

RESEARCH ARTICLE

Dating burial histories: radiocarbon wiggle-match of Kurgan 8 at Uzun Rama (Western Azerbaijan)

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Abstract

Burial mounds, or *kurgans*, are a widespread archaeological feature in ancient Eurasia. In the South Caucasus, the Kura-Araxes (KA) culture adopted these funerary structures to express horizontal social ideology through collective inhumations. KA communities also constantly re-engaged with the dead through the regular reopening of burials, contributing to a rich organic archive that relates to episodes of funerary manipulation. This article reports on the results of a radiocarbon wiggle-match obtained from a semi-burnt branch of *Juniperus* sp. associated with Kurgan 8 at Uzun Rama (Ganja, Azerbaijan). This structure yielded evidence of burial activity during the KA I phase (ca. 3500–3000/2900 BCE) and the post-KA, the “Early Kurgan” period (ca. 2500–2000 BCE), and the Late Bronze Age (ca. 1500–1150 BCE). The sample came from a wooden structure constructed and then burnt in the ritual closure of the kurgan by fire, marking the final stage of its KA use. The results of the wiggle-match allowed us to produce a close estimate for the felling of the branch, thus providing a refined *Terminus Post Quem* (TPQ) for the construction of the wooden structure itself and its use within 3204–3174 BCE. These results shed light on finer temporal resolution of burial history not just pertaining to funerary sequences, but also in terms of social engagement with visible landmarks and long-term cultural or generational memory. The results correlate with broader trends observed in other KA kurgans and settlements excavated along the Kura basin, pointing at large-scale landscape (or even historical) reconfigurations across the Kura-Araxes world.

Introduction

Burial mounds—or *kurgans*—are a distinctive marker of prehistoric Eurasia. This funerary tradition, found over a vast area encompassing southern and central Europe, southwest Asia, and the Eurasian steppes, represents a peculiar mode of landscape “monumentalization”—the artificial transformation of the environment for display purposes (Reinhold 2012, 2019)—that ties in with broader aspects of the social organization, economy, and world views of past societies (Borgna and Muller Celka 2012; Bourgeois 2013; Gosden et al. 2019). In the Caucasus, kurgans have been excavated since at least the 1890s (e.g. Veselovsky 1897) and catalyzed much of archaeological research in Bronze Age culture history and periodization during Soviet times (e.g. Andreeva 1977; Iessen 1950). In this region, kurgans appeared from at least the fifth millennium BCE as part of a broader trend attested in the Pontic Steppe and Volga regions (Korenevsky 2012; Rassamakin 2012). However, it was from the early fourth millennium BCE onwards that they became a locus for the monumental expression of social ideology (Belinskij et al. 2017; Reinhold 2019), emerging as a distinctive marker of communities until the first millennium BCE as they adapted to the needs of different social groups in both the North and the South Caucasus (see Laneri et al. 2019). Historically, radiocarbon dates have helped establish the absolute

chronology of kurgans in relation to the different stages of the Bronze Age. These earlier works have primarily operated at the scale of cultural sequences and their synchronization—notable examples are the debate over the chronological position of the Maikop kurgans in the North (e.g. Korenevsky 1993; Munchaev 1994; for a complete overview see Ivanova 2007) and the Early/Middle Bronze Age attribution of the Trialeti kurgans in the South (Gogadze 1972; Kuftin 1941)—or sub-divisions within the same archaeological horizon—such as the chrono-cultural “components” of the Maikop-Novosbodnaya phenomenon (Korenevsky 2004; Rezepkin 2000). While former research has, importantly, defined a chrono-cultural grid, high-resolution radiocarbon dating and Bayesian chronological modeling now allow for a more refined reconstruction of specific burial histories beyond fixed archaeological cultures (intended as material packages associated with a specific social group within a fixed temporal span). Under ideal preservation conditions, kurgans can be a remarkable source of organic materials that can be linked not just to generalized and very approximate archaeological cultures, but to specific actions of funerary ritual and remembrance practices via high-resolution radiocarbon dating and Bayesian chronological modeling. This study provides one such example from the South Caucasus.

In the South Caucasus, kurgans appeared in the early fourth millennium BCE as a marker of elite individuals associated with the Late Chalcolithic Leylatepe culture (ca. 4000–3500 BCE, Lyonnet et al. 2008; Museibli 2014), in parallel with the contemporary hierarchical trends signaled by wealthy burial assemblages attested in the Maikop kurgans of the North Caucasus (Korenevsky 2012). From the mid-fourth millennium BCE, collective kurgans in the South Caucasus are found in association with the so-called Kura-Araxes (KA) culture. The latter represents an expansive archaeological culture marked by a recurring “package” of ceramics, hearths, and architectural and funerary traditions that defines the local Early Bronze Age ca. 3500–2500 BCE (Palumbi 2016; Sagona 2018). While KA kurgans are present throughout the South Caucasus, their concentration is especially noticeable in the middle Kura region of today’s Azerbaijan (Poulmarc’h et al. 2014, 237). In this area, the intentional concentration of funerary mounds may have connected with seasonal movements compatible with a transhumant or nomadic lifestyle, suggesting a close relationship between the funerary landscape and the subsistence strategies of these early communities (Pappalardo and Laneri 2023, 363–365). The high visibility and diachronic physical (and intentional) modification of kurgans may also speak to their function as gathering places for the kindred groups involved in funerary rituals, thus contributing to reinforcing a sense of ancestry, communal identity, and territoriality (Pappalardo and Laneri 2023, 365–366). Unlike earlier Leylatepe contexts, KA kurgans clearly emphasized horizontal kinship relationships, reflecting egalitarian social values that permeated contexts of practice both in life and death (Smith 2015, 2019). Current evidence of KA funerary practices suggests that collective depositions resulted from multiple burial events, highlighting, structured by, and structuring/reinforcing such kinship ties. This practice—attested in both kurgan and non-kurgan funerary contexts—denotes a particular mode of engagement with the dead, who are perceived as active and continuing members of the community, through periodical reopening of burials and tending to human remains (Aghikyan 2021; Badalyan et al. 2008; Erdal et al. 2019; Poulmarc’h et al. 2014). Recurring evidence from kurgan sites in the middle Kura basin also testifies to the symbolic value of a termination ritual—an important and deliberate break in this social world connecting the living and the dead—consisting of the intentional firing of the funerary chamber after what was determined as the last burial (Akhundov 1999; Huseynov 2019; Jalilov 2018; Laneri et al. 2020; Poulmarc’h et al. 2014). These elements identify KA kurgans as a rich diachronic archive for better understanding the social and ritual behavior of communities moving within the region between the Kura River and the mountains of the Lesser Caucasus.

