Thirty years in the making: A critical overview of the Kura-Araxes periodization from a radiocarbon perspective

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Abstract: The chronology of the Kura-Araxes culture has long been a matter of debate, particularly as regards its internal periodization. To date, two main periodization systems have been proposed, which argue, respectively, for a three-part and two-part scheme. Despite the acquisition of new ^{14}C and archaeological datasets, universal consent on this issue still hasn't been reached. This paper reviews the state of the art in chronological studies on the Kura-Araxes culture and provides a critical assessment of the two periodization systems since the introduction of radiocarbon dating in the South Caucasus. The discussion demonstrates that the understanding of the Kura-Araxes chronology exceeds mere questions of 'objective' chronometric agreement, as seen in the way that different archaeological agendas have influenced the interpretation of ambiguous calibrated data, and vice versa. Finally, the paper highlights the potential of Bayesian chronological modeling to disambiguate chronometric evidence and exploit archaeological knowledge to the benefit of regionalized periodization frameworks.

Keywords: Kura-Araxes, radiocarbon, periodization, calibration, Bayesian chronological modeling

Introduction

The absolute chronology and periodization of the Kura-Araxes (KA) culture have long been subjects of debate in the archaeology of the South Caucasus. Chronological endeavors have focused on establishing an absolute timeframe for the Kura-Araxes to place it within a comprehensive chrono-cultural history of the region, all the while attempting to establish chronological boundaries for the internal stages of its material development. For the moment, while dedicated discussions[1] appear to have largely settled the question of the absolute extent of the Kura-Araxes culture, comfortably placed between 3500 and 2500 BCE (although not without controversies, see below), much less consensus surrounds the understanding–let alone definitions–of its internal periodization as scholars continue to embrace differently defined chronological subdivisions between a varying number of developmental stages.

[1] E.g. Palumbi, Chataigner 2014; Batiuk *et al.* in press.

The importance of the Kura-Araxes culture as a cultural 'label' for the Early Bronze Age (EBA) in the South Caucasus[2] also amplifies the importance of its internal periodization for the chronological definition of the interface between the Late Chalcolithic (LC) and the EBA in the broader context of KA expansion and interaction within the Near Eastern sphere.[3] In that regard, scholars are particularly at odds with the apparent anachronism of the beginning of the EBA in the South Caucasus (*c.* 3500 BCE) compared to the Santa Fe system (*c.* 3000 BCE).[4] Although this issue pertains to the regional context of chronological analysis, whereby discontinuities in material culture are identified differently according to local developments,[5] scholars ascribing to the school of the 'Metal Ages' insist on the relevance of the beginning of the KA culture to define these macro periodizations.[6]

Reviews of the status of scientific chronology in the South Caucasus[7] often point to the scarcity of radiocarbon data and the lack of secure stratigraphic sequences as the main source of disagreement between conflicting periodization systems applied to the KA culture. This is partially true, but archaeological research in the South Caucasus has come a long way over the last three decades and extensive series of radiocarbon dates have been produced by both local research programs and international collaborations. Of particular note is the radiocarbon series produced by Project ArAGATS, a collaboration between Cornell University and the Armenian Institute of Archaeology and Ethnography,[8] which to date constitutes the largest corpus of ^{14}C dates in the region. Other series have been produced in the frame of the Georgian Italian Shida Kartli (now Lagodekhi) Archaeological Project (Ca' Foscari University of Venice),[9] the Georgian Australian Archaeological Project (University of Melbourne), the French-Armenian Mission Caucase (CNRS), and the Vorotan Project (Brown University).[10] Bayesian modeling is increasingly being integrated in regional and site-based syntheses,[11] helping to reduce chronological ranges inflated by radiocarbon uncertainty and highlight patterns of local development.

Disagreements over periodization systems typically stem from different accounts of what constitutes the material hallmarks of the KA, an issue that is usually defined in relation to ceramic styles. While the problem of inconsistency in ceramic

[2] Smith *et al.* 2009.

[3] See Sagona 2014; Rova 2020.

[4] Rothman 2001.

[5] That is, the advent of KA lifeways as a marker of the EBA *c.* 3500 BCE in the South Caucasus and the dissolution of the Uruk system as a marker for the end of the LC *c.* 3000 BCE, see also Rova, Tonussi 2017 and Rova 2020 on this topic.

[6] E.g. Kavtaradze 2012; *idem* 2017.

[7] E.g. Sagona 2014; *idem* 2018.

[8] Manning *et al.* 2018.

[9] Rova 2014.

[10] Cherry *et al.* 2007.

[11] Passerini *et al.* 2016; Manning *et al.* 2018.

typologies has been previously noted by several scholars,[12] Ruben Badalyan most recently reiterated how chrono-cultural discrepancies relate to the more thorny issue of explicitly conceptualizing which material characteristics should hold chronological significance.[13] These criteria may predetermine the interpretation of the associated radiocarbon record, undermining its status as an independent corpus of evidence. Work elsewhere in the world has highlighted the need to separate pre-existing cultural assumptions lacking clear stratigraphic basis from an independent assessment of ^{14}C dates in order to achieve robust and independent timeframes.[14] In the case of the KA culture, conventional chronologies based on ceramic typologies prior to the advent of radiocarbon dating have overemphasized homogeneity and continuity in the history of Kura-Araxes assemblages.[15] One result was the spread of chronologically limited assemblages across the entirety of the Early Bronze Age. In that regard, Badalyan's proposal[16] based on the ^{14}C data produced by Project ArAGATS has broken away from this 'illusion of continuity' in favor of a more discrete and fragmented model, which emphasizes both spatial and temporal variation. These opposing approaches to periodization are embodied by the two main developmental schemes proposed for the Kura-Araxes culture: a continuous three-part scheme (KA I-III)[17] and a discrete two-part sequence (KA I-II).[18] In his latest work, Sagona still observed this scholarly division.[19]

The separation between scholars adopting the three-part or the two-part system[20] clearly demonstrates that radiocarbon has not settled debates over relative chronologies. In fact, at times an uncritical trust in radiocarbon dates may have introduced further complications through the elaboration of explanatory frameworks due to calibration ambiguity and inflated chronological spans. Such ambiguity obscures the relationship between archaeological materials and associated radiocarbon dates, and calls into question the neat divide between relative and absolute chronology. As such, the impact of radiocarbon dating on the understanding of the EBA/KA culture in the South Caucasus has become deeply entangled with the underlying approaches to material phylogeny that characterize the three-part and the two-part periodization systems. This paper provides an overview of how radiocarbon dating has shaped the re-interpretation of pre-^{14}C periodizations and how traditional views of material culture have impacted understandings of radiocarbon data.

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[12] E.g. Sagona 2014; Rova 2020.

[13] Badalyan 2018.

[14] E.g. Manning *et al.* 2021.

[15] Badalyan *et al.* 2009: 38.

[16] Badalyan 2014; *idem* 2021.

[17] Sagona 1984; Palumbi 2008.

[18] Badalyan 2014.

[19] Sagona 2018: 224-226.

[20] See Rova 2020: 370, n. 41.

