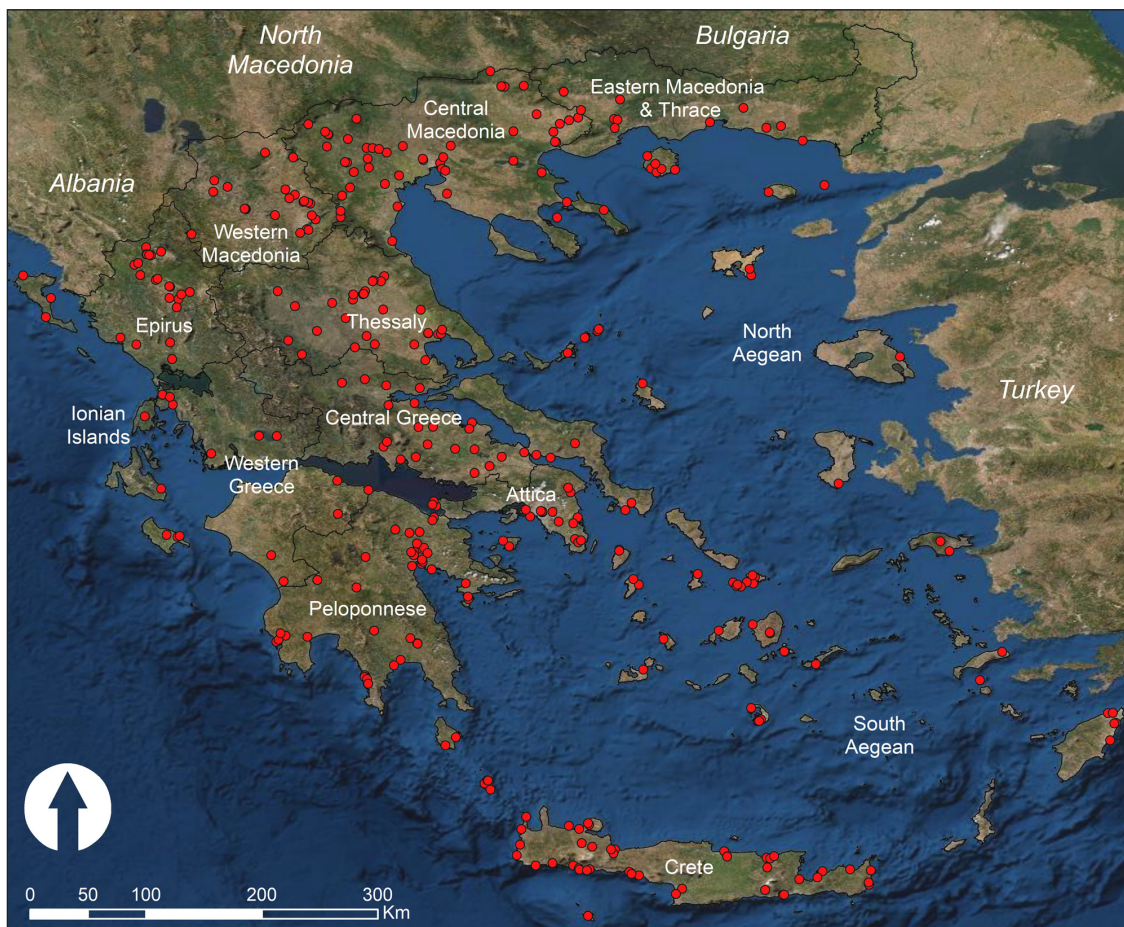


Figure 1: Study area and distribution of sites with archaeological and environmental samples within administrative divisions of Greece (basemap sources: ESRI, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors and the GIS User Community).

Temporal coverage

Dates range from the Middle/Late Palaeolithic (ca.60,000 cal. BC) to early modern times.

(2) Methods

The creation of this dataset was only possible due to the growing availability of openly available data records and relevant digital scholarship [12]. To approach the data collection, we combined secondary sources of already compiled radiocarbon datasets with other available online sources than might be screened and harvested for radiocarbon data.

Steps

More specifically, we have extracted lists of Greek dates from available ¹⁴C date lists and databases [13–20]. The lead author further screened digital versions of original publications and paper-based sources to find new dates or check, enhance and georeference those already listed by others.