Because in the KA culture ancestors continued to participate in communal life, we may reasonably assume that the manipulation of kurgan structures aligned with events of importance across the KA world: termination rituals in particular. Thus far, high-resolution radiocarbon dating on kurgan contexts has been limited in the South Caucasus, one exception being the case of the much later kurgan 3 at Ananauri (Boaretto et al. 2016). To date, the temporal relationship within and among collective kurgans in the KA culture remains poorly understood. In this article we report on the results of a wiggle-match

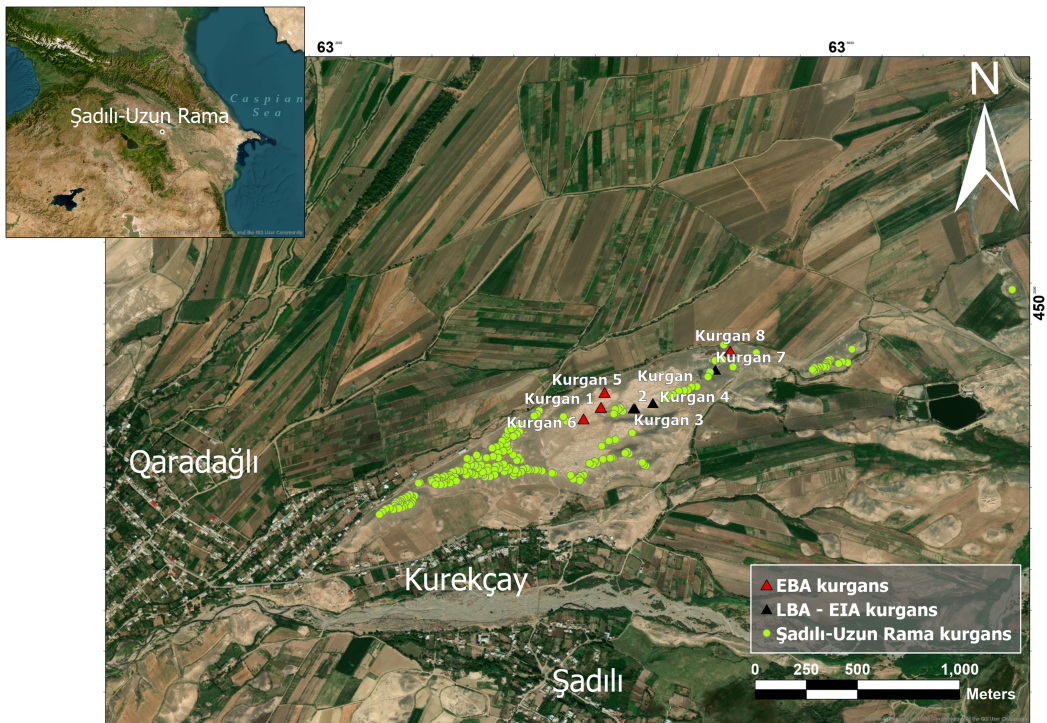


Figure 1. Map of the Şadıllı-Uzun Rama plateau highlighting the distribution of: the kurgans identified by the survey (green circles); the kurgans, excavated between 2012 and 2019, dating to the Early Bronze Age (red triangles) and the Late Bronze-Iron Age I (black triangles).

sequence of 10 new ^{14}C dates that we recently obtained from a sample of *Juniperus* sp. associated with Kurgan 8 at Uzun Rama (Ganja, Azerbaijan). The site was the subject of archaeological investigations by the Ganja Regional Kurgan Archaeological Project (GarKAP) in 2018 and 2019 (Laneri et al. 2019, 2020). Kurgan 8, in particular, yielded evidence of use during the early phase of the Kura-Araxes culture, KA I, ca. 3500–2900 BCE (Badalyan 2014) and the later “Early Kurgan” period associated with the so-called Martkopi assemblages, ca. 2500–2000 BCE (Dzhaparidze 1993; Sagona 2004) assigned to the final Early Bronze or initial Middle Bronze Age depending on nomenclature and periodization proposals (see also Badalyan and Perello 2024 on this issue). Burial activity also includes an intrusive inhumation dating to the Late Bronze Age, ca. 1500–1150 BCE (Manning et al. 2018; Smith et al. 2009). Our sample (AZ-2022-01a) belongs to a wooden structure that was built purposely to stage the ritual fire that sealed the funerary chamber of Kurgan 8 once it exhausted its function, inscribing its changed status. The results of the wiggle-match are presented here and combined in a Bayesian model with six ^{14}C dates previously obtained by the GarKAP project.

Archaeological background

Şadıllı-Uzun Rama (literally “empty land”) is a limestone plateau located in the Goranboy district of Azerbaijan, stretching for almost 3 km along the north shore of the Kurekçay creek, a tributary of the Kura River, near the modern villages of Şadıllı and Gharadaghli (Figure 1). The Azerbaijani National Academy of Science began the archaeological investigation of the site in 2012 (Jalilov 2010, 2011, 2012, 2015, 2018), and the Azerbaijani-Italian Ganja Region Kurgan Archaeological Project (GarKAP) joined its efforts in 2018 (Laneri et al. 2019, 2020). A systematic survey of the area has enabled the identification and mapping of more than 205 burial mounds. The kurgans excavated

between 2012 and 2019 are located on the northeastern part of the plateau and date to two main archaeological phases. The first phase is associated with the Kura-Araxes I-II (as per Palumbi 2008) or Kura-Araxes I cultural phase (as per Badalyan 2014; for details on how these periodization systems compare, see Passerini 2022) and is attested in Kurgan 1, Kurgan 5, Kurgan 6, and Kurgan 8, ca. 3600/3500–2900 BCE (Laneri et al. 2019, 2020), with a documented case of reuse of the mound in a “Post Kura-Araxes” or “Early Kurgan” phase of the final Early Bronze Age/Middle Bronze Age, ca. 2500–2000 BCE, (Sagona 2018). The second phase is associated with the Late Bronze/Early Iron Age, ca. 14th–10th century BCE (see Manning et al. 2018) represented by Kurgan 2, Kurgan 3, Kurgan 4, and Kurgan 7 (Laneri et al. 2019, 2020). Despite the protracted funerary activity on the plateau and with the exception of a concentration of sherds dating to the Chalcolithic on a flat spot to the southwest of Kurgan 8, it should be noted that no permanent settlements have been found in this area (Laneri et al. 2019, 145). This observation aligns with the documented spread of only temporary “light” architecture at the turn from the Chalcolithic to the Kura-Araxes I, suggesting the presence of short-lived occupations that may indicate, at this stage, a prevalently mobile character of these early Kura-Araxes communities as formerly suggested (Avetisyan 2022; Palumbi 2008; Rothman 2003). In this context, kurgans might therefore constitute the main “fixed” (more) permanent reference within a mobile social world.