Traditions of Kura-Araxes periodization after the introduction of radiocarbon dating

The tree-part system

By the time radiocarbon dating entered archaeological debates on the EBA in the South Caucasus, several relative chronologies had already been elaborated for Kura-Araxes materials.[21] With few exceptions,[22] these schemes argued for a tripartite sequence consisting of an early (KA I), mature (KA II), and late stage (KA III) based on ceramic typologies. The absolute chronological boundaries of these schemes, though varying in their exact estimation, tended to be confined within the limits of the 3rd millennium BCE. While scattered ^{14}C dates occasionally served as reference points for these early schemes,[23] Kavtaradze was the first to propose a revised absolute chronology based entirely on calibrated radiocarbon dates.[24] The advent of calibration radically changed perspectives on KA studies, most notably by pushing the beginning of the culture well into the 4th millennium BCE, thus placing the KA culture between 3700 and 2800 BCE. As a result of this chronometric expansion, archaeological periodization also needed to be stretched to comprise the required material continuity over almost a millennium of existence. On the one hand, Kavtaradze's proposal sanctioned a fundamental shift toward 'high' chronologies[25] and revealed a prior tendency to underestimate the age of Bronze Age complexes, a phenomenon that is well-known in European prehistory.[26] On the other hand, his proposal inaugurated a phase of discomfort in the making of KA periodization, particularly as scholars attempted to maintain the techno-historical continuity and coherence between the Late Chalcolithic and the Middle Bronze Age,[27] all the while accounting for patterns of synchronic and diachronic diversity. Ultimately, this relates to whether the KA phenomenon should mark the beginning

[21] E.g. Djaparidze 1961; Khanzadyan 1967; Kushnareva, Chubinishvili 1970; Burney, Lang 1971; Munchaev 1975. For an extended overview of the history of EBA/KA periodization see Palumbi 2008: 12-16 and Badalyan *et al.* 2009: 35-38.

[22] E.g. Martirosyan 1964.

[23] E.g. Mirtskhulava 1975; see Badalyan *et al*. 2009: 37, n. 19.

[24] Kavtaradze 1983. However, note that Kavtaradze referred to the now outdated Clark's calibration curve. In addition, earlier ^{14}C readings performed by Soviet laboratories routinely reported ^{14}C dates with the half-life of 5730 instead of 5568, which is the accepted convention in radiocarbon reports. See Chataigner 1995 on this issue.

[25] Palumbi 2008: 14.

[26] See Renfrew 1973.

[27] Kuftin (1941) originally assigned the Kura-Araxes culture to the Aeneolithic period based on erroneous assumptions about the KA metallurgical repertoire, considered to be copper. Once analysis established that it in fact consisted of arsenic copper, scholars split between those supporting a transitional interpretation of this technology, thus being closer to the Chalcolithic, and those embracing it as a form of innovation sanctioning the beginning of the EBA (see Akhundov 2004). The attainment of 'high' dates for the beginning of the KA essentially added a chronological argument in support of its Late Chalcolithic affiliation.

of the EBA in the South Caucasus and, if so, which material traits should mark this change in the archaeological record.

After Kavtaradze, various chronological proposals suggested to shift the internal boundaries of the KA developmental stages in order to re-align radiocarbon and conventional perspectives. Most notably, Sagona[28] set out the bases for a newly elaborated tripartite system that mediated between 'high' and 'low' chronologies.[29] However, the incoherence of early ^{14}C determinations produced by Soviet laboratories[30] and the lack of complete stratigraphies spanning the period between the LC and the Iron Age in the South Caucasus led Sagona to define the boundaries of the 'core' Kura-Araxes phase (KA II) based on cross-references with data from Anatolia and the Levant. Specifically, the beginning of the KA II was set around 3200 BCE based on the co-presence of KA materials and Uruk and Jemdet Nasr imports at KA sites in the Elaziğ region.[31] Similarly, the end of the KA II was set between 2800/2750-2450 BCE, corresponding to the appearance of KA/Khirbet Kerak sherds in the levels of Mardikh IIA.[32] Therefore, the KA I (*c.* 3600-3200 BCE) and KA III (*c.* 2500-2200 BCE) phases were defined chronologically working backwards from the derived boundaries of KA II. This reappraisal of the tripartite periodization fundamentally relied on a geographical criterion, whereby each phase described a period of expansion from the South Caucasus outwards, most notably signaled by the presence and diffusion of the so-called *Red-and-Black Burnished Ware* (RBBW) that had long been known outside of the Caucasian 'homeland'.[33] Glumac and Anthony[34] endorsed the basic terms of Sagona's proposal, while Kushnareva[35] suggested terminating the KA II/EB II phase at 2900 BCE, followed by a KA III/EB III (2900-2600 BCE) and post-KA/EB IVA (2600-2400 BCE) phase. Both Sagona's and Kushnareva's periodizations were elaborated based on the same handful of ^{14}C dates from the South Caucasus.[36]

Twenty years later, Palumbi[37] revisited Sagona's periodization by examining a new, but still limited, array of ^{14}C dates (Table 1) from Horom,[38] Talin and Aparan III,[39]

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[28] Sagona 1984.
[29] Palumbi 2008: 14.
[30] Such ^{14}C dates were not the product of a systematic site-based dating strategy. Problems include sample size (one date per site or for a single phase within a site), statistical inconsistency (^{14}C dates from the same contexts with very different ranges), and ambiguous provenience (scarce characterization of the material and the archaeological context).
[31] Sagona 1984: 125.
[32] Sagona 1984: 126.
[33] Braidwood, Braidwood 1960.
[34] Glumac, Anthony 1992.
[35] Kushnareva 1997.
[36] See Sagona 1984: Table 4; Glumac, Anthony 1992: 167f., Table 2; Kushnareva 1997: 52, Table 3 and 83, Table 4.
[37] Palumbi 2003; *idem* 2008.
[38] Badalyan *et al.* 1994.
[39] Badalyan 2003.

Site	Lab Code	^{14}C years BP	±	Materials	Reference
Aparan III	AA-40153	4455	75	Seeds *Hordeum sp.*	Badalyan 2003; Badalyan and Avetisyan 2007
	Bln-5528	4428	39	Seeds *Hordeum sp.*	
	LY-10623	4321	33	Seeds *Hordeum sp.*	
Berikldeebi	LE-2197	4850	50	Seeds	Kiguradze 2000
	OZE-595	5070	40	Animal bone	Kiguradze and Sagona 2003
Didube	OZF-720	4486	60	Undetermined charcoal	Kiguradze and Sagona 2003
Horom	AA-10191	4505	50	Burned human bone	Badalyan *et al.* 1994; Badalyan *et al.* 1993
	AA-11130	5130	60	Undetermined charcoal	
	AA-7767	4565	60	?	
Mokhrablur	GrN-8177	4140	30	Undetermined charcoal	Kushnareva 1997
	GrN-8178	3825	30	Undetermined charcoal	
Shengavit	LE-458	4020	80	?	Dolukhanov and Timofeev 1972
	LE-672	3770	60	?	
Sos Höyük VA	Beta-107910	4910	170	Undetermined charcoal	Sagona 2000; Sagona and Sagona 2000; Sagona 2014
	Beta-107912	4390	70	Undetermined charcoal	
	Beta-120452	4590	50	Undetermined charcoal	
	Beta-135362	4440	50	Undetermined charcoal	
	Beta-135363	4290	70	Phytolith	
	Beta-74452	4510	70	Undetermined charcoal	
	OZF-125	4643	43	Undetermined charcoal	
	OZF-126	4440	40	Animal bone	

Table 1. Radiocarbon dates from KA sites discussed in text and shown in Figures 3 and 4.

Site	Lab Code	^{14}C years BP	±	Materials	Reference
Sos Höyük VA	OZF-594	4457	34	Animal bone	Sagona 2000; Sagona and Sagona 2000; Sagona 2014
	OZF-721	4524	34	Undetermined charcoal	
	OZF-944	4430	40	Undetermined charcoal	
	OZF-942	4510	40	Undetermined charcoal	
	OZH-823	4340	50	Undetermined charcoal	
	Beta-95219	4600	90	Undetermined charcoal	
Talin	R-2627	4230	58	Human remains	Badalyan 2003; Palumbi 2003
	R-2628	4448	52	Human remains	

Table 1. Continued.