Journal sources that were extensively screened include but are not limited to: *Acta Archaeologica*, *Annual of the British School at Athens*, *Antiquity*, *Archaeological and Anthropological Sciences*, *Archaeometry*, *Bulletin de Correspondance Hellénique*, *BSA Archaeological Reports*, *Eurasian Prehistory*, *European Journal of Archaeology*, *Geoarchaeology*, *Géomorphologie*, *Hesperia*, *International Journal of Nautical Archaeology*, *International Journal of Osteoarchaeology*, *Journal of Archaeological Research*, *Journal of Archaeological Science*, *Journal of Archaeological Science Reports*, *Journal of European Archaeology*, *Journal of Field Archaeology*, *Journal of Human Evolution*, *Journal of the Royal Anthropological Institute*, *Journal of World Prehistory*, *Méditerranée*, *Mediterranean Archaeology and Archaeometry*, *Oxford Journal of Archaeology*, *PLOS One*, *Proceedings of the Prehistoric Society*, *Radiocarbon*, *Mediterranean Historical Review*, *Science*, *Vegetation History and Archaeobotany*, *Volumes of the Archaeological Work in Macedonia and Thrace annual conference*, *World Archaeology*. All the above were checked for all those volumes that were available online up to 2016. Radiocarbon lists were further extracted from several monographs, chapters in edited volumes, websites and site reports. Finally, Y. Maniatis (one of the authors here) provided clarifications for partially published (i.e. published by archaeologists only as calibrated timespans) radiocarbon dates from the NCSR Demokritos Radiocarbon Laboratory.

Sampling strategy

In addition to providing basic and alternative lab codes (stored in “LabID” and “OthLabID” respectively) as well as date codes in searched radiocarbon dating databases (“OtherDateCode”), conventional (pre-calibration) radiocarbon age (“CRA”) and 1-standard deviation error (“Error”), we have further collected several data fields per date containing:

- isotopic fractionation of stable carbon isotopes Carbon-13 ($\delta^{13}\text{C}$) for allowing clear assessment of

fractionations and reservoir effects, but also for understanding changing water-stress across regions and through time (“DC13”),

- other measurements related to the reported data, e.g. Percent Modern Carbon (pMC) (“Oth Measures”),
- notices on the technique/method used to process the sample (“DateMethod”),
- basic information on the sample material (“Material”) as well as genus or species level identifications where possible (“Species”).

For each date, we report its original publication and all subsequent works referencing it including online databases or publicly accessible data archives. In this respect, a considerable amount of contextual and supplementary information associated with each date has been included. The collection procedure focused on data quality control, by cross-checking all attributes associated with the radiocarbon dates and addressing possible inconsistencies in the published records. In cases where conflicting statements (e.g. sample age, deviation error) were encountered in the sources, we made decisions on our final database entry based on the most complete/detailed descriptions, the preference of original publications rather over compiled secondary sources (e.g. databases), the comparison with later (paper) publications on the possibility of measurement revisions (e.g. [21]). Problematic cases are reported in the “Problems” field, while alternative measurements alongside their link to their respective references have been included in the “Comments” field, both contained in the “C14Samples” table.

The geographic location of samples has been assigned Latitude/Longitude coordinates in decimal degrees (“Longitude” and “Latitude”) recorded under the WGS84 ellipsoid (EPSG 4326). Each location has been coded according to its perceived accuracy using four different assessment levels (A: sub-site quality +/-10 m, B: within +/-1 km, C: Moderate accuracy within Admin Region, D: Unknown accuracy within Country). In cases of large sites (e.g. Knossos) where it was possible to locate samples within smaller or neighbouring research areas (e.g. Unexplored Mansion), this differentiation is also reflected in the “SiteName” field. However, the published dataset includes downgraded location coordinates that have been grouped by site name, in line with looting prevention policies by the Greek Ministry of Culture and Tourism. Researchers wishing to obtain the accurate coordinates can contact the lead author. Current Greek administrative divisions (“AdminRegion” and “Country”) have been used to group samples.

In terms of contextual information, recordings include typological distinctions between site types (“SiteType”), notes on the stratigraphic context of each sample (“SiteContext”), chronological distinctions related to intra-site phasing (“SitePhase”) and broader chronological periods related to the sample’s cultural context (“CulturalPeriod”).