Kurgan 8 was excavated by GaRKAP between 2018 and 2019 (Laneri et al. 2019, 2020). A 12-m diameter tumulus of pebbles and limestone covered a large funerary chamber (ca. 5 m wide and 7 m long) dug into the natural soil in an east-west orientation, preceded by a narrow dromos entrance, and encircled by a row of large stones (Figure 2a). The chamber was lined with rectangular mud bricks covered in white plaster, forming 30–35 cm thick walls, a technique that is well attested in earlier Chalcolithic kurgans in Azerbaijan (Lyonnet et al. 2008; Museibli 2014). In fact, it has been suggested that the South Caucasian tradition of constructing mud brick burial chambers may reflect a Mesopotamian trait and, possibly, the intent to reproduce an idealized house for the dead (Pappalardo and Laneri 2023; Sagona 2018, 153). Funerary depositions were placed inside the chamber through the rectangular entrance corridor with sloping floor, excavated on the eastern side of the chamber according to a funerary pattern that characterizes contemporary barrows from Northwest Azerbaijan (Huseynov 2019; Pappalardo and Laneri 2023). Wooden beams, probably from a type of juniper tree, were placed at an interval of 10 to 20 cm to support the heavy roofing, possibly filled with wattle and daub, although the fire did not leave evidence of it. The floor of the burial chamber was most likely constructed with fine gravel and white lime from the plateau, though it was not possible to detect a coherent floor in the dromos. In the middle of the funerary chamber, a small pit lined with heavy burned pebbles was filled with ash from a fire or, perhaps, from a wooden column burned by a vigorous flame.

Evidence collected from Kurgan 8 allowed for the reconstruction of a complex sequence of events related to the funerary function of the site (Laneri et al. 2020). At least two different phases of deposition could be identified inside the main chamber, and one, exceptionally, inside the dromos. Human remains were amassed on the western side, opposite to the entrance of the funerary chamber, where the disarticulated bones of adults and subadults (infants, children to adolescents) were mixed with pebbles and mudbrick pieces, indicating that these remains may have undergone a further intervention after the collapse of the southern wall and part of the roofing. Eight individuals were found in primary deposition. Two of these were laid on wooden sledge-stretchers or boxes that were possibly involved in a ritual that required dragging the deceased before taking them inside the chamber through the dromos, as suggested by clear imprints on the ground (Figure 2b and c). The deceased were accompanied by a limited set of funerary equipment comprising tableware vessels, bone spindle whorls, necklaces of limestone beads, flint arrowheads, and selected animal remains (i.e., horns and *bucrania*) (Figure 3). The ceramic assemblage primarily comprises medium grit-tempered Monochrome Burnished Ware (Palumbi 2008) with occasional traces of chaff in two morphological shapes that probably reflect the intention to set meals for the deceased: deep bowls with simple profile and an omphalos base, and handled jarlets with globular body, pronounced shoulders, and outflaring necks featuring, in a few cases, geometric decorations incised or relieved with the motif of knobs and ribs (Laneri et al. 2020,



Figure 2. Kurgan 8, Uzun Rama. General view of the funerary chamber from the east (a); a primary deposition (“Individual 2”) on the imprints of a sledge/stretcher viewed from the west (b); wooden structure and funerary depositions piled up on the western side of the chamber opposite the dromos entrance viewed from the east (c).

119–120). According to Badalyan (2021, 224), the ceramic assemblage from Uzun Rama shares characteristics with the so-called “Didube-Kiketi” ceramic group that defines the first KA phase of homogeneity. This assemblage characterizes the Kura-Araxes I horizon of the South Caucasus and East Anatolia that, despite minor regional variations, diffused with astonishing consistency as a result of the transfer of people, technical skills, ideas, and practices (Sagona 2018, 214–215). The finds from Şadılı-Uzun Rama also aptly reflect the prevalent homogeneity of funerary goods from KA tombs ascribed to a lack of vertical differentiation within contemporary society.

While the complete analysis of the human remains is in progress, the low number of depositions compared with other known contemporary kurgans (hosting from 30 up to more than 100 individuals, see Erdal et al. 2019; Lyonnet 2014) could be attributed to the premature collapse of the structure. Following this event, the dromos was exceptionally used as a second funerary chamber. In fact, a thick deposit of commingled and very poorly preserved human remains, mixed with animal bones and