Berikldeebi,[40] Didube,[41] and Sos Höyük.[42] The increase in ^{14}C dates from Armenian sites is particularly noticeable considering that, until the 1990s, the Armenian dataset comprised only a few ^{14}C readings from Shengavit[43] and Mokhrablur,[44] which had laid the foundations for most of the traditional chronologies in Armenia.[45] Much like in Sagona 1984, the RBBW is central to Palumbi's (RBBW) analysis, as it acts as a material proxy to track the development of the core phase of the KA culture (the appearance of RBBW marks the KA II) in the broader context of its relations with the Upper Euphrates region. As such, the KA I and the KA III phases in Palumbi's system are archaeologically defined in contrast with the RBBW (KA II): thus, the KA I is marked by the prevalence of so-called Monochrome Ware (MW) and the KA III by

[40] Kiguradze 2000. Note that although the date from Berikldeebi Level IV1 (LE-2197) had already been published by Kavtaradze (1983), it was not included in Sagona's date list (1984, Table 2). Since included dates from the South Caucasus were retrieved from published issues of *Radiocarbon*, presumably this was due to difficulty in accessing Russian literature.

[41] Kiguradze, Sagona 2003.

[42] Sagona 2000.

[43] Originally published in Dolukhanov, Timofeyev 1972.

[44] Dates from Mokhrablur were partially published in Kushnareva (1997) and more recently appeared in Badalyan 2014, although without specification of their radiocarbon age (BP). A publication of the complete ^{14}C series and stratigraphy of Mokhrablur is still missing.

[45] Three dates from Karnut were also produced around this time (Badalyan *et al.* 1992, n. 6), but were only fully released by Badalyan and Avetisyan (2007: 138).

the prevalence of Black Burnished Ware (BBW) with incised and grooved decorations. Chronometrically, in line with Kavtaradze's proposal (1983), the beginning of phase KA I was set around 3600 BCE based on the single ^{14}C date from Berikldeebi (LE-2197, see Table 1), associated with the earliest evidence of MW,[46] and the ^{14}C dates from the early levels at Sos Höyük.[47] The beginning of the KA II was placed between *c.* 3300 and 2700 BCE primarily based on the higher boundary of the overlap of Aparan III and Horom at 95% probability,[48] and phase KA III was fixed between *c.* 2700/2600 and 2500 BCE in reference to the then limited ^{14}C dataset available for the excavated levels of Gegharot, characterized by pottery with grooved and incised decorations.[49] However, it should be noticed that Palumbi already noted limitations in considering the MW/RBBW ratio as a pure chronological marker,[50] thus introducing ambiguities in defining the boundary between KA I and KA II.[51]

The two-part system

A two-part approach to Kura-Araxes periodization has been proposed by Ruben Badalyan[52] based on the results of the excavations carried out by Project ArAGATS in the Tsaghkahovit Plain,[53] and, as such, tends to be associated with the 'Armenian sequence' in contrast with the conventional, more general South Caucasian approaches.[54] This periodization differs from the three-fold system not only in terms of the number of material stages, here broken down in two phases (KA I and KA II), but also regarding the underlying criteria employed to define the phases archaeologically. While the three-fold system privileges the appearance and diffusion of RBBW as the chrono-cultural link between the KA developmental phases (whether in reference to its absence, prevalence, or replacement in ceramic repertoires), the two-fold system focuses on four geographically discrete, stylistically defined ceramic assemblages: 'Elar-Aragats', 'Karnut-Shengavit', 'Shresh-Mokhrablur', and 'Ayghum-Teghut'.[55] Morphology and ornamentation are the main criteria that distinguish the different groups, which were originally assumed to represent sequential stages of the KA culture, although with rather different understandings about their temporal order.[56]

46 Palumbi 2008: 35, 45.
47 Sagona 2000.
48 Palumbi 2008: 158, 201.
49 Smith *et al.* 2004.
50 Palumbi 2008: 205.
51 For an extended discussion on these issues see also Passerini *et al*. 2018.
52 Badalyan 2014; *idem* 2021.
53 Smith *et al*. 2009.
54 Sagona 2018: 226.
55 Badalyan 2014.
56 Badalyan *et al.* 2009: 38. For instance, Martirosyan (1964) and Khanzadyan (1967) seem to have interpreted the relatively poor presence of ornamentation in Elar-Aragats assemblages as signal for a late/declining phase of the KA culture and placed it at the end of their respective sequences.

In line with the conventional chronologies, earlier proposals in Armenia were also working within a normative three-fold system. Combined stratigraphic information from Mokhrablur and Shengavit contributed to defining a canonical order, whereby the Elar-Aragats group was assigned to KA I, the Shresh-Mokhrablur to KA II, and the Karnut-Shengavit to KA III.[57]

In terms of ^{14}C dates, until the late 1990s chronometric datasets from KA sites in Armenia essentially included few readings from Shengavit and Mokhrablur. As mentioned earlier, new, though still isolated, ^{14}C dates appeared between this period and the early 2000s (i.e. Horom, Aparan III, Talin, Karnut), while a substantial corpus of ^{14}C dates has since been produced within the scope of Project ArAGATS.[58] New stratigraphic and chronometric information uncovered at Gegharot, in particular, served as the basis for adjusting the dating of the Karnut-Shengavit complex and re-assessing the ambiguous ^{14}C dates obtained from the early excavations at Karnut.[59] The occupation at Gegharot is characterized by early Elar-Aragats and late Karnut-Shengavit ceramic repertoires, thus confirming the general stratigraphic order of these groups. However, the extensive dating program carried out at the site revealed the chronometric overlap between the Karnut-Shengavit and the Shresh-Mokhrablur ceramic complexes, which had previously been considered as sequential and mutually exclusive chrono-cultural stages of the KA culture.[60] It was also noticed that a hiatus separated the Elar-Aragats and the Karnut-Shengavit occupations at Gegharot.[61] These observations prompted a rethinking of the KA periodization both in chrono-cultural and interpretative terms, as exemplified by the elaboration of the two-fold system.[62] The latter describes an early phase of 'homogeneity' (KA I), represented by the geographically ubiquitous Elar-Aragats ceramics and dated to 3500/3350-2900 BCE, and a late phase of 'heterogeneity' (KA II), represented by the geographically specific ceramic groups of Karnut-Shengavit and Shresh-Mokhrablur,[63] dated to 2900-2600/2500 BCE. The Ayghum-Teghut and Aygavan-Shengavit complexes are also thought to belong to this period by virtue of their regionality, and the same has been postulated for the Shida-Kartli, Yanik Tepe, and Khirbet-Kerark variants in Georgia, Iran, and the Southern Levant.[64]

Chronometrically, the two-part system does not contradict the overall 3500-2500 BCE proposed for the KA culture within the three-part system, but it does emphasize the 'break' in the radiocarbon distributions around 3000/2900 BCE, which marks the cut-off point between the KA I and KA II phases and, hence, the transformation from

[57] Badalyan *et al.* 2009: 42.
[58] Smith *et al.* 2009; Manning *et al.* 2018.
[59] Badalyan *et al.* 2008: 89f., see Table 1.
[60] Badalyan *et al.* 2009: 49-51.
[61] Badalyan *et al.* 2008: 49.
[62] Badalyan 2014.
[63] Based on the ^{14}C dates partially released in Badalyan 2014.
[64] Badalyan 2021: 219.