Quality Control

After the completion of the data collection stage we undertook painstaking steps in data cleaning and checking. To solve data discrepancies, we had to re-visit and cross-check already screened sources. In descriptive fields, such as “SiteContext”, readily available information was edited to achieve a standardized contextual notation for each site and mitigate differences in site context reporting between publications (e.g. Franchthi Cave). In fields where a term list could be established we tried to standardize entries as much as possible and map resulting terms to reference vocabularies or thesauri (see relevant tables). We used the *Getty Art and Architecture Thesaurus* (AAT) to map terms in the fields of “SiteType”, “Material” and “Species”. Also, the *Getty Thesaurus of Geographic Names* (TGN) to standardize individual entries for the “SiteName” and “AdminRegion” fields. Finally, we employed *PeriodO* and the *Greek Historical Periods Vocabulary* (URI: <http://semantics.gr/authorities/vocabularies/historical-periods>) from the National Documentation Centre (NDC) [22] to further normalize the chronological periods reported in the “CulturalPeriod” field. All mappings are also being made available to ARIADNEplus to enhance data interoperability in the ARIADNEplus portal.

Constraints

In every respect, the dataset remains far from ideal. For example, almost 48% of the dates do not have associated $\delta^{13}\text{C}$ values, whereas ca. 32% are not associated with any defined chronological period. Radiocarbon dates have been reported in the literature with varying degrees of associated information. Although the most recent publications are obviously more detailed, in many aspects reporting continues to vary significantly between laboratories or individual reports. Although, we have given a special emphasis to quality control while moving through the labyrinth of different paper and digital sources, a feeling persists that certain constraints rise from the original data reporting sources. In this regard, it remains up to the user to assess data reliability and proceed with appropriate caution. The data archive to which this paper points should be considered a versioned first release: we encourage all users to inform the lead author of any possible errors and we will seek to produce and update a more dynamic online repository accordingly.

(3) Dataset description

The dataset contains a single tab delimited text file (.txt) of the 14C dates for Greece (*C14Samples*) plus a BibTex format bibliography (*References*). A further tab delimited text file has been included to document the main file fields and the domain values included in the (*C14Greece_fields*). The project’s relational database was originally in MS Access and a version of this has been made available as a SQL dump file containing DDL (Data Definition Language) and DML (Data Manipulation Language) queries for reconstructing the database (*C14Greece_dump*). Apart from the main *C14Samples* table, the full relational database contained six more tables with standardized domain values for the following fields contained

in the main table: 1) Admin Region, 2) CulturalPeriod, 3) Material, 4) SiteName, 5) SiteType, 6) Species, 7) Source. Values from tables 1 and 4 have been mapped to TGN, those of table 2 to PeriodO and NDC chronological periods, while the values from 3, 5 and 6 to the AAT. Table 7 included the original transcription of the source reference, which eventually resulted in the BibTeX file, but was also maintained in the original database.

Object name

C14Samples.txt – single file (Tab Delimited Text, UTF8 encoding) providing the data for all 14C samples. It corresponds to the original database main table.

C14Greece_fields.txt – single file (Tab Delimited Text, UTF8 encoding) containing field type definitions and domain values for all content included in the projects database.

References.bib – single BibTeX file containing references cited for all 14C samples recorded.

C14Greece_dump.sql – single file containing the main data table and seven additional tables for domain values and references.

Data type

Secondary data

Format names and versions

TXT UTF8, SQL, BibTeX

Creation dates

Most of the records were created in 2016–2017 as part of the INSTAP funded project “An Aegean Prehistory Written in Radiocarbon Dates”. Between 2019–2020 records underwent cleaning and standardization in the framework of the ARIADNEplus project, while a small number of additions were implemented.

Dataset Creators

The researcher responsible for data entry was Markos Katsianis. Online radiocarbon listings and literature sources were provided by Andrew Bevan, who supervised the data recording and standardisation process. Records were restructured, cleaned and standardized by Giorgos Styliaras. Yannis Maniatis provided additional records from the NCSR Demokritos Radiocarbon Laboratory and helped solve discrepancies between entries. Terminology mappings were performed by Giorgos Styliaras and Markos Katsianis.

Language

English. Greek literature has been included in modern Greek. Site context descriptions from Greek sources may contain Greek characters (e.g. Sector Φ).

License

<https://creativecommons.org/licenses/by/4.0/>.

Repository location

<https://doi.org/10.5522/04/12489137.v1>

Publication date

16/06/2020.