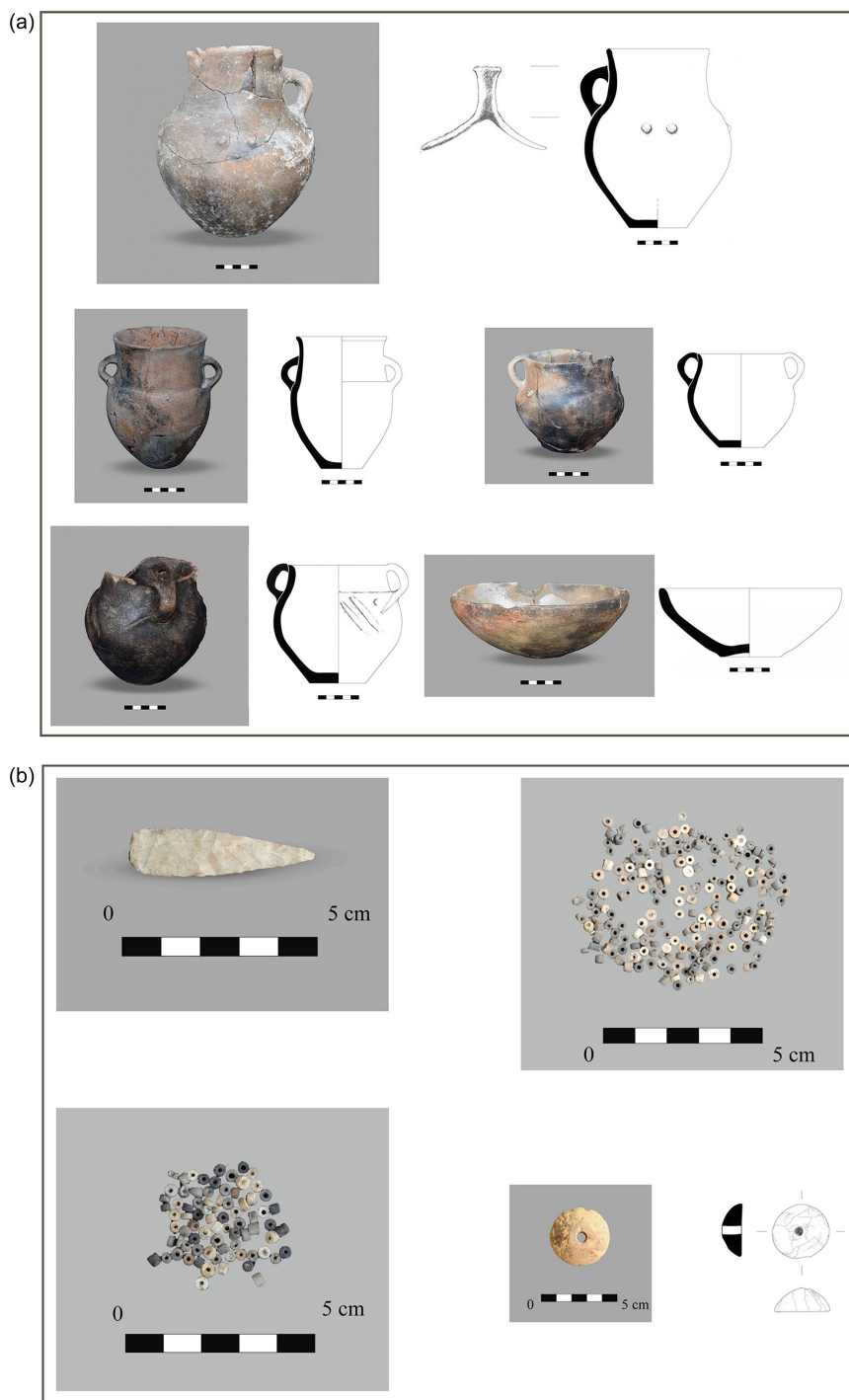


Figure 3. Assemblage of jarlets and deep bowls of monochrome burnished ware (a) and objects (b) from the burial chamber of Kurgan 8.

ceramics, may have resulted from successive depositions that pushed the previous ones along the sloping floor of the entrance corridor. At the end of their funerary use, both the funerary chamber and the dromos were set on fire as part of a termination ritual. According to the pattern of the burnt traces, the fire inside the chamber was initiated in the southwestern corner, where the wooden boards of a rectangular structure were found on top of a layer of limestone and rubble that covered two primary depositions (Laneri et al. 2020). An analogous structure has been identified inside the funerary chamber of Kurgan 1 at Şadıllı-Uzun Rama (Erdal et al. 2019; Jalilov 2015, 2018), and comparable fire patterns, with heavier traces of burning on the western side of the chamber, come from the contemporary sites of Tatarlı, Dashuz, Gabala, Khanlar and Borsunlu in Northwest Azerbaijan (Huseynov 2019). This wooden structure—interpreted as either a “pyre” or possibly a structural element that kept part of the roof open in order to initiate and fuel the fire—together with the consistent pattern of fire traces, hint at the symbolic importance of a shared and anticipated eventual final ritual that was planned from the kurgan’s initial laying and use. After the fire, the resulting destruction layer in the area of the chamber and the dromos was sealed through the construction of a monumental tumulus. A single deposition of an adult individual may be associated with this phase, isolated beneath the final tumulus, along with an accompanying vessel.

To the ritual activity connected with the following phase of abandonment belongs, in all probability, a small pit that was excavated on its surface, right outside the burial chamber, and containing a small, handled jar with incised decoration, according to a practice documented elsewhere on the plateau (Jalilov 2018). A continuous awareness of the kurgan’s function, and maybe its connection to a perceived ancestral memory, may be glimpsed in the subsequent use of the monumental tumulus. As revealed during the 2018 season (Laneri et al. 2019), the tumulus was reused at the end of the third millennium (final Early Bronze Age/Middle Bronze Age, ca. 2500–2000 BCE) to incorporate two intrusive pit graves, Grave I-I and Grave I-II, excavated, respectively, along the northern and western walls of the burial chamber (Laneri et al. 2019, 2020). Grave I-I (Figure 4a) contained the incomplete skeleton, probably due to later robbing, of one individual, together with a few funerary goods that included a stone necklace with a bronze clasp and a black burnished handled jar (Laneri et al. 2019). A deposit of animal bones belonging to a sheep, a lamb and a snake occupied the southeastern section of the tomb (Laneri et al. 2020, 117). Even the larger pit of Grave I-II was excavated to host just a single deposition (Figure 4b). A preserved beam found near the grave suggests that it had a wooden roof that was most probably removed by looters, who disturbed the buried individual. A deposit of animal offerings, ceramic vessels and a bronze dagger was located along the northern section of the earthen pit. The assemblage of large jars from the two graves is of the Black Burnished Ware (BBW) type that distinguishes the immediate “Early Kurgan” period associated with the so-called Martkopi and Bedeni cultural groups, ca. 2500–2000 BCE (see Sagona 2000, 2004), with manufacture characteristics (i.e., globular body, short necks, slightly everted and thickened rims, flat bases, and wide handles along the shoulders) typical of the region (Laneri et al. 2020, 122–123). The intrusive tombs testify to a shift from a collective to an individual ethos in the final stage of the kurgan’s life, emphasized by the deposition of valuable metals alongside the deceased. Following the deposition of the two graves, only marginally damaging the previous structure, the whole complex was covered by a larger, slightly more elongated, and highly visible burial mound (Laneri et al. 2020, 120).

Materials and methods

Original radiocarbon dataset

The radiocarbon evidence produced by the GarKAP project includes six ^{14}C dates obtained from samples collected manually in the field between 2018 and 2019 (Table 1). Of these, four ^{14}C dates are associated with the main funerary chamber (i.e. Kura-Araxes use), one is associated with Grave I-I (post-Kura-Araxes use), and one is associated with an inhumation possibly linked with medieval or modern visitation of the site (stratum K6). Dates from the first burial phase were obtained from: a



Figure 4. Intrusive grave (Gr I-I) with disturbed skeletal remains and accompanying objects viewed from the northeast (a) and Intrusive grave (Gr I-II) with a single primary burial and deposit of animal offerings, ceramic vessels and a bronze dagger (viewed from the east) (b).

sample of semi burned (undetermined) wood from a wooden sledge used to accommodate the inhumations (LTL20068A); a sample of charcoal (*Juniperus* sp.) from the wooden structure associated with the ritual burning (LTL20067A); a sample from undetermined seeds deposited with the burial