homogeneity to heterogeneity.[65] This is important, because it relies on the precision of ^{14}C calibration to fix a chrono-cultural change (see below). The two-part system also highlights the importance of hiatuses occurring between early and late material assemblages at rare multi-layered KA sites, thus contributing to the 'discreteness' of the KA phenomenon, by which Badalyan refers to the tendency of KA occupations to be represented by only one ceramic assemblage.[66] The maximum threshold for the beginning of the KA I phase is fixed around 3500 BCE according to two ^{14}C dates from Jrvezh/Avan, which, according to Badalyan[67] resembles similar material dated to the same period at Mentesh Tepe.[68] It should be noticed that Badalyan has suggested the possibility of subdividing the KA I phase into subphrases Ia, Ib, Ic based on ^{14}C and changes in ornamentation patterns.[69] This partially aligns with typological considerations brought forward by Palumbi.[70]

A comparative picture: how radiocarbon informs the discrepancies between the two periodization systems

The three-part and the two-part systems are the two prevailing periodization schemes proposed for the study of the Kura-Araxes culture to date.[71] Despite the attainment of new ^{14}C datasets, scholars have maintained different approaches to defining its internal stages.[72] Former proponents of the three-part system now appear to have embraced the two-part proposal,[73] and more scholars have been persuaded to adopt the framework proposed by Badalyan following a symposium held in Toronto in 2015.[74] In his latest work, while recognizing the existence of the two systems, Sagona[75] remarked on the importance of 2900 BCE as a 'watershed in the Kura-Araxes tradition' that marks the stage of expansion and regionalization within and outside the South Caucasus, as described in Badalyan's proposal. However, Sagona maintained 3300 BCE as the distinctive threshold between the earliest and the later settlements, as well as ceramic styles,[76] a date more reminiscent of the three-part system.[77] Furthermore, scholars focusing on the Kura-Araxes tradition in Iran, although they now generally align the first two phases with Badalyan's

[65] Badalyan 2021.
[66] Badalyan 2021: 225.
[67] Badalyan 2014: 79.
[68] Lyonnet 2014.
[69] Badalyan 2014: 79.
[70] Palumbi 2008: 43.
[71] Sagona 2018: 224-226.
[72] See Palumbi, Chataigner 2014: 248, Figure 1.
[73] E.g. Palumbi 2016.
[74] Batiuk *et al*. in press, see also Rothman 2021: 52.
[75] Sagona 2018: 228.
[76] Sagona 2018: 228-231, 253-261.
[77] However, much like in Sagona 2014: 29, there is no explicit reference to a 'KA III' phase.

<table>
<tr><th>Years BCE</th><th>Palumbi 2008</th><th>Badalyan 2014</th></tr>
<tr><td>3500</td><td rowspan="3">KA I</td><td rowspan="7">KA I</td></tr>
<tr><td>3400</td></tr>
<tr><td>3300</td></tr>
<tr><td>3200</td><td rowspan="5">KA II</td></tr>
<tr><td>3100</td></tr>
<tr><td>3000</td></tr>
<tr><td>2900</td></tr>
<tr><td>2800</td><td rowspan="5">KA II</td></tr>
<tr><td>2700</td><td rowspan="4">KA III</td></tr>
<tr><td>2600</td></tr>
<tr><td>2500</td></tr>
<tr><td>2400</td></tr>
</table>

Table 2. Comparison between the three-part (Palumbi 2008) and the two-part system (Badalyan 2014).

chronology, also recognize a third phase of transformation labeled as KA III, dating from 2700-2600 to 2400 BCE.[78]

In absolute terms, Badalyan's KA I phase overlaps with the KA I and part of the KA II phase as defined in the three-part system, while Badalyan's KA II phase overlaps with part of the KA II and the KA III as defined in the three-part system (Table 2 and Figure 1). These offsets are the direct result of the approaches to material phylogeny that underlie the two proposals, which are ultimately related to the different meanings assigned to tangible changes in the ceramic record (i.e. the chronological value of the red-black bichromy). At the same time, a closer look at the nature of the radiocarbon dates reveals complications in the definition of chrono-cultural boundaries in both systems, whether proceeding from the materials to the dates, or from the dates to the materials (Figure 1). This is because the period between 3500 and 2500 BCE is characterized by plateaus and reversals that compromise the precision of ^{14}C calibration in isolation.[79] In essence, ^{14}C dates drawn from this period calibrate to the span of a few hundred years and are statistically indistinguishable based on the calibrated radiocarbon age, thus making it difficult to discern continuity from change. Such calibration issues impact both periodization systems. The only exception is the 3000-2900 BCE range, which corresponds to an area of high precision on the calibration curve. It should be noticed that this period was also most likely characterized by a marked climate change, seen as a major 'slope' in the ^{14}C curve (Figure 1): this slope signals an increase in ^{14}C production linked with a decrease in solar activity, which

[78] Maziar 2019: 55, Table 3.

[79] Taylor *et al.* 1996.

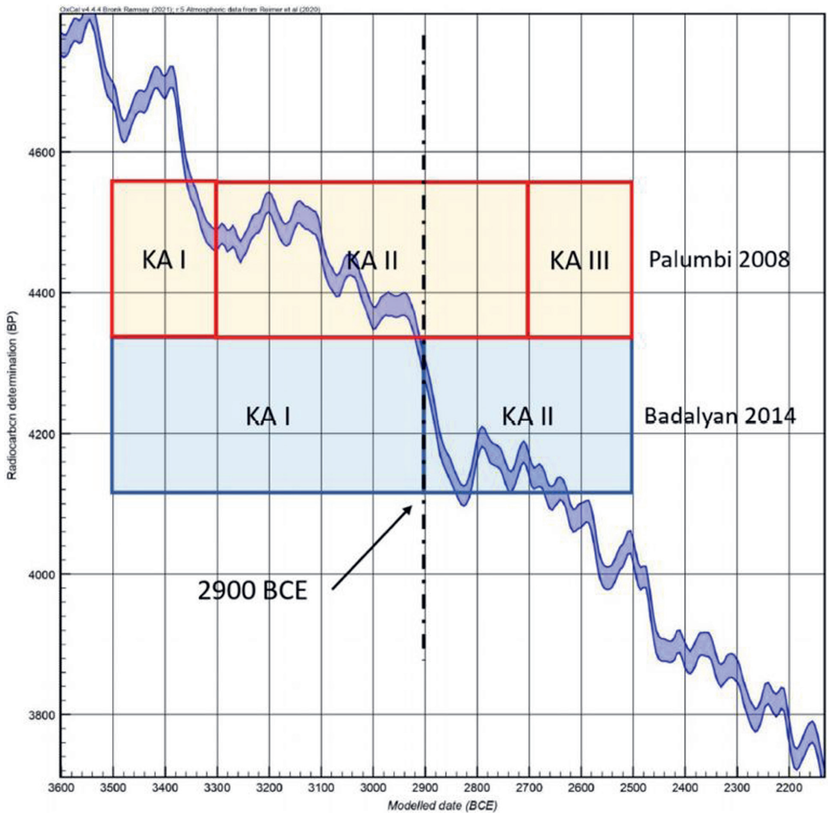

Figure 1. The three-fold (Palumbi 2008) and the two-fold (Badalyan 2014) periodization plotted on the ^{14}C calibration curve. The 'steep' shape of the curve around 3000-2900 BCE indicates a period of increased production of atmospheric ^{14}C (associated with a Grand Solar Minimum), which results in much tighter resolution in terms of calibration. Note how the 'wiggles' between 3500-2900 and 2900-2500 BCE dilate the calibrated span of ^{14}C dates from these periods (see also Figures 2-4).

regulates the production of ^{14}C in the atmosphere.[80] It is, therefore, possible that the cultural changes observed around 2900 BCE across the KA culture were linked to a response to climatic fluctuations expressed, among other things, as settlement reorganization.