(4) Reuse potential

This dataset comprises the largest single collection so far of radiocarbon data for the Aegean region, covering the equivalent area of modern Greece. It provides a comprehensive resource for accessing detailed chronological data from specific sites or wider regions within Greece. Sites have been located to the highest possible accuracy and although their coordinates have been downgraded to ca. 500 m. radius to discourage illegal uses, their positions can still be used in archaeological site mappings. The creation and circulation of radiocarbon databases of this kind follows wider efforts in sharing open licensed, georeferenced large-scale datasets in archaeology and beyond. On a broader level, the dataset allows the Greek radiocarbon listings to be added to data collections of other kinds from the Aegean region and to be used in comparative agendas of greater geographical scope. One key reuse potential relates to the use of aggregate lists of anthropogenic radiocarbon data as a proxy for human population change, for example via summed probability distributions (SPDs). Further potential might relate to enhanced interpretation of Aegean prehistoric archaeological sequences at regional levels or chronological comparison between different regions. Also, the juxtaposition of large lists of radiocarbon dates with other scientific data, such as pollen cores, macrobotanical remains, skeletal assemblages or archaeological settlement survey datasets offers further opportunities to approach long-term socio-environmental trajectories and questions.

Note

¹ Project website: <https://ariadne-infrastructure.eu/>, ARIADNE Portal: <http://portal.ariadne-infrastructure.eu/>.

Acknowledgements

We would like to thank INSTAP for the funding behind this project as well as colleagues involved in the Changing the Face of the Mediterranean project who provided extra impetus for data collection. Likewise, to the ARIADNEplus project for allowing us to include this dataset in the ARIADNE portal. We would also like to acknowledge the various researchers and developers involved in creating other online radiocarbon databases and individual date-lists with dates from the Aegean region that are openly published and have been used in our research (see Methods). Access to several unavailable sources has been provided by Ž. Tankosić and M. Ntinou.

Competing Interests

The authors have no competing interests to declare.

References

- Aitken, MJ** 1988 The Thera eruption: continuing discussion of the dating. I: Resume of Dating III: further arguments against an early date IV: Addendum. *Archaeometry*, 30(1): 165–182. DOI: <https://doi.org/10.1111/j.1475-4754.1988.tb00444.x>
- Bruins, HJ, Van der Plicht, J and MacGillivray, J A** 2009 The Minoan Santorini eruption and tsunami deposits in Palaikastro (Crete): Dating by geology, archaeology, 14C, and Egyptian chronology. *Radiocarbon*, 51(2): 397–411. DOI: <https://doi.org/10.1017/S003382220005579X>
- Bruins, HJ and Van der Plicht, J** 2014 The Thera olive branch, Akrotiri (Thera) and Palaikastro (Crete): Comparing radiocarbon results of the Santorini eruption. *Antiquity*, 88(339): 282–287. DOI: <https://doi.org/10.1017/S0003598X00050390>
- Friedrich, WL, Kromer, B, Friedrich, M, Heinemeier, J, Pfeiffer, T and Talamo, S** 2006 Santorini eruption radiocarbon dated to 1627–1600 B.C. *Science*, 312(5773): 548. DOI: <https://doi.org/10.1126/science.1125087>
- Manning, SW** 1988 The Bronze Age eruption of Thera: absolute dating, Aegean chronology and Mediterranean cultural interrelations. *Journal of Mediterranean Archaeology*, 1(1): 17–82. DOI: <https://doi.org/10.1558/jmea.v1i1.17>
- Manning, SW, Bronk Ramsey, C, Doumas, C, Marketou, T, Cadogan, G and Pearson, C** 2002 New evidence for an early date for the Aegean Late Bronze Age and Thera eruption. *Antiquity*, 76(293): 733–744. DOI: <https://doi.org/10.1017/S0003598X00091183>
- Manning, SW, Höflmayer, F, Moeller, N, Dee, M W, Bronk Ramsey, C, Fleitmann, D, Higham, T, Kutschera, W and Wild, EM** 2014 Dating the Thera (Santorini) eruption: archaeological and scientific evidence supporting a high chronology. *Antiquity*, 88(342): 1164–1179. DOI: <https://doi.org/10.1017/S0003598X00115388>
- Maniatis, Y** 2012 Radiocarbon dating of the Late Cycladic building and destruction phases at Akrotiri: new evidence. *European Physical Journal Plus*, 127: 9. DOI: <https://doi.org/10.1140/epjp/i2012-12009-y>
- Weiberg, E, Bevan, A, Kouli, K, Katsianis, M, Woodbridge, J, Bonnier, A, Engel, M, Finné, M, Fyfe, R, Maniatis, Y, Palmisano, A, Panajiotidis, S, Roberts, N and Shennan, S** 2019 Long-term trends of land use and demography in Greece: A comparative study. *The Holocene*, 29(5): 742–760. DOI: <https://doi.org/10.1177/0959683619826641>
- Bevan, A, Palmisano, A, Woodbridge, J, Fyfe, R, Roberts, CN and Shennan, S** 2019 The changing face of the Mediterranean – Land cover, demography and environmental change: Introduction and overview. *The Holocene*, 29(5): 703–707. DOI: <https://doi.org/10.1177/0959683619826688>
- Shennan, S, Downey, S, Timpson, A, Edinborough, K, Colledge, S, Kerig, T, Manning, K and Thomas, MG** 2013 Regional population collapse followed initial agriculture booms in mid-Holocene Europe. *Nature Communications*, 4: 2486. DOI: <https://doi.org/10.1038/ncomms3486>
- Bevan, A** 2015 The data deluge. *Antiquity*, 89(348): 1473–1484. DOI: <https://doi.org/10.15184/aqy.2015.102>