Table 1. List of ¹⁴C dates from Kurgan 8, Uzun Rama

Context	Archaeological Phase	Material	Sample ID	Lab code	¹⁴ C age (BP)	±	Calibrated age BCE (at 95%)
Grave I-I	Late Bronze Age	Human bone	CAMP 1	LTL20061A	2879	45	1207 (95.4%) 927
Main chamber, ind. 3	Early Bronze Age/Kura-Araxes I	Human bone	CAMP 5	LTL20065A	4756	45	3639 (76.4%) 3496 3451 (0.7%) 3446 3439 (18.3%) 3378
Main chamber, vessel associated with ind. 3	Early Bronze Age/Kura-Araxes I	Charred seed (undet.)	CAMP 6	LTL20066A	4805	40	3651 (95.1%) 3516 3391 (0.3%) 3386
Main chamber, wooden sledge	Early Bronze Age/Kura-Araxes I	Charcoal (undet.)	CAMP 8	LTL20068A	4740	45	3635 (66.4%) 3494 3459 (29.1%) 3376
Main chamber, wooden structure	Early Bronze Age/Kura-Araxes I	Wood fragment (<i>Juniperus</i> sp.)	CAMP 7	LTL20067A	4729	40	3632 (37.3%) 3551 3543 (22.1%) 3493) 3461 (36.0%) 3376
		Wood beam (<i>Juniperus</i> sp.)	AZ-2022-01a				
		Sub-sample* A	RY 1018-1022	UCIAMS-279401	4540	20	3366 (33.5%) 3317 3239 (35.4%) 3172 3167 (26.6%) 3104
		B	RY 1039-1042	UCIAMS-279402	4515	15	3354 (18.3%) 3307 3300 (3.0%) 3283 3275 (1.3%) 3267 3242 (72.8%) 3102
		C	RY 1049-1051	UCIAMS-279403	4505	20	3346 (28.4%) 3264 3246 (67.0%) 3101
		D	RY 1068-1072	UCIAMS-279404	4480	15	3336 (59.7%) 3211 3194 (35.7%) 3093
		E	RY 1088-1092	UCIAMS-279405	4480	20	3338 (56.9%) 3208 3196 (36.6%) 3091 3052 (2.0%) 3037
		F	RY 1108-1112	UCIAMS-279406	4475	20	3336 (57.1%) 3211 3194 (34.4%) 3089 3056 (4.0%) 3033
		G	RY 1128-1132	UCIAMS-279407	4505	15	3345 (26.1%) 3265 3245 (69.4%) 3102

(Continued)

Table 1. (Continued)

Context	Archaeological Phase	Material	Sample ID	Lab code	¹⁴ C age (BP)	±	Calibrated age BCE (at 95%)
		H	RY 1148-1152	UCIAMS-279408	4520	15	3357 (20.2%) 3312 3296 (1.5%) 3286 3240 (73.7%) 3103
		I	RY 1158-1162	UCIAMS-279409	4520	15	3347 (20.2%) 3312 3296 (1.5%) 3286 3240 (73.7%) 3103
		J	RY 1166-1170	UCIAMS-279410	4515	20	3355 (24.1%) 3282 3276 (2.1%) 3266 3244 (69.2%) 3102

*RY= relative years in tree-ring sequence

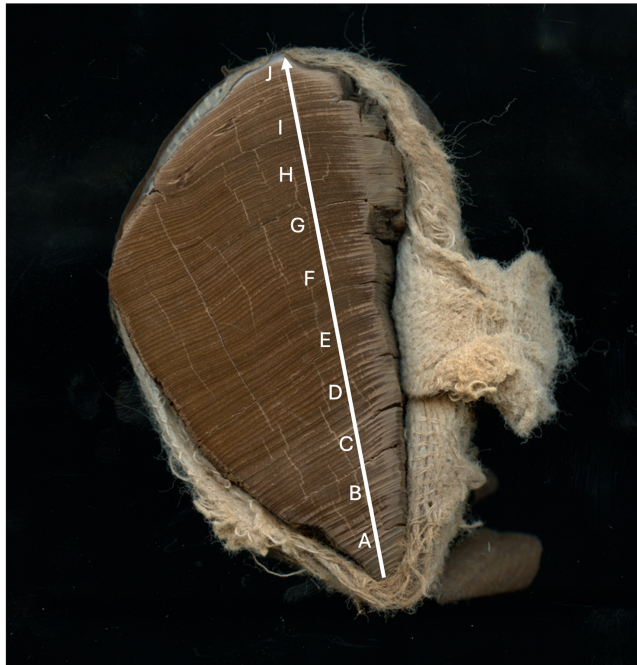


Figure 5. Sample AZ-2022-01a (*Juniperus* sp.) with indication of the approximate location of tree-ring groups that were sub-sampled for wiggle-match (from A to J, see Table 1).

assemblage associated with the second group of inhumations (LTL20066A); an undetermined human bone sampled from the second group of inhumations (LTL200665A). The date associated with Grave I-I was sampled from an unspecified human bone (LTL20061A). All the samples were ^{14}C -dated at the CEDAD Laboratory of the University of Salento. Botanical samples were pretreated according to the routine acid-alkali-acid (AAA) chemical protocol (Calcagnile et al. 2004; D’Elia et al. 2004). Bone samples were pretreated for collagen extraction following the Longin (1971) method. Following chemical pretreatment, the samples were combusted to CO_2 in vacuum-sealed quartz tubes at 900°C and reduced to graphite by using H_2 as the reducing agent at 600°C on Fe powder as catalyst. Graphite samples were then pressed into aluminum target and measured for ^{14}C content with a 3 MV HVEE Tandemtron accelerator (Mod. 4130 HC).

Wiggle-match

This study expanded on the ^{14}C dating of Kurgan 8 by producing a tree-ring defined ^{14}C wiggle-match sequence (e.g. Galimberti et al. 2004) from a sample of *Juniperus* sp. acquired in 2022. Our aim was to refine a more precise age estimate for the ritualized closure of the kurgan and its temporal relationship with the earlier and later burial uses—in particular we sought to better define calendar resolution in this fourth millennium BCE period where wiggles in the ^{14}C calibration curve often render individual ^{14}C measurements ambiguous. The sample (AZ-2022-01a, Figure 5), associated with the wooden pyre, was assessed at the Cornell Tree Ring Laboratory. Tree-ring investigation identified a total of likely ca. 175–176 annual rings. The sample exhibited some regions with micro-rings or very indistinct tree-rings (as common in *Juniperus* sp. from arid to semi-arid areas). Given no other population of samples of the same species from the area for comparison and dendrochronological crossdating, it is therefore unclear whether or not a few of these observed tree-rings are false rings (although the latewood appeared distinctly formed and hence we assume individual annual rings and not false rings in most cases—but