As explained above, the three-part system focuses on the RBBW as the hallmark of the KA culture and employs it as a chronological marker to track the development of the KA through time.[81] Palumbi[82] already noted limitations in his demarcation of

[80] See Eddy 1977.

[81] In Passerini *et al.* 2018 we also attempted a chrono-cultural synthesis following Palumbi's (2008) original proposal. However, the results highlighted regional discrepancies and, ultimately, questioned the usefulness of this material trait as a marker for a 'universal' KA chronology.

[82] Palumbi 2008: 205.

KA II by association with the RBBW, particularly since the latter occurs in the same contexts alongside MW or BBW, or both (as is the case at Sos Höyük VA). Hence, relative frequency is often employed to discern the chrono-cultural affiliation of analyzed contexts based on 'rare' or 'widespread' occurrence of a ceramic type, which, in some cases, introduces ambiguity. For example, Palumbi assigns the ceramic repertoire of Aparan III to the KA II phase despite being characterized for the most part by MW,[83] while he assigns Didube, also characterized by mostly MW and rare RBBW, to the KA I phase.[84] Presumably, Palumbi drew this distinction based on the fact that the Aparan III dates include a younger range closer to 2900 BCE, which overlaps with Horom. However, the raw ^{14}C dates associated with Didube and Aparan overlap and are not easily discernible based on their calibrated radiocarbon age alone (Figure 2).

Even more concerning is the interpretation of level VA at Sos Höyük. This level, which Sagona originally assigned to the Late Chalcolithic period following the Anatolian chronological conventions,[85] comprises distinct stratigraphic occupations that are synchronized within the range 3500/3350-3000 BCE. This corresponds to the range of Badalyan's KA I phase (Figure 2). Stratigraphically, Sos level VA, characterized by the presence of a massive stone wall, can be distinguished between a pre-wall and a post-wall phase that followed the collapse of the original structure.[86] Following Palumbi's[87] analysis on the ceramic repertoire, Sagona[88] proposed an updated chrono-cultural interpretation of Sos VA, whereby the single ^{14}C date from the exploratory sondage in L17/M17 (pre-wall phase) have been assigned to the KA I phase due to the presence of both LC Sioni and early KA pottery, and the dates from the so-called *Ceramic Floor* and *Round House* have been assigned to the KA II phase in relation to the appearance of fully formed RBBW.

Some contradictions arise when closely analyzing the interpretation of the ^{14}C dates associated with the Sos VA contexts. Sagona placed the collapse of the wall around 3100 BCE based on the lower end of the distribution of the dates associated with the stratigraphically successive *Ceramic Floor* and *Round House*,[89] when this distinction cannot be justified by ^{14}C ranges, which are ambiguously scattered between 3500/3350 and 3000/2900 BCE due to calibration noise (Figure 3 and 4). In fact, the synchronization of these contexts within a 'level VA' phase at the site reproduces the tendency of ^{14}C during this period to calibrate and overlap in the order of a few hundred years. When taken in isolation, these ^{14}C dates appear to spread out the upper and lower boundaries of the phase or phenomenon under study, giving an illusion of longer duration. One way to smooth the calibration noise to look at the underlying distribution of a ^{14}C dataset without a stratigraphic model is to perform a Kernel Density Estimation

[83] Palumbi 2008: 188f.
[84] However, in Sagona 2014: 29 Didube is listed as a KA II site.
[85] Sagona 2000.
[86] Sagona and Sagona 2000: 58-63.
[87] Palumbi 2003; *idem* 2008.
[88] Sagona 2014: 29.
[89] Sagona 2014: 40.

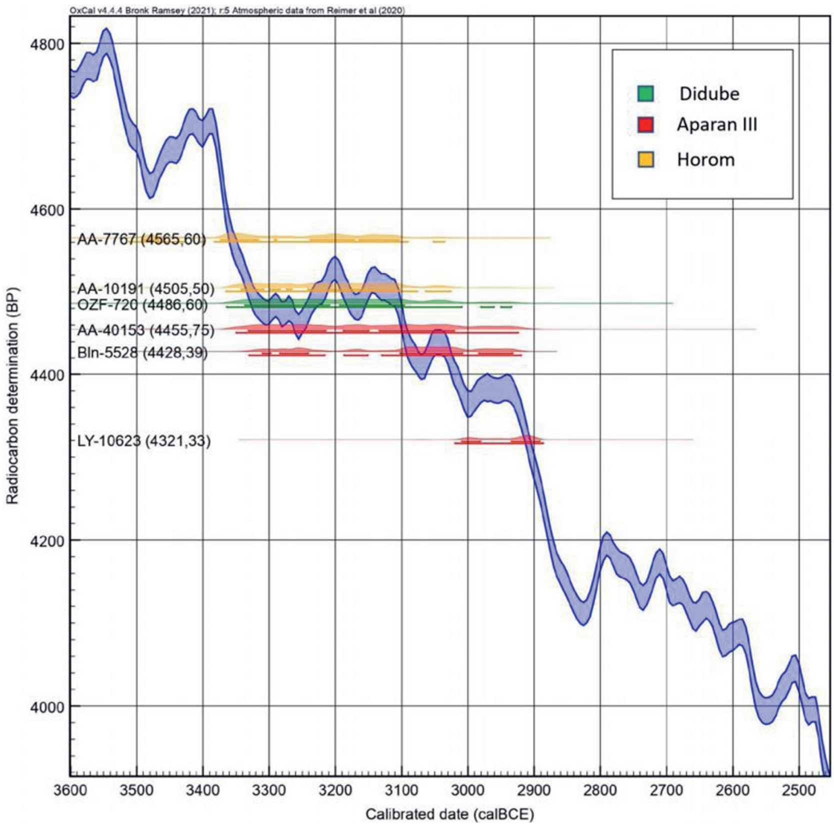

Figure 2. Curve plot showing the distribution of calibrated ^{14}C dates from Didube, Horom, and Aparan III.

model (KDE).[90] The results of a KDE model are essentially a summary plot that displays the distribution of ^{14}C-dated events without the noise of individual calibrations. A KDE model performed on the Sos VA dataset (Figure 5) shows that, overall, the ^{14}C-dated activity related to Sos VA span *c.* 3360-3040 BCE and little dates to 3500-3360 BCE, a trend that Sagona[91] also noted for the entire unmodelled corpus of the earlier phases of the Kura-Araxes culture. The chronological 'stretch' towards the 3500 BCE higher threshold for the beginning of the KA occupation at Sos (thus KA I) is represented by a single ^{14}C date from the exploratory sounding (Beta-120452).[92] New dates[93]

[90] Bronk Ramsey 2017.

[91] Sagona 2018: 227.

[92] Note that in Sagona 2014: 39 date Beta-107910, which covers the first half of the 4th millennium, is listed as Sos VA, but was previously published as belonging to Sos VB along with Beta-107909 and Beta-107908.

[93] However, it should be noted that dates Beta-107908, Beta-107909, Beta-107910 (the latter covering the first half of the 4th millennium BCE with a considerable uncertainty) had been previously published as belonging to VB.