13. **Reingruber, A** and **Thissen, L** 2005 14C database for the Aegean catchment (Eastern Greece, southern Balkans and western Turkey) 10,000–5500 cal BC. In: Lichter, C and Meriç, R (eds) *How Did Farming Reach Europe? Anatolian-European Relations from the Second Half of the 7th through the First Half of the 6th Millennium cal BC: Proceedings of the International Workshop, Istanbul, 20–22 May 2004* (Byzas 2). İstanbul: Ege Yayınları, 295–327.
14. **Hinz, M, Furholt, M, Müller, J, Raetzl-Fabian, D, Rinne, C, Sjögren, K-G** and **Wotzka, H-P** 2012 RADON – Radiocarbon dates online 2012. Central European database of 14C dates for the Neolithic and the Early Bronze Age. *Journal of Neolithic Archaeology*, 14: 1–4. DOI: <https://doi.org/10.12766/jna.2012.65>. Database available at: <https://radon.ufg.uni-kiel.de/> (accessed 10 August 2019).
15. **Manning, K, College S, Crema E, Shennan, S** and **Timpson, A** 2016 The Cultural Evolution of Neolithic Europe. EUROEVOL Dataset 1: Sites, Phases and Radiocarbon Data. *Journal of Open Archaeology Data*, 5: e2, DOI: <https://doi.org/10.5334/joad.40>
16. **Brami, M** and **Zanotti, A** 2015 Modelling the initial expansion of the Neolithic out of Anatolia. *Documenta Praehistorica*, 42: 103–116. DOI: <https://doi.org/10.4312/dp.42.6>
17. **Centre de Datation par le and Radio Carbone de Lyon (CDRC)** 2016 *Banadora (BANque NAtionale de DONnées RAdiocarbone pour l'Europe et le Proche Orient)*. CDRC. <http://www.arar.mom.fr/banadora/> (accessed 10 August 2019).
18. **Reingruber, A** and **Thissen, L** 2016 *The 14SEA Project. A 14C database for Southeast Europe and Anatolia (10,000–3,000 cal BC)*. http://www.14sea.org/2_dates.html (accessed 10 August 2019).
19. **ORAU**. 2016 Oxford Radiocarbon Accelerator Unit (ORAU) database. <https://c14.arch.ox.ac.uk/> (accessed 27 August 2018).
20. **Weninger, B** 2017 *Cologne Radiocarbon Calibration and Paleoclimate Research Package (CalPal)*. <https://monrepos-rgzm.de/forschung/ausstattung.html> (accessed 10 January 2018).
21. **Manning, S W** 1995 *The Absolute Chronology of the Aegean Early Bronze Age: Archaeology, Radiocarbon and History*. Sheffield: Sheffield Academic Press.
22. **Georgiadis, H, Papanoti, A, Paschou, M, Roubani, A, Hardouveli, D** and **Sachini, E** 2017 The Semantic Enrichment Strategy for Types, Chronologies and Historical Periods in Searchculture.gr. In: Garoufallou, E, Virkus, S, Siatiri, R and Koutsomiha, D (eds) *Metadata and Semantic Research. MTSR 2017. Communications in Computer and Information Science*, vol 755. Cham: Springer. DOI: https://doi.org/10.1007/978-3-319-70863-8_20

How to cite this article: Katsianis M, Bevan A, Styliaras, G and Maniatis, Y 2020 An Aegean History and Archaeology Written through Radiocarbon Dates. *Journal of Open Archaeology Data* 8: 5. DOI: <https://doi.org/10.5334/joad.65>

Published: 17 August 2020

Copyright: © 2020 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/4.0/>.