one ring in the outermost portion may be an exception, and hence we say ca. 175–176 rings, but there is a further small unquantifiable error associated). The sample was then dissected with a steel blade under a binocular microscope to obtain 10 additional samples of 3–5 rings for ^{14}C dating (Table 1). The sub-samples were extracted at regular intervals of ca. 10–20 rings (calendar years), targeting segments that were not affected by the presence of micro-rings or indistinct rings rendering it feasible to extract samples of 3–5 tree-rings. We preferred groups of 3–5 rings for sub-sampling due to the extreme narrowness of single rings and to avoid introducing noise by interpolating single-year increments to a smoothed calibration curve (for IntCal20 does not include annually resolved measurements for this period). The new samples were processed and dated by AMS at the W.M. Keck Carbon Cycle AMS Facility at the University of California Irvine. Prior to combustion, the samples were treated with acid-alkali-acid (1N HCl and 1N NaOH, 75°C), bleached to alpha-cellulose (1:1 1M NaClO₂, 1N HCl, 75°C), treated with 6N NaOH (room temperature) to produce alpha cellulose, washed with 1N HCl and ultra-pure MQ water, and vacuum dried. Measurements were carried out with a 500kV compact AMS unit (NEC 0.5MV 1.5SDH-2).

Bayesian chronological modeling

Bayesian chronological modeling, wiggle-matching, and calendar age calibration were performed using OxCal (Bronk Ramsey 2009; Bronk Ramsey et al. 2001) v.4.4.4 of 2021 (as noted in Figures) and the IntCal20 calibration dataset (Reimer et al. 2020). We derived prior information from the sequence of funerary actions reported in Laneri et al. (2020), taking into account that not all the associated events are directly represented in our ^{14}C dataset (Figure 6). We modeled the wiggle-match sequence derived from sample AZ-2022-01a, aimed at determining the age of the outermost preserved tree-ring, by employing the D_Sequence and Gap and Date functions (Figure 7; Table S1). The *Terminus Post Quem* (TPQ, “date after which”) for the construction of the wooden structure was further incorporated as a cross-reference into a separate model that employed the burial stratigraphy (Figures 6 and 8, Table S2). In the latter, we grouped the ^{14}C dates associated with the first burial phase as a uniform bounded Phase placed at the beginning of the Sequence (a Date query estimates the date for the Phase between its start and End Boundaries). The beginning of the second burial phase (i.e. accumulation of burials in the chamber and dromos) is represented by a hypothetical Boundary (“Start of second burial phase”, Figures 6 and 8), while the phase itself is not directly dated. This is followed by the cross-referencing of the Date estimate derived from the wiggle-match, which defines a TPQ for the ritual fire, the closure of the kurgan, and, thus, the end of the second (undated) burial phase within the main chamber. We employed the Difference function to interrogate the model about the time lapsed between the end of the first burial phase, which is derived from a directly dated Phase, and the wiggle-match Date estimate offering a TPQ for the end of the second Phase (and also compare this with an Interval query). Since the second burial phase is not directly dated, this function provides a hypothetical duration associated with this activity, assuming that the kurgan was used continuously until its final closure. The last Phase of the funerary Sequence includes a single ^{14}C date from Gr I-I, representing an intrusive burial event after the kurgan chamber was sealed.

Results and discussion

The new radiocarbon analyses provided additional insights into the history of Kurgan 8, partially challenging expectations based on the existing GarKAP ^{14}C dataset. The unmodeled UCIAMS series (sample AZ-2022-01a) calibrates between ca. 3370 and 3100 BCE, postdating the events dated by the samples associated with the first burial phase (roughly clustered within a range of 3650–3400 BCE, Table 1). This raises questions about the LTLT20067A measurement formerly obtained from the wooden structure, which predates the UCIAMS series. Since sample AZ-2022-01a probably constituted a branch, it is possible that LTLT20067A refers to an earlier sequence from the same tree that is not

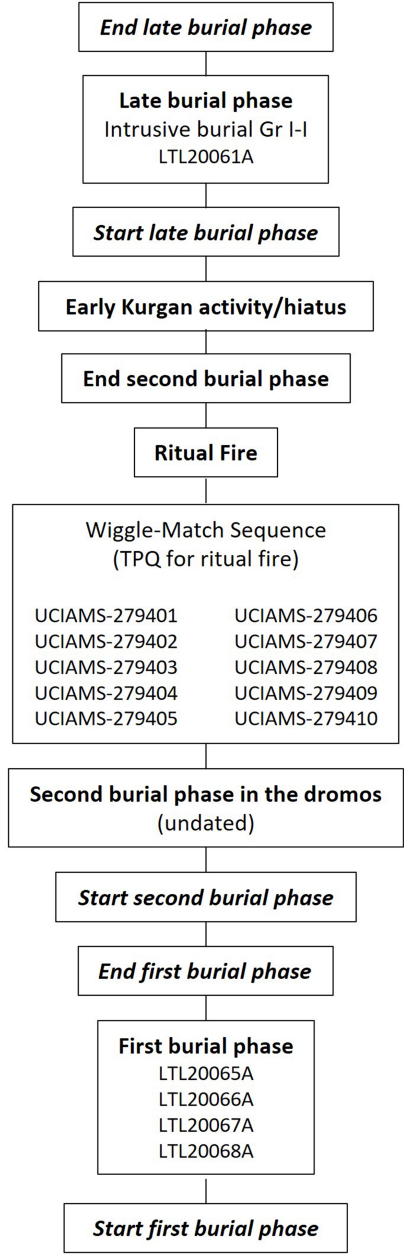


Figure 6. Visual summary of the prior information incorporated in the chronological model in Figure 8 and associated radiocarbon samples. Stratigraphic relationships are shown from earliest (bottom) to latest deposits (top).

represented in our sample (of the possible *Juniperus* sp. trees/shrubs in this region of Azerbaijan, e.g. Gurbanov and Rzaeva (2019), long-lived examples can be expected based on comparanda from other areas, but we lack suitable dendrochronological comparisons for this sample; nonetheless, juniper trees in Eurasia regularly exhibit considerable longevity (e.g. Esper et al. 2007) and ages of several hundred years are plausible in a semi-arid/arid context and as evidenced by AZ-2022-01a). However, probably more plausible is a second explanation: that LTLT20067A derived from displaced material belonging to