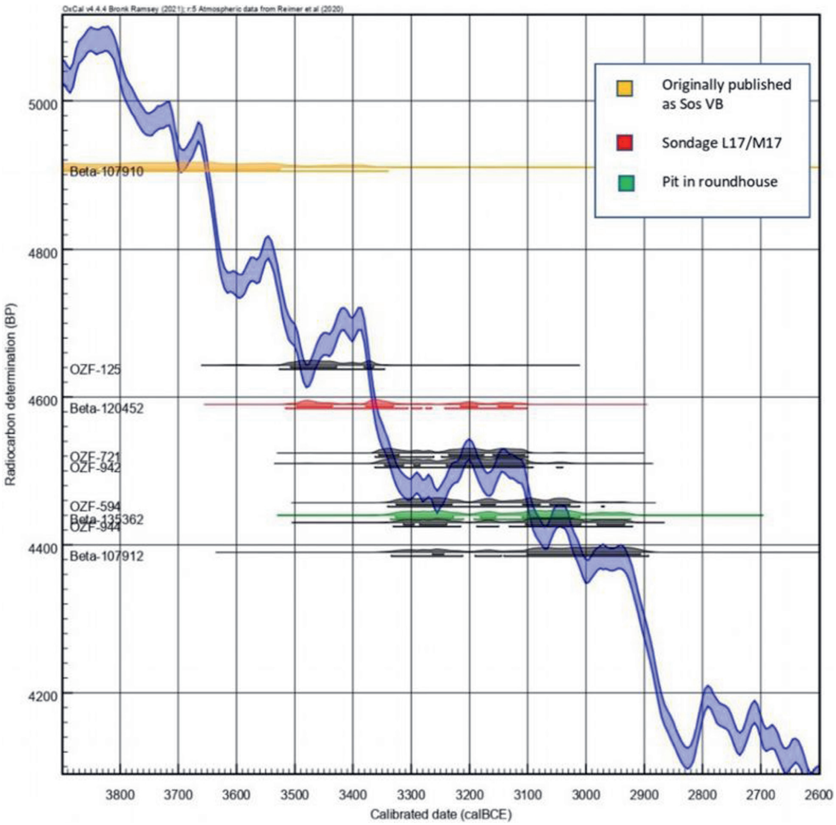

Figure 3. Curve plot showing the distribution of calibrated ^{14}C dates from Sos Höyük VA, with indication of the archaeological contexts mentioned in the text.

associated with VA are listed in Sagona 2014: 39, but their arrangement in order of radiocarbon age fosters an illusion of continuity, regardless of their stratigraphical position.[94]

A persuasive reason for the separation of the 3500/3350-2900 BCE range among the supporters of the three-part system is the postulation of the existence of a 'Proto-Kura-Araxes' (Proto-KA) phase linking the Late Chacolithic and the Early Bronze Age. This proto-KA phase has been defined archaeologically based on the occurrence of pottery foreshadowing 'typical' characteristics of the KA repertoire at both Sos Höyük VA and Berikldeebi V before the widespread presence of KA assemblages across the South Caucasus.[95] However, the chronological placement of the Proto-KA is rather elusive. The single date from the Late Chalcolithic occupation

[94] For instance, date OZF-125 associated with locus 3770 is stratigraphically later than Beta-120452, which was sampled from the sondage in L17/M17.

[95] Marro 2009.

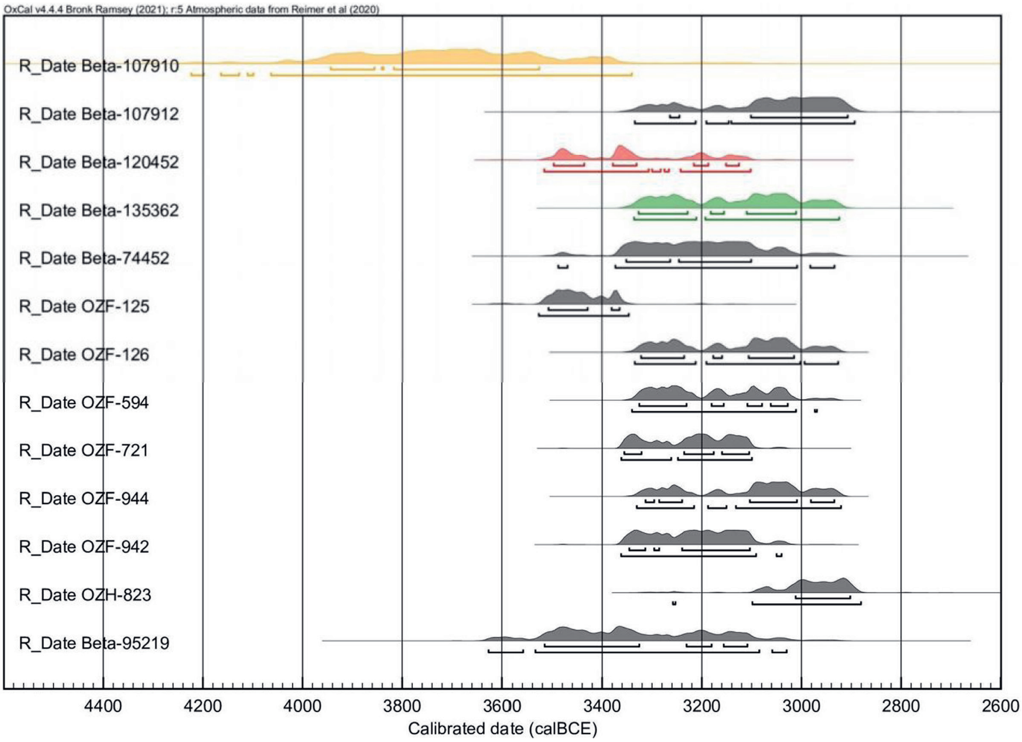

Figure 4. Multiplot of the ^{14}C dates associated with Sos Höyük VA. Note that Beta-107910, discarded due its wide uncertainty, was originally published as belonging to Sos VB, together with Beta-107908 and Beta-107909 (not shown). Date Beta-120452 (red) is associated with the sondage in L17/M17, which yielded stratigraphic evidence of the earliest occupation (Sagona 2000). Date Beta-135362 comes from a pit dug into the Roundhouse (Sagona and Sagona 2000). Dates in grey were published in Sagona 2014 as belonging to Sos VA, although without specific descriptions of their contexts and stratigraphic position.

of Berikldeebi V1 (OZE-595)[96] has been overly stressed as evidence for the existence of the Proto-KA phase due to the presence of pottery resembling MW, even though, as noted in Palumbi and Chataigner,[97] the definition and chrono-cultural interpretation of these ceramics is problematic due to both their scarce presence and ambiguous stratigraphic attribution. Arguments in favor of a Proto-KA phase[98] have been based primarily on the evidence from the later occupation of Berikldeebi IV, characterized by typical MW production and dated to *c.* 3600 BCE according to a single ^{14}C determination (LE-2197).[99] Given this early chronological threshold and the clustering of the KA II dates around 3300 BCE, the KA I phase is assumed to

[96] Kiguradze, Sagona 2003.

[97] Palumbi, Chataigner 2014: 247 and n. 1.

[98] E.g. Rova 2014.

[99] Kiguradze 2000.