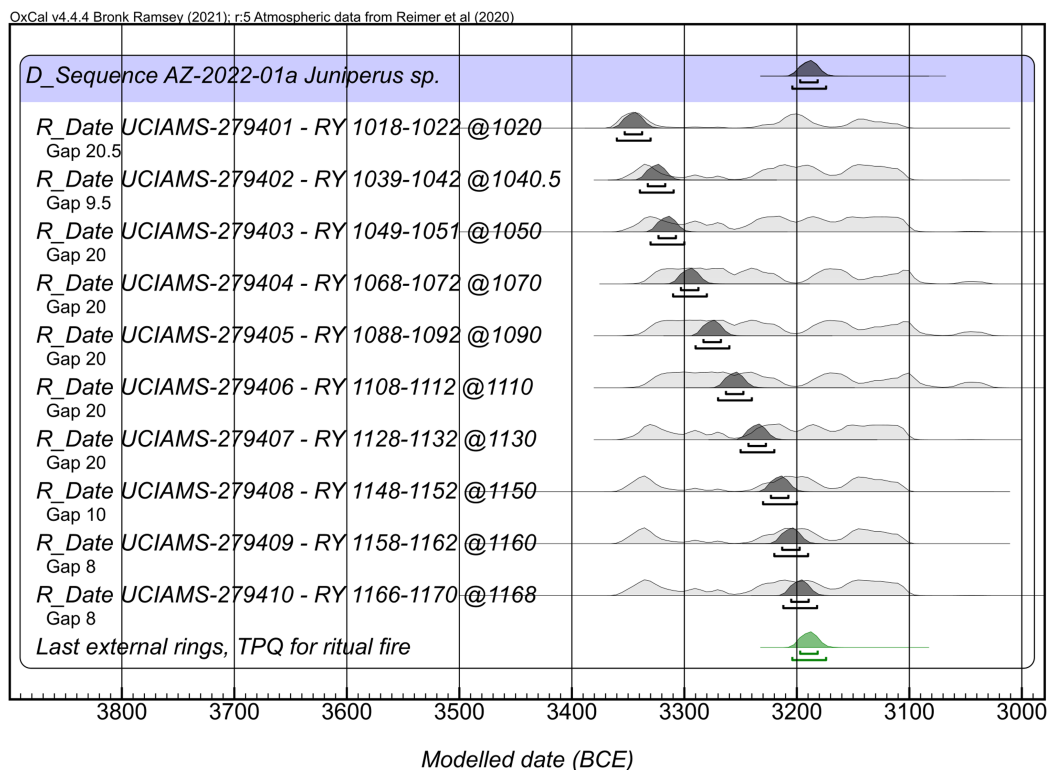


Figure 7. Wiggle-match sequence obtained from sample AZ-2022-01a. Radiocarbon dates are ordered according to the tree-ring sequence and known intervals using the *D_Sequence* functions in OxCal 4.4.4. We employed the *Date* function to estimate the age of the last extant rings (in green), which are not directly dated (see Table S1).

the earlier use of the kurgan chamber and was erroneously attributed to the wooden pyre. Statistical similarity between this date and the remaining measurements associated with the first funerary phase appear to support this second scenario (this is the scenario we opted for in the preferred model). A third possible explanation is the failure to eliminate contamination from humic or other contaminating mobile materials before AMS dating, since the CEDAD laboratory was not asked to pretreat the sample for a cellulose extraction.

The model compiled for the funerary sequence is accepted at $A_{\text{model}} = 138$ and $A_{\text{overall}} = 142.8$. The results estimate the Start of the first funerary phase within 3654–3569 BCE (68.3% highest posterior density, hpd) or 3756–3523 BCE (95.4% hpd), and its End within 3599–3489 BCE (68.3% hpd) or 3624–3359 BCE (95.4% hpd) with a Date estimate for this Phase of 3624–3529 BCE (68.3% hpd) and 3675–3410 BCE (95.4% hpd). As for the results of the wiggle-match, the Date estimate for the outermost extant tree-ring places the TPQ for the construction of the wooden structure within 3198–3182 BCE (68.3% hpd) or 3204–3174 BCE (95.4% hpd). Assuming that the construction of the structure occurred close to the felling of the branch (and given from the ring pattern and shape of the sample that the outermost extant tree-ring is relatively close to the original exterior of the tree/shrub), this TPQ should be reasonably close to the dating of the ritual event associated with the burning of the pyre, including the re-deposition of human remains present in the chamber within the kurgan's *dromos*. This estimate also provides a TPQ for the end of the second burial phase within the kurgan chamber. Since not all the inhumations from inside the chamber have been ^{14}C -dated, there remains doubt about whether the first tumulus was in use continuously until its ritual closure, or whether burial episodes were separated by periods of inactivity. To approximately estimate the period of time between the end of the

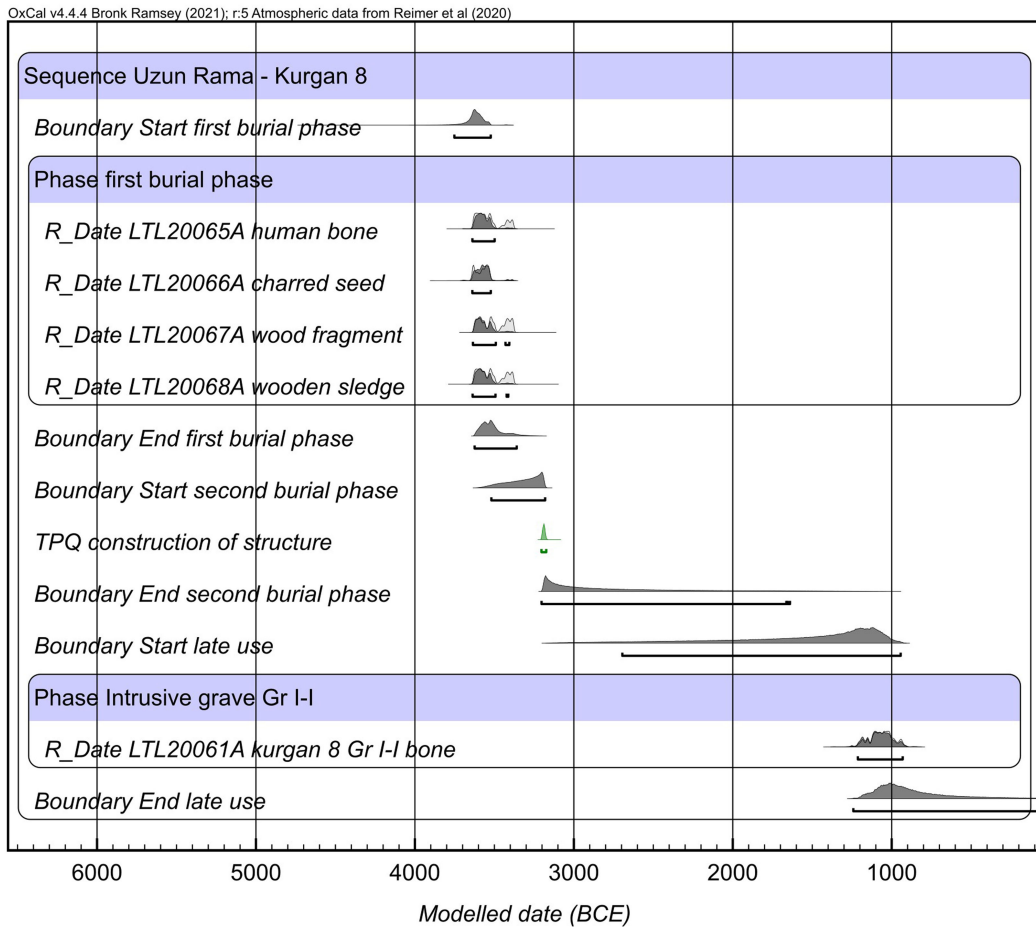


Figure 8. Bayesian chronological model of Kurgan 8 at Uzun Rama. Radiocarbon dates are grouped and ordered according to the associated burial phase (see text for details). The model cross-references the TPQ derived from the wiggle-match obtained from sample AZ-2022-01a (in green, see Figure 7).

first burial phase and the end of the second burial phase we considered two measures. An Interval query between the Boundary for the start of the second burial phase and the wiggle-match date on AZ-2022-01a indicates 0–123 years (68.3% hpd) and 0–322 years (95.4% hpd). This is likely a minimum estimate (given the start Boundary is only informed by the end of the previous phase and the end of the second phase, with no data from within the second phase). A Difference query between the end of the first burial phase and the wiggle-match estimate on AZ-2022-01a in contrast likely indicates a maximum estimate since there is no reason to assume the second burial phase was directly contiguous from the end of the first phase; this query yields a period of 299–410 (68.3% hpd) or 170–438 years (95.4% hpd) between the end of the first burial phase and the (TPQ estimate) closure of the second burial phase. The dating of the remaining inhumations associated with the second tumulus is currently unknown. The archaeological assemblage associated with Gr I-I attests to visitation of the monumental area by Early Kurgan communities. Following the accepted chronological range for the Early Kurgan period (2500–2000 BCE), this would indicate that at least five hundred years separated the closure of Kurgan 8 from later revisitations, highlighting its importance as *lieu de mémoire* (Nora and Kritzman 1984). However, date LTL20061A, the only one associated with Gr I-I, places it within the late second millennium BCE, suggesting activity falling well into the Late Bronze Age/Early Iron Age. There is, therefore, a discrepancy between the age of the human remains and the date suggested by the ceramic

assemblage. Most likely, this discrepancy is the result of later disturbances linked with looting or other re-use activities in antiquity, as the absence of several of the deceased's remains suggests.

In addition to securely dating the closure of Kurgan 8 at Uzun Rama, the new data substantially contribute toward our knowledge regarding broader regional dynamics in the development of the Kura-Araxes horizon both within and beyond the Kura basin. To date, Kurgan 8 at Uzun Rama constitutes the earliest dated KA location in the Kura basin, adding to a very limited dataset of KA sites dating to ca. 3500 BCE (e.g. Jrvezh/Avan, Badalyan 2014) in the South Caucasus. As Laneri et al. (2020) discussed, the ritual fire that sealed Kurgan 8, dated to after 3204–3174 BCE (95.4% hpd) according to our wiggle-match, relates directly to the transformation of this structure into a permanent landmark (an act of “monumentalization”). The same scenario (i.e. a tumulus closed by fire at the end of a funerary phase) is attested at Mentesh Tepe, a multiperiod site located along the Kura basin where KA and post-KA kurgan structures are present (see Lyonnet and Guliyev 2017). According to available radiocarbon data, at Mentesh Tepe the construction of kurgan 4, associated with KA funerary activity, probably dates to between the early 36th and the late 33rd centuries BCE, and the structure was possibly in use until the 28th century BCE (though estimates for kurgan 4 are, at this stage, imprecise, see Figure S1 and Table S3). A potential gap separates the dated use of kurgan 4 from the post-kurgan activity (identified as Martkopi, ca. 2600–2200 BCE) associated with the later kurgan 54, though its estimate is poorly defined at this stage (see Figure S1). An interesting, and possibly related situation is attested at Namgala, also located along the Kura River within today's territory of Tbilisi, Georgia, where an EBA kurgan was recently excavated by a team of the Georgian National Museum (see Passerini et al. 2025). Altogether, data from these kurgans might point towards a consistent and conscious pattern of revisitation and burial deposition along the Kura in correspondence with the sealing of long-lived kurgan structures. According to the results of a recent reassessment of KA chronology, the closure of these locations possibly coincided with a spatial reorganization of settlements across the KA world (Passerini et al. 2025). If ancestors did, in fact, continue to play active roles in living communities, our findings at Kurgan 8 may indicate a major transformative event in KA history.

Conclusions

Collective kurgans are a critical feature of the archaeological landscape of the South Caucasus and broader Eurasia in later prehistory. As long-lived structures, kurgans represent a remarkable archive of humans' diverse relationships with life and death across space and time, offering insights into the socio-cultural values of the communities that inhabited the South Caucasian highlands during the EBA. Undifferentiated approaches to the dating of these structures (often based on isolated ^{14}C measurements and focused on chrono-cultural phases rather than single actions) risk oversimplifying (and generalizing) the multi-temporality of these archives, particularly in the absence of obvious stratigraphic sequences. In this study, we harnessed the dating potential of a wood-charcoal wiggle-match to obtain highly informative constraints for the active use of Kurgan 8 at Uzun Rama. While some of the burial contexts within the structure remain undated, our wiggle-match contributed to refining a precise TPQ for the ritual closure of the main chamber, dating likely shortly after 3204–3174 BCE (95.4% hpd). This TPQ immediately intervenes in the otherwise ambiguous (due to calibration noise) dating of EBA contexts during the second half of the fourth millennium BCE. When combined with existing (though, to date, approximate) radiocarbon data from other EBA kurgans located in the Kura basin, our results suggest that the “monumentalization” of Kurgan 8 (Laneri et al. 2020) might have been part of a broader reconfiguration of funerary locations across the Kura-Araxes landscape around this time. Though abundant, wood-charcoal from similar contexts has been under-exploited in the archaeology of the South Caucasus thus far. Moving forward, implementing adequate recovery and documentation strategies will help enhance the potential of these materials for resolving chronological questions well beyond the history of single mounds.

Supplementary material. To view supplementary material for this article, please visit <https://doi.org/10.1017/RDC.2026.10191>

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