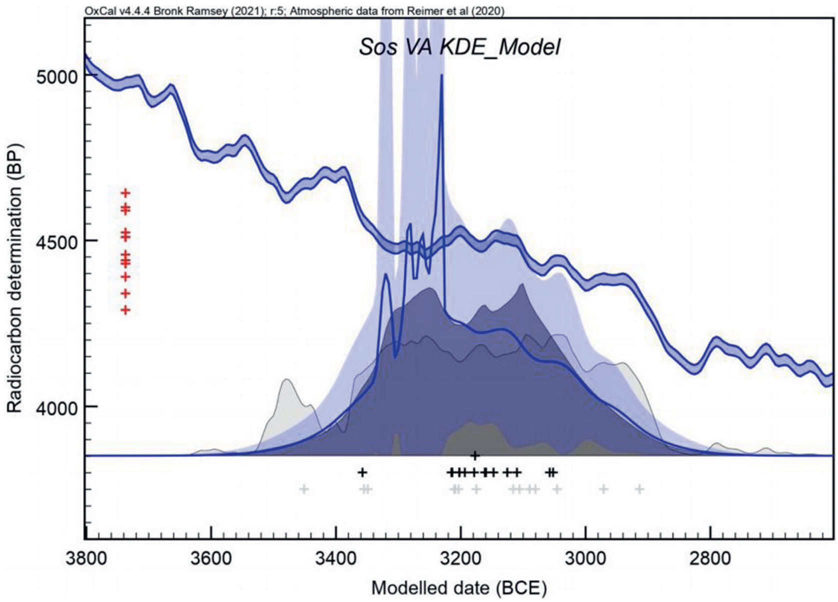

Figure 5. Kernel density estimate summarizing the ^{14}C dates from Sos Höyük VA using the OxCal function KDE_Model (Bronk Ramsey 2017). The KDE Model function creates a summed plot showing the underlying distribution of ^{14}C dates in a dataset and that is less sensitive to the 'noise' created by calibration ambiguity. Red crosses (left) show median uncalibrated ^{14}C ages. Black crosses (below) show the median calibrated ^{14}C ages after KDE modeling, grey crosses (below) show the median calibrated ^{14}C ages before KDE modeling. The plot shows that the median calibrated ^{14}C ages from Sos VA span *c.* 3360-3060 BCE and that little is dated before 3400 and after 2900 BCE.

run continuously between these 3600 and 3300 BCE, although occupations that are ^{14}C-dated to this period are scarce.[100] It should be noticed that the reliance on a single ^{14}C date to date a phase or occupation is very unsatisfactory according to modern standards for good radiocarbon practice. In the absence of a wider ^{14}C dataset, it is not possible to test how representative single dates are of the event or activity and, therefore, how robust the association is between samples and target events. Issues of association are further exacerbated when dating material that is loosely associated with the archaeological unit of interest. This is very much the case for undetermined charcoal affected by in-built age ('old-wood effect'):[101] fragmentary charcoal that comes from heartwood (the innermost tree-rings) will provide a date that is older than the felling event most likely associated with its use at an archaeological site. In the case of long-lived species, this offset may be of a few hundred years. Unless properly determined, these samples will provide a date much older than the archaeological unit or event of interest.

[100] Sagona 2018: 227.

[101] See Schiffer 1986.

As for what concerns the two-part periodization,[102] the distinction between phase KA I and KA II reflects the separation in areas of the calibration curve overlapping with the Kura-Araxes period, which present a clear divide around 3000/2900 BCE (Figure 1). The order of the ceramic assemblages associated with each phase, which are geographically specific, is discerned from local stratigraphy, and particularly based on the combination of materials and ^{14}C dates observed at Gegharot,[103] but also as formerly deducted from the stratigraphy of Mokhrablur and Shengavit. As such, this system focuses more on the spatio-temporal specificity of material assemblages, rather than adopting a 'transversal' look that collates chronometric information tied to single material categories across the South Caucasus (e.g. the RBBW) as in the three-part system, whereby entire chrono-cultural phases are essentially derived as postulations moving backwards or forward from a 'core' ^{14}C-dated phase.

The attention to 'whole' assemblages, rather than isolated characteristics of ceramics (e.g. the red-black bichromy), also demonstrates greater concern for the 'life of settlements' over the 'life of materials'. However, where the three-part system privileges chronological continuity as discerned from interpretations of ceramic assemblages (with types following one another in a historical continuum linking the Late Chalcolithic and the Bronze Age),[104] the two-part system may have overplayed the concept of synchronicity on the order of several hundred years as an effect of ^{14}C calibration ambiguity. In other words, the large, calibrated spans of the ^{14}C datasets that characterize the two KA phases may mask finer sub-periods or changes that may break with the postulated synchronic 'homogeneity' of the Elar-Aragats horizon or may obscure finer diachronic processes at play in the synchronic 'heterogeneity' of the later KA horizons. For instance, Badalyan[105] has noted that, despite their morphological homogeneity, the Elar-Aragats materials display differences in ornaments and production techniques, thus identifying sub-groups that are not represented altogether at every KA I site. This observation, in addition to corroborating the 'discrete' character of the KA phenomenon, suggests that further chronological investigations within the KA I phase may reveal finer and more complex dynamics in the making of the Kura-Araxes horizon during the early stages of its existence. Nevertheless, the two-fold system rightfully highlights the importance of 3000-2900 BCE as a chronological threshold in the KA horizon (Figure 1), marking macro chrono-cultural changes seen in settlement life and material developments. Badalyan's proposal also pays attention to the specificity of settlement occupations, especially as regards their nature as single-layered (intended as ceramic horizon) sites and the presence of hiatuses in case of multi-

[102] Badalyan 2014.
[103] Smith *et al.* 2009.
[104] Particularly notable are the cases of Ovçular Tepesi, where the excavators (Marro *et al.* 2014) claim to have identified an earlier example of RBBW dated to the 5th millennium BCE, and that of Sos Höyük VD-IVB, where Sagona (2000) identified a late KA production known as 'Late Gritty' dated to the 2nd millennium BCE.
[105] Badalyan 2018: 52.

layered settlements.[106] This consideration for the contingencies of settlement life also allows for a normalization of periods of inactivity and gaps in the two-fold periodization, whereas the three-part system assumes continuity based on a continuous understanding of material phylogeny, even in cases where evidence for the continuity of settlement life is not available.

Discussion

The discrepancies between the three-part and the two-part periodization systems proposed for the Kura-Araxes culture cannot be reduced simply to an issue of chronometry. As demonstrated above, the increase in the quality and quantity of ^{14}C dates over the last two decades, while clarifying the overall temporal extent of the KA phenomenon, has not solved the residual problems of chrono-cultural interpretation. It should be acknowledged that Palumbi's re-articulation[107] of the three-part system was based on relatively few new ^{14}C dates. However, even in the presence of more extensive and contextualized ^{14}C datasets, scholars continue to be divided in their periodization choices,[108] with an overall preference for the three-part system, as most evident in Sagona's recent synthesis.[109] In radiocarbon terms, the two periodization schemes refer to the same chronometric background, but in chrono-cultural terms they advance very different readings of the archaeological record, particularly as it regards questions of temporal continuity or discontinuity and the interpretation of their material correlates.

On the one hand, the three-part system proposes a historicist view of the Kura-Araxes phenomenon that describes it as a cycle of rise, fluorescence, and fall, and which reproduces the structure of a closed explanatory 'narrative' typical of tripartite chronologies.[110] This narrative is focused around the 'typical' red-black bichromy, around which an assumed earlier and later phase display either archaic or later features connecting the central phase with the immediate pre-KA and post-KA periods. In that sense, it is no accident that a 'Proto-KA' phase embedded in the Late Chalcolithic has been suggested in the framework of the tripartite sequence, but not the two-part system. As noted above, this has led scholars to 'stretch' the chronometric evidence in favor of a Proto-KA and pre-3300 BCE KA I phase even when scarcely substantiated by the ^{14}C record. On the other hand, the two-fold system adopts an 'open look' at materials, where the directionality of change in the ceramic assemblage is dictated by their stratigraphic information, and it privileges the potentially discontinuous 'life of settlement' over the presumed continuity of the 'life of materials'. This system also integrates regional aspects and spatial

[106] Badalyan 2014: 87.
[107] Palumbi 2008.
[108] See Palumbi, Chataigner 2014: 248, Figure 1.
[109] Sagona 2018.
[110] Lucas 2005: 50-52.

thinking with chronology building. Since the two-part system does not proceed from the isolation of a single material hallmark to track 'precocious' or derivative forms relatively to a core material phase, it does not require the postulation of intermediary ('proto') stages. This is also why the two-part proposal is more accepting of periods of inactivity and chronological gaps in local and regional sequences, as demonstrated by the attention for hiatuses and breaks (particularly around the 2900 BCE threshold) in the regional periodization.[111]

The three and two-part systems also demonstrate different approaches to chrono-cultural continuity and discontinuity. The formulation of a 'Proto-KA' phase and a 'pre-RBBW' (KA I) phase within the tripartite system evidences an abiding concern to link the Kura-Araxes phenomenon to Late Chalcolithic antecedents. Hence, discussions of the 'origins' of the KA have emphasized the exceptionality of Sos Höyük and Berikldeebi[112] as multi-level sites with uninterrupted sequences from the Late Chalcolithic through the Iron Age. Although some scholars have cast doubts on the statistical significance of the 'Proto-KA' wares in level V at Berikldeebi,[113] the presence of a KA occupation on top of a LC level, marked by Syro-Mesopotamian influences, is regarded as an important case of chrono-cultural continuity despite the scarcity of ^{14}C dates.[114] At Sos Höyük VA, the co-presence of LC Sioni wares and KA wares has also been regarded as compelling evidence for the Late Chalcolithic origins of the Kura-Araxes.[115] At the same time, these accounts note the rarity of continuous LC-KA occupations at the same site, as well as the overall stark differences in ceramic traditions, architecture, and settlement patterns between the LC and KA complexes.[116] Aside from the question of Proto-KA wares, at Berikldeebi the superposition of the KA on top of LC occupation is assumed to represent chrono-cultural continuity, even though the KA represents a cultural break with former traditions. At Sos Höyük VA, the first unambiguous KA occupation (i.e. *Ceramic Floor* and *Round House*) only appears after the destruction of the Late Chalcolithic (pre-KA) wall,[117] marking a significant break between LC and KA occupations. In general, a break with LC traditions appears to be the prevailing pattern behind the emergence of KA settlements during the 4th millennium BCE across the South Caucasus,[118] suggesting that discontinuity rather than continuity should be the primary chrono-cultural scaffolding shaping KA periodizations.

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111 Badalyan 2014: 87.

112 Extreme positions have also suggested the existence of a Late Chalcolithic RBBW at Areni-1 (Wilkinson *et al.* 2012) and Ovçular Tepesi (Marro *et al.* 2014).

113 Palumbi, Chataigner 2014: 247.

114 E.g. Palumbi 2008: 45; Rova 2014; Sagona 2018: 228.

115 Kiguradze, Sagona 2003.

116 Palumbi, Chataigner 2014: 249; Sagona 2014: 40.

117 Sagona, Sagona 2000: 59f.

118 Palumbi, Chataigner 2014: 249 and Figure 1. For instance, a hiatus between pre-KA and KA occupations has been noticed at Kültepe I (Sagona 1984: 59), Mentesh Tepe (Lyonnet 2014), and even Ovçular Tepesi (Marro *et al.* 2014).

The two-part system highlights the discreteness of the Kura-Araxes phenomenon, as demonstrated by the occurrence of single-layered occupations at most sites, and the presence of hiatuses separating different ceramic complexes in the case of a handful of multilayered settlements.[119] Even within the KA I phase in Armenia, the discreteness is such that not all the elements of the Elar-Aragats complex are represented altogether within the KA I occupations.[120] Hiatuses between KA I and KA II material complexes have been observed at Gegharot,[121] but are also potentially evident in several stratified sites traditionally referenced for continuous relative chronology, such as Mokhrablur.[122] It should also be noted that the recent stratigraphic refinement of Gegharot by means of Bayesian chronological modeling has enabled further insights into the broad settlement patterns of the KA, as seen, for instance, in the chronological alignment of single-layered early KA occupations in Georgia (e.g. Chobareti) with the pre-hiatus occupation of Gegharot, but not the post-hiatus stratum.[123] Macroscopically, the two-part periodization highlights 2900 BCE as a stark chrono-cultural demarcation in the development of the KA phenomenon,[124] which, despite being a point of ^{14}C calibrated precision, is obscured by the structure of the three-part system (see above). Hence, the two-part system allows archaeologically observable breaks in settlement life to trump theoretical assumptions of material continuity. This is also why this proposal has been more open to accepting a variegated image of the KA development, whereby local expressions may not necessarily respond to a universal periodization. Moving back to ceramic-based chronologies and keeping in mind that the life of materials may not necessarily overlap with the life of settlements, an approach based on presence/absence and not frequency, as in the three-part proposal, appears to be more suitable for the discrete character of the Kura-Araxes, especially thanks to its attention for matters of spatial peculiarity through time.

On a final note, the chronometric limitations of the two-part periodization related to the ambiguity of ^{14}C calibration between 3500 and 2500 BCE pose issues of interpretation on a large scale. In a recent contribution, Rothman extended Badalyan's proposal beyond Armenia to the rest of the Kura-Araxes world.[125] Certainly, the precision achievable around 3000-2900 BCE is an important element in distinguishing broad changes in settlement and material patterns, as also extensively discussed by

[119] Badalyan 2021: 224f.

[120] Badalyan 2018: 52.

[121] Manning *et al.* 2018: 1534.

[122] Areshian, Ghafadaryan 1996. Interestingly, Summers (2014: 148) suggested the presence of a hiatus at Yanik Tepe separating what he refers to as the ETC II and ETC III phases, marked by stark differences in architectural traditions. Since the ETC/KA III appears to be an extension of the KA phenomenon in northwestern Iran (Maziar 2019: 55), the evidence at Yanik Tepe may suggest discreteness even in the final dissolution/transformation of the KA after 2500 BCE.

[123] Manning *et al.* 2018: 1534.

[124] Badalyan 2021: 228.

[125] Rothman 2021.

Badalyan in terms of transformation toward heterogeneity and regionalization.[126] However, as demonstrated by the recent work at Gegharot,[127] the chronometric imprecision that affects the period before and after 3000-2900 BCE considerably inflates the perceived duration of site sequences. This, in its turn, may encourage comparisons based on a faulty perception of 'contemporaneity' at various scales, and erroneously stretch questions centered around the origin and end of archaeological phenomena and the directionality of their diffusion. While defining the overall chronological boundaries of the KA phenomenon has been an important step, a closer attention to the 'life of settlements' over the 'life of materials' through a careful application of Bayesian chronological modeling can help highlight important nuances in the unfolding of Kura-Araxes life in the South Caucasus at specific places and at specific times.

Conclusions

The three and two-part periodizations proposed for the Kura-Araxes culture result from a complex interplay between the archaeological and the radiocarbon evidence. Although radiocarbon dating has helped reorient studies in the KA culture, the ambiguity of calibration has introduced complications in chronological interpretation which limit the ability to compare and contrast KA developments at and across various temporal and geographical scales. The two-fold proposal cleverly highlights the importance of breaks and discontinuity in the understanding of the Kura-Araxes phenomenon, and rightfully identifies a macroscopic watershed in KA tradition around 2900 BCE. Furthermore, the focus of the two-part periodization on geographic variation opens important new opportunities for Bayesian chronological modeling to disclose finer patterns of chrono-cultural development that depart from traditional historicist models of the 'life of materials'. Badalyan's approach to periodization thus represents an important opportunity to examine not just the KA materials, but the 'life of settlements'.

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[126] Badalyan 2021.

[127] Manning *et al.* 2018.